



Tamale Water Supply Scheme

Tamale Environmental and Social Impact Assessment

Non-Technical Summary

Biwater International Limited

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1. Introduction

Overview

This document is the Non-Technical Summary (NTS) of the Environmental and Social Impact Assessment (ESIA) for the Tamale Water Supply Scheme in the Northern and Savannah Regions of Ghana (the Project). The Ghana Water Company Limited (GWCL), the Government utility supplying water services to the population of Ghana, is proceeding with a water treatment plant (WTP) at Yapei, that will transmit treated water to Tamale, Damongo and surrounding communities. This NTS describes the Project design and the potential impacts (both positive and negative) it may have on the environment and on people. It also addresses the mitigation measures that will be implemented during the Project's construction and operation phases, to reduce negative impacts and enhance potential positive impacts.

Box 1. Project proponents and ESIA Team

Biwater International Limited (Biwater), a wholly owned, UK registered company that designs, constructs and operates water and wastewater infrastructure, has developed the Project on behalf of the GWCL through a Project Contract Agreement.

WS Atkins International Limited (Atkins) has been appointed by Biwater to deliver the ESIA's for the Project. Atkins prepared the ESIA's with support from FANPAG and Synergy in Ghana.

The Project is seeking funding from the United Kingdom Export Finance (UKEF), and as such is subject to the Environmental and Social requirements of the UKEF. The Project will also require an Environmental Impact Assessment (EIA) permit from the Ghana Environmental Protection Agency (EPA) and therefore, is also subject to Ghana EIA legislative requirements.

The Project

The Tamale Water Supply Scheme comprises a river intake on the White Volta River, water treatment plant (WTP) with ancillary infrastructures at Yapei, treated water transmission main to Tamale, new storage reservoirs at the existing reservoir sites at Bagabaga and Kaladan to supply water into the Tamale primary and secondary distribution system.

In addition to the main WTP and transmission to Tamale, this Project will also include a new water transmission main from the WTP to Damongo, via Busunu, and associated infrastructure.

The Project also includes the implementation of Water Asset Management (WAM) techniques, together with the construction of primary and secondary distribution network expansion with Tamale. The WAM requirements, however, will not be determined in detail until the Construction Phase of the Project.

See Box 2 below for more details.

Box 2. Key project infrastructure

Tamale Water Supply

- Raw water intake pump station on the White Volta River at Yapei (135 megalitres per day (MLD))
- Yapei WTP will include:
 - Aerator, clariflocculators, rapid gravity filters, chlorine contact / balance reservoir, chemical and chlorine buildings, elevated service water holding tank and sludge lagoons
 - Administration / workshop building, laboratory and workers' living accommodation
 - Treated water pumping station
- Treated water transmission pipeline between Yapei WTP and Tamale plus water supply feed to Kusawgu elevated storage reservoir and water dispenser kiosks
- New storage reservoirs at existing reservoir sites at Bagabaga and Kaladan
- Electricity power supply to the WTP, existing water treatment plant at Dalun and existing Bagabaga and Kaladan reservoir sites.

Damongo pipeline

- Treated water transmission pipeline between Yapei WTP and Damongo
- Elevated storage reservoir, pumping station and re-chlorination facility at Busunu
- Ground level storage reservoir, pumping station and re-chlorination facility at Damongo
- Distribution of water to local villages between Yapei WTP and Damongo via elevated storage reservoir and water dispenser kiosks
- Treated water transmission pipeline between Damongo and Mole plus distribution of water to local villages between Damongo and Mole via elevated storage reservoir and water dispenser kiosks.
- Early works water supply to Damongo. Water from Ntereso WTP will be delivered to Damongo via the pipelines mentioned above.

Water Asset Management

- Implementation of Water Asset Management techniques such as leak detection and training, and primary and secondary distribution network expansion in Tamale.

The Project is located across the following sites, as shown in Figure 1 and 2 below:

- Tamale Metropolitan Area (TAMA) in the Northern Region (where Tamale is located);
- Sagnerigu District (which was carved from TAMA and where the Bagabaga reservoir is located);
- Central Gonja District (where Yapei is located); and
- West Gonja District (where Damongo is located).

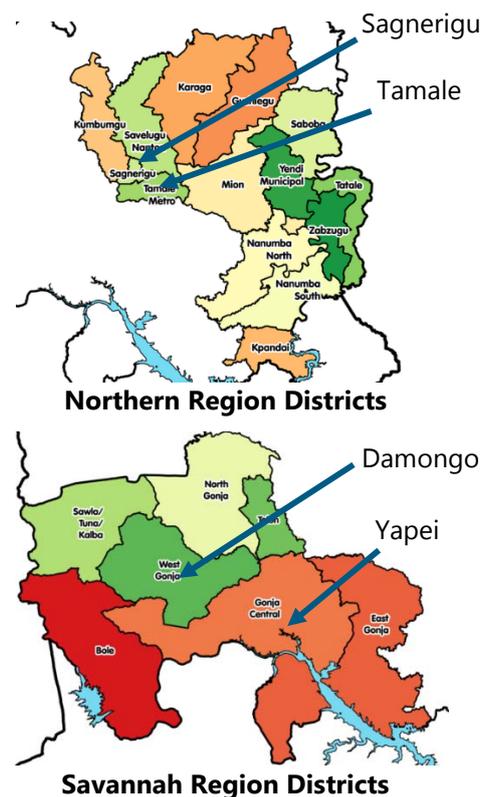
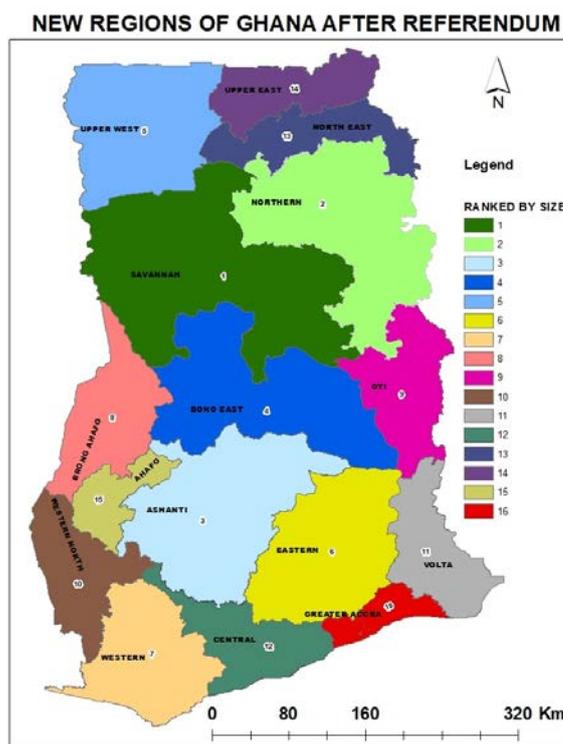


Figure 1. Regions of Ghana in relation to the Project

During construction and operation, temporary and permanent land take will be required. This land acquisition is the responsibility of the GWCL, however where possible Biwater has advised the GWCL in undertaking these activities to international standards.

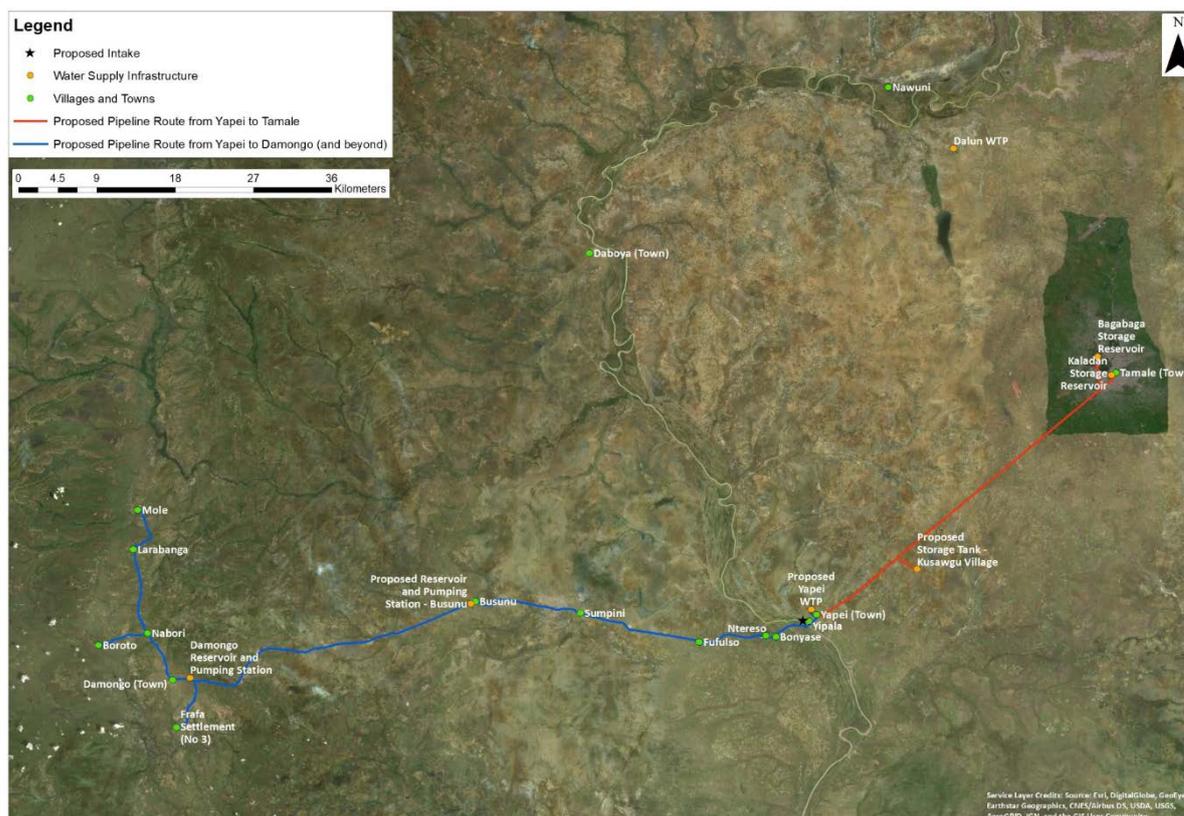


Figure 2. Location of the Project

Need for the Project

Since the inception of the 1972 plant at Dalun, the number of inhabitants in Tamale and its surrounding environs has now grown from 120,000 to a population of over 500,000 in 2020. The Project is therefore needed to address the current shortfalls in potable water supply, meet population growth, and the desire to meet the Ghanaian development goal of expanding access to sustainable water supplies.

According to recent data published by the Ghana Statistical Service the population of Tamale Metropolis is 275,364 people. With an annual population growth rate of 3.5%, the Tamale metropolis is one of the fastest growing cities in Ghana. Given its concentric structure, Tamale is developing in all directions and has become the hub for immigrants from within and outside the Northern Region.

The Ghana Statistical Service 2010 Population and Housing Census – District Analytical Report – Tamale Metropolis published in October 2014 was used along with local knowledge from GWCL to determine the size of the WTP required to meet the needs of consumers to the Year 2040.

According to the 2010 Population and Housing Census, the population of Central Gonja District and West Gonja District were 87,877 and 41,180, respectively. The population for Tamale and its surrounding environs was estimated to be 537,759 (2020) increasing to 854,994 (2040), an annual population growth rate of 2.3%. Based on this, a water demand table was produced taking into account the per capita daily demand, non-domestic demand and non-revenue water reduction to arrive at current water demand, availability and future demand. Based on the estimated population figures, per capita daily demand, non-domestic demand and non-revenue water reduction, a 135 million litres per day (MLD) WTP is required to meet the demands up to 2040.

2. ESIA approach and methodology

The purpose of the ESIA is to: provide a baseline against which Project impacts can be assessed; identify and assess potential negative and positive environmental and social impacts of the Project; determine mitigation measures that will avoid, minimise or mitigate negative impacts and optimise potential positive impacts; inform option selection and Project design; and consult with and obtain feedback from Project stakeholders.

The ESIA has been prepared in accordance with Biwater policies, the Ghanaian regulatory framework, relevant Ghana policies, regulations, legislation (Box 3), international conventions / protocols (to which Ghana is a signatory) and permitting requirements, and the UKEF requirements which are based on international standards (Box 4).

Box 3. National legislation relevant to the Project

Constitution of the Republic of Ghana (1992):

The constitution of Ghana is the supreme law of the country. The 1992 constitution with Amendments through 1996 states in Chapter 6 Section 36 subsection (9) that:

The State shall take appropriate measures needed to protect and safeguard the national environment for posterity; and shall seek co-operation with other states and bodies for purposes of protecting the wider international environment for mankind.

The State is therefore required to implement systems and measures to ensure the protection of the environment for posterity.

Chapter 6, Section 41 of the constitution talks about the duties of the citizen. Subsection (k) states that:

*The exercise and enjoyment of rights and freedoms is inseparable from the performance of duties and obligations, and accordingly, it shall be the duty of every citizen:
(k) to protect and safeguard the environment.*

The citizenry is respectfully required to ensure the protection and safeguard of the environment in their day to day functions. It is the responsibility of project proponents and all others who will be involved in the construction and operation of the Tamale Water Project to ensure the Environment is protected for prosperity. Article 35 subsection 3 of the constitution of Ghana states that:

The State shall promote just and reasonable access by all citizens to public facilities and services in accordance with law.

By this the State owns it a responsibility to ensure that the citizenry have access to those water facilities and services that are created under the Ghanaian Law.

Legal and Regulatory Framework:

- The ESIA for the Project has been undertaken in accordance with the Environmental Assessment Regulations of 1999 (LI 1652) and Appendix 10 of Ghana's Environmental Impact Assessment Procedures 1995

Environmental Guidelines:

- National Environmental Policy (NEP) 2012
- Effluent discharges GS1212-2019
- Ambient Air Quality and Point Source/Stack Emissions GS1236-2019
- Ambient Noise Control GS1222-2018
- Environmental Sanitation Policy (Revised 2009)

Key standards which relate to the water sector:

- National Water policy (NWP) 2007
- Water quality standards – GS 175-1 2013 4th Edition
- Riparian Buffer Zone Policy for Managing Freshwater Bodies in Ghana
- National Drinking Water Quality Management Framework in Ghana

Workplace Safety Policy and Guidelines:

Occupational Safety and Health Policy of Ghana (OHSP) 2014

Box 4. Key international standards relevant to the Project

- World Bank Group Environmental, Health and Safety Guidelines (2007)
- International Finance Corporation Performance Standards on Environmental and Social Sustainability (2012)
- Equator Principles (2013)

Considering the above, the approach and key stages undertaken to prepare the ESIA for the Project are shown in Figure 3.

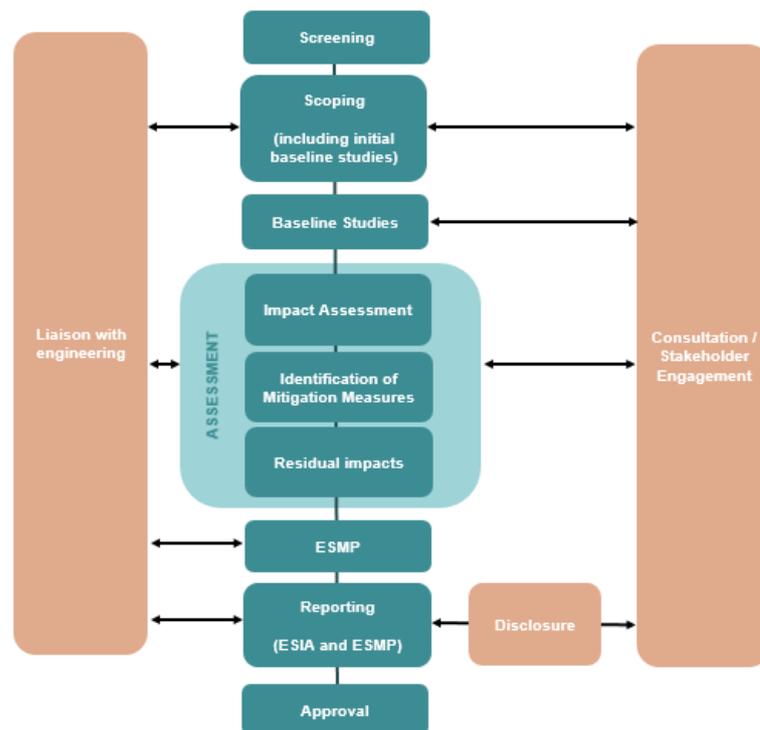


Figure 3. ESIA approach for this Project

Screening

The Project was screened by UKEF and defined as a Category B project. Category B projects are those where potential environmental and social impacts are few in number and site-specific.

Scoping

Prior to the ESIA Report, a Scoping Report was prepared in August 2020. by FANPAG on 24 August 2020 in conformance with the Ghanaian EPA Environmental Assessment Regulations, LI 1652, (1999). The aim of scoping was to identify potential impacts on environmental and social receptors arising from Project activities that needed to be further considered in the impact assessment and to determine how the assessment would be undertaken. The Scoping Report sets out the potential impacts that have been considered in the ESIA as well as those scoped out (with reasons why).

Baseline studies

Baseline data has been collected to characterise the existing environmental and social receptors and conditions in the Project (Study) Area [the TAMA, Sagnerigu District, Central Gonja District and West Gonja District] and Area of Influence (AOI) [the area of which impacts may occur], and trends in such conditions including the situation that would prevail in the absence of the Project. The baseline data has been compiled from a number of sources including a review of existing published sources and other available secondary information, information held by government agencies, non-governmental organisations, and research agencies, a site reconnaissance visit, field surveys, anecdotal evidence, and analysis and interpretation of data.

Box 5. Field surveys and stakeholder engagement undertaken to inform the baseline condition

- Social and stakeholder engagement – Stephen Baffoe between 15 to 18 June 2020 and 13 to 30 July 2020
- Aquatic ecology – Kwasi Adu Obirikorang between June 2020 to 31 July 2020
- Terrestrial ecology – Kwasi Adu Obirikorang between June 2020 to 31 July 2020
- Air quality – Jonathan Hogarh from 20 to 31 August 2020
- Noise – Daniel Osie Twumasi between 20 to 31 August 2020
- Cultural heritage – William Narteh Gblerkpor between 3 to 12 September 2020
- Soils – Henry Oppong Tuffour between 29 August to 4 September 2020
- Traffic – Kwabena Adomako between 20 to 31 August 2020

Assessment

The assessment of Project impacts has been undertaken by technical specialists for each topic identified as relevant during the scoping phase of the Project. Topics considered included: Surface water resources and water quality; Groundwater; Terrestrial and aquatic (river) flora and fauna; Transport; Air quality; Noise and vibration; Waste management; Social impact assessment; Soils and agricultural land use; Cultural heritage and archaeology; Landscape and visual impacts; Labour (workforce) issues; Conflict; and Climate risk and vulnerability.

A generic assessment methodology has been used, which has been adapted where necessary by the specialists based on relevant international guidance for their topic. The methodology involves consideration of the impact that the Project activities could have on the baseline conditions for each topic. Impacts are categorised as minor, moderate or major, positive or negative, and may be direct (e.g. footprint of the Project) or indirect (e.g. economic growth as a result of construction workers' demand for food). For all negative impacts, mitigation measures have been identified where possible, based on the following hierarchy: avoid, minimise, restore, and where that is not possible, compensate or improve conditions. Residual impacts were then identified – these are the impacts that remain following the implementation of the proposed mitigation. Overall, any moderate or major residual impacts are considered to be significant.

Environmental and Social Management Plan

An Environmental and Social Management Plan (ESMP) has been prepared, based on the findings in the ESIA Report. The ESMP consists of a set of management, mitigation and monitoring measures to be taken during Project construction and operation and maintenance to manage key potential environmental and social impacts identified in the ESIA.

Reporting and Disclosure

The outputs of the tasks identified above have been drawn together into an ESIA Report and issued to UKEF and Ghana EPA. Ghana EPA has issued an EIA Permit for the project and UKEF has approved the ESIA Report.

3. Project Programme and Activities

Construction Phase - will cover a period of 36 months for the water supply scheme and a period of 43 months for the Water Asset Management, which will commence a few months after the beginning of the water supply scheme and will finish in parallel with the Defects Liability Period (see below). It will include finalisation of the design, enabling works, mobilisation and site establishment, construction and installation, and commissioning.

Operation and Maintenance (O&M) Phase - Biwater will be responsible for the commissioning and 7-day trial operation of the works, after which they have a one-year defects liability period. Following commissioning, GWCL will be responsible for the O&M of the Project. It is anticipated that Biwater will assist GWCL in the O&M for 12 months.

Decommissioning – as appropriate, at the end of the lifespan of the Project.

The Damongo works will be incorporated into the above.

