



# Ghana Bridge Power Project

Early Power Limited

Environmental and Social Impact Assessment

60K36301

Revision: 3

Date: August 2017

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**Ghana Bridge Power Project**  
**Environmental and Social Impact Assessment**  
**Volume I: Non-Technical Summary**

**EARLY POWER LIMITED**  
**JACOBS CONSULTANCY PROJECT NO: 60K36301**

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	<b>Section No.</b>	<b>Change</b>	
	Wherever relevant	Reference to "power plant site" changed to reflect revised plan involving two power plant sites (PPS1 and PPS2).	
	Wherever relevant	Corrections to spelling, grammar and other changes for consistency. Abbreviated terms provided in full at first usage.	
	2.2	Updated with new project design and development details	
	2.5	Additional information regarding PPS2	
	2.6	Updated details of project development timescales	
	3.2	Updated details of additional baseline monitoring of air quality, as well as results of updated modelling of impacts	
	3.3	Updated results of calculated greenhouse gas emissions	
	3.4	Updated results of noise modelling and impact assessment	
	3.6	Additional mitigation measure	
	3.7	Updated comments on management of flood risk issues	
	3.8	Updated information to incorporate current use of PPS2 and management of social impacts	
	3.10	Update of construction timescale	
	3.13	Update of cumulative impact assessment and further measures	
	4	Updated conclusions on potentially significant impacts and project actions taken to address them.	
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	Wherever	Reference to updated plant site locations (PPS1 and PPS2).	

	relevant		
	2.2	Updated with new project design and development details	
	2.6	Updated details of project development timescales	
	3.2	Updated details of revised modelling of impacts	
	3.3	Updated results of calculated greenhouse gas emissions	
	3.4	Updated results of noise modelling and impact assessment	
	3.7	Updated to include results of numerical flood risk assessment and associated mitigation	
	3.8	Updated information to incorporate new impacts associated with the new PPS2 and changes to the pipeline alignment	
	3.10	Update transport routes	
	3.13	Update of cumulative impact assessment and further measures	
	4	Updated conclusions on potentially significant impacts and project actions taken to address them.	

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## List of Abbreviations

CCGT	Combined Cycle Gas Turbine
CO	Carbon monoxide
CO <sub>2</sub>	Carbon dioxide
EPA	Environmental Protection Agency
EPC	Engineering, procurement and construction
ESMP	Environmental and social management plan
ESIA	Environmental and social impact assessment
FRA	Flood risk assessment
IFI	International Financial Institution
IFC	International Finance Corporation
LNG	Liquefied Natural Gas
MW	Mega Watt
NO <sub>x</sub>	Nitrogen oxide
NO <sub>2</sub>	Nitrogen dioxide
PM	Particulate matter
PS	Performance Standard
SO <sub>x</sub>	Sulphur oxide
SF <sub>6</sub>	Sulphur hexafluoride
SO <sub>2</sub>	Sulphur dioxide
TTPC	Tema Thermal Power Complex
VRA	Volta River Authority

## 1 Introduction

This Non-technical Summary (NTS) forms part of the Environmental and Social Impact Assessment (ESIA) prepared to support the permit application and international finance of the Early Power Limited (EPL) Ghana Bridge Power Project (“the project”).

Since the project has the potential to result in environmental and social effects, an ESIA was required under the requirements of the Environmental Protection Agency Act 1994 (Act 490) and the Environmental Assessment Regulations 1999 (LI 652).

In order to decide which aspects of the project are likely to give rise to environmental and social impacts, a detailed Screening Report was prepared and approved by the Ghana Environmental Protection Agency (EPA) in March 2015. The screening report set out the perceived likely environmental and social effects that could be anticipated as a result of the development of the project and initial discussions on how these effects would be managed / mitigated.

Following the EPA screening phase, EPL’s ESIA team then undertook various baseline studies to collect site-specific information to add to the publically available reports and data obtained through internet search. This included taking measurements of the existing air quality and noise levels, and collecting information on the local communities.

All phases of the ESIA process included several rounds of stakeholder consultation meetings. Consultees were asked for site information, opinions on the scheme and their views on the proposed assessment methodologies. This information was logged and relevant technical data was included in the process assessment process.