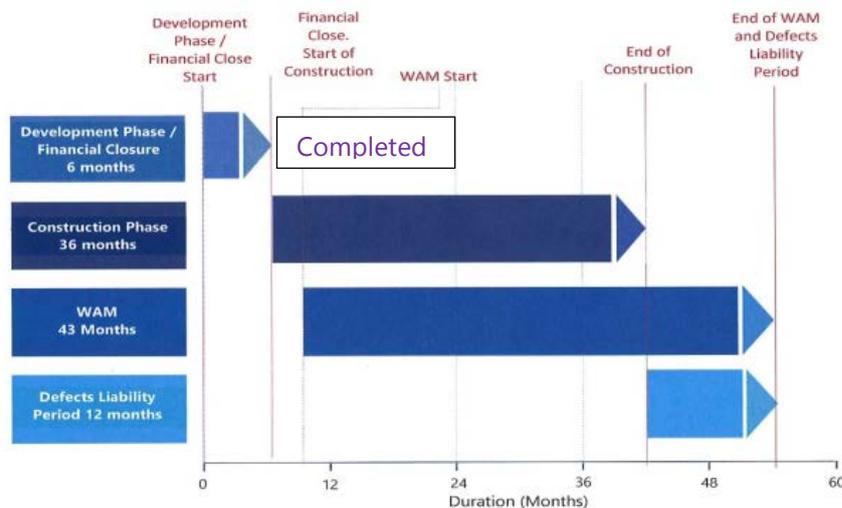


Figure 4 – Project phases

Project activities for the construction, operation and decommissioning phases are summarised below.

Box 6 Project Programme and Activities

Construction Phase

Workforce

- International and local workforce.
- Around 720 personnel will be required

Mobilisation and preparatory works

- Notify the community of works; site fencing and safety; site clearance and establishment; establishment of access roads; build construction staff offices / compounds; establish the temporary marshalling yards; establish the concrete batching plant; carry out excavations; if required, carry out dewatering activities to support construction works below the water table; build infrastructure; commissioning and demobilisation.

Power

- At the construction sites, power will be using power generators sized for specific requirements from 8 kVA to 200 kVA.

Equipment

- A range of earth moving equipment will be required, trenching, cranes and other construction equipment typically associated with large infrastructure works.

Logistics

- All imported containerised goods will be shipped to Tema, south of Ghana. This includes the ductile iron pipework, fittings and valves and the containers for the electro-mechanical equipment. No oversized goods are envisaged to be imported or transported to site.

Raw materials

- The use of water on construction sites will include use in concrete mix and for compacting fill. Approximately 10 million litres will be used across the sites during construction. Potable water to the construction working

sites will likely be in the form of water refreshment points. It is envisaged that these containers will be filled by tanker regularly.

- The main construction raw materials will include pipework, sand, aggregate, mesh reinforcement, reinforcement bar, cement, formwork, blinding concrete, concrete, and roof gravel.
- The total volume of excavated soil is site clearance, including removal of shrubs, etc. and topsoil, 16,000 m³; and excavation for structures, 75,000 m³.
- A concrete batching plant will be located at Yapei WTP to service works at the WTP. For the other sites, mini concrete mixer plants will be used.

Traffic

- Offshore materials will be delivered to the Tema port or Accra airport and transported to an existing lay down area/consolidation yard at Tema. The consolidation yard will distribute equipment and material to the construction sites with all items being delineated by a definitive site code to allow correct segregation within the consolidation yard and then scheme specific delivery to site.

The equipment and construction plant will be transported from the Tema docks or Bewater plant yard in Tema to Yapei and Tamale by the N1, N6 and N10 roads generally in 20 or 40 foot containers.

Waste

- Waste is likely to include the surplus construction spoil from the construction sites, general domestic waste including sanitary and food waste, office waste, organic material, and small volumes of wastes arising from mobile plant, primarily waste lubricating oil and packing materials (e.g. crates).

Construction Emissions

- The primary emissions expected will be noise from construction activities and movement of construction vehicles. Other emissions include exhaust emissions from onsite plant and construction traffic; dust and particulate matter may be generated by dust-raising activities on-site and the movement of heavy goods vehicles (HGVs) on local roads.

Security

- All security requirements will be developed based on a security threat assessment. During construction, there will be a security fence and security presence at all sites, providing a secure check point verifying all personnel and transport access/exit and perimeter/compound surveillance.



Operation phase

Workforce

- Around 55 personnel will be required.
- Wherever possible, the Project will seek to maximise local job creation and provide adequate training to support local staff in the discharge of these jobs.

Workers' accommodation

- There will be permanent workers' living accommodation at Yapei WTP and Bagabaga Reservoir.

Traffic

- During operation, the main traffic movements will include some staff movements from Tamale Head Office to the sites for operation and maintenance, staff movements from Yapei WTP, Bagabaga and Kaladan Reservoir and Damongo to the other sites for routine maintenance, deliveries of raw materials to WTP site, and removal of solid wastes from staff use and sludges from operational processes.

Raw materials

- Raw materials at Yapei WTP will include cleaning and laboratory chemicals, water, substances / chemicals used during the water treatment process namely aluminium sulphate, PACL, lime, chlorine and calcium hypochlorite.

Site drainage

- The preferred option for site drainage is the re-use of greywater (shower/basin effluent) and black water (surface/rainwater runoff), for site irrigation via drainage and collector tanks; surface water soakaways are also being considered. The surface water drainage systems at the sites are based on a closed contaminated drainage system.

Waste

- Waste is likely to include process wastes, sludge, general wastes (i.e. rubbish, scraps) and domestic wastewater. The Project Operators will apply the waste hierarchy of reduce, re-use, recycle/recover and disposal.
- There will be effluent, overflow and sludge supernatant from the Yapei WTP to the White Volta River. It is anticipated that 135 MLD could be discharged back to the river in an overflow event. The raw water quality and treated water quality will be monitored in accordance with the parameters set out in the Contract

Agreement between Biwater and the GWCL, which are based on international standards. On site sampling, analysis and laboratory testing will be carried out daily or more frequently as required.

- Effluent and solid waste streams will be collected by a licensed waste carrier and disposed of in accordance with a Waste Management Plan.

Emissions

- The main emissions from the Yapei WTP will be noise. This will be largely generated by the water process (intake pumps, blowers, booster pump stations etc.). Noise emissions will be controlled by installing all the sound-producing equipment (pumps, blowers, etc.) in sound-proof buildings or acoustic enclosures. No significant noise sources are anticipated at the other Project infrastructure. There will be effluent, overflows and solid waste streams from the WTP to the White Volta River; and generated at the Reservoirs including the accommodation at Bagabaga.

Security

- All security requirements will be developed based on a security threat assessment. During operation, a security fence and security presence within the Yapei WTP, pump stations and reservoirs providing a secure check point verifying all personnel and transport access/exit and perimeter/compound surveillance.



Decommissioning phase

- A site closure and restoration/decommissioning plan will be developed prior to initiation of decommissioning activities.
- All infrastructure should be dismantled and removed. Machinery, steel and dismantled materials would be recycled where possible and disposed of at licensed disposal sites.

4. Project Alternatives

The Project has considered alternatives to infrastructure site locations, routes to site, technologies and processes. The 'do nothing' option is the option of not implementing the activity or executing the proposed development. Assuming that the proposed WTP and associated infrastructure is not developed, Tamale and Damongo would continue to suffer a severe potable water shortage, that will worsen year on year.

Alternative sites

Intake

The location of the intake structure has been dictated by the water resource to be used, in this case the White Volta River. The specific location of the intake along the river is a factor of operational criteria related to water depth and flow. To identify a suitable location for the intake, Biwater have undertaken a bathymetric survey and are undertaking ongoing river level surveys. Considerations for the precise siting of the intake include projected river depths, which are predicted to deplete in future with climate change, to ensure pumping is still optimal in low flow conditions. The selected site was chosen as this section provided a relatively straight channel section, free from obstruction (and thus not impinging river flow) and is considered to provide an acceptable depth of water at known low flow conditions.

Water treatment plant

The option of placing a WTP at the existing Dalun WTP site to the north-west of Tamale city was considered. This was discounted due to the history of flooding and siltation concerns and poor power supply. The location of a new plant to the south-west of Tamale was seen as offering a more strategic option to supply not just Tamale, but also its environs.

The Yapei WTP was confirmed as the preferred location as it provided the following:

- Diversification of the water supply to the growing city of Tamale;
- Improved security of supply with a greatly increased source sufficiency being available at Yapei without flood threats;
- Villages in the Yapei Tamale and Yapei Damongo corridors can be supplied with potable water, which they currently do not have; and
- Aspirations of GWCL in bringing diversification of supply to the city and more importantly bringing potable water to a hitherto unserved sections of the communities in the typical ribbon development seen along the pipeline corridors.

The specific location of the WTP at Yapei was based on available land that would avoid displacement, within a suitable location to the river to avoid a lengthy raw water transmission line. A WTP site was considered immediately adjacent to Yapei but this was rejected and the plant moved closer to the intake and further away from Yapei in consideration to reducing construction inconvenience to Yapei/Yipala local communities. The specific site was also dictated by the need to avoid other infrastructure such as overhead power lines. The Yapei WTP is sited away from the local residents of Yapei and Yipala; it also is away from the existing overhead power lines on the site.

Pipeline routes

Direct pipeline routes have been considered but have been rejected in preference to pipeline routes that follow the main roads to Tamale and Damongo and associated villages, which will ensure minimal physical and economic displacement and make use of existing road easements, thus limiting environmental and social disturbance.

Along the Fufulso-Damongo Road, the road itself passes through the Damongo Scarp Forest Reserve Important Bird Area (IBA). An IBA is an area identified by BirdLife International, using an internationally agreed set of criteria as being globally important for the conservation of bird populations. The alternative to avoid the IBA would be to take the pipeline offline at this site; however, given the road exists and there are no habitats within the road easement, it has been determined that the impact on potentially protected

species; and other potential displacements; would be significantly lower by keeping the pipeline within the road easement.

The pipeline route also passes into the Mole National Park and IBA in order to deliver water to a kiosk in Mole village. There is no alternative to passing into the National Park/IBA, as the village itself is located in the designated area. The small diameter pipeline will run within the existing road easement and therefore will avoid direct damage or disturbance to habitats; no other alternative exists other than providing a pipeline outside of the existing road, which would result in a higher potential for adverse effects on habitats that running the pipeline along the existing road. A small distance of pipeline will also need to cross other land uses locally to access sites, such as at Kaladan Reservoir (and from the WTP site, as there are no existing roads to these sites that can be followed.

In the original design, there were three distinct pipelines coming from the WTP and crossing other land uses to link up the road network – for the mains to Tamale, the mains to Damongo and the mains to Yapei/Yipala. To minimise disturbance and potential displacement impacts, the mains to Yapei/Yipala has since been re-routed along the same route as the transmission main to Busunu/Damongo.

In all cases, the pipeline routes will only be affected during construction; during operation they will be buried and will not be visible.

Other water supply infrastructures

Distribution storage reservoirs are located based on distribution centres and the need for water supply, where there is population and industry demand for water. Wherever possible, all other Project infrastructure has been considered at existing sites to avoid the need for additional land take. However, some additional land take is required at Kaladan and Bagabaga simply to meet the size of the new supply system.

The area of land available at Kaladan and Bagabaga is restricted due to these sites being in urban, built up areas; and the need to connect into the existing facilities at these sites; and therefore, the land selected has been chosen based on land adjacent to the existing sites, in liaison with the land owners.

In order to remove the need for pumping water to the inhabitants of Damongo, and utilising gravity flow to save on GWCL energy operation costs, Biwater surveyed the whole of the Damongo area for a high ground site location for the Damongo Reservoir. The original survey looked at sites in and around Damongo and concluded that the only high ground level location, to meet the criteria for gravity feed, was in the location along the scarp, see Figure 5 below.

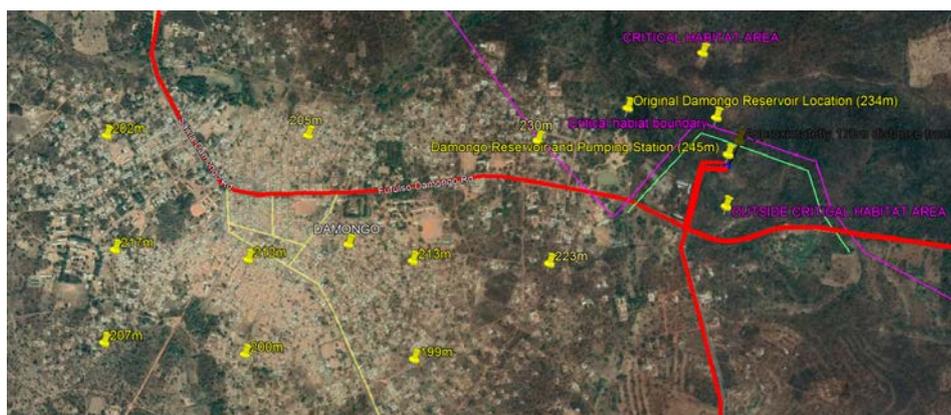


Figure 5 Damongo showing Reservoir Site and Spot Ground Levels

The original Damongo Reservoir location was proposed at a ground level of 234 m. Ground levels within the Damongo city limits range from 230 m near to the reservoir site, approximately 220 m to the West and East and 190 m to the South. However, the ESIA study identified that this site was within the Damongo Scarp Forest Reserve IBA and could constitute critical habitat for migratory or congregatory bird species. As such, Biwater identified a new location, see Figure 6, which is near to the original location but is outside the Critical Habitat Area along the scarp with a ground level of approximately 245 m. This

will provide the gravity feed to the inhabitants of Damongo and is the only suitable area due to height and that is also not in the IBA. The old and new sites are shown in Figure 6.

The only alternatives available to meet the design criteria for gravity feed are along this high ground; and therefore, to avoid the designated IBA site, this only leaves one general area that can be used. It should also be noted that a cluster of buildings and dwellings are already located within the IBA/Critical Habitat Area, approximately 200 m west of the original proposed Damongo Reservoir site location, see Figure 7.

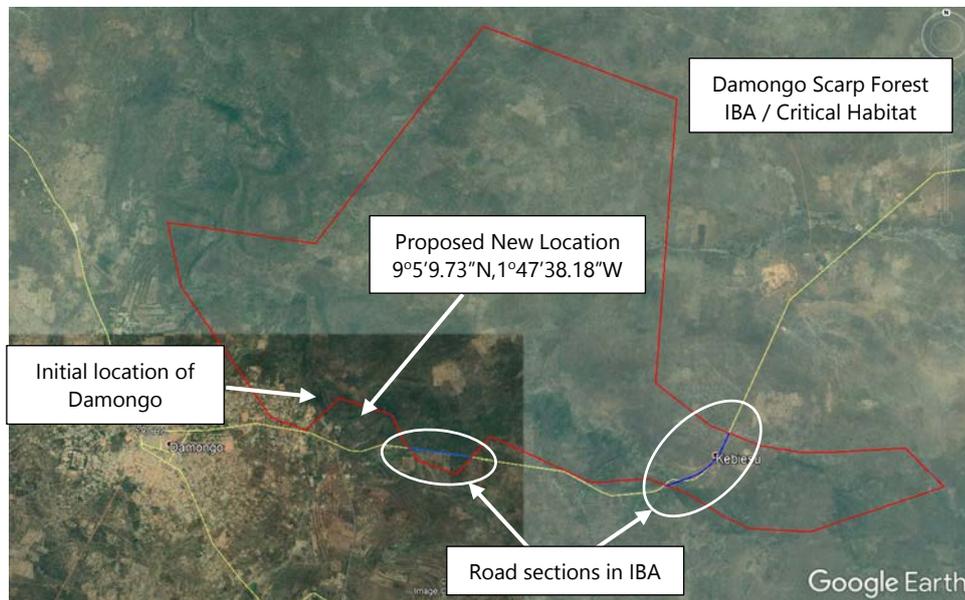


Figure 6. Location of Damongo Reservoir



Figure 7. Extent of Buildings and Dwellings within the Critical Habitat Area

Overhead Line Routes

The design and implementation of the overhead power lines, though part of this Project, is being undertaken directly by the Volta River Authority (VRA)/Northern Electricity Department (NEDCo) and therefore detailed information is not available. However, as with the pipeline routes, the overhead lines will be routed along existing roads to avoid and minimise any displacement impacts.

Alternative Routes to Site

The routes to site are dictated by the sourcing of goods and materials for the Project. Certain materials, such as the large diameter pipes required are not available for purchase in Ghana and therefore needs to be procured overseas.

The route to site for imported goods and materials is therefore determined by the main port and airport locations; and main roads from these sites to Tamale. The main airport in Accra and main port at Tema will be used and equipment taken to an existing consolidation yard at Tema. From here, as required, the equipment will be transported via road to Tamale, using main roads only – as such, the road transport route will be the N1, N6 and N10 roads.

Rail transportation for freight only exists in the south of the country therefore was not considered a viable option.

Water transport via the Volta Lake was also considered, however, was also discounted as a viable option for a number of reasons:

- Full travel by vessel is not possible due to two dams (Akuse and Akosombo Dams);
- Road transport would still be required from Tema to Akosombo on Lake Volta; and road transport once offloaded to site; and
- The facilities for cargo handling both ashore and on board are very poor and loading/offloading the large diameter pipes and containers would pose a problem and likely require reconstruction of the landing bay in Yapei.

In addition, as this is not a regular transportation route in Ghana, it is unlikely that this form of transport would be able to handle the quantities of materials that need to be transported within the timeframe required; with vessels often being out of service.

Alternative Design and Layouts

General design considerations that have been applied to all construction sites are listed below:

- Use of LED lamps instead of traditional lighting, which on average will reduce overall lighting power demand by 80%.
- Ensuring that construction materials are recyclable and, where possible, use recycled materials and packaging.
- Suitable guard houses and accommodation has been identified with variant temperatures in mind. Passive housing techniques will be used where practicable, including heat resistant paints topped with gravel to reduce the internal temperature range, which also reduces the need for extensive heating / cooling systems.

The design of the proposed intake structure is intended to mitigate the long term environmental impact on the aquatic ecosystem and impacts of climate change: the adjustable intake seeks to reduce the intake of fauna, organics and sediments, returning to the river all those entrained through primary process discharge and overflow points. This approach was favoured as it also reduces overall intake power and chemical dosing requirements for potable water quality criteria. Consideration has been given to intake structure building floor levels and river bank flooding protection to reduce existing and future risk of flooding.

Biwater have investigated various pumps types for the intake and have selected submersible type pumps. This pump is simple to maintain and can be removed and a new one installed within one hour, minimising downtime.

The design of the WTP has considered a site layout that has reduced the overall plant footprint. The design of the WTP utilises the topography of the selected site to minimise the requirement for pumping and thereby increases efficiency. At the WTP, excavated materials will be used where suitable to provide appropriate bunding/security around the site. The WTP site itself is significantly above the flood level of the White Volta River.

Alternative Technologies and Processes

Biwater has discussed with GWCL alternative process/structure designs such as intake roughing filters/sand separators to augment clarification during high turbidity periods in the flood season. In the final analysis these large area process basins have been rejected in favour of clarifiers designed as sole entity units minimising the process basins required and the corresponding land take.

The water treatment process can vary depending on the technology of the plant and the quality of the raw water however the basic principles are largely the same and are outlined below.

Stages considered	Selected	Description
Collection & Screening	✓	Abstraction via intake structure with screens to remove suspended materials and large debris such as fish and vegetation from entering the WTP.
Pre-Chlorination	✓	Control the growth of slime and algae in process units
Aeration	✓	To remove dissolved iron and manganese in raw water.
Coagulation & Flocculation	✓	Flocculators to allow maximum flexibility with minimum down time for the plant operation.
Sedimentation & Clarification	✓	Clariflocculators will remove the floc
Filtration	✓	Gravity filtered to remove any residual suspended particles.
Disinfection	✓	Post-chlorination
Storage	✓	Ground storage reservoirs and one storage tank
Sludge drying	✓	Solids that are collected and settled out of the water by sedimentation and filtration are removed to drying lagoons.
pH Correction	✓	Lime added to filtered water to adjust pH and stabilise to minimise corrosion in distribution system.

In relation to the power supply, the use of diesel engines was considered in operation due to their significantly cheaper operational costs. However, to reduce air emissions it was determined to include the power supply extensions from the main grid to the plant.

5. Stakeholder Engagement

Stakeholder consultation is critical in gaining an understanding of how the Project will impact stakeholders and the general public. It is used to understand stakeholder's ideas and opinions on how the impacts should be managed. Stakeholder consultation is required from the outset of a project, through to disclosure of the ESIA Report, and on-going through the lifecycle of the Project. The Project recognises the importance of this and has completed comprehensive consultation with a wide range of stakeholders to date.

At the most fundamental level, the stakeholder engagement process involves three main components. These are iterative and ongoing components of continuous successive rounds of engagement undertaken throughout the project ESIA process, through construction and, where applicable, operation and closure.

- 1. Stakeholder identification**, which can be considered the first component in any *initial* round of stakeholder engagement and involves identifying and profiling stakeholders, including their representatives, and the relationships between them.
- 2. Stakeholder disclosure**, which can be considered the next key component of engagement. It involves the timely disclosure and dissemination of accessible and understandable project information to stakeholders who, once informed, will better comprehend the trade-offs between proposed project costs and benefits and can contribute more meaningfully to consultation.
- 3. Stakeholder consultation**, which can be considered the third key component of engagement. It involves communicating directly with project stakeholders to answer any further questions that they may have following project disclosure and to understand the expectations, hopes, concerns and suggestions of stakeholders, and their constituents, in relation to the project.

Stakeholder identification

Stakeholders are persons or groups who are directly or indirectly affected by a project, or who may have interests in and/or influence over its outcomes. The Project's key stakeholders can, therefore, be classified into two categories:

- **Category I** stakeholders include all persons or groups who are predominantly impacted by the project, who are often also collectively referred to as Project Affected Persons (PAPs); and
- **Category II** stakeholders include all persons or groups who predominantly have a significant interest in and/or an influence over the project.

The initial, and often subsequent, identification of Project stakeholders is mainly conducted through the application of a combination of procedures that are periodically repeated throughout Project development:

- Consideration of the Project's activities and Area of Influence (AOI), insofar as it has been defined;
- Scoping of potential, or review of current, positive and negative Project impacts;
- Review of secondary data on the Project's social and environmental context;
- Contact with Project relevant government bodies and civil society and business groups;
- Contacts with the local communities; and
- Contact made with organisations expressing, or likely to have, an interest in the Project.

The Category I and II stakeholders are identified below. During construction, Biwater will maintain a Stakeholder Register that will record all stakeholders, contact details, dates of engagement with comments and follow up requirements. This will be a live document.

Category I Stakeholders

Stakeholder	Description	How they are impacted
Project affected persons / Project affected communities	<p>People and groups whose property rights or assets will be affected in case of permanent loss for the Project footprint</p> <ul style="list-style-type: none"> Football users of the football pitch at Kaladan Tamale Secondary School, Tamale and School Teachers' use of field for crops – Bagabaga site Informal herders grazing animals at the intake and WTP site Users of fallow lands – at the intake, WTP, Bagabaga, Yapei, Yipala, Kusawgu village, Busunu and Damongo 	<p>Potential negative impacts: Directly impacted by permanent or temporary loss of access to land or assets. Low level physical relocation of football field. Loss of area of school grounds. Low-level economic displacement from loss of informal grazing land and fallow land/subsistence crops.</p> <p>Potential positive impacts: Temporary and possibly permanent job opportunities. Access to clean potable water supply in operation.</p>
	<p>Local communities / people living adjacent to the Project sites, including along transmission lines.</p> <p>Local businesses.</p> <p>Ghana Private Road Transport Union (GPRTU).</p> <p>Fisherman</p>	<p>Potential negative impacts: Environmental quality (general nuisance, loss of access, noise, dust, emissions) during construction. Elevated risk of pedestrian and vehicle accidents during construction. Population influx. Potential impacts on water quality in rivers and local streams through accidental releases and pollution, if not controlled. Potentially slightly reduced access to social infrastructure facilities (health, education and police) during construction.</p> <p>Potential positive impacts: Temporary and possibly permanent job opportunities. Access to clean potable water supply in operation.</p>
	<p>Representatives and users of sensitive sites such as health centres, schools and places of worship located along or within close proximity of the Project.</p>	<p>Potential negative impacts: Predominantly impacted through general nuisance, congestion, loss of access, noise, dust, emissions during construction. Elevated risk of pedestrian and vehicle accidents during construction.</p> <p>Potential positive impacts: Temporary and possibly permanent job opportunities. Access to clean potable water supply in operation.</p>
	<p>Vulnerable persons living or working along the Project sites or affected by works along roads</p>	<p>Potential negative impacts: The SIA identifies vulnerable persons as those who are economically deprived and unemployed (the Project Area falls within the poverty-endemic regions of Ghana. Issues of poverty, poor health and access to potable water remain topmost challenges in the area). Vulnerable people also include: those with disabilities; persons aged 65 or more; and Children under age of 16 who are vulnerable to child labour; and Women in women's shelter camps. These vulnerable groups or persons may be disproportionately affected by the Project.</p>
	<p>Transport providers and other regular users (roads where transmission and distribution lines will be laid)</p>	<p>Potential negative impacts: Increased congestion during construction will raise travel times and temporarily effect economic productivity. Elevated risk of vehicle accidents during construction.</p>
Local administration	<ul style="list-style-type: none"> Tamale Metropolitan Assembly (TAMA) West Gonja Municipal Assembly Central Gonja District Assembly 	<p>Potential negative impacts: Elected representatives are accountable to their constituents and are therefore impacted by, and have an interest in, the Project and its impacts on their constituents. They also have influence and can be utilized in mobilizing and coordinating Project communities in project consultation and provide technical advice and assistance with regard to the monitoring and management of impacts and activities.</p>

Stakeholder	Description	How they are impacted
		<p>Potential positive impacts: Improved potable water supply to their communities. Employment opportunities for local community members. Increased revenues during operation.</p>
Traditional leadership	<ul style="list-style-type: none"> Tamale (in Dagbon Kingdom): the Dakpeama (sub-chief) at Kaladan; the Sagnarigu chief (paramount chief) at Bagabaga; and the Chiefs they report to: Gukpena (Tamale's Paramount chief, higher than the Sagnarigu) and the King, Ya Naa who is based in Yendi. Damongo and Yapei (in Gonjaland): the King of Gonjaland (Yagbonwura) who is based in Damongo; the Yapei Chief; and the Paramount chiefs of Busunu and Kusawgu who cover the Yapei and Damongo Project Area. 	<p>Potential negative impacts: Traditional authorities are directly involved in customary land administration in their areas of jurisdiction, as well as in upholding cultural traditions, norms and practices. There are certain rituals that should be considered to honour these customs. These leaders are accountable to their communities and are therefore impacted by, and have an interest in, the project and its impacts on their communities. As custodians of the land, they play an important role as the first authority to cede land for the Project.</p> <p>Potential positive impacts: Improved potable water supply to their communities. Employment opportunities for local community members.</p>
Potential employees	Locals and expats	<p>Potential positive impacts: Direct and indirect project employment opportunities during construction - approximately over 721 locally. Longer term employment opportunities for the water management staff.</p>
Suppliers	Direct and indirect suppliers of goods and services	<p>Potential negative impacts: Support for national and local upstream Project supplier businesses during construction. Indirect and 'spin-off' Project employment opportunities during construction and operation.</p>
Services	Ghana Police Service (GPS) Ghana Ambulance Service Ghana National Fire Service (GNFS) National Disaster Management Organisation (NADMO) Metropolitan / District Security Council (METSEC / DISEC) Ghana Highway Authority (GHA) Health centres	<p>Provide support services during the Construction Phase e.g. Emergency Preparedness and Response Plan.</p> <p>Potential negative impacts: Potentially increase in demand for services during the Construction Phase and, possibly, during O&M activities.</p>
Utilities	Telecommunications Sanitation	<p>Potential negative impacts: Organizations whose utility networks may be affected by the Project in the case that networks are within the area required for works. It is assumed that water and power utilities will be fully accounted for as these organisations are developing the Project (i.e. GWCL and NEDCo).</p>

Category II Stakeholders

Stakeholder	Description	How they are impacted
Project owners	<ul style="list-style-type: none"> Government of Ghana, represented by the Ministry of Water Resources and Sanitation which in turn is represented by the GWCL. 	The Project has been developed by the GWCL.
Construction Contractor	<ul style="list-style-type: none"> Biwater 	A contract has been signed between the Ministry of Water Resources and Sanitation represented by GWCL and Biwater to design and construct the Project.
Lenders	<ul style="list-style-type: none"> UKEF Deutsche Bank 	Have an interest in minimizing risk to their investment by ensuring compliance with the relevant lending requirements.
National Government departments, ministries, functions and directorates	Governmental Ministries <ul style="list-style-type: none"> Ministry of Environment Science Technology and Innovation (MESTI) Ministry of Finance (MoF) Ministry of Energy 	National authorities are defined as those agencies of the Government who have the power to regulate or influence the Project in terms of establishing policy or guidance for the Project and monitoring and enforcing compliance with Ghanaian Law throughout the Project lifecycle.

Stakeholder	Description	How they are impacted
	<ul style="list-style-type: none"> Ministry of Health/ Ghana Health Service Ministry of Lands and Natural Resources Ministry of Chieftaincy and Traditional Affairs Ministry of Roads and Highways Agencies, Authorities and Commissions <ul style="list-style-type: none"> EPA Water Resources Commission (WRC) Community Water and Sanitation Agency (CWSA) Public Utility Regulatory Commission (PURC) Ghana Standards Authority (GSA) Museums and Monuments Board Land Valuation Board. National Development Planning Commission (NDPC) 	
Regional and Local Government departments, ministries, functions and directorates	<ul style="list-style-type: none"> Regional Health Directorate, Tamale Regional Coordinating Council (RCC) of the Northern Region and the RCC of the Savannah Region Regional Minister Metropolitan, Municipal and District, Chiefs Executive. Northern Regional EPA, Northern Regional Inspectorate Division Water Resources Commission Lands Commission, Tamale Town and Country Planning, Tamale Ghana Highways Authority, Tamale 	Regional and local authorities are defined as those agencies of the Government who have the power to regulate or influence the Project in terms of establishing policy or guidance for the Project and monitoring and enforcing compliance with Ghanaian Law throughout the Project lifecycle.
Regulatory authorities	<ul style="list-style-type: none"> EPA Tamale Water Resources Commission Energy Commission Lands commission Land Use and Spatial Development Authority (LUPSA) National Communication Authority Forestry Commission (if trees require felling) Department of Feeder roads Department of Urban Roads (DUR) 	Provision of regulations, policies and guidance that are directly applicable to the Project and that need to be adhered to in order to secure Project approval and gain and maintain license to operate the Project.
Organisations involved in Project implementation and contractor organisations	<ul style="list-style-type: none"> Northern Electricity Company (NEDCo) and their contractors 	NEDCo is the supplier of the power for the Project. Their contract suppliers will install the new overhead lines.
	<ul style="list-style-type: none"> Private sector project suppliers 	Interested in providing goods and services to the Project.
	<ul style="list-style-type: none"> Project employee unions 	Protecting employee rights.
Civil society advocacy organisations Religious and ethnic representatives	<ul style="list-style-type: none"> International Development Enterprises (IDE) Integrated Social Development Centre (ISODEC) Savannah Signatures Center for Active Learning & Integrated Development (CALID) 	Consultation with civil society and religious groups or interests that may be affected by the project provides credibility to the ESIA process. They can provide technical advice on baseline conditions, vulnerable persons and mitigation measures at the Project level.
State media outlets	<ul style="list-style-type: none"> Savannah Radio. etc. 	Accountability to readership in the reporting of project developments and activities and influencing public opinion about the Project.

Stakeholder consultation

Box 7. Stakeholder consultation

Engagement has been carried out with UAEF, GWCL, government authorities, communities, non-governmental organisations, and civil societies. This has been undertaken through public and formal meetings, and informal meetings with community stakeholders. Comments, key issues raised, and key themes were logged and have been incorporated into the ESIA.

The following stakeholder engagement has been undertaken in Tamale as part of this ESIA:

- Meetings with key Ministries and organisations.
- Meetings with Ghana EPA.
- Meetings with Government departments e.g. Ghana Health Service, Regional Health Directorate.
- Meetings with regional and local administration e.g. Northern Regional Coordinating Council
- Meetings with Traditional authorities e.g. Presbyterian Agriculture Services and Ghana Private Road Transport Union (GPRTU) stations (Accra and Bole unions)
- Meetings with Associations and NGOs e.g. Integrated Social Development Centre (ISODEC).
- Semi-structured interviews with affected communities (Kaladan, Bagabaga, Yapei, Damongo).
- Community meetings in Fufulso, Ntereso, Sankpala and Aboabo.

Over the Project lifetime, requirements for stakeholder engagement and implementation of a community and labour grievance mechanism throughout the construction and operation phases of the Project, are outlined in the Stakeholder Engagement Plan.



Meeting with Regional Minister (NRCC)



Meeting with the DCE, DCD and their team (CGDA)



Meeting with the Savanna Regional Coordinating Director (SRCC)



Semi-structured interview with Assemblyman and Opinion leaders at Yapei



Consultative meeting with the EPA



Consultative meeting with Metropolitan Football Association

6. Key Environmental and Social Sensitivities in the Existing Environment

This section summarises the key baseline conditions and environmental and social sensitivities within the Project Area of Influence (AOI).

Climate

The Project Area climate is determined by the location of the Inter-Tropical Convergence Zone (ITCZ), where the rain bearing south-westerly tropical maritime air mass and the dry, north-easterly tropical continental air mass meet to form a zone of low pressure. Within the White Volta catchment, where the Project is located, there are three climate zones according to the Köppen climate classification:

- Tropical semi-arid in the Sahel in the northern extent in Burkina Faso. The climate is typically hot, sunny and dry.
- Tropical Savanna in Sudanean Savanna Zone over southern Burkina Faso and most of Ghana. This climate is characterised by warm temperatures and distinct wet and dry seasons.
- A very small area of Tropical Monsoon in the south of Ghana

Temperature

Temperatures in the White Volta catchment are uniformly high throughout the year with a mean annual temperature of approximately 28°C. Daily mean temperatures range between 25.8°C and 30.9°C. Daily temperatures can however be as high as 44°C, whereas night temperatures can be as low as 15°C.

The months of March and April are the hottest with temperatures averages of around 32°C, and August is coolest with averages of 26°C.

Rainfall

Rainfall across the White Volta catchment has a uni-modal regime. The rainy season extends from April to October, peaking in August or September followed by a prolonged dry season from November to March. The spatial and temporal distributions of rainfall in the catchment are high and the mean annual rainfall varies from 600 mm in the semi-arid north to 1,200 mm in the more humid south.

Surface water resources and quality

The Yapei intake is on the White Volta River. The White Volta River (also known as the River Nakembe) flows into Lake Volta, the largest man-made lake by surface area in the world, see Figure 8 below.

The mean annual flow in the White Volta at the raw water intake site (estimated from available gauge data) is approximately 10,500,000,000 m³ (10.5 km³) and the river contributes 28% of the total flow into Lake Volta. Highest flows are in September and low flows from November to June and 80% to 85% of the total annual runoff occurs during August, September and October. The White Volta has become more perennial since 1994 with the construction of the Bagré Dam in Burkina Faso, due to the steady release of water for hydropower generation. As a result, mean flows in the White Volta in the dry season have increased (prior to 1995, the average discharge of the White Volta River for the low-flow period covering the months of January to April was 8.9 m³/sec, compared to 27.1 m³/sec for the same period following the dam completion); however, many of its tributaries have low or no flow in the dry season. During this period, irrigation dams, small reservoirs and dugouts that exist in the White Volta River Basin become an (unprotected) source of water for many of the population.

The highest flows are from August to October, with a peak in September. Low flows are from November to June.

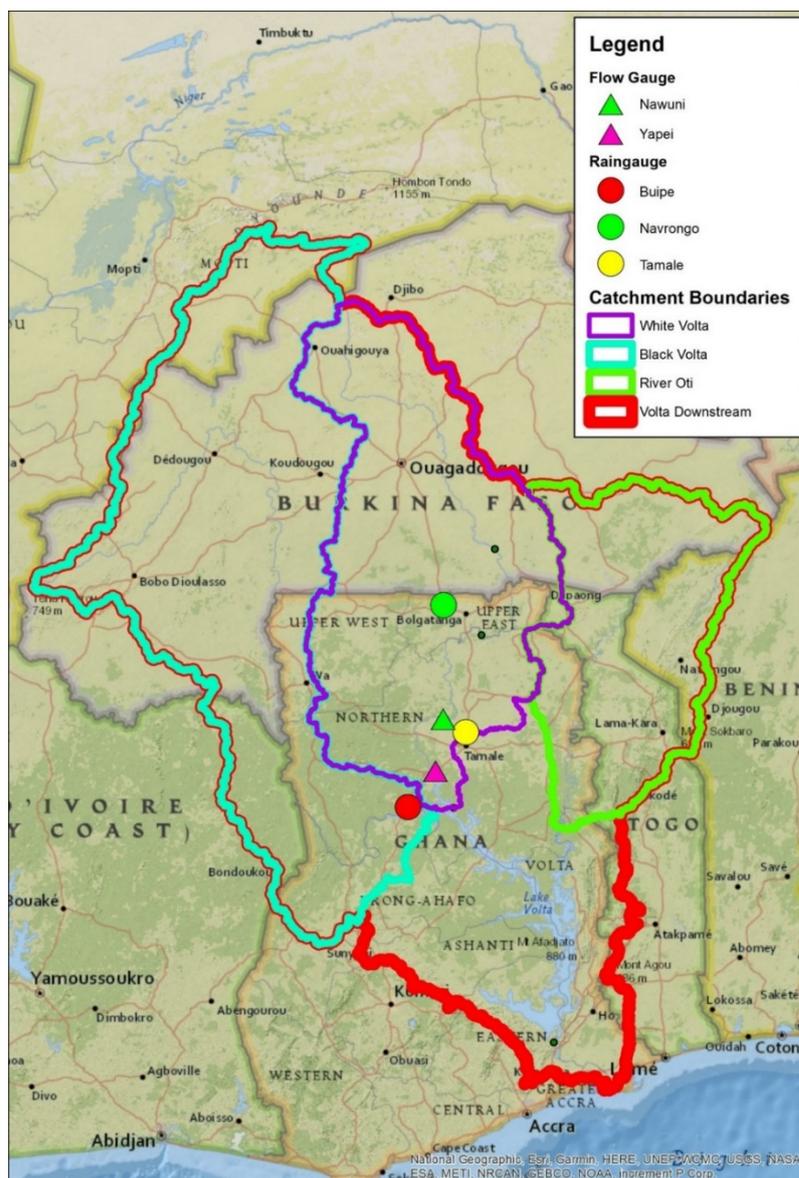


Figure 8. River Volta catchment

For water quality, all spot samples show parameter concentrations met National standards and were in line with WHO guidelines, with the exception of: turbidity (in all samples); pH (in 2 samples), ammonia (in 2 samples); and iron (in all but one of the samples for which dissolved and total iron were analysed for). Soils and sediment are washed into waterbodies in run-off from the land as a result of rainfall, which increases the turbidity of receiving waters thus explaining why high turbidity levels were typically recorded.

Groundwater

Groundwater resources serve as an important source of water supply in the Project area in rural areas and some piped urban water supply schemes are also reliant on groundwater. The Project Area is underlain predominantly by the voltains formation which, based on available hydrogeological data, are known to have a low to moderate productivity having overall transmissivity that range from 0.3 m²/d to 267 m²/d with an average of 11.9 m²/d. Borehole yields range from 0.3 m³/h to 72 m³/h with a mean yield of 7.3 m³/h. It is understood that occurrence is mainly controlled by geologic structures. The area is seen to have limited potential for the development of sustainable boreholes as a result of the challenging hydrogeological terrain.

Biodiversity

There are two Important Bird Areas (IBA) in the Project Area, Mole National Park IBA and Damongo Scarp Forest Reserve IBA. Mole is also a National Park. Using the precautionary principle, the Mole National

Park IBA and Damongo Scarp Forest Reserve IBA are considered to constitute critical (ecological) habitat in accordance with the definition in IFC Performance Standard (PS) 6. The White Volta river, Tamale landfill site and large reservoirs in the study area are also potentially areas of critical habitat for certain species of migratory birds. However, within the footprint of the Project in these areas the habitats, where they exist, are considered to be modified habitats in accordance with the definition in IFC PS6. The area along the roads that fall within the critical habitat zones have been degraded by various human activities over time, including persistent annual deliberate bush fires by hunters, cattle grazing, plantation agriculture, wood harvesting and vegetation clearance through ploughing for seasonal crop cultivation, and although the tree species are native they are predominately secondary woodland with secondary grassland growth vegetation that is burnt off annually during the dry season. The sites along the White Volta River corridor are dominated by secondary grassland vegetation which dominated with typical facultative wetland species such as *Mitragyna inermis*, and *Chrysopogon zizanioides* (Vetiver grass) which is non-native; and a small patch of planted *Tectona grandis* (Teak) which is also non-native. The site is part of the intake in general is fallow land in the area that is also for cattle grazing and experiences seasonal bush burning. Habitats immediately adjacent the White Volta River bridge are also heavily disturbed and modified by human activities such as vegetation clearance, collecting water, washing and children's recreation. These sites have therefore been seriously disturbed by human activities and can be considered modified habitat.

The majority of plant species recorded are listed as not-assessed under the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species. Three species have been assessed as providing economic benefits locally, i.e. *Vitellaria paradoxa* (listed as vulnerable) and *Ludwigia octovalvis* and *Parkia biglobosa* (listed as least concern). None of the plant species encountered are of conservation concern; they are not listed in any of the conservation related categories of IUCN, Convention on International Trade of Endangered Species (CITES) or national star ratings.

The only mammal recorded (or evidence of) during the field survey comprised two individuals of the Yellow-winged bat (*Lavia frons*), which were encountered during the vegetation assessment at the Yapei-intake site.

A total of 76 bird species were recorded during the June/July field surveys; and also a total of 76 bird species across the 13 Vantage Points in October 2020. All species recorded are listed as Least Concern on the IUCN red list, and no species are listed on the Appendices of CITES.

No reptiles or invertebrates of conservation status were identified in the field surveys.

Fish sampling at three sampling locations yielded a total of 34 species of fish belonging to 14 distinct families. The IUCN has classified all the captured fish species as "least concern" fish species.

Sampling across the sites yielded only sixteen aquatic macroinvertebrate taxa belonging to eight orders. Within the assemblage, taxon tolerance to organic pollution ranged from tolerant to sensitive. None of the identified macroinvertebrates are protected species.