The impact assessment and was then undertaken using the various data sets above and appropriate mitigation was designed to address the identified potential impacts. The original ESIA was submitted to Ghana EPA in October 2015, with the Environmental Permit subsequently issued in January 2016. A second iteration of the ESIA was submitted to the EPA in June 2016.

This ESIA iteration (August 2017) is the third issue of the ESIA documentation and was undertaken to consider various design changes as discussed in Section 2 below.

This NTS describes, in non-technical language, the project and the main findings of the third iteration of the Ghana Bridge Power Project ESIA, including the likely effects of the project and the measures which will be taken to minimise these effects. The publication and circulation of this NTS will further assist local communities and stakeholders in the understanding of the potentially significant positive and adverse effects of the project in relation to its surrounding environment.

## 2 The Project

### 2.1 Project Objectives

The increasing demand for power and the unreliability of power supply remains a major constraint to the future economic and social growth of Ghana. Ghana's reliance on a few primary sources of power generation makes it vulnerable to power shortages.

The primary objective of the Project is to deploy electrical energy as quickly as possible to support Government of Ghana's short term strategy for power generation. The project is also required to meet more long term objectives to help meet the increasing energy demand in Ghana and so ensure its continued social and economic development.

Ghana's current and future energy requirements and the need and justification for the proposed development is discussed in Section 2.4.

In accordance with these needs, objectives of the project are as follows:

- Provide continuous, reliable, high efficiency and low cost gas-based electric power;
- Provide emergency power to the Tema Industrial zone,
- Provide emergency power to the Ghanaian economy; and,
- Contribute to the long-term national and regional energy requirement to support sustainable development.

### 2.2 Project Overview

The Ghana Bridge Power Project will be located on two brownfield sites. Power plant site 1 (PPS1) lies approximately 225m east of the Volta River Authority (VRA) Tema Thermal Power Complex (TTPC), in Tema, Ghana. Power plant site 2 (PPS2) lies immediately north of PPS1, separated by the access road easement. The project includes the development of power plant facilities in 3 Stages – Stage 1a, 1b and Stage 2.

Initially, the plant will generate electricity utilising Liquefied Petroleum Gas (LPG) sourced via a new pipeline from the Tema Oil Refinery (TOR) jetty. Within 5 years of the commencement of phase 2 operation it is expected that the plant will switch to operation using Natural Gas (NG), should this be made available by the Government of Ghana. A LPG pipeline will run from the TOR jetty to a new tank farm developed by the project, adjacent to the power plant sites. On completion of phase 2, the power plant output capacity will be approximately 424 MW<sub>e</sub>.

The project components are shown on Figure 2-1 and include:

- Two new power plants;
- A new 9.2 km LPG pipeline from Tema jetty to TOR, from TOR to the tank farm and then from the tank farm to the power plant sites;
- A new tank farm for LPG storage;

- New pipelines to transport diesel fuel oil (DFO) stored at the Quantum Terminals Limited tank farm site to PPS1 and PPS2; and,
- New pipelines to transport water to the power plants from the Ghana Water Company (GWC) municipal supply network.

The revised project proposals incorporate a number of enhancements over the original plans and the subsequently revised plans, which will enable a higher generation capacity (424 MW, instead of the previous design of 400MW, and original of 344 MW).

This was achieved by incorporation of heat recovery on trailer mounted gas turbine units thereby increasing their energy efficiency. Other improvements include increased heights for the discharge stacks which reduce the plants' impacts on air quality in the surrounding residential areas.

The current design (and associated assessment within the ESIA) also allows for operation on DFO for worst-case operation during a significant disruption to the supply of LPG.

The project will be constructed and operated in line with all relevant Ghanaian legal and regulatory requirements, and in accordance with international finance agency environmental and social standards as detailed in Section 2.8.2.

### 2.2.1 Key Power Plant Features

The power plant at PPS1 will comprise GE mobile Trailer Mounted (TM) turbine units, initially operating as open cycle generating turbines (OCGT) in Stage 1a, and later converted into 'combined cycle' generating turbine (CCGT) mode in Stage 1b.

The power plant at PPS2 will comprise GE LM6000 PC Sprint turboshaft gas turbines (LM) units, which will operate in CCGT mode from the outset.

In combined cycle mode, additional plant is used to take heat from the turbine exhaust and use it to make steam. The steam is then routed to another turbine and generator to create more electricity, which increases the efficiency of the plant. The steam for Stage 1b and Stage 2 will be provided respectively by a once through steam generator (OTSG) and a heat recovery steam generator (HRSG).

The arrangement of turbines and electrical capacity of each phase is shown below:

- Stage 1:
  - Stage1a – Five TM2500 gas turbines - 145MW net; and,
  - Stage1b – addition of a steam generator and turbine - 57MW net.
- Stage 2:
  - Four LM6000 PC Sprint units - 222MW net.
- Total plant capacity of 424MW total for Stage 1 & 2.

The plant will be fuelled by LPG under normal operation, but will also run on diesel .

The TM units (in open cycle) will be cooled by integral closed loop system with radiators. Cooling for the OTSG/HRSG for Stage 1 and Stage 2 plants in CCGT mode will be by air-cooled condensers (ACC).

Evacuation of the power for Stage 1a will be via underground connection to the existing Electricity Company of Ghana (ECG) Station H substation, adjacent to the VRA TTPC at 33kV. Stage 1b evacuation will initially be via a new 161kV spur into a new double circuit 161kV overhead line to be constructed by GRIDCO by early 2018, which will run adjacent to the existing overhead lines that run east-west along the northern boundary of the Stage 2 site.

Stage 2 evacuation will be via a new substation into the new GRIDCO 161kV power lines. The Stage 1b evacuation spur will be transferred to the Stage 2 substation as that switch yard is completed.

Sulphur hexafluoride (SF<sub>6</sub>) will be used in the transformer equipment for the project. As this is a significant greenhouse gas pollutant, its use has been considered in the greenhouse gas assessment.

The project will require potable water and process demineralised water for the steam / water cycle and for emissions control for oxides of nitrogen (NO<sub>x</sub>) in the exhaust from each gas turbine.

The raw water will be supplied by a new 900m connection from the Ghana Water Company municipal supply at a connection point north of Valco Road to site water storage tanks on the Stage 2 site. Further water pipeline connections will then provide the supply to the power plant and tank farm sites.

All waste effluent including sewage will be treated prior to discharge by dedicated waste water treatment units to meet limits as defined by the EPA and international standards.

### 2.2.2 Tank Farm

The current design for the tank farm consists of eight spherical LPG fuel storage tanks and one fire water tank as follows:

- Stage 1: Three spherical tanks: two x 3800m<sup>3</sup> (2,071 tonnes) capacity and one x 6000m<sup>3</sup> (3,270 tonnes);
- Stage 2: Three spherical tanks: three x 6000m<sup>3</sup> (3,270 tonnes) capacity;
- Two fire water tanks of capacity 4080 m<sup>3</sup> each, sized to cover the largest fire on the tank farm; and,
- Ancillary equipment, including three propane pump per Stage and four fire water main pumps.

All elements of the tank farm installation will be constructed in line with relevant Ghanaian and international construction codes, good international industry practice and environmental standards as discussed in Section 2.8.2.

Stage 1 of the project will also utilise some LPG storage tanks within TOR.

### 2.2.3 LPG Pipeline Description

The proposed LPG pipeline route is 9.2km long in total, with four distinct sections as shown on Figure 2-1.

An above ground 12” diameter section of 5.2 km passes from TOR jetty at the Tema harbour, along the existing TOR pipeline’s Right of Way (RoW) adjacent to the Accra to Tema rail line, to a new booster station to the west of the TOR.

The second section of is also 12”. It exits the new Booster Station and travels above ground, eastwards along the north side of Valco Road. It enters the TOR and travels approximately 850m within the TOR facility and exits adjacent to the east gate. The remainder of the pipeline route, from TOR to the tank farm site, and then on to the power plant sites, will be buried.

It is currently anticipated that the pipeline will travel along the north side of Valco road, beneath the Ghana Oil Limited (GOIL) driveway and cross to the south side of the road before the Sentuo Steel Limited driveway. It then runs along the south side of the road, in a utility easement until the storm drain. Here, the route turns north and runs along the eastern side of the local access road, to the tank farm site.