One juvenile turtle of the genus *Pelusios* was observed during the field surveys. This species is identified as Least Concern by the IUCN.

Key ecosystem services that may be affected by the Project include provisioning services, i.e. the White Volta River, areas in which timber or firewood is harvested, and areas supporting food plants such as the Shea Tree *Vitellaria paradoxa*.

Transport

The main road network in the Project Area is shown in Figure 9 below. Tamale is accessible through a number of trunk roads; from the south by the Techiman-Tamale road (N10), from the north the Tamale-Yendi road (N9), as well as from a secondary network of roads. Tamale has an airport which has been upgraded to the status of an international airport and is 18 km by road from the town centre. Yapei can be reached from the south by the Techiman-Tamale (N10) road, from the north by the Tamale-Yapei road. In the West Gonja Municipal the main trunk road is the Sawla-Damongo-Ffulso Road, which leads from Damongo to Larabanga.

Outside of Tamale, the use of bicycles and motor bikes as alternative means of transport is high.

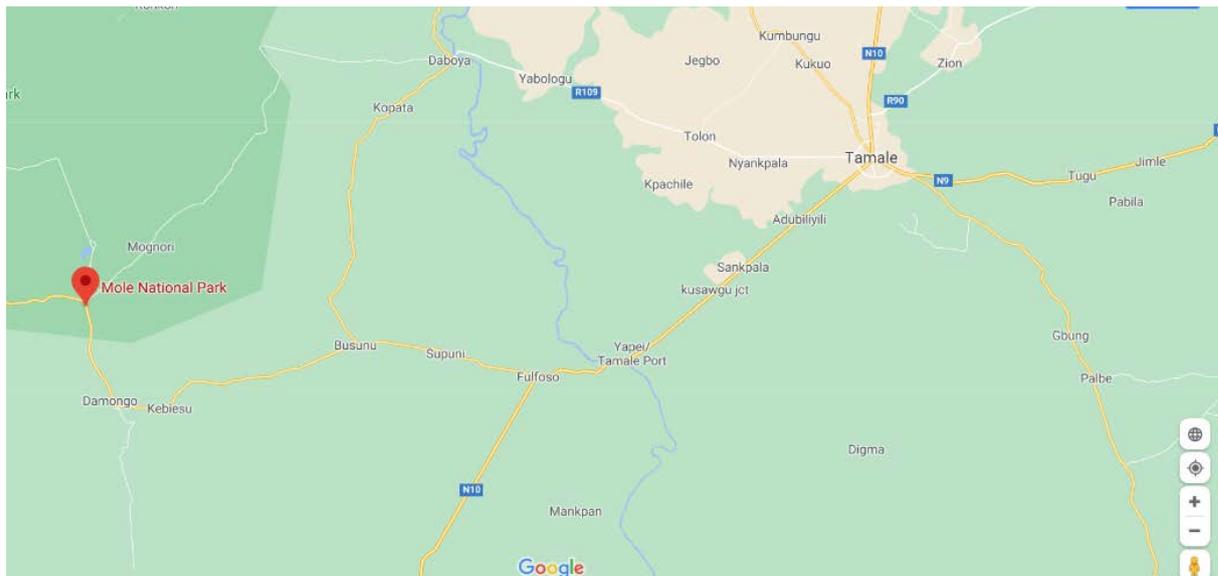


Figure 9. Main Road Network

The sites are accessed by a good network of main roads, including the Techiman-Tamale road, the Fufulso-Damongo Road and the Sawla-Damongo Road.

Air Quality

An ambient air quality survey was undertaken in August 2020 to provide information on baseline particulate and gaseous emissions in the Project Area. The following methods were employed:

- All measurements were taken downwind of the suspected sources of generation.
- Dust (total suspended particles (TSP) and Particulate Matter (PM10)): Field measurements were undertaken using a portable BGI PQ100 FRM Sampler. Samplers were installed to collect ambient air particulate matter over a sampling period of 24 hours at each monitoring location.
- SO₂ and NO₂: Field measurements were undertaken using Aeroqual Series 500 (S500) gas monitors (Aeroqual Limited, Auckland, New Zealand). Monitoring was undertaken for one hour at each site.

Atmospheric conditions are generally high relative to the EPA residential guidelines for particulate matter Total Suspended Particles (TSP) and Particulate Matter (PM) PM10 during the dry season. This is attributed to the influence of the dry and windy conditions of the harmattan winds that prevail over the area for most of the year.

Noise and vibration

Noise and vibration monitoring survey was undertaken in August 2020 to provide baseline information in the Project Area. The measured equivalent levels have been compared with the Ghanaian permissible noise limits. The permissible noise limits have been determined according to the noise zones tentatively assigned to each monitoring location.

A robust comparison of the measured noise levels against the WHO recommended thresholds is not possible because of the different definitions of the day- and night-time periods adopted by the Ghanaian legislation and WHO. However, assuming that this inconsistency would not influence significantly the outcomes, the level exceedances are confirmed with the WHO limits for the same locations and the same time periods.

In summary the permissible baseline noise limits are significantly exceeded in the measured locations in Kaladan, both for night-time and day-time. Only one slight exceedance has been recorded in Bagabaga at the College of Education during day-time. Other slight exceedances have been measured at Yapei community (both night-time and day-time), Larabanga (night-time only) and the village of Busunu (only day).

Waste

Tamale is challenged with poor environmental sanitation especially in the area of solid and liquid wastes management

The 2010 Population and Housing Census (PHC) shows that most households dispose of their solid waste either in a public dump container or public open dump. In the metropolis, it is estimated that 810 tonnes of waste is generated a day and out of this, 216 tonnes are hauled daily. This leaves a backlog of 594 tonnes uncollected a day. This has resulted in littering, heaping of waste and overflowing of skips with waste in the metropolis most especially in the low class residential and peri-urban areas. The recent proliferation of polythene bags for packaging has seriously aggravated the waste management situation. Out of these figures, about 87% of solid waste and about 92% of liquid waste are generated by households. In terms of waste composition, solid waste forms the bulk (70%) of total waste generated in the Tamale metropolis comprising polythene (35%), plastic (20%), paper (10%) and other materials such as pieces of broken woods (5%).

A 2014 study revealed poor management of the available landfill site, as shown below where it has been left over two years without any treatment due to financial constraints. About 72.5% of household in urban locations have their solid waste collected and for rural households only 27.5% have their waste collected.



Sagnarigu Municipality

The main methods of waste disposal (2010 PHC) is public dump (open space) constituting 29.3%, for the urban areas, public dump in open spaces (30.6%), burnt by household (22.5%) and public dump in a container (22.4%). For the rural areas, the three main methods are public dump in open spaces (27.0%), indiscriminate dumping (24.9%) and burnt by household (19.5%). The proportion of household waste that is collected is lower in the urban areas (9.3%) compared to the rural localities (10.2%). Again, in the urban localities, indiscriminate disposal of waste is 8.3%. The proportion of household buried waste is also small at 5.9% in the urban and 3.9% in the rural areas.

Central Gonja District

Around 2,056 households dump their solid waste at the public dump site (open) while some other 805 households use public dump (container). 547 households representing 8.7% have their solid waste collected by a routine house-to-house collection of waste by Zoomlion, a private waste management company which operates nationwide.

West Gonja District

In the West Gonja district, 50.2% of households dispose of their solid waste in open space at public dumps and 2.3% dispose of their solid waste into public containers. A higher proportion of households either have their solid waste dumped indiscriminately (26.9%) or burned (10.4%). The 2010 PHC reports that a little less than half (49.6%) of households throw their liquid waste onto the street/outside. Another

38.5% of households throw their liquid waste onto the compound, while 3.7% of households throw their liquid waste into gutters. Only 0.5% of households dispose of their liquid waste through plumbing systems into gutters.

Health and Human Services (HHS) Waste Practices

The HHS of 413 households in key communities across all four Project districts (Figure 10) found that 41.9% of the respondents and their households dump their solid waste into waste skips provided at vantage points by the Assemblies; while a significant 42.4% dump refuse close to their homes; 7.5% resort to burning or incinerating waste; and only about 3.6% use private waste contractors. Figure 10 illustrates relative proportions of the various waste disposal options available to households in each district.

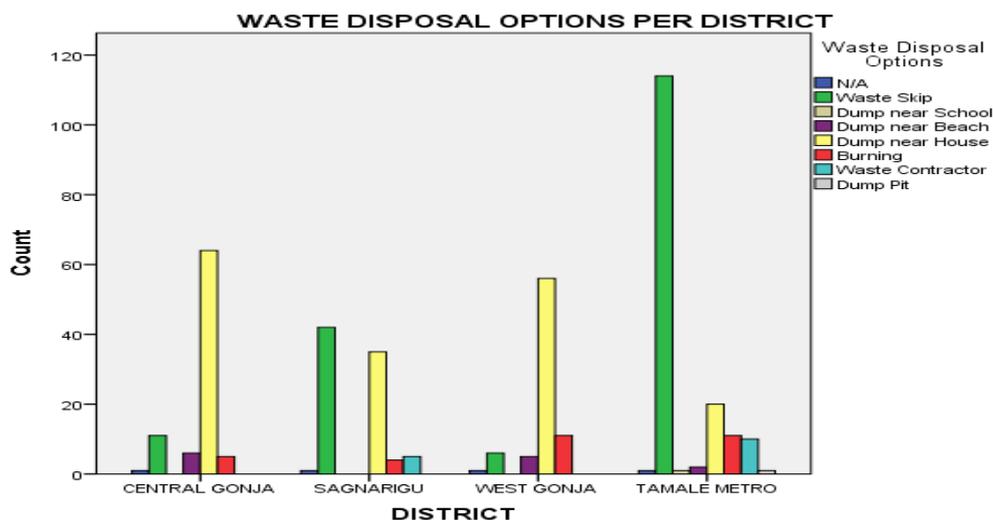


Figure 10 – Waste Disposal Practices in Project Districts.

The districts have no engineered landfill site for disposing of waste. Not many homes had waste bins. Skips are a common waste collection/dumping practice. The major waste management company/service is ZOOMLION.

Social

Primary information was obtained through a site reconnaissance walkover and the administration of questionnaires and key informant interviews with relevant stakeholders such as the Assembly members for the Project Areas/communities. The purpose of face-to-face interviews with key informants was to verify and address data gaps in the secondary information, if any.

Social field surveys were undertaken between 14 and 29 July 2020. Primary data collection methods involved community profiling and household surveys using structured questionnaires .

A random sampling survey method was used to identify the community members to be interviewed. The following number of households were interviewed:

- Tamale metropolis – 160 households;
- Sagnarigu Municipality – 87 households;
- Central Gonja District – 87 households; and
- West Gonja District - 79 households.

The completed questionnaires were analysed using the Statistical Package for the Social Sciences (SPSS) - Version 24. The data analyses involved using both qualitative and quantitative analysis tools.

Key socio-economic sensitivities in the Project Area include:

- National population growth rate of 3.2%. The population is composed largely of persons within the 0-24 age group, with a smaller population in the 75 years and above. Tamale is the most urban of the Project Area.
- Dagomba is the main ethnic group, though many smaller groups co-exist. The main religion is Islam.
- Ghana has no officially classified indigenous people. There are no Indigenous people in the Project Area. However, the Project Area is located within two traditional kingdoms – Gonjaland and Dagbon.
- The Project districts (Tamale metropolis, Sagnarigu, Central and West Gonja) average number of persons per household (i.e. 6.3, 6.3, 7.6 and 6.6 respectively) is lower than the regional average of 7.8. The average population per house in the rural areas of the four districts (6.95) is relatively higher than that of the urban areas (6.43). Male-headed households are dominant.
- Highest ownership of houses was recorded in the HHS in Central Gonja district, then West Gonja district, Sagnarigu district and finally Tamale metropolis.
- The Project districts overall record and average of 39.2% who have not had any form of formal education at all – the highest being in Central Gonja District and the lowest level of no education recorded in Tamale metropolis. Tamale and Sagnarigu had higher levels of higher education; both Gonja districts was
- Malaria is the number one disease for both OPD and in-patient, constituting about 50% of all morbidity cases, and high incidence of malaria is more prevalent during the rainy season. Health services are generally good in the Project districts, with 64.4% of all HHS respondents and their households reporting to a government health facility as their first port of call when unwell. Most respondents had access to healthcare within a 30 minute walking distance.
- Each project district has at least one Police Station; one Police Post and one Fire Service Station to ensure public safety and security. The National Disaster Management Organisation (NADMO) also has offices in all the Project districts to coordinate emergency relief services.
- The predominant land use in the Project Area is agricultural for food, tree crop cultivation and livestock farming.
- The main river affected and crossed by the Project is the White Volta River. At the site of the intake, Yapei is the main town. Fishing is practiced along the White Volta River; though the main landing site for fishing is approximately 1.8 km upstream of the intake site.
- The main source of potable water in the Project districts is mains supply by the GWCL. Other water sources include town water systems, mechanized bore holes, wells, dams and dugouts. West Gonja and Central Gonja have low access to GWCL water supplies. Overall, the surveys show that the top three categories of monthly expenses incurred on water consumption are GHS100-299, GHS50-99 and GHS20-49, representing a combined percentage of about 81.2.
- Key ecosystem services from a social perspective that may be affected by the Project include the White Volta River, areas in which timber or firewood is harvested, and areas supporting food plants such as the Shea Tree *Vitellaria paradoxa* and African locust bean *Parkia biglobosa*.
- In the 2010 census, Tamale's population had the least access to sanitary facilities such as liquid and solid waste disposal and toilet facilities among the five metropolitan areas in Ghana.
- The Project Area contains populations with low-income levels and livelihoods compared to the national average, especially farmers and small traders. Tamale has higher levels of employment as it is the most urban of the districts. The low levels of employment in the rural areas, among the employable population presents an opportunity for artisans who could benefit as non-skilled labourers during the Construction Phase.
- Unemployed youth rates are high – in many of the communities surveyed the community leaders and youth asked for jobs for the unemployed youth.

Soil and land use

Soil

The major type of soils in the Tamale Metropolis are the Ferric Acrisols, Dystric Planosols and Plinthic Lixisols. The soil of Yapei area are generally alluvial and savanna Ochrosols.

The results of a geotechnical survey at the WTP site indicate that the topsoils are a dry to moist, loose, brown silty sand, around 1 m thick. The topsoil is underlain by a moist, loose to very dense, brownish yellowish greyish red mottled, silty clayey Sand. Beneath this layer is a layer of reddish brown, very stiff to hard, lateritic hardpan. This hardpan layer varied in thickness between about 1.20 m to 2.2 m however was not present in all boreholes drilled. Beneath the hardpan layer was a yellowish greyish brown mottled, clayey Silt with quartz pebbles about 1.2 m thick. The underlying layer was rock, purplish coffee brown with greenish grey patches, completely weathered, fine-grained, soft rock (Mudstone/Siltstone). Drilling extended into the rock which was averagely encountered at a depth of 6.0 m to a depth of 12.0 m where the investigation was stopped. Groundwater was not encountered within the overburden layers at the time of the investigation.

The ESIA survey indicates that the soils in the Project Area are classified as Changnayili series in the Tamale monitoring sites, and Puga series in the Yapei, Damongo and Busunu monitoring sites in the Interim Ghana Soil Classification System and soil map of Ghana; and Pisoplinthic Plinthosols and Plinthic Lixisols in the World Reference Base Systems of Classification. The sparse vegetation cover and flat terrain of the sites are typical characteristics of savannah landscapes, and also suggest that the soils are heavily affected by the accumulation of salts, and also low matter. Additionally, the soils have poor drainage and are prone to localised flooding.

Soils at sample sites

Area	Site	Soil types
Tamale	Kaladan Reservoir	Changnayili series (Interim Ghana soil classification) or Pisoplinthic Plinthosol.
	Bagabaga Reservoir	Changnayili series (Interim Ghana soil classification) and Pisoplinthic Plinthosol.
	Tamale College of Education	Changnayili series (Interim Ghana soil classification) or Pisoplinthic Plinthosol.
Yapei	Yapei Water Treatment Site	Puga series (Interim Ghana soil classification) or Plinthic Lixisols.
	Water Abstraction point	Puga series (Interim Ghana soil classification) or Plinthic Lixisols.
Busunu	Busunu Reservoir & pumping station	Puga series (Interim Ghana soil classification) or Plinthic Lixisols.
	Busunu East Community	Puga series (Interim Ghana soil classification) or Plinthic Lixisols.

Land use

The Ghanaian part of the White Volta River basin is characterised by fairly low-lying relief and agriculture, hunting and forestry are the main land uses. Farming to produce food crops (such as rice, beans and groundnuts) and cattle grazing are the predominant agricultural activities and are practiced for the purposes of both commerce and subsistence. In addition, cultivation of crops occurs along the banks of the White Volta River. Improper farming practices such as 'bush burning' and 'slash and burn' are also commonly used.

The predominant land use within the Project Area is agricultural for food, tree crop cultivation and livestock farming. The main crops cultivated include maize, rice, groundnuts, sorghum, millet, yam, cassava, cowpea soya bean cashew and mango. Livestock production includes cattle, sheep, goats, pigs. Poultry production is also undertaken and also includes local poultry, ducks, guinea fowls and turkey.

The key sites and their land uses are described below; in addition to these sites, there will be distribution pipelines and kiosks within small villages; distribution pipes will follow local roads and kiosks are sited in

locations of a mix of local trade and residential land uses; on land that has been identified as savannah/fallow land.

Results are summarised in Box 8.

Box 8. Land uses at the proposed sites

Intake and WTP at Yapei

Both sites are located in mostly in savannah with scattered trees or bushes; and both are lands under the authority of the Yapei Chief with informal uses for subsistence cropping (cereals on an ad-hoc basis) and grazing. The tree cover is often used as fuelwood. Indeed, it is noted that large areas of forests around Yapei have been cleared for firewood and charcoal. Although some cleared areas are used as gravel and sand winning sites in the area, others are used as farmlands. There are no sensitive receptors at the intake and there is one residence approximately 80m from the WTP plant site. The raw water pipeline traverses this savannah, crossing a minor road. There are two properties within 100 m of the pipeline.

Industrial activities are not the dominant land use type in the area which surrounds Yapei, however, industrial infrastructure including a petrol reservoir, a cement production plant and a pipeline system are all present in Yapei town.

Transmission main from Yapei to Tamale

The transmission main from Yapei WTP to Tamale will run for 48.8 km along the asphalted N10 Techiman-Tamale road. The road passes through several villages: Aliepe, Jiramoape, Galenzigu, Sankpala, Kampontili, Zanzigu Yipala, unnamed village, Adubiliyili, Datoyili, Dongu on the outskirts of Tamale before entering Tamale. In between the villages is open savannah with scattered trees.

Main uses along the road are informal use for grazing of cattle and other animals such as goat and sheep. Scattered tree cover includes the *Vitellaria Paradoxa* (shea nut) tree which is picked by women for production of shea butter. Other trees are harvested for fuelwood. Crop farming is undertaken in the rainy season. There are some scattered mango and cashew plantations under cultivation.

Kaladan reservoir at Kaladan park

In the city of Tamale residential and industrial land uses dominate. The land required at Kaladan Park is a 115 m x 75 m plan area, which includes some of the existing land owned by GWCL. Kaladan Park is a recreational area, and the site is partly used as a football field by the youth at the Kaladan suburb, including sports organisations such as the Oruma Stars. Kaladan park is popular in Tamale and there is much emotional attachment to it. It was the first public park in the area and served as the home for Real Tamale United FC and produced the like of Abedi Pele. There was a long standing dispute between the Traditional Council and the TaMA over the ownership of the park. The Courts however earlier in the year ruled in favour of the TaMA and subsequently invested ownership in the TaMA.

Adjacent to the Park is the existing water tanks to the north, the Aboabo market to the north, and mainly commercial properties in general on all sides. The north and east of the site are particular high density developments.

Bagabaga Reservoir

Works at Bagabaga include within the existing reservoir site and an additional area of 230 m x 130 m; this land will be taken from the grounds of the Ghana Education Service (Tamale Senior High School). Adjacent land uses include the school, commercial and residential properties.

Transmission main from Yapei, Yipala and Kusawgu village

The transmission main from Yapei WTP to Yapei and Yipala will follow the mains transmission line towards Damongo on exiting the WTP, and then diverts north into Yapei and Yipala, following main roads. The first stretch of the mains exiting the WTP is greenfield, crossing savannah with trees or bushes, minor local routes/tracks. Receptors include several sparse houses. The water dispenser kiosks will be based in each town; adjacent land uses a mix of commercial and residential.

The pipe to Kusawgu village will follow the N10, and then divert along the main access road off the N10 to Kusawgu village. The elevated storage tank will be on fallow land. The water dispenser kiosk will be in the village, on fallow land, adjacent to a mix of commercial and residential properties.

Transmission main from Yapei to Busunu

The 43.4 km main to Busunu will cross the White Volta river on the N10 and continue along the N10 road to Fufulso; where the pipeline will then follow the Fufulso -Damongo Road to Busunu. Part of the overhead transmission line from Buipe will also follow the N10 to the WTP. The road passes through several villages: Bonyase, Ntereso, small settlement between Ntereso and Fufulso and Fufulso along the N10; and then Janikura, Kojope, Sumpini, Abubakarikura and Zanjikura to Busunu along the Fufulso -Damongo Road. Savannah is present between the towns. Closer to the towns, the savannah is used for grazing of cattle and other animals such as goat and sheep. Scattered tree cover including the *Vitellaria Paradoxa* (shea nut) tree which is picked by women for production of shea butter. Other trees are harvested for fuelwood.