The third and fourth sections run from the LPG tank storage area to PPS1 (c.170m) and PPS2 (c.100m) respectively.

### 2.3 Project Proponent

A consortium of Endeavour Energy, General Electric (GE) and Sage Petroleum has been formed under a local company Early Power Limited (EPL – “the Proponent”) to develop the project and contract with Electricity Company of Ghana (ECG). The EPL consortium has liability/responsibility for both the development and operational phases of the project in a build-own-operate arrangement.

Comments relating to the project and this ESIA can be addressed to the following:

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### 2.4 Why is the Project Needed?

Inadequate electricity supply and transmission systems, coupled with an increasing demand for power as a result of an economic prosperity and expanding population, leads to frequent power shortages in Ghana.

Investment in power generation facilities is required to both meet the immediate shortfalls and increasing demand to ensure continued long-term economic growth. As part of its short-term strategy, the Government of Ghana has requested the development of this emergency power

solution to deploy electrical energy as quickly as possible to address the immediate demand for reliable power.

The meeting of increasing energy demands, both locally and within Ghana as a whole, is required to support continued growth, associated employment opportunities, social improvement and necessary infrastructure developments.

## 2.5 Project Site and Surrounding Area

The project is located in the industrial port town of Tema on the Gulf of Guinea, approximately 27km east of Ghana's capital city, Accra, and 20km south-east of the town of Madina. This section of coastline is dominated by a mix of residential and industrial areas, interspersed with a series of north-south flowing rivers which drain higher ground to the north. Figure 2-1 shows the regional project location.

The nearest site of ecological importance is the Sakumo Lagoon Ramsar<sup>1</sup> site, which bounds the western end of Tema, approximately 5.5km west of the power plant sites. Other sites of ecological importance in the surrounding area include the Shai Hills resource reserve, an Important Bird Area<sup>2</sup> 25km north of the project site; and the Songor Lagoon Ramsar site protected area, approximately 40km east of the site.

The nearest major surface water feature is an artificially straightened drainage channel, which forms the southwest boundaries of both PPS1 and PPS2.

The project infrastructure is all located within the Tema Heavy Industrial Area (THIA), between Tema town and the district of Kpone, which has been zoned for industrial / commercial land use by the Tema Metropolitan Assembly (TMA).

The area is located at UTM zone 31N: the centrum of the main infrastructure sites are as follows:

- PPS1: 1502799.7286 635416.1113 meters;
- PPS2 (western portion): 1502515.1191 635581.2162 meters;
- PPS2 (eastern portion): 1502787.1491 635584.3611 meters; and,
- LPG Tank Farm: 1503024.5858 635719.5899 meters.

Industrial and/or commercial land use extends for a minimum of approximately 2km in all directions from the power plant and tank farm sites to the nearest residential areas of Tema New Town to the south, the district of Kpone to the east and Tema town to the west. The development site locations are shown on Figure 2-2.

The plant and tank farm sites are both located on undeveloped brownfield land. The closest developments to the plant site are the power stations within the TTPC and TOR to the west, and Valco Aluminium and Sentuo Steel to the south. The tank farm site is located adjacent to the Quantum Power (a subsidiary of Sage Petroleum) storage facility which is currently under

<sup>1</sup> Ramsar sites are wetlands of international importance designated under the Ramsar convention, 1971.

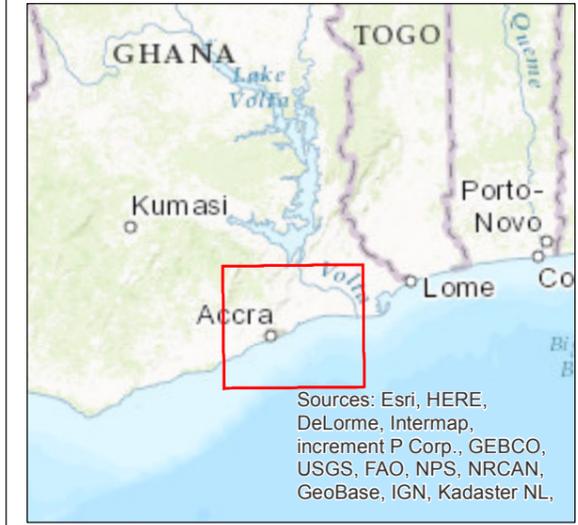
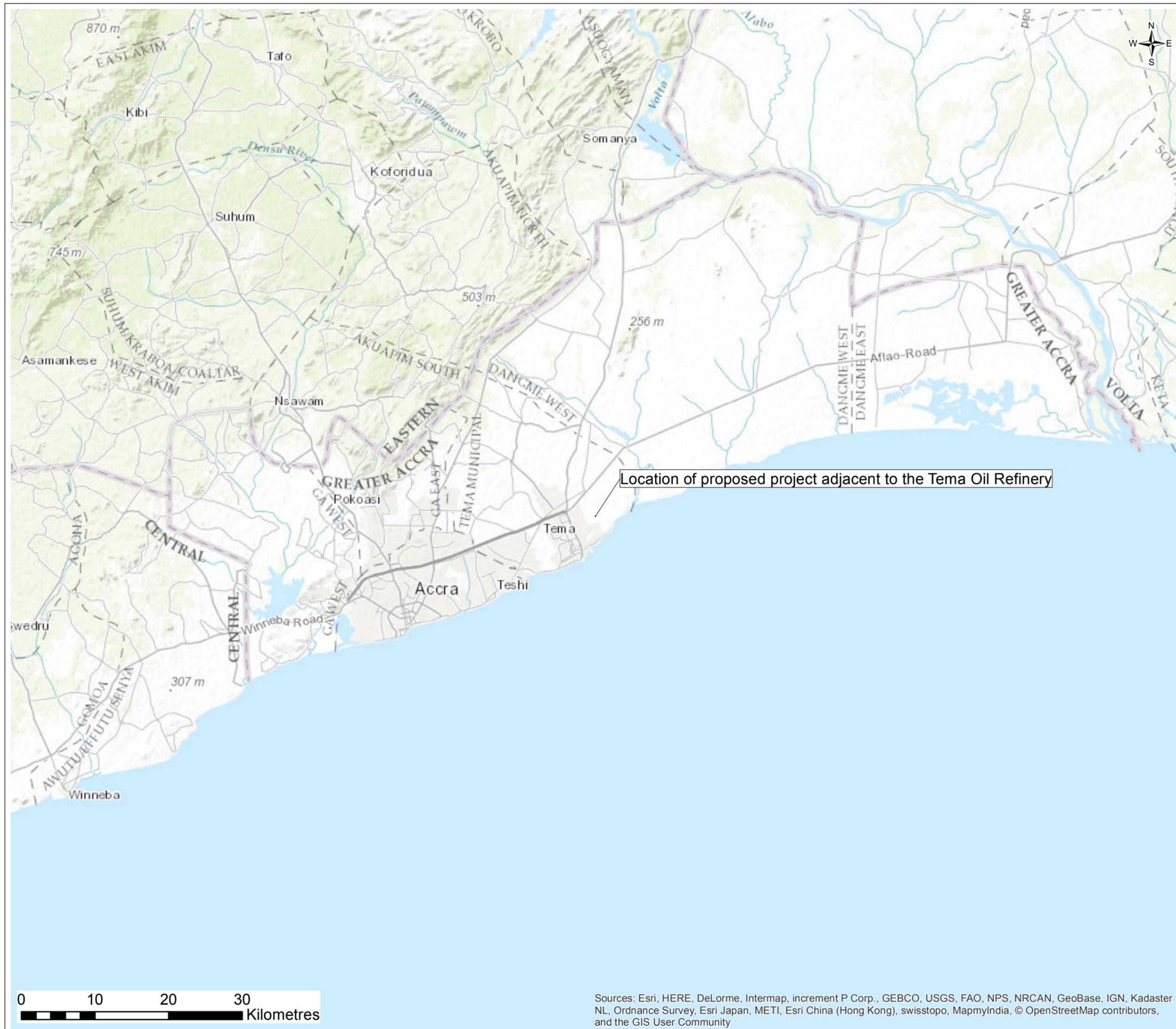
<sup>2</sup> Important Bird and Biodiversity Area is an area recognised as being globally important habitat for the conservation of bird population. The sites are identified by BirdLife International following an internationally agreed set of criteria.

construction. Surrounding land uses are either undeveloped brownfield or commercial business/industrial installations.