The transmission line will align with the existing road N10 and Fulfoso-Damongo Road except for minor diversions to avoid junctions at:

- Fufulso (0.8 km suburban several houses min distance 10 m); and
- Busuno (1.2 km suburban several houses min distance 10 m, Busuno Reservoir).

Busunu reservoir and pumping station

At Busunu site, an area of 25 m x 25 m will be required, is away from Busunu town on high ground and used as fallow land.

Transmission main from Busunu to Damongo

The road passes through several villages: Tailorpe, Kawankura, settlements between Kawankura and Kukunde, Kukunde, Mempeasem, Jonokponto, Achubunyor, settlements between Achubunyor and Bonyanto, Bonyanto, Soalepe and Damongo. Between settlements is savannah with scattered trees. Settlements along the road use the savannah for grazing of animals – cattle, goat and sheep. Sparse tree cover including the *Vitellaria Paradoxa* (shea nut). Other trees are harvested for fuelwood. Crop farming undertaken in the rainy season. Petty trading undertaken in the villages along the road.

The transmission line will align with the existing Fufulso–Damongo Road except for minor diversions to avoid junctions at Damongo (0.6 km alignment with secondary road to reach Damongo reservoir).

Another pipe will also run from Damongo, down an existing secondary road to Canteen Zongo and Frafra Settlement No 3. There are small settlements along the main road, though mainly savannah; and the lands are used for grazing of animals.

Damongo reservoir and pumping station

The Damongo reservoir site is to the east of the Damongo Scarp IBA; and on the eastern outskirts of Damongo town. The adjacent land use to the south and west is mainly commercial; with some residential; as well as winning sand. At the site and to the north is a rocky outcrop.

Transmission to Mole and surrounding area

The transmission main from Damongo to Mole will continue to follow the Fufulso-Damongo Road into Damongo, then will proceed north along the Sawla-Damongo Road to Larabanga. At Larabanga, the pipeline will take the local road to the east, then north to Mole. There are small villages and settlements along the road, as well as savannah and cultivated/fallow lands.

Between Damongo and Larabanga, an offtake pipeline will follow a local road to the west to Boroto. The pipeline will align with an existing secondary unpaved road into Boroto, crossing savannah and cultivated areas/fallow land. There is one house 120 m from axis and the pipeline then enters the small village of Boroto.

Cultural heritage and archaeology

The cultural heritage baseline was established through a review of literature available for the Project Area, including the Ghana Museums and Monuments (GMMB) website; a search of Google earth to identify potential areas of archaeological importance and how such sites relate to the Project footprint; and a field walkover survey of key Project sites to collect any field evidence on heritage remains.

There is no official register for the country's heritage assets or resources. The GMMB only has a catalogue of movable heritage objects deposited at the National Museum in Accra. Nevertheless, the Board has identified several cultural and historical places, some of which are listed on its website and which have been reviewed in the ESIA.

During the walkover survey, sites which were more likely to contain archaeological and/or other heritage remains were critically examined. This included areas such as open cuttings, drainage openings from erosional activities, outcrop exposures and relatively high grounds within natural topography for potential heritage exposures. Several transects were also made to confirm assumptions.

Meetings were also held with various community members to help identify the presence of cultural heritage sites:

A total of 19 cultural heritage sites comprising shrine, and historic sites of significance were identified in the Project Area; there is also a high likelihood for the presence of buried cultural heritage especially in areas not previously disturbed.

7. Summary of Construction and Operational Phase Impacts and Mitigation Measures

This section summarises the key potential Project impacts and mitigation measures, and the main residual impacts of various topics such as water resources, water quality, terrestrial biodiversity, aquatic biodiversity, traffic and transport, air quality, noise, soils, waste, socio-economic impact assessment, cultural heritage and labour issues.

The Summary Tables below provide a summary of the key environmental and social residual effects over the Project phases (Construction and Operation).

- *Key*

Major Adverse	Minor Beneficial
Moderate Adverse	Moderate Beneficial
Minor Adverse	Major Beneficial

In Summary Tables, where more than one level of impact has been identified for a topic, the range is stated however in terms of applying the key, the highest 'Adverse' (i.e. worst) or 'Beneficial' (i.e. best) rating is shown.

Water Resources

Summary of Water resources potential residual effects during construction

Project activity	Receptor and sensitivity	Impact	Magnitude of Impact	Significance of effect	Proposed mitigation measures	Revised magnitude of impact	Residual effect
Abstraction of water from the White Volta River for construction purposes	White Volta River High	Reduced availability of water for downstream flora and fauna and other water users.	Negligible	Negligible	<ul style="list-style-type: none"> Water Management Plan. Ensure water permit for construction abstraction is obtained. 	Negligible	Negligible
	Lake Volta High	Reduced availability of water for downstream flora and fauna and other water users.	Negligible	Negligible	<ul style="list-style-type: none"> As above. 	Negligible	Negligible
Land clearing and grading	White Volta River High	Alteration of surface water drainage patterns and compaction could affect surface water runoff rates.	Low	Minor Adverse	<ul style="list-style-type: none"> Soil Management Plan. Water Management Plan. Activity restrictions near drains and small rivers/crossings to avoid impacts. Natural drainage patterns to be maintained where practicable. Where required, temporary drainage grooves will be installed and, if required settlement ponds, for the collection of surface water runoff. The outflow from any drainage grooves and settlement ponds will be regularly inspected. Storm water management measures should be designed to avoid creating ponds. Where required, settlement ponds for temporary flood storage should be positioned in areas which 	Negligible	Negligible

Project activity	Receptor and sensitivity	Impact	Magnitude of Impact	Significance of effect	Proposed mitigation measures	Revised magnitude of impact	Residual effect
					could potentially capture and store water from on the site.		
	Lake Volta High	Alteration of surface water drainage patterns and compaction could affect surface water runoff rates.	Low	Minor Adverse	<ul style="list-style-type: none"> As above 	Negligible	Negligible
	Waterbodies located on or near the pipeline route Low	Alteration of surface water drainage patterns and compaction could affect surface water runoff rates.	Low	Negligible	<ul style="list-style-type: none"> As above 	Negligible	Negligible

Summary of Water Resources potential residual effects during operation

Project activity	Receptor and sensitivity	Impact	Magnitude of Impact	Significance of effect	Proposed mitigation measures	Revised magnitude of impact	Residual effect
Abstraction of water from the White Volta River	White Volta River High	Reduced availability of water for downstream flora and fauna and other water users.	Low	Minor Adverse	<ul style="list-style-type: none"> Integrated approach to management of the water resource in the river basin to ensure there is a balance between the needs of all water users. Intake flow should be measured together with the flow upstream and downstream of the intake to understand the impacts going forward. It is recommended that a gauge be installed which can measure daily flows (for example, this could be a level 	Low	Minor Adverse

Project activity	Receptor and sensitivity	Impact	Magnitude of Impact	Significance of effect	Proposed mitigation measures	Revised magnitude of impact	Residual effect
					gauge, which is rated using check gaugings).		
	Lake Volta High	Reduced availability of water for downstream flora and fauna and other water users.	Low	Minor Adverse	<ul style="list-style-type: none"> As above. 	Low	Minor Adverse
Abstraction of water from the White Volta River under future Climate Change conditions	White Volta River High	Reduced availability of water for downstream flora and fauna and other water users.	Low	Minor Adverse	<ul style="list-style-type: none"> As above 	Low	Minor Adverse
	Lake Volta High	Reduced availability of water for downstream flora and fauna and other water users.	Low	Minor Adverse	<ul style="list-style-type: none"> As above. 	Low	Minor Adverse
Transfer of water from the White Volta River into adjacent catchments	Waterbodies located on or near the pipeline route Low	Increased flows in adjacent catchments.	Negligible	Negligible	<ul style="list-style-type: none"> None proposed. 	Negligible	Negligible
Pipeline crossings of watercourses	Waterbodies located on or near the pipeline route Low	None anticipated.	-	-	-	-	None

Water quality

Summary of Water Quality potential residual effects during construction

Project activity	Receptor and sensitivity	Impact	Magnitude of impact	Significance of effect	Proposed mitigation measures	Revised magnitude of impact	Residual effect
In-channel works	White Volta River High	Release of sediments and increase of turbidity	Medium		Water Management Plan, including the following measures: <ul style="list-style-type: none"> • Use sediment traps to capture sediment released • Keep activities/time spent in-channel to a minimum • Restore the channel if altered (i.e. sediment disturbed/removed) 	Low	Minor Adverse
Land clearing and grading		Alteration of surface water drainage patterns with potential to increase sediment runoff	Low	Minor Adverse	Install effective drainage channels at the intake site and at Yapei WTP and, where possible, avoid altering natural drainage patterns.	Negligible	Minor Adverse
Surface water pollution from accidental spillages		Contamination of watercourse impacting flora, fauna and downstream users	Medium	Moderate Adverse	Spill Prevention and Response Plan	Negligible	Minor Adverse
Soil erosion and runoff from site clearance		Contamination of watercourse impacting flora, fauna and downstream users	Medium	Moderate Adverse	Soil Management Plan	Low	Minor Adverse
Groundwater pollution from percolation of accidental spillages		Contamination of the river via percolation of contaminated groundwater	Low	Minor Adverse	Spill Prevention and Response Plan	Low	Minor Adverse
In-channel works		Lake Volta High	Release of sediments and increase of turbidity	Low	Minor Adverse	As above for White Volta River.	Low
Land clearing and grading	Alteration of surface water drainage patterns with		Low	Minor Adverse	Consider drainage as part of detailed design	Negligible	Minor Adverse

Project activity	Receptor and sensitivity	Impact	Magnitude of impact	Significance of effect	Proposed mitigation measures	Revised magnitude of impact	Residual effect
		potential to increase sediment runoff					
Surface water pollution from accidental spillages		Contamination of watercourse impacting flora, fauna and downstream users	Low	Minor Adverse	Spill Prevention and Response Plan	Negligible	Minor Adverse
Soil erosion and runoff from site clearance		Contamination of watercourse impacting flora, fauna and downstream users	Low	Minor Adverse	Soil Management Plan	Negligible	Minor Adverse
Land clearing and grading	Waterbodies located on or near to pipeline routes	Alteration of surface water drainage patterns with potential to increase sediment runoff	Medium	Minor Adverse	Consider drainage as part of detailed design	Low	Negligible
Surface water pollution from accidental spillages	Low	Contamination of watercourse impacting flora, fauna and downstream users	Medium	Minor Adverse	Spill Prevention and Response Plan	Negligible	Negligible
Soil erosion and runoff from site clearance		Contamination of watercourse impacting flora, fauna and downstream users	Low	Negligible	Soil Management Plan	Low	Negligible
Groundwater pollution from percolation of accidental spillages		Contamination of the river via percolation of contaminated groundwater	Medium	Minor Adverse	Spill Prevention and Response Plan	Negligible	Negligible

Summary of Water Quality potential residual effects during operation

Project activity	Receptor and sensitivity	Magnitude of impact	Significance of effect	Mitigation	Revised magnitude of effect	Residual effect
Accidental spillages resulting from maintenance activities	White Volta River	Low	Minor Adverse	Spill Prevention Plan	Negligible	Minor Adverse

Project activity	Receptor and sensitivity	Magnitude of impact	Significance of effect	Mitigation	Revised magnitude of effect	Residual effect
Decreased dilution capacity from abstraction	High	Low	Minor Adverse	Mass Balance Model	Low	Minor Adverse
Accidental spillages resulting from maintenance activities	Lake Volta High	Low	Minor Adverse	Spill Prevention Plan	Negligible	Minor Adverse
Decreased dilution capacity from abstraction		Low	Minor Adverse	Mass Balance Model	Low	Minor Adverse
Accidental spillages resulting from maintenance activities	Waterbodies located on or near to pipeline routes Low	Low	Negligible	Spill Prevention Plan	Negligible	Negligible

Terrestrial Biodiversity

Summary of Terrestrial Biodiversity potential residual effects during construction

Project activity	Receptor and sensitivity	Impact	Magnitude of Impact	Significance of effect	Proposed mitigation measures	Revised magnitude of impact	Residual effect
Construction of Project infrastructure	Critical Habitats (Mole National Park, Damongo Scarp Forest Reserve IBA, Gallery Forest, large reservoirs, Tamale landfill site the) Protected and Designated Areas Very High	Direct habitat loss and degradation	Negligible	Minor Adverse	<ul style="list-style-type: none"> ECW to undertake a walkover survey of proposed working areas to identify key sensitive areas and identify specific work method statements. Micro-siting of infrastructure including overhead powerlines to reduce impacts on sensitive areas (particularly within protected and designated areas) and vegetation, such as mature trees, riparian vegetation, running water and escarpments where possible. Avoid clearance of mature trees, particularly adjacent to the White Volta River and all Vitellaria paradoxa, where possible. Protective fencing erected to prevent damage to retained habitats. Ensure the footprint of the Project is not increased in order to minimise habitat loss and through demarcation of working areas. Avoid clearance of mature trees, particularly adjacent to the White Volta River, and all Vitellaria paradoxa where possible. Management of dust and air emissions (see air quality for further details). Monitoring of contractor’s compliance with method statements during construction works, e.g. daily and weekly inspections as appropriate. An appropriate biodiversity monitoring and evaluation programme (BMEP), tailored to the project situation, will be designed and implemented as part of the Construction 	Negligible	Minor Adverse
	Aquatic/riparian habitat High			Negligible			Negligible
	Woodland savannah, Grass savannah, Disturbed or modified habitats Low			Negligible			Negligible
	Ecosystem services: provisioning services Medium			Minor Adverse			Negligible
	IUCN critically endangered and endangered species Very High			Minor Adverse			Minor Adverse
	IUCN vulnerable species; IBA trigger species; Schedule 1, 2 and 3 of the Wildlife Conservation Regulation, 1971, species High			Negligible			Negligible
	Other species Low			Negligible			Negligible
	Critical Habitats - White Volta river corridor Very High		Low	Moderate Adverse			Minor Adverse

Project activity	Receptor and sensitivity	Impact	Magnitude of Impact	Significance of effect	Proposed mitigation measures	Revised magnitude of impact	Residual effect
					Environmental and Social Management Plan (CESMP).		
	Critical Habitats (Mole National Park, Damongo Scarp Forest Reserve IBA and the White Volta river corridor) Protected and Designated Areas Very High	Direct mortality and disturbance (general construction)	Low	Moderate Adverse	<ul style="list-style-type: none"> Any carcasses near roads should be removed to prevent scavengers coming close to roads. Where possible, waste storage areas should be covered to avoid attracting vultures and other scavengers. Preparation and implementation of Traffic Management Plan, including speed limits for construction traffic on roads and access routes. Use of poison at waste sites should not be allowed. Measures taken to prevent accidental fires. A pre-clearance walkover will be undertaken by a suitably qualified ecologist or trained ECW to check for the presence of active bird nests. Should any nests be identified, it is recommended that these are excluded from works until such time that the chicks have fledged the nest. Chick of relevant species listed on Schedules 1 to 3 of the Wildlife Conservation Regulation, 1971 must be allowed to fledge. Any scrub or low vegetation clearance should be undertaken in two stages. Ensure all excavations are covered at night or ramps/sloping sides provided to allow animals to escape. Soft start-up of plant and machinery (i.e. initial start-up undertaken away from sensitive areas). 	Negligible	Minor Adverse
	IUCN critically endangered and endangered species Very High			Moderate Adverse			Minor Adverse
	IUCN vulnerable species; IBA trigger species; Schedule 1, 2 and 3 of the Wildlife Conservation Regulation, 1971, species High			Minor Adverse			Minor Adverse
	Other species Low			Negligible			Negligible
	Critical Habitats - Gallery Forest, large reservoirs, Tamale landfill site Very High		Negligible	Minor Adverse			Minor Adverse

Project activity	Receptor and sensitivity	Impact	Magnitude of Impact	Significance of effect	Proposed mitigation measures	Revised magnitude of impact	Residual effect	
	Critical Habitats, Protected and Designated Areas (Mole National Park IBA, Damongo Scarp Forest Reserve IBA) IUCN critically endangered and endangered species Very High	Direct mortality (increase in hunting/ poaching)	Medium	Major Adverse	<ul style="list-style-type: none"> A total ban on hunting or poaching of wildlife by the workforce would be implemented for the duration of the Project. Prohibit the workforce from, buying and consuming bushmeat and other wildlife. 'Toolbox talks' provided by a construction environment manager, Environmental Clerk of Works or equivalent to ensure workforce are aware of required mitigation and legislation, and that hunting/poaching would not be tolerated. Funding for the employment (and, if required, training) of additional, suitably experienced and qualified local patrol staff within protected and designated areas during the duration of the Construction Phase. 	Negligible	Minor Adverse	
	IUCN vulnerable species; IBA trigger species; Schedule 1, 2 and 3 of the Wildlife Conservation Regulation, 1971, species High		Medium	Moderate		Negligible	Negligible	
	Critical Habitats (White Volta river corridor) Very High	Changes to local hydrology and water quality	Medium	Major Adverse		<ul style="list-style-type: none"> A suitably robust pollution prevention plan should be produced and adopted during construction Management of aqueous discharges and waste Additional mitigation measures are detailed in the Water Quality and Water Resources chapters) 	Negligible	Minor Adverse
	Aquatic/riparian habitat High			Moderate Adverse				Minor Adverse
	Ecosystem services: provisioning services Medium			Moderate Adverse				Negligible
	IUCN vulnerable species; IBA trigger species; Schedule 1, 2 and 3 of the Wildlife Conservation Regulation, 1971, species High			Moderate Adverse				Minor Adverse
	Other species Low			Minor adverse				Negligible

Summary of Terrestrial Biodiversity potential residual effects during operation

Project activity	Receptor and sensitivity	Impact	Magnitude of Impact	Significance of effect	Proposed mitigation measures	Revised magnitude of impact	Residual effect	
Operation of intake/WTP and maintenance of Project infrastructure	Critical Habitats (Mole National Park, Damongo Scarp Forest Reserve IBA and the White Volta river corridor) Protected and Designated Areas Very High	Disturbance	Low	Moderate Adverse	<ul style="list-style-type: none"> Management of noise emissions (see Noise and Vibration and Air Quality for further details) Soft start-up of plant and machinery (i.e. initial start-up undertaken away from sensitive areas) Preparation and implementation of Traffic Management Plan, including speed limits for project traffic on roads and access routes 	Negligible	Minor Adverse	
	IUCN critically endangered and endangered species Very High			Moderate Adverse			Minor Adverse	
	IUCN vulnerable species; IBA trigger species; Schedule 1, 2 and 3 of the Wildlife Conservation Regulation, 1971, species High			Minor adverse			Negligible	
	Other species Low			Negligible			Negligible	
Operation of water supply project	Critical Habitats (Mole National Park, Damongo Scarp Forest Reserve IBA and the White Volta river corridor) Protected and Designated Areas Very High	Direct mortality (increase in hunting/ poaching)	Medium	Major Adverse	<ul style="list-style-type: none"> Provide funding for the employment (and, if required, training) of additional, suitably experienced and qualified local patrol staff within Mole National Park; Where possible, raise awareness/educate children and youth in local communities of the importance of wildlife. Collaborate with environmental departments and specialists on regional biodiversity conservation such as Ghana Wildlife Society and Bird Life International to provide mitigation advice regarding poaching as and when needed. 	Negligible	Minor Adverse	
	IUCN critically endangered and endangered species Very High			Major Adverse			Negligible	Minor Adverse
	IUCN vulnerable species; IBA trigger species; Schedule 1, 2 and 3 of the Wildlife Conservation Regulation, 1971, species High			Moderate Adverse			Negligible	Negligible
Maintenance of Project infrastructure and operation	Critical Habitats (White Volta river corridor) Very High	Changes to the local hydrology	Low	Moderate Adverse	<ul style="list-style-type: none"> Incorporation of water efficiency methods in WAM Training in appropriate use and handling of chemicals i.e. application between periods of 	Negligible	Minor Adverse	
	Aquatic/riparian habitat High			Minor adverse			Negligible	

Project activity	Receptor and sensitivity	Impact	Magnitude of Impact	Significance of effect	Proposed mitigation measures	Revised magnitude of impact	Residual effect
of water intake	Ecosystem services: provisioning services Medium	and water quality		Minor Adverse	rainfall to limit risk of runoff and ensure applications are the appropriate amount (i.e. no excess) • Spill kits and spill booms to be readily available; • Develop appropriate water quality/resources monitoring regime		Negligible
	IUCN critically endangered and endangered species Very High			Moderate Adverse			Minor Adverse
	IUCN vulnerable species; IBA trigger species; Schedule 1, 2 and 3 of the Wildlife Conservation Regulation, 1971, species High			Minor adverse			Negligible
	Other species Low			Negligible			Negligible
Operation of overhead powerlines	IUCN critically endangered and endangered species Very High	Direct mortality (collision/electrocution)	High	Major Adverse	<ul style="list-style-type: none"> High-visibility markers such as colourful bands and aviation balls, bird flight diverters and dynamic 'swinging plate' or 'flappers' should be installed on the transmission line in areas where high levels of activity have been recorded. Provide artificial bird-safe perches and nesting platforms placed at a safe distance from the energised parts of transmission infrastructure. Cross-arms, insulators and other parts of the power lines to be constructed so that there is no space for birds to perch where they can come into contact with energised wires. Avoid clearance of mature trees, particularly adjacent to the White Volta River and all <i>Vitellaria paradoxa</i>, where possible. Undertake regular (at least annual) monitoring of the transmission line for evidence of birds nesting on the pylons. In the event of nesting, anti-perch and nest devices will be installed to discourage birds from regularly visiting these 	Negligible	Minor Adverse
	IUCN vulnerable species; IBA trigger species; Schedule 1, 2 and 3 of the Wildlife Conservation Regulation, 1971, species High			Major Adverse			Minor Adverse
	Other species Low			Moderate Adverse			Minor Adverse

Project activity	Receptor and sensitivity	Impact	Magnitude of Impact	Significance of effect	Proposed mitigation measures	Revised magnitude of impact	Residual effect
					<p>structures. These will be replaced when necessary.</p> <ul style="list-style-type: none"> Collaborate with environmental departments and specialists on regional biodiversity conservation such as Ghana Wildlife Society and Bird Life International to provide mitigation advice regarding collision and electrocution risk from overhead powerline as and when needed. 		