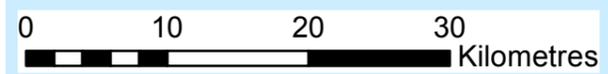
Both the PPS1 and PPS2 sites were being used for farming by people with informal access to the site agreed with the land owner, but no legal entitlement to the land. PPS2 also includes one residential property and one commercial business with a short term agreement to reside on the site. The residential property and commercial business on PPS2 will be relocated by the land owner, whilst the farmers will be compensated as discussed in Section 3.9.

The pipeline route is also within industrial/commercial land with various facilities located adjacent to the route. No formal residential properties were identified in the vicinity of the pipeline, although an abandoned informal dwelling was located on the tank farm site. A small number of informal trader kiosks were identified along the pipeline alignment, some of which were used as at least temporary residences by the owners. These kiosks will require relocation away from the pipeline route as discussed in Section 3.9.

**FIGURE 2-1**



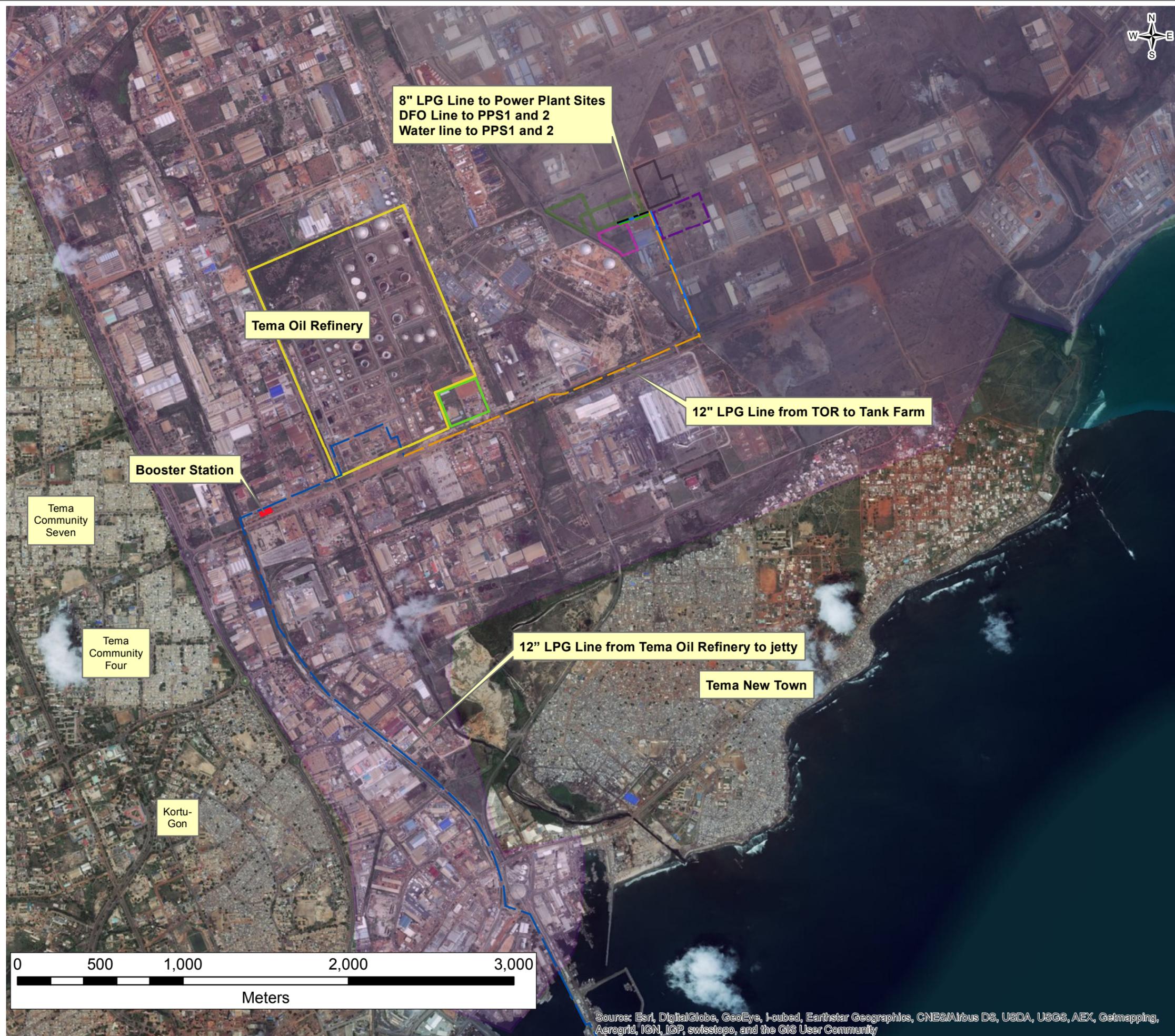
Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL,



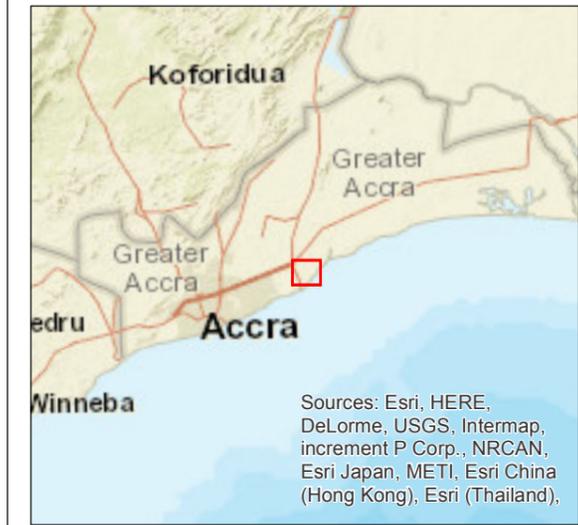
Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

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Drawing No.	60K36301/LVA/1_1					
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**FIGURE 2-2**



- Legend**
- 12 " LPG Pipeline (Overground)
  - 12 " LPG Pipeline (Underground)
  - 8 " LPG Pipeline to Site (Underground)
  - Diesel Pipeline
  - Water Pipeline (Underground)
  - Tema Oil Refinery
  - Ghana Bridge Power Plant Site 1
  - Ghana Bridge Power Plant Site 2
  - Quantum Terminals Limited Tank Farm
  - LPG Tank Farm
  - Tema Heavy Industrial Area (THIA)
  - Ghana Oil Company (GOIL)



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Project			Ghana Bridge Power Project ESIA			
Drawing Title			Development Site Locations and Pipeline Routes			
Drawing Status						
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Drawing No.	60K28902/LVA/1_2					
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**2.6 Project Timescales**

The estimated timing of the development for each of the project phases is summarised as follows, assuming an August 2017 start date:

**Table 2-1: Proposed Project Timescales**

Site / Phase	Net Capacity (MW)	Construction Months																																		Commercial Operation Date
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	
<b>PPS1</b>																																				
1a	145 (OCGT)	█	█	█	█	█	█	█	█																											
1b	57 (CCGT)	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	
<b>PPS2</b>																																				
2	222 (CCGT)										█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	█	
<b>Total</b>	<b>424</b>	Operation life: 25 years																																		

OCGT – Open cycle gas turbines  
 CCGT – Combined cycle gas turbines

## 2.7 Consultation and Disclosure

Early Power Limited has undertaken and will continue to undertake stakeholder consultation throughout the project development and lifecycle. EPL has prepared a Stakeholder Engagement Plan (SEP) which identifies all those parties consulted regarding the project, consultation events undertaken and proposed.

The project SEP can be viewed at: [www.earlypowerltd.com](http://www.earlypowerltd.com) along with other relevant E&S documentation including this NTS and the various iterations of the ESIA.

A number of stakeholder consultation meetings have taken place throughout the ESIA process. Details of these meetings are provided in the project SEP. Given the limited scale of the project, distance to the nearest formal settlements (~2km) and minimal direct impacts to local communities, the process did not involve extensive socio-economic baseline surveys of the local community.