Aquatic biodiversity

Summary of Aquatic Biodiversity potential effects during construction

Project activity	Receptor / Receptor sensitivity	Impact	Impact severity	Significance of effect	Proposed mitigation measure	Revised magnitude of impact	Residual effect
Construction footprint of the proposed Raw Water Intake structure at Yapei	White Volta riverine and riparian habitats Medium	Direct riparian and marginal riverine habitat loss and damage from proposed water intake structure	Low (Only a small area will be impacted - approx. 0.1 ha)	Minor Adverse	Avoidance of tree and vegetation removal. An Ecological Clerk of Works (ECW) should be retained for the pre-construction & construction works. Pre-construction walkover and development of site-specific method statements. Monitoring of compliance with method statements during construction works. Regular toolbox talks. Following the works, the riparian habitats affected by the construction works should be restored using native species.	Low	Minor Adverse Even with mitigation measures in place, some loss of habitat will occur.
	Fish species Turtles Medium	Direct loss of habitats used by these species	Low	Minor Adverse	As above for ECW. Construction works in the river should be undertaken outside key spawning periods where practically possible	Low	Minor Adverse
	Aquatic macroinvertebrates Medium	Direct loss due to project footprint	Low	Negligible	As above for ECW.	Low	Negligible
General disturbance due to construction related activities such as heavy plant movements and piling, light, etc	Fish species Turtles Medium	Changes in visual, noise and vibration stimuli due to construction activity and the increased presence of people and plant could result in the temporary disturbance has the	Low	Minor Adverse	As above for ECW. Construction works in the river should be undertaken outside key spawning periods where practically possible. Percussive piling should be avoided adjacent to the watercourse in favour of softer alternatives (e.g. silent sheet piling, vibratory sheet piling) where ground	Low	Minor Adverse

Project activity	Receptor / Receptor sensitivity	Impact	Impact severity	Significance of effect	Proposed mitigation measure	Revised magnitude of impact	Residual effect
		potential to result in physiological harm or have a negative effect on recruitment potential.			conditions allow. Where not possible, soft start piling procedures should be utilised. Any requirement for coffer dams and associated dewatering to include ecological watching brief and fish rescue and translocation procedures under an ecological watching brief.		
General construction related discharges and spills at all sites, and in particular when working near the Greater White River	Fish species Turtles Medium	Potential for chemical spills and fine sediment ingress to watercourse to cause detrimental effects on habitat and water quality that could result in negative effects on existing species and communities through lethal and sub-lethal effects.	Low	Minor Adverse	Adoption of appropriate pollution control measures as detailed within the CESMP, including relevant UK guidance such as Guidance for Pollution Prevention; GPP 5: Works and maintenance in or near water (January 2017).	Low	Negligible Considered that through adoption of appropriate pollution prevention guidance and appropriate site management procedures the risk of adverse impacts will be effectively controlled.
	Macro-invertebrates Medium	As above.	Low	Minor Adverse	As above	Low	Negligible

Summary of Aquatic Biodiversity potential effects during operation

Project activity	Receptor	Impact	Impact severity	Significance of effect	Proposed mitigation measure	Revised magnitude of impact	Residual effect
Abstraction from the White Volta River	Fish Turtles Medium	Potential for entrainment of fish and turtle life stages. Risk of impingement of fish and juvenile turtles at any associated intake screens.	Low	Minor Adverse	Ensure bank protection along the river at the intake does not encourage fish/ juveniles through use of gabions (or other structures that provide attractive habitat for juvenile fish), which could then get entrained. Recommended to use a concrete apron and wing walls, or stone pitching (rocks mortared into concrete) to the flanks of the river bank that tie into the abutments of the intake structure. Screening arrangements to avoid impingement. Pipe siting to reduce risk to demersal (benthic) species. Slow start up of the abstraction giving fish species adequate time to relocate from the vicinity of the structure. Periodic inspections conducted in storage tanks to ascertain if fish or turtles are being entrained. Where inspections suggest further screening, improvements are required the use of acoustic/bubble deterrents at the intake structure should be considered. Other deterrents such as air bubbles / strobing could be considered if required.	Low	Minor Adverse
Abstraction from the White Volta River	Watercourse and riparian habitat Medium	Impact on watercourse and riparian habitat quality as a result of water abstraction. Reduction in water quality, flow conditions or water levels in channel leading to	Low	Minor Adverse	None proposed	Low	Minor Adverse

Project activity	Receptor	Impact	Impact severity	Significance of effect	Proposed mitigation measure	Revised magnitude of impact	Residual effect
		negative effect on aquatic receptors.					
	Fish Turtles Medium	Reduction in water quality, flow conditions or water levels in channel leading to negative effect on aquatic receptors.	Low	Minor Adverse	None proposed	Low	Minor Adverse
	Macro-invertebrates	Reduction in water quality, flow conditions or water levels in channel leading to negative effect on aquatic receptors.	Low	Negligible	None proposed	Low	Negligible
Pollution incidents, discharges, runoff	Watercourse and riparian habitat Medium	Operational related discharges such as during maintenance of the Yapei WTP could lead to reduction of water quality. Such discharges could include Supernatant from the Sludge that find their way into the White Volta River. Such discharges have the potential of denigrating the water quality and could result in adverse effects on existing species communities.	Low	Minor Adverse	Implement the OESMP	Negligible	Negligible
	Fish Turtles Medium		Low	Minor Adverse	Implement the OESMP	Negligible	Negligible
	Macro-invertebrates Lose		Low	Negligible	Implement the OESMP	Negligible	Negligible

Air Quality

Summary of Air Quality potential residual effects during construction

Project activity	Receptor and sensitivity	Impact	Magnitude of impact	Significance of effect	Proposed mitigation measures	Revised magnitude of impact	Residual effect
Excavations and construction activities	Humans within 350 m of works (High sensitivity) at the following sites: - Yapei intake and WTP; and raw water pipeline - Kaladan and Bagabaga Reservoirs - Transmission / distribution lines >200 mm diameter - Busunu Reservoir - Damongo Reservoir IBA – Very High sensitivity	Construction activities can give rise to dust emissions under particular circumstances if not effectively managed. Construction activities have the potential to affect receptors near to the main construction sites due to dust generated from site preparation, site excavation, construction activities and the tracking out of dust from HGVs onto the local road network. Earth works will result in exposed areas of soil which will potentially generate dust when it is windy, with dust potentially being generated when winds blow at all times of day or night, not just during active periods of construction.	Medium	Moderate Adverse	Mitigation measures to control dust emissions during construction are included in the CESMP. Mitigation measures may include the following: <ul style="list-style-type: none"> Ensuring that parked construction vehicles are not located in proximity to sensitive receptors (particularly near to schools at Bagabaga and Busunu Reservoirs). Using wheel washes, shaker bars or rotating bristles for vehicles leaving the site where appropriate to minimise the amount of mud and debris deposited on the roads; Sheeting vehicles carrying dusty materials to prevent materials being blown from the vehicles whilst travelling; Enforcing speed limits for vehicles on unmade surfaces to minimise dust entrainment and dispersion; 	Low	Minor Adverse
	Humans within 350 m of works (High sensitivity) at the following sites: - Transmission / distribution lines < 200 mm diameter			Low	Minor Adverse	<ul style="list-style-type: none"> Ensuring all vehicles switch off engines when stationary - no idling vehicles; Ensuring an adequate water supply on the site for effective dust/particulate matter suppression/mitigation, using non-potable water where possible and appropriate; 	Low to Negligible

Project activity	Receptor and sensitivity	Impact	Magnitude of impact	Significance of effect	Proposed mitigation measures	Revised magnitude of impact	Residual effect
	<ul style="list-style-type: none"> - Kiosks and local water storage tanks 				<ul style="list-style-type: none"> • Damping down of surfaces prior to their being worked; • Regular water-spraying and sweeping of unpaved and paved roads to minimise dust and remove mud and debris; • Using cutting, grinding or sawing equipment in conjunction with suitable dust suppression techniques such as water sprays; • Ensure effective water suppression is used during demolition operations; • Storing dusty materials away from receptors as far as possible and in appropriate containment (e.g. sheeting, sacks, barrels etc.); • Erecting solid screens or barriers around dusty activities or the site boundary that are at least as high as any stockpiles on site; • Prohibiting bonfires and burning of waste materials; and • Avoiding site runoff of water or mud from site compounds by providing appropriate temporary drainage. 		
Movement of construction vehicles	Humans - High sensitivity	The main sources of gaseous emission during construction will be construction machinery, equipment and construction HGVs. The operation of vehicles and equipment will result in	Medium	Moderate Adverse	Use of transportation with more stringent emission standards would reduce vehicle emissions wherever this is feasible.	Low	Minor Adverse

Project activity	Receptor and sensitivity	Impact	Magnitude of impact	Significance of effect	Proposed mitigation measures	Revised magnitude of impact	Residual effect
		emissions of carbon monoxide, sulphur dioxide, and oxides of nitrogen.					

Air Quality potential residual effects during Operation

During operation local air quality could potentially be affected by vehicle exhaust emissions as a result of workers travelling to and from the plant, and materials required to be brought in and waste taken out by HGVs. It is anticipated that these operational traffic movements are likely to be minor, and sufficiently smaller in volume than construction traffic so as they may be considered not significant.

There are not expected to be any routine emissions to the atmosphere from the operation of the plant as electricity will be provided from the grid.

No mitigation for operational effects on air quality are required, nor is monitoring relevant.

There are no significant residual effects on air quality due to operation of the Project.

Noise and Vibration

Summary of Noise and Vibration residual effects during Construction Phase

Project activity	Receptor and sensitivity	Impact	Magnitude of impact	Significance of effect	Proposed mitigation measure	Revised magnitude of impact	Residual effect
Construction of Water Intake, WTP, \ Pumping stations and reservoirs	Residential and other noise-sensitive receptors - High	Noise and vibration from construction activities and movement of personnel and HGVs	Negligible	Negligible	Implementation of best practical measures and provision of temporary noise barriers	Negligible	Negligible
Construction of the transmission mains	Residential and other noise-sensitive receptors - High	Noise and vibration from construction activities and movement of personnel and HGVs	Low	Minor Adverse	Implementation of best practical measures and provision of temporary noise barriers	Low	Minor Adverse
Construction related traffic	Residential and other noise-sensitive receptors - High	Noise and vibration from construction activities and movement of personnel and HGVs	Low	Minor Adverse	Community liaison. Implementation of the Traffic and Transport Management Plan.	Negligible	Negligible

Summary of Noise and Vibration residual effects during Construction Phase

Project activity	Receptor and sensitivity	Impact	Magnitude of impact	Significance of effect	Proposed mitigation measure	Revised magnitude of impact	Residual effect
Mechanical plant at intake, WTP and Pumping stations	Residential and other noise-sensitive – High	Noise and vibration due to operation of the equipment	Low	Minor Adverse	Select quiet equipment, design buildings and local barriers to minimise noise emissions	Negligible	Negligible

Soils

Summary of Soil potential effects during construction

Project activity	Receptor and sensitivity	Impact	Magnitude of impact	Significance of effect	Proposed mitigation measures	Revised magnitude of impact	Residual effect
Excavations for foundations and pipelines	Soils - High	Soil loss and quality deterioration from excavations	High	Major Adverse	Development and implementation of a Soil Management Plan that covers: <ul style="list-style-type: none"> ○ How to define soil type and depth of topsoil horizons. ○ Handling and stripping of topsoil and subsoil to avoid deterioration of soil structure and mixing of topsoil and subsoil. ○ Management of stockpiles to reduce the risk of erosion, prevent weed growth and to reinstitute the ecological processes within the soil. ○ Where practicable, a wheel washing system dislodge accumulated dust and mud prior to leaving the sites. ○ Permanent/temporary land use restriction/loss. Wherever possible, excavated materials, in particular topsoils, will be re-used on site. The Contractor will undertake revegetation only with native species and will execute site rehabilitation including all waste removal and soil restoration at all sites impacted by construction activities.	Medium	Moderate Adverse
Soil stockpiles		Loss of soil structure in stockpiled soils	High	Major Adverse	Management of stockpiles in accordance with the Soil Management Plan	Low	Minor Adverse
Movement of construction vehicles and personnel		Soil compaction	Medium	Moderate Adverse	Permanent/temporary land use restriction/loss. Development and implementation of traffic controls to limit passage of vehicles to designated roads thus avoiding disturbance to soils and clearance of vegetation.	Low	Minor Adverse

Project activity	Receptor and sensitivity	Impact	Magnitude of impact	Significance of effect	Proposed mitigation measures	Revised magnitude of impact	Residual effect
<p>Clearance of vegetation and topsoils sites</p> <p>Soil stockpiles</p>		Soil erosion	Low	Minor Adverse	<p>Development and implementation of a Soil Management Plan.</p> <p>Development and implementation of traffic controls to limit passage of vehicles to designated roads thus avoiding disturbance to soils and clearance of vegetation.</p> <p>Construction activities will be timed to avoid the rainy season.</p>	Negligible to Low	Minor Adverse to Negligible
<p>Excavations for foundations and pipelines</p>		Contamination of soils through use and accidental spills	Medium	Moderate Adverse	<p>Development and implementation of a Spill Prevention and Response Plan that covers:</p> <ul style="list-style-type: none"> o Management of all chemicals, fuels and oils used during the Project, including the construction diesel generators. o Training all staff and third party suppliers in the emergency procedures. o Ensuring spill kits are kept in accessible locations at all times during construction, and employees trained in their use and disposal. o Ensuring all vehicles, machinery and equipment are maintained and refuelled on hard standing and will develop and adopt procedures to minimise the risk of spills to the environment. <p>Development and implementation of a Waste Management Plan. Wastes generated during the construction activities that have the potential to pollute will be stored within appropriate storage facilities (bunded, secondary containment) and procedures will be implemented for handling, storage, transport and transfer, subject to a full method statement to address construction risks and avoid impacts.</p>	Negligible to Low	Minor Adverse to Negligible

Summary of Soils potential effects during operation

Project activity	Receptor and sensitivity	Impact	Magnitude of impact	Significance of effect	Proposed mitigation measures	Revised magnitude of impact	Residual effect
O&M activities, in particular storage and use of hazardous materials	Soils High	Contamination of soils	Medium	Moderate Averse	Development and implementation of a Spill Prevention and Response Plan that covers: <ul style="list-style-type: none"> • Management of all chemicals, fuels and oils used during the Project, including the construction diesel generators. • Training for all staff and third party suppliers in emergency procedures. • Ensure spill kits are kept in accessible locations at all times during construction, and employees trained in their use and disposal. • Ensure all vehicles, machinery and equipment are maintained and refuelled on hard standing and will develop and adopt procedures to minimise the risk of spills to the environment. • Development and implementation of a Waste Management Plan: • Wastes generated during the construction activities that have the potential to pollute will be stored within appropriate storage facilities (bunded, secondary containment) and procedures will be implemented for handling, storage, transport and transfer, subject to a full method statement to address construction risks and avoid impacts. • Measures that ensure the sludge is not disposed of to land. 	Low to Negligible	Minor Adverse to Negligible

Waste

Summary of Waste potential effects during construction

Project activity	Receptor and sensitivity	Impact	Magnitude of impact	Significance of effect	Proposed mitigation measures	Revised magnitude of impact	Residual effect
Excavations for foundations and pipelines	Waste management facilities High	Requirement to transport excavated materials to landfills.	Low to Medium	Minor Adverse	<ul style="list-style-type: none"> Material to be used as backfill around structures and in trenches. Material to be left on-site and graded to levels. Materials to be recycled (on or off site) or screened and re-used (on or off site). 	Low	Negligible
Waste Management and Disposal – Non-hazardous waste	Humans and waste management facilities High	There are potentially a number of risks to human health and the environment that are associated with the handling, storage and disposal of waste, both on and off-site. Incorrect handling and storage could result in possible cross contamination, wind-blown litter, and contamination of air, soil and water resources; as well as direct and indirect effects on human health. Environmental pollution with organic and non-organic waste generated from Project activities may occur due to uncontrolled disposal and inadequate management of waste during road construction and operation of the camps for construction workers. Discharge of untreated wastewaters can result in pollution to soils,	Medium to High	Moderate to Major Adverse	<ul style="list-style-type: none"> Waste Management Plan. The waste hierarchy shall be applied in project planning to ensure efficient use and management of resources so that priority is to prevent generation of waste at source (i.e. smart purchase approach by estimating the amount correctly and efficient use of materials so that no surplus material that might end up as a waste) and facilitate waste recovery wherever possible. Provide project employees with training on waste management to improve knowledge and awareness on reducing waste generation, waste types and their classification, and project waste management rules. Disposal of wastes without a permit shall be prohibited. Designated waste storage area will be located away from surface water drains and areas which discharge directly to the water environment. Each designated waste storage area will be equipped with waste skips, containers or bins for temporary storage before recycling, treatment or disposal off site. Periodic inspections of waste storage areas will 	Low to Medium	Minor Adverse

Project activity	Receptor and sensitivity	Impact	Magnitude of impact	Significance of effect	Proposed mitigation measures	Revised magnitude of impact	Residual effect
		water bodies and have adverse effects on human health, flora and fauna and surface water.			be conducted; inspection findings will be documented. <ul style="list-style-type: none"> • Temporary storage areas for inert and non-hazardous waste will: <ul style="list-style-type: none"> a. be placed in areas with minimum fire and explosions risks; b. be easily identifiable and clearly signed; c. have periodic inspections and findings documented. • Waste storage containers will be: <ul style="list-style-type: none"> a. clearly labelled – to describe the contents using the appropriate waste labels which shall be completed; b. old labels shall be removed to avoid confusion; c. appropriate to the waste they contain; d. appropriately sealed (e.g. with a lid or cover); e. not emitting any harmful gases or generating heat. • Food waste shall be disposed to a designate collection points protected with fencing in order to prevent from animal poisoning. The burning of waste will be prohibited.		
Waste Management and Disposal – hazardous waste	Humans and waste management facilities High	As above	Medium	Moderate Adverse	<ul style="list-style-type: none"> • Waste will be stored in a manner that: <ul style="list-style-type: none"> a. prevents a contact between incompatible wastes, and b. allows for inspection between containers to monitor leaks or spills. • Hazardous waste will be stored in closed containers away from direct sunlight, wind and rain. 	Low	Minor Adverse

Project activity	Receptor and sensitivity	Impact	Magnitude of impact	Significance of effect	Proposed mitigation measures	Revised magnitude of impact	Residual effect
					<ul style="list-style-type: none"> • Secondary containment systems will be constructed with materials appropriate for the wastes being contained and adequate to prevent loss to the environment. Secondary containment is included wherever liquid wastes are stored in volumes greater than 220 litres. The available volume of secondary containment will be at least 110% of the total storage capacity, or 25% of the total storage capacity. • Adequate ventilation will be provided where volatile wastes are stored. • Readily available information on chemical compatibility to employees will be provided, including labelling each container to identify its contents. • The hazardous waste storage area will be clearly identified and demarcated, including on a facility map or site plan. Access to hazardous waste storage areas will be limited to employees who have received proper training. • Spill response and emergency plans will be prepared to address their accidental release. For spills, once the sand absorbs oil, it shall be disposed designated waste disposal area. Before removing contaminated soils, take special containers or plastic bags to avoid pollution. • Storage areas will be provided with fire extinguishers, spill kits according to the type and quantity of stored hazardous waste. Waste containers will be secured and labelled with the contents and associated hazards, be properly loaded on the transport vehicles and be accompanied by a shipping paper with the 		

Project activity	Receptor and sensitivity	Impact	Magnitude of impact	Significance of effect	Proposed mitigation measures	Revised magnitude of impact	Residual effect
					description of the load and its associated hazards.		
Waste Management and Disposal – wastewaters	Humans and waste management facilities High	Risks to human health and the environment associated with the handling, storage and disposal of wastewaters.	Medium	Moderate Adverse	<ul style="list-style-type: none"> Site sanitary facilities will be provided, with all waste collected and disposed of by an approved contractor. No direct or indirect discharge to the site or the river will occur. Vehicle and equipment wash will be undertaken at designated areas where all wastewater can be collected and disposed of by an approved contractor. No direct or indirect discharge to the site or the river will occur. 	Low	Minor Adverse

Summary of Waste potential effects during operation

Project activity	Receptor and sensitivity	Impact	Magnitude of impact	Significance of effect	Proposed mitigation measures	Revised magnitude of impact	Residual effect
Waste Management and Disposal – Non-hazardous waste	Humans and waste management facilities High	Potential contamination of air, soil and water resources. Human health impacts. Pressure on existing landfill.	Medium	Moderate Adverse	<ul style="list-style-type: none"> Develop and implement Waste Management Plan. Identify target for waste recovery and recycling. Engage with private/local recycling to establish an appropriate level of segregation on site for onwards recovery. MSW waste will be gathered on a regular basis and stored in closed containers until recycled or disposed of as per the local legal requirements. Provision of clearly marked and / or colour coded to enable easy identification of what materials should be placed inside (residual and recyclable waste) for both visitors and staff. 	Low	Minor Adverse
Waste Management and Disposal – hazardous waste	Humans and waste management facilities High	Potential contamination of air, soil and water resources. Human health – potential hazards of handling hazardous substances include	Medium	Moderate Adverse		Low	Minor Adverse

Project activity	Receptor and sensitivity	Impact	Magnitude of impact	Significance of effect	Proposed mitigation measures	Revised magnitude of impact	Residual effect
		inhalation of hazardous vapours and corrosive reactions to body parts. Fire hazard potential for reaction between incompatible chemicals. Pressure on existing landfill.			<ul style="list-style-type: none"> • Within the designated waste storage area(s) clear signs should be placed on the walls behind the receptacles. • A dedicated area for the storage of hazardous waste arisings (including clinical waste, batteries and WEEE). • Provision of regular training for staff on recycling and waste reduction and the practices necessary to minimise waste and facilitate good practice waste management. • Recycling of vehicle and plant maintenance waste i.e. oil or grease contaminated filters and Recycling or re-use of empty chemical containers or bags. • Urban waste will be disposed of in containers properly labelled indicating the type of waste. • Organic waste will be stored in a manner that ensures vermin will not be attracted. • Where possible, compost organic material and vegetation. 		
Sludge	Waste management facilities High	Disposal of sludge from WTP process to landfill	Medium	Moderate Adverse	<ul style="list-style-type: none"> • Process management to minimise the sludge produced. 	Medium	Moderate Adverse

Socio-economic impact assessment

Summary of Socio-economic impact assessment potential residual effects during construction

Project activity	Receptor and sensitivity	Impact	Magnitude of Impact	Significance of effect	Proposed mitigation measures	Revised Magnitude of Impact	Residual effect
Land clearance, excavating, stockpiling, backfilling, compacting, levelling, movements of construction personnel, and material and equipment transport and handling	Health and wellbeing of Tamale Metropolis and Sagnarigu district Medium	Heightened dust levels, vehicle emissions, noise and vibration and present general nuisance impacts	Medium	Moderate Adverse	A detailed Air Quality, Noise and Traffic Management Plan will be developed and implemented as part of the CESMP. All Project transport providers and employees to be strictly required to limit their speed to 30 km/h or less when passing through or near local communities, with the suspension or cancellation of contract in the event that this is not adhered to. Local authority representatives must also be made aware of this obligation so they can hold contractors to account.	Low	Minor Adverse
	Health and wellbeing of Central and West Gonja districts High		Medium	Major Adverse		Low	Minor Adverse
Works near rivers	Health and well-being of Water Users High	Increased turbidity and pollution events affecting water supply / ecosystem services	Low	Minor Adverse	Stockpiles shall be located at least 10m away from watercourses. Design fertile soil storage pile according to GIIP and cover stockpiles. Sediment controls shall be established around unstabilised stockpiles and batters. If surfaces of stockpiles are producing dust, they shall be dampened with controlled application of water sprays or screen as appropriate. If silty water is formed by erosion of stockpiles, it shall be managed in a suitable manner.	Low	Minor Adverse
Influx of workers	Health and wellbeing of Tamale Metropolis and Sagnarigu district Medium	Increase tension between local communities and the workers Inequalities in pay and conditions between local and foreign workers	Medium to Low	Minor to Moderate Adverse	A Local Resourcing Plan will be developed to maximise possibilities for involvement of local communities in Project employment. Delivery of a short course in community awareness and responsibility (that includes instruction on sexual harassment, conduct, and	Low	Minor Adverse

Project activity	Receptor and sensitivity	Impact	Magnitude of Impact	Significance of effect	Proposed mitigation measures	Revised Magnitude of Impact	Residual effect
	Health and wellbeing of Central and West Gonja districts High		Medium to Low	Moderate to Major Adverse	health) will be included as part of the induction programme for all Project employees. All Project employees will be issued with a Code of Conduct addressing Colas expectations and punitive measures concerning their discipline and behaviour (including for inappropriate sexual fraternisation) in Project-affected communities.	Low	Minor Adverse
Construction activities and vehicular movements	Community safety and security Tamale Metropolis and Sagnarigu district Medium	Public injuries as a result of, for example; vehicular movements; electricity and gas lines being damaged; construction materials and equipment being dropped; and, machinery or operator loss of control	Medium to High	Moderate Adverse	Development and implementation of an Community Health, Safety, Community Grievance Mechanism and Security Plan and Emergency Preparedness and Response Plan. A robust communication plan and grievance mechanism will be in place. Stakeholder engagement in advance of works to inform users and consult stakeholders (and sensitive receptors (e.g. schools, hospitals) that may be affected by traffic increase. All Project transport providers and employees to be strictly required to limit their speed to 30 km/h or less when passing through or near local communities, with the suspension or cancellation of contract in the event that this is not adhered to.	Low	Minor Adverse
	Community safety and security Tamale Central and West Gonja districts High		Medium to High	Moderate to Major Adverse		Low	Minor Adverse
	Community safety and security Road Users High		Medium to High	Moderate to Major Adverse		Low	Minor Adverse
Security guards	Community safety and security Tamale Metropolis and Sagnarigu district Medium	Human rights violations	Medium	Moderate Adverse	The security developed by Biwater will comply with local laws.	Low	Minor Adverse

Project activity	Receptor and sensitivity	Impact	Magnitude of Impact	Significance of effect	Proposed mitigation measures	Revised Magnitude of Impact	Residual effect
	Tamale Central and West Gonja districts High						
Construction employment	Employment, skills and livelihoods Tamale Metropolis and Sagnarigu district Medium Tamale Central and West Gonja districts High	Temporary employment of local workers and youth, increased incomes, training and skills development	Medium	Moderate Beneficial	Recruitment process will be fully disclosed to the public and open to all people locally of working age and ability, including women. A Local Resourcing Plan will be developed to maximise possibilities for involvement of local communities following IFC PS2 and GIIP; and Biwater work with the Labour Department in Tamale and Damongo. Where possible Biwater will ensure that this includes employment of the youth (16-25). Individual training registers for a worker will be maintained which they can have at the end of contract for procuring future work.	Medium	Moderate Beneficial
Demand for goods and services	Local and regional economy High	Impact on national economy through state receipt of import duties and value added taxes on construction supplies, and through state receipt of workforce income tax contributions. Project expenditure on sector base facilities and principally regionally and locally sourced raw materials, services, foodstuffs, and labour Salary-based expenditure of Project construction employees and contractors on	Medium	Moderate Beneficial	Development of a Local Sourcing and Procurement Plan.	Medium	Moderate Beneficial
	National economy Medium		Medium	Minor Beneficial		Medium	Minor Beneficial

Project activity	Receptor and sensitivity	Impact	Magnitude of Impact	Significance of effect	Proposed mitigation measures	Revised Magnitude of Impact	Residual effect
		transport, assets, hard goods and consumables, will principally provide additional stimulus to the local economy.					
Clearance of vegetation; potential spills in the White Volta River; resulting in impacts on provisioning services	Local communities High	Clearance resulting in food plants such as the Shea Tree <i>Vitellaria paradoxa</i> and African locust bean <i>Parkia biglobosa</i> being lost. Changes in local hydrology due to the construction of the water intake and changes in water quality due uncontrolled discharges may impact ecosystem services (provision of freshwater and food) downstream of the works.	Low	Minor Adverse	Ecological mitigation measures to reduce clearance on site – see Terrestrial ecology. Salvaging of trees. Measures to avoid pollution during works near rivers – see Water Quality.		Minor Adverse to Negligible
Construction employment labour and working conditions	Construction Workers High	Impacts on human rights, discrimination, child labour, etc if not managed appropriately. However, Bewater has significant experience in Ghana. They will comply with the Ghanaian Labour Code and GIIP and will ensure that all employees will be provided with a contract. Bewater also has a Collective Bargaining agreement, which they will negotiate with the National Union wherein all conditions relative to employment are stated.	Low to Medium	Minor to Moderate Beneficial	Development of an Environmental and Social Management System, including a Labour Management Plan and OHS Plan in line with applicable national labour laws and IFC PS2 and general GIIP, and a labour grievance mechanism will be put in place. The Project's commitment to labour rights, including specific policies, will be identified in procurement information and addressed in contracts. The Project human resource policy will be readily available and understandable to all employees. The Contractor should help promote fiscal sustainability and responsible wage expenditure among directly contracted Project workers. A Labour Grievance Mechanism will be put in place during the Construction Phase; and will be disclosed to all employees.	Medium	Moderate Beneficial

Project activity	Receptor and sensitivity	Impact	Magnitude of Impact	Significance of effect	Proposed mitigation measures	Revised Magnitude of Impact	Residual effect
Construction activities labour and working conditions	Construction Workers High	Potential that workers could be exposed to an additional level of personal safety risk relating to workplace activities e.g. noise	Medium	Moderate Adverse	Development and implementation of an OHS Plan and an Emergency Preparedness and Response Plan. All construction will to be contractually obliged to adhere to internationally recognised best practice OHS standards, including regular reporting and auditing against these to the Project contracting authority. Appropriate training for the job will be provided and records of all training maintained up to date. All products used will comply with relevant international standards such EN BS, IFC Performance Standards, and corporate sustainable procurement and shipping policy.	Low	Minor Adverse
Demand for services such as water, electricity and health	Infrastructure and services - health services Medium	There may be a demand for health services related to potential accidents on construction sites.	Low	Minor Adverse	Appropriate licenses and permits will be obtained. The Emergency Preparedness and Response Plan will be developed in liaison with local health providers.	Negligible to Low	Minor Adverse to Negligible
	Infrastructure and services – electricity Medium	There will therefore be no demand on the grid mains supply during construction.	No impact	-	-	-	-
	Infrastructure and services – water and sanitation Medium	Water will come from the White Volta river and be treated using a Biwater small package WTP.	No impact	-	-	-	-
Permanent land requirements	Physical and economic displacement High	Permanent loss of land resulting in: <ul style="list-style-type: none"> Permanent loss of land owned by traditional 	Medium	Minor adverse to Moderate	Preparation of a SLACP. Development of a detailed Land Acquisition and Compensation Action Plan.	Low	Minor Adverse

Project activity	Receptor and sensitivity	Impact	Magnitude of Impact	Significance of effect	Proposed mitigation measures	Revised Magnitude of Impact	Residual effect
		chiefs and access to land for informal grazing and crops at the Yapei WTP/intake sites <ul style="list-style-type: none"> • Permanent loss of a football pitch at Kaladan reservoir • Permanent loss of land owned by Ghana Education Service (Tamale Senior High School) and used for crops 		Adverse (Kaladan)			
Temporary land requirements	Physical and economic displacement High	Temporary land requirements resulting in: <ul style="list-style-type: none"> • Potential loss or restriction of access to properties and business • Depending on time of year of the works, loss of crops within the works area along road pipeline routes 	Low	Minor Adverse	Preparation of a SLACP. Development of a detailed Land Acquisition and Compensation Action Plan. Farmers will be allowed to harvest any crops already planted on the Project sites. Where this is not possible, compensation will be provided to full replacement value. Where possible, pre-emptive action through liaison with local communities to ensure that no planting prior to the works occurs in areas that will be affected by the works.	Negligible to Low	Minor Adverse to Negligible

Summary of Socio-economic impact assessment potential residual effects during operation

Project activity	Receptor and sensitivity	Impact	Magnitude of Impact	Significance of effect	Proposed mitigation measures	Revised Magnitude of Impact	Residual effect
Provision of potable water supply – 135 MLD	Infrastructure and services – Water Supply High	Increase the production capacity of potable water to meet the demand horizon of 2040 and beyond in the Project Area. Diversification of the production away from the existing Dalun WTP. Improvement in the distribution system management. Provision of new water supply to stressed areas. Additional production capacity.	High	Major Beneficial	In order to maximise access to the Project water supply, the extent and location of distribution pipelines will need to be reviewed as part of the WAM activities in the Construction Phase. It is recommended that in the consideration of the final distribution networks, a review is undertaken to ensure the maximum connections to the local communities.	High	Major Beneficial
	Infrastructure and services – Tamale Metropolis and Sagnarigu district Medium	Estimated 800,000 people in the Northern and Savannah Regions will benefit from the Project.	High	Major Beneficial		High	Major Beneficial
	Infrastructure and services - Central and West Gonja districts High		High	Major Beneficial		High	Major Beneficial
Operation of the sites	Infrastructure and services – Electricity Medium	Project sites will be provided from the main power grid.	Low	Minor Adverse	Outside the scope of this Project, but Ghana is working towards improved electricity generation.	Low over time	Negligible
Provision of potable water supply	Infrastructure and services – Health services High	Use of health care facilities may reduce due to reductions in water-related health issues. Though some demand due to O&M accidents and injuries may prevail.	High	Moderate Beneficial	Development and, as necessary, implementation of an Emergency Preparedness and Response Plan, developed in liaison with local health providers.	High	Moderate Beneficial

Project activity	Receptor and sensitivity	Impact	Magnitude of Impact	Significance of effect	Proposed mitigation measures	Revised Magnitude of Impact	Residual effect
	Tamale Metropolis and Sagnarigu district Medium	Reductions in water-related health issues. Improvements in well-being due to availability to clean, reliable water supply.	High	Moderate Beneficial	Water supply network will be subjected to regular testing to ensure its suitability for use as per national drinking water standards. If maximum permissible concentrations are exceeded, appropriate measures will be put into place to remedy the situation. A post-Project implementation monitoring of the health profiles by the District, Municipal and Metropolitan (MMDA) Health directorates in the Project AOI should be completed. A community grievance mechanism will be available.	High	Moderate Beneficial
	Central and West Gonja districts High	Reductions in water-related health issues. Improvements in well-being due to availability to clean, reliable water supply.	High	Major Beneficial		High	Major Beneficial
Provision of potable water supply	Health and well being Tamale Metropolis and Sagnarigu district Medium	Absence of an associated development of a wastewater treatment plant may result in an increased deterioration of water quality in local rivers due to the increased volume of untreated wastewater as a result of increased water use with no commensurate adequate sewage treatment facility.	High	Moderate Adverse	The only effective mitigation measure is to provide additional wastewater treatment capacity in the Project Area; however, until this is achieved, the effect will remain the same.	High	Moderate Adverse
	Health and well being Central and West Gonja districts High		High	Major Adverse		High	Major Adverse
Provision of overhead power to the operational sites	Health and well being Tamale Metropolis and Sagnarigu district Medium Central and West Gonja districts High	EMFs with detrimental effects on health within very close proximity to the lines (10 to 20 m)	Low to negligible	Negligible to Minor Adverse	Overhead lines should be sited to avoid proximity (10 to 20 m) of sensitive receptors such as schools and residential properties.	Low to negligible	Negligible

Project activity	Receptor and sensitivity	Impact	Magnitude of Impact	Significance of effect	Proposed mitigation measures	Revised Magnitude of Impact	Residual effect
Operation of the sites	Community safety and security Tamale Metropolis and Sagnarigu district Medium Central and West Gonja districts High	Unauthorised access to sites. Accidental spills.	Negligible	Negligible	All sites will be fenced and only authorised personnel will be permitted to enter. Each site will have an entry and exit logs and vehicle access restrictions. An Emergency Preparedness and Response Plan will be prepared and implemented as necessary. The final Emergency Preparedness and Response Plan will be disclosed to the GWCL and local communities via the CLO. A community grievance mechanism will be available.	Negligible	Negligible
Operation of the Project – employment benefits	Employment, skills and livelihoods Tamale Metropolis and Sagnarigu district Medium	Approximately 46 staff positions will be available; 34 at Yapei WTP, nine at Bagabaga and Kaladan Reservoirs and three in the Tamale offices. For those employed, this will result in potentially improved incomes and job security; and upskilling through training.	High	Moderate Beneficial	A Labour Management Plan will be prepared for the operation phase or integrated into existing GWCL labour plans. Operator will develop and implement a Local Resourcing Plan. Operator will undertake structured training of personnel. A Labour grievance mechanism will be put in place by the Operator.	High	Moderate Beneficial
	Employment, skills and livelihoods Central and West Gonja districts High		High	Major Beneficial		High	Major Beneficial
Provision of water supply	Employment, skills and livelihoods Tamale Metropolis and Sagnarigu district Medium	Water tariffs will favour access for those with higher incomes. Savings may be made overall by providing a cheaper source of water than currently used when mains supplies are not accessible.	Medium	Moderate Beneficial	None proposed.	Medium	Moderate Beneficial
	Employment, skills and livelihoods	Accessibility may be harder for those with a lower income,	Low (West Gonja)	Minor Positive or	Where necessary, i.e. in the more rural communities in the Project Area, the price of the	Low	Minor Positive

Project activity	Receptor and sensitivity	Impact	Magnitude of Impact	Significance of effect	Proposed mitigation measures	Revised Magnitude of Impact	Residual effect
	Central and West Gonja districts High	especially in West Gonja districts most.	Medium (Central Gonja)	a Minor Adverse	tariffs to vulnerable people should be reviewed to maximise accessibility.		
Water abstraction and operation of the intake	Local communities High	Changes in local hydrology due to the abstraction of water and changes in water quality due to uncontrolled discharges during maintenance may indirectly impact Ecosystem Services (provision of freshwater and food) downstream of the water intake.	Low	Minor Adverse to Negligible	See Water Quality and Aquatic Ecology	Negligible	Negligible
Operation of the Project. O&M contracts.	Economy – Local and regional High	Indirect impacts stemming from: a demand for O&M contractors; improved water supply, employment, earnings and expenditure discussed above. These indirect impacts include; a bigger local tax base to support social service and infrastructure provision; adequate water supplies to encourage commercial and industrial development thereby creating employment opportunities; and subsequent enhanced circulation of money in the local economies.	High	Major Beneficial	Wherever possible, the Operator should seek to use local goods and services.	High	Major Beneficial
	Economy – National Medium		Medium	Moderate Beneficial	None proposed.	Medium	Moderate Beneficial

Project activity	Receptor and sensitivity	Impact	Magnitude of Impact	Significance of effect	Proposed mitigation measures	Revised Magnitude of Impact	Residual effect
Operation of the Project.	Labour and working conditions. Workers High	If not managed correctly, there is a risk of negative impacts on labour and working conditions associated with the project's supply chain and occupational health and safety. However, it is expected that the GWCL and O&M Contractors will comply with the Ghanaian Labour Law and will ensure that all employees, including permanent and temporary, will be provided with a legally compliant contract.	Low	Minor Adverse	<p>All national laws related to labour rights, the provision of satisfactory working conditions and terms of employment, workers' organisations, non-discrimination and equal opportunity, and protecting the work force by not employing child labour or forced labour will be met.</p> <p>The Operator should develop a Human Resources Policy and Procedures detailing the principles guiding the Operator's approach to management of workers, including equal opportunities, non-discrimination, non-employment of children or forced workers and Operator's approach to trade unions, collective bargaining and employment of migrant workers.</p> <p>All Project staff will be issued with an individual contract of employment detailing their rights and conditions in accordance with the Ghanaian law and IFC requirements related to working hours, wages, overtime, benefits and compensation (such as maternity or annual leave) and update the contract when material changes occur.</p>	Negligible	Negligible

Project activity	Receptor and sensitivity	Impact	Magnitude of Impact	Significance of effect	Proposed mitigation measures	Revised Magnitude of Impact	Residual effect
Operation of the Project.	Labour and working conditions. Workers High	OHS risks during operation are Medium to Low, depending on the activity (for example, risk will be higher for the workers at the WTP who are working with hazardous materials), and therefore appropriate training of staff will be required; it is assumed that a sufficiently trained and equipped workforce will be provided to deliver O&M activities in accordance with Ghanaian law and GIIP.	Medium to Low	Minor to Moderate Adverse	The Operator will employ a suitably qualified HSE manager and support staff in order to assess risks to worker health and safety and implement preventive and protective measures. An O&M Plan will be drawn up by the O&M engineers and safety specialists in accordance with equipment manufacturer specifications and international OHS best practices. All staff will be appropriately trained to perform the job they are employed for, and all project workers will be given basic health and safety training, including in the use of appropriate PPE. An Emergency Preparedness and Response Plan will be prepared covering risks to workers in emergencies, that addresses fire, flood, road accidents, serious personal injury, etc., and provides operational facility Emergency Response Teams.	Low to Negligible	Minor Adverse to Negligible

Cultural heritage

Summary of Cultural Heritage potential residual effects during construction

Project activity	Receptor and sensitivity	Impact	Magnitude of Impact	Significance of effect	Proposed mitigation measures	Revised Magnitude of Impact	Residual effect
Construction works	Identified Tangible Heritage Mole National Park above ground features- Very High	Potential impacts to the site through construction activities and traffic	Low	Minor Adverse	Hire professional cultural heritage specialist to design method statements for work in Mole On-going liaison with the client, GMMB and local chiefs / Park staff Provision of cultural heritage tool box talks and information sheets for construction staff Code of Conduct will include prohibiting worker interaction with cultural heritage.	Negligible	Minor Adverse
	Other sites of Identified Tangible Heritage – Low to High	Potential impacts to the site through construction activities and traffic	Low	Minor Adverse		Negligible	Negligible
Excavations for pipelines, WTP/ Reservoir sites and kiosk foundations	Unidentified tangible cultural heritage - Medium	Damage and destruction of buried archaeology	Low	Minor Adverse	Chance finds procedure	Low	Minor Adverse
	Mole National Park – buried archaeology - very High	Damage and destruction of buried archaeology	Medium	Major Adverse	Chance finds procedure	Low	Minor Adverse
	Intangible Cultural Heritage Medium	Disturbance to traditional lifestyles due to the influx of non-local workforce during the construction works	Medium	Moderate Adverse	On-going liaison with the client, GMMB and local chiefs / Park staff Provision of cultural heritage tool box talks and information sheets for construction staff Code of Conduct will include prohibiting worker interaction with cultural heritage.	Negligible to Low	Negligible to Minor Adverse

Summary of Cultural Heritage potential residual effects during operation

Project activity	Receptor and sensitivity	Impact	Magnitude of Impact	Significance of effect	Proposed mitigation measures	Revised Magnitude of Impact	Residual effect
Presence of above ground infrastructure	Mole National Park tentative World Heritage site – Very high	Changes to the setting resulting from presence of Project infrastructure	Negligible	Minor Adverse	None proposed, beyond landscape planting	Negligible	Minor Adverse
Presence of above ground infrastructure	Shrines close to the intake - Medium	Changes to the setting resulting from presence of Project infrastructure	Negligible	Negligible	None proposed, beyond landscape planting	Negligible	Negligible
Pipelines	Shrines close to pipeline routes – Low to High sensitivity	No impact as pipelines will be buried.	No impact	-	-	--	

Labour issues

Construction of the Project

Biwater will have an overall Contractor project management team during construction and will be responsible for recruiting and managing workers they use on construction activities.

The Project will generate a range of employment opportunities, including specialist labour, however there will also be the requirement for semi-skilled and unskilled labour. Most labour will be sourced from the local community.

All Human Rights will be protected during the Project.

Box 9. Summary of Labour Issues and control measures during construction

During construction potential impacts related to labour and working conditions include:

- Foreign migrant workers, especially those who are unskilled, are known to be more vulnerable to exploitation than workers from the local area, and that workers from particular regions / countries are also likely to be more vulnerable to exploitation as a result of standard recruitment practices in their countries of origin.
- Potential for migrant workers to pay recruitment fees in home country or in Ghana to secure work, increasing vulnerability to exploitation, such as forced labour.
- Potential for employers to hold migrant workers' passports on arrival in Ghana, increasing vulnerability to exploitation, such as forced labour.
- Potential for workers to be paid below the minimum wage, or not be paid on time.
- Excessive overtime and inadequate rest time.
- Potential for migrant workers to be discriminated against and not be treated as equals by superintendents.
- Inability of workers to raise complaints or to engage constructively with employers.
- Potential for workers to be employed in unsafe and/or unhealthy working conditions, and potential loss of life.
- Limitations on free association and right to strike.
- Right to an effective remedy/ availability of suitable means of grievance resolution in relation to incidents involving security services.
- Potential for workers' freedom of movement to be negatively impacted.
- Potential for security to work excessive hours, not be paid on time, be provided poor temporary accommodation.
- Potential for workers to be informally recruited, increasing risk of unethical recruitment practices, increasing worker vulnerability to exploitation.
- Potential for child workers to be employed at the margins of the Project.
- Potential for workers to be informally employed, increasing worker vulnerability to exploitation.
- Risk of spread of COVID-19 among working personnel.

During Construction the following control measures will be implemented:

Biwater has an HR Policy; Sustainable Procurement and Shipping Policy; Collective Bargaining Policy; Equal opportunities and Discrimination Policy; Modern Salary; Statement on Ethics; Termination policy; Health and Safety Policy; and a Grievance Policy.

The policies detail the principles guiding Biwater's approach to management of workers, including equal opportunities, non-discrimination, non-employment of children or forced workers and Biwater's approach to trade unions, collective bargaining and employment of migrant workers. The policies cover the following:

- Human resources / labour and working conditions policies and procedures;
 - Social responsibility
 - Anti-corruption and bribery
 - Working conditions and terms of employment
 - Workers' organisations
 - Non-discrimination and equal opportunity (including migrant workers)
 - Labour grievance mechanism
 - Worker Code of Conduct (this is contained within the Biwater Collective Agreement as well as a Separate Code of conduct policy to cover wider E&S issues)
- Protecting the workforce;
 - Child labour
 - Forced labour
 - Modern slavery
- Occupational health and safety; and
- Supply chain.

Biwater has also signed an agreement with the Construction and Building Materials Workers' Union of the Trades Union Congress in Ghana.

Biwater will provide all construction workers with documented information that is clear and understandable, regarding their rights under national labour and employment law and any applicable collective agreements, including their rights related to hours of work, wages, overtime, compensation, and benefits upon beginning the working relationship and when any material changes occur.

Biwater will provide all construction workers with a summary of their employment service and training activities at the end of each contract as a means to finding continued employment.

Operation of the Project

GWCL will have an overall site management during operations and will be responsible for recruiting and managing workers they use on operational activities.

The Operations will generate a range of employment opportunities, including specialist labour, however there will also be the requirement for semi-skilled and unskilled labour. All labour will be sourced from the local community.

All Human Rights will be protected during the operations.

Box 10. Summary of Labour Issues and control measures during operation

During operation, potential impacts related to labour and working conditions include:

- Potential for security to work excessive hours and not be paid on time.
- Potential for Sub-contractors, where used, to not have policies, procedures and systems in place to protect workers' rights.
- Potential for workers to be informally recruited, increasing risk of unethical recruitment practices, increasing worker vulnerability to exploitation.
- Potential for child workers to be employed at the margins of the Project.
- Potential that female staff working on site will be vulnerable to discrimination and or harassment by male colleagues.
- Potential for impacts in relation to a safe and healthy working environment.

During operation the following control measures will be implemented:

GWCL will adopt and implement human resources policies and procedures appropriate to its size and workforce that set out its approach to managing workers consistent with the requirements of IFC PS 2 and national law. Additional information on how to develop HR policies can be found in "*Measure & Improve your Labor Standards Performance: Performance Standard 2 Handbook for Labor and Working Conditions*" (Social Accountability International and IFC, 2010).

GWCL will provide workers with documented information that is clear and understandable, regarding their rights under national labour and employment law and any applicable collective agreements, including their rights related to hours of work, wages, overtime, compensation and benefits upon beginning the working relationship and when any material changes occur.

Policies and procedures dealing with human resource matters include, but are not limited to:

- Human resources / labour and working conditions policies and procedures:
 - Social responsibility
 - Anti-corruption and bribery
 - Human resources
 - Working conditions and terms of employment
 - Workers' organisations
 - Non-discrimination and equal opportunity (including migrant workers)
 - Retrenchment

- Labour grievance mechanism
- Sustainable procurement and shipping
- Worker Code of Conduct
- Protecting the workforce:
 - Child labour
 - Forced labour
- Occupational health and safety
- Sub-contractor selection and monitoring
- Workers engaged by third parties

All staff will be made aware of their role in ensuring the Project meets international standards related to labour and working conditions. In particular, overtime arrangements and the timely payment of wages will be addressed. GWCL will provide all staff with a summary of their employment service and training activities at the end of each contract

8. Summary of Decommissioning Phase Impacts and Mitigation Measures

At the end of the life of the project, as appropriate GWCL will have, among other things, the following alternatives for decommissioning:

- Undertake major rehabilitation works for civil engineering works;
- Renew electro-mechanical and hydro-mechanical equipment; or
- Complete the decommissioning of the installations.

9. Conflict Sensitivity

Ghana operates a local governance process through a decentralized system of administration.

Administration is run ultimately from central government in the capital, Accra through the Ministry of Local Government and Rural Development (MLGRD). The country is then divided into 16 administrative regions. These regions represent a sub-national level of decentralisation, with the Regional Coordinating Council (RCC) of each region acting as a coordinating body. The RCCs represent the highest level of Local Government in Ghana. The RCC consists of the Regional Minister (the chairperson), his deputies, the Presiding Member of each District Assembly and the Chief Executive of each district in the region, as well as two chiefs from the regional house of chiefs and the regional heads of decentralised departments, who have no voting rights.

According to Act 462, the RCC is an administrative and coordinating rather than political or policy-making body. As stated in the Act, its functions are to:

- Monitor, coordinate and evaluate the performance of the District Assemblies in the region;
- Monitor the use of all monies allocated to the District Assemblies by any agency of the Central Government,
- Review and coordinate public service generally in the region;
- Resolve any conflict between a District Assembly and an agency of Central Government, public corporation, statutory body, Non-governmental Organisations and individuals;
- Provide security, including managing conflicts within the region, settling chieftaincy, tribal, land and religious disputes;
- Coordinate district development plans and programmes and ensure that these plans and programmes are compatible with national development objectives;
- Integrate economic, spatial and sectoral plans of ministries and sector agencies and ensure that these plans are compatible with national development objectives.

Within each region are metropolitan, municipal and district assemblies based on size and population. The Metropolitan Assemblies are the largest in terms of population and economic activities followed by the Municipalities and the Districts are the smallest. The MMDAs are headed by the Metropolitan, Municipal and District Chief Executives respectively. The assemblies have both deliberative and legislative powers with respect to their specific geographical locations, and performs such functions as conferred on all Metropolitan, Municipal and District Assemblies by the Local Governance Act 2016 (Act 936).

Based on the above any conflicts would be mitigated.

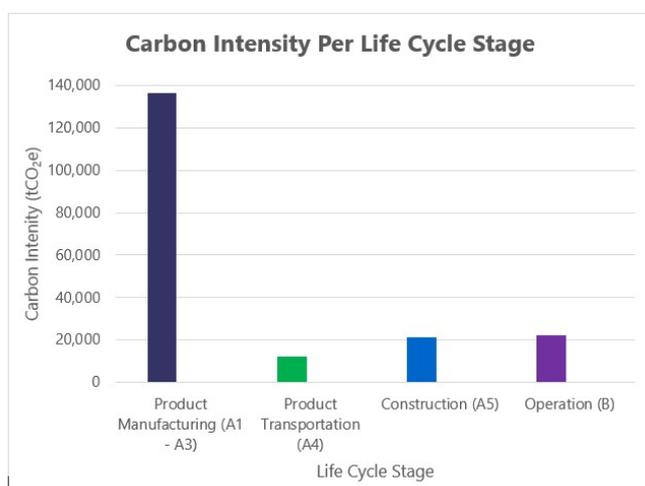
10. Climate Risk and Vulnerability

A Climate Risk and Vulnerability Assessment was undertaken as part of the ESIA to assess and demonstrate the consideration of climate change adaptation throughout the design of the Project. The climate risks and vulnerability findings are:

- **Precipitation** – The ESIA findings in respect to precipitation stated that the change is likely to be medium in terms of its magnitude; therefore a Minor Adverse effect is considered at all sites, with a Moderate Adverse effect at the intake in the case of extreme floods
- **Temperature** - The ESIA findings in respect to temperature stated that the higher temperatures are likely to result in higher solar radiation. It may result in further increases in the periods of Harmattan. Overall, a medium magnitude of change is anticipated. This could result in a Moderate adverse effect on the Project.
- **Wind** – The ESIA findings in respect to wind stated that overall a medium magnitude of impact is predicted, with a Moderate Adverse effect if there is an increase in Harmattan storms.
- **Evaporation** - The ESIA findings in respect to evaporation stated that overall sensitivity of Project infrastructure to evaporation is considered Medium and the magnitude of the impact Medium, resulting in a potential Moderate Adverse effect on the Project operation
- **Water quality and soils** – The ESIA findings in respect to water quality and soils stated that overall sensitivity of Project infrastructure to changes in water quality and soils, such as changes in salinity and soil stability is considered Medium. The impact is likely to medium, resulting in a Moderate Adverse effect over time.
- **Climate adaption** - The construction the new WTP, will help improve the resilience to climate change through increasing the availability of clean water and capacity to the population in Tamale, Damongo and associated villages. Improvements to water quality will also improve wider resilience by improving the capacity to support competing needs for constrained water resources in the region. These upgrades are likely to improve climate resilience by improving capacity to treat water as climate change exacerbates water quality issues (e.g. reduced precipitation and increased evaporation leading to drought conditions).

The structural features selected for the new WTP and supporting infrastructure are expected to provide a high degree of resilience to climate risks.

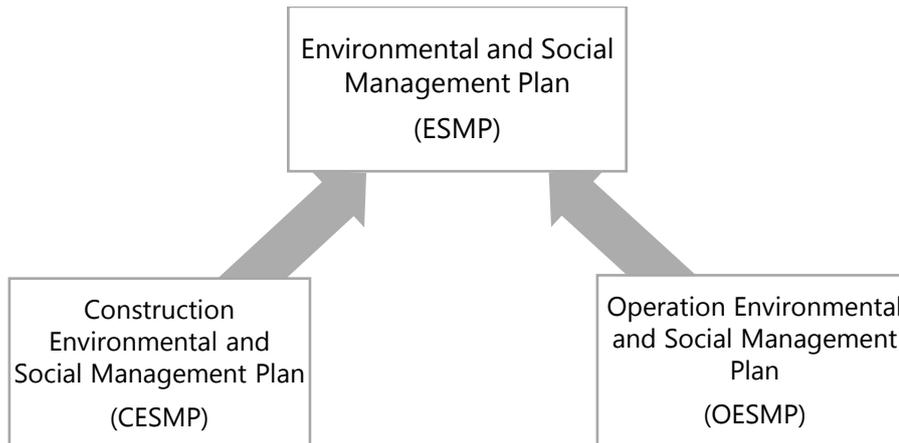
- **Carbon emissions** - The overall finding of this assessment is that the life cycle stage contributing the largest volume of emissions is Product Manufacturing (A1-A3), due to the large quantities of materials required to construct the various infrastructure of the project. Operation (B6) however, will have the highest carbon impact over the lifetime of the project, overtaking emissions from Product Manufacturing materials within 7 years of operation.



11. Environmental and Social Management Plan

The mitigation, management and monitoring measures that have been proposed in the ESIA to reduce potential negative impacts and enhance potential benefits have been set out in an Environmental and Social Management Plan (ESMP), together with good construction practice measures. The ESMP also sets out the organisational structure, roles and responsibilities for its implementation.

The ESMP is set out as an overarching document, and then divided into a Construction Environmental and Social Management Plan (CESMP) and Operation Construction Environmental and Social Management Plan (OESMP), as shown below:



Within the CESMP and OESMP there are a number of sub-plans that cover the following, where relevant to the phase of works:

Box 11. Sub-plans

- Ecological and Vegetation Management Plan
- Air Quality Management Plan
- Noise and Vibration Management Plan
- Waste Management Plan
- Hazardous Materials Management Plan
- Soil Management Plan
- Traffic and Transport Management Plan
- Water Management Plan
- Spill Prevention and Response Plan
- Emergency Preparedness and Response Plan
- Community Health and Safety Plan
- Community Grievance Mechanism
- Labour and Working Conditions Management Plan
- Labour Management Plan
- Labour Grievance Mechanism
- Occupational Health and Safety Plan
- Cultural Heritage Management Plan and Chance Finds Procedure

These plans will be developed further by Biwater and GWCL, as necessary.

12. Conclusion

Overall the conclusion of the ESIA is that the impacts of the Project are manageable and construction and operation of the Project will not result in irreversible, unacceptable risks to people or the environment.

The specific objectives of the Project are:

- To increase the production capacity of potable water in a single-stage development to meet the demand horizon of 2040 and beyond; and
- To increase water service coverage within the city of Tamale and surrounding villages with the installation of additional primary and secondary distribution pipelines and house connections
- To diversify the production away from the existing Dalun WTP; and
- To improve the distribution system management.

The intended benefits from the implementation of the Project will include:

- Provision of new water supply to stressed areas;
- Additional production capacity;
- Provision of potable water that meets Ghanaian water quality standards set by GWCL;
- Reduced demand on primary health care due to improvements in health from improved quality and quantity of water;
- Adequate water supplies to encourage commercial and industrial development thereby creating employment opportunities;
- Employment opportunities and local business opportunities (goods and services) during Construction Phase of the Project; and
- Employment opportunities during the operation of the Project.

For adverse effects, the ESIA has identified mitigation and management measures that have been integrated as part of the Project design by Biwater and/or include best practice measures and additional recommended measures by the ESIA Team with the intent of further avoiding or minimising adverse effects and complying with international standards and guidelines such as the International Finance Corporation. Where possible, measures have also been identified to maximise the benefit of the Project. It is recognised that some of these measures can and will be implemented by Biwater, whereas others are recommendations for the GWCL.

An ESMP, CESMP and OESMP has been developed and will be further refined and implemented during the construction and operation phases.

Chapter 7 – “Summary of Construction and Operational Phase Impacts and Mitigation Measures” provides Tables showing key environmental and social residual effects over the Project phases. It highlights Major to Minor adverse effects and Major to Minor beneficial effects. It also provides the Residual effect after proposed mitigation measures have been put in place.

In respect to the adverse and beneficial effects the following is stated: -

Construction Phase

With appropriate mitigation in place through a Project ESMS and ESMP, the majority of these impacts are anticipated to be reduced to Minor Adverse or Negligible and are, for the most part, temporary i.e. occurring for the period of the construction works only. Residual **Moderate Adverse** effects are Soil loss and quality deterioration from excavations.

Operation Phase

With appropriate mitigation in place through a Project ESMS and CESMP/OESMP, the majority of these impacts are anticipated to be reduced to Minor Adverse or Negligible. Remaining major to moderate adverse effects are:

- Absence of an associated development of a wastewater treatment plant may result in an increased deterioration of water quality in local rivers due to the increased volume of untreated wastewater as a result of increased water use with no commensurate adequate sewage treatment facility – Major to Moderate Adverse.
- Disposal of sludge from WTP process to landfill – Moderate Adverse.

Beneficial effects

The Project will increase the production capacity of potable water to meet the demand horizon of 2040 and beyond in the Project Area covering 27 communities within Tamale and 24 villages/towns with treated water along the route of the Damongo pipeline (**Major Beneficial**); reductions in water-related health issues which will positively affect the local population and the demand for local health services (**Moderate beneficial and Major Beneficial in Central and West Gonja districts**).

The Project will also have a positive effect on Employment, predominately within the Construction Phase (**Moderate to Major Beneficial**);

The Project will have a positive impact on livelihoods in terms of access and cost of access to clean potable water (**Moderate Beneficial** in Tamale Metropolis and Sagnarigu district and **Minor Beneficial** in West Gonja; and knock on economic benefits locally (**Major Beneficial**) and nationally (**Moderate Beneficial**).

An ESMS will be developed by Biwater for the Construction Phase to manage environmental and social performance. A Project ESMP, CESMP and OESMP have been developed for the Project. The ESMP sets out the organisational structure for the delivery of the mitigation, management and monitoring measures during the construction and operation phases, as well as roles and responsibilities for implementation. The CESMP and OESMP cover the detailed individual sub-plans for the Project, to ensure that the measure identified in this ESIA are implemented during the construction and operation phases. These Plans have been developed to the extent possible at the time of writing, and further development of some plans, such as the Occupational Health and Safety Plan, as well as the overarching ESMS will be required as the Project moves forward.

13. Contact Information

This Non-Technical Summary accompanies the Tamale Water Supply Scheme ESIA that will be made available by Biwater on their website for 30 days.

Any comments can be directed to:

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14. Available ESIA Documents

Documents produced as part of the ESIA process to date are as follows: -

- Tamale Water Supply Scheme – Part 1 of 2: Environmental and Social Impact Assessment (ESIA)
- Tamale Water Supply Scheme – Part 2 of 2: Environmental and Social Impact Assessment (ESIA)
- Tamale Water Supply Scheme – Supplementary Land Acquisition and Compensation Plan (SLACP)
- Tamale Water Supply Scheme – Project Environmental and Social Management Plan (ESMP)
- Tamale Water Supply Scheme – Construction Environmental and Social Management Plan (CESMP)
- Tamale Water Supply Scheme – Operation Environmental and Social Management Plan (OESMP)
- Tamale Water Supply Scheme – Stakeholders Engagement Plan (SEP)
- Tamale Water Supply Scheme – Management Plan for Future Temporary Disturbance
- Tamale Water Supply Scheme – Critical Habitat Assessment Note