Formal public consultation and disclosure events were therefore not held. Instead, to gain an understanding of community views of project, collect socio-economic data and disclose environmental and social information (including the project grievance mechanism), focus group discussions were held with representatives of the nearest local communities in Tema, Tema New Town and Kpone, including the chiefs (or their representatives), representatives of municipal authorities, youth groups, women groups and the fishing communities. Focus group discussions were held in 2015 and again in 2017.

EPL will continue to engage with key stakeholders during the development and operation of the Ghana Bridge Power Project.

## 2.8 Legal Requirements

The project is required to comply with the relevant Ghanaian laws and regulations. The project must also comply with international Conventions to which Ghana is a signatory. The project is seeking international finance and is also committed to meeting the requirements of the international financing institutions as discussed below. The following provides a brief overview of the key applicable environmental legislation.

### 2.8.1 National and Local Regulation

The Constitution of Ghana (1992) states that *'the State shall take appropriate measures needed to protect and safeguard the national environment for posterity; and shall seek cooperation with other states and bodies for purposes of protecting the wider international environment for mankind'* (Section 6 (41) (9)).

National Environmental regulation within Ghana falls under the requirements of the Environmental Protection Agency Act 1994 (Act 490) and the Environmental Assessment Regulations 1999 (LI1 652). There are a number of other national Legislative instruments regarding matters such as energy policy, employment, health and safety, utilities, cultural heritage and environmental aspects such as ecology which are relevant to the development and whose requirements will be met throughout the project.

At local level, the project will be governed and follow the requirements of the Tema Metropolitan Assembly (TMA) and Kpone-Katamanso District Assembly (KKDA). These assemblies exercise deliberative, legislative and executive functions, including approval of development plans and enforcement of by-laws. As such, EPL will require approval from both assembly bodies, in addition to the necessary agreements with Tema Development Corporation (TDC) and land owners of the development sites.

### **2.8.2 International Regulation**

The project will also meet international standards as required by international financing institutions (IFI). Whilst there are some variations in the requirements of different IFIs, the project will follow the requirements of the Equator Principles / IFC performance standards.

The Equator Principles are a voluntary set of standards intended to ensure that projects financed by Equator Principle Finance Institutions (EPFIs) are developed in a manner which is environmentally and socially responsible. The Equator Principles apply to all new project financings with a total project capital cost in excess of US\$ 10 million or more. There are ten principles.

For projects located in non-designated<sup>3</sup> countries such as Ghana, Equator Principle 3 requires the project to be compliant with the IFC Performance Standards and the corresponding general and applicable sector-specific World Bank Group / IFC Environmental, Health and Safety (EHS) Guidelines.

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<sup>3</sup> Designated Countries are those countries deemed to have robust environmental and social governance, legislation systems and institutional capacity designed to protect their people and the natural environment.

<http://www.equator-principles.com/index.php/ep3/designated-countries>

### 3 Environmental and Social Effects

A series of environmental studies have been undertaken and a summary of the predicted environmental impacts is presented in the following sections.

#### 3.1 Land and Water Quality

The power plants and associated infrastructure will be located within land already used for industrial and commercial purposes. Existing land contamination due to surrounding activities could pose risks to the construction or future use of the land. This could arise from the presence of harmful substances and pathways by which potential receptors could be harmed, e.g. petroleum products absorbed onto soil which workers may come into contact with, ingest or inhale during construction works. There is also the potential that existing contamination could be mobilised during construction works, e.g. contamination in near surface soils could be pushed down into bedrock groundwater during piling activities.

It is possible that activities undertaken during construction, operation and decommissioning, and materials brought to site could impact land and water quality unless properly managed. Accidental spills or leaks of materials used in construction could infiltrate ground and contaminate soils, groundwater and surface waters.

Intrusive ground investigations in 2016 and 2017 investigated the existence of any existing land contamination. A limited extent of contamination was identified in the vicinity of old fuel tanks in the east of PPS2, approximately 40m by 80m, with the hydrocarbon contamination mainly concentrated in near surface soils. This was considered to pose a low risk to workers during construction, however appropriate management arrangements to address the localised contamination will be devised and implemented by the EPC contractor, as part of site preparation works.

The operation of the new power stations in an area where existing power stations operate will add to the loading on district surface water drainage. Therefore the risk that surface waters could become contaminated with run-off will increase. There will also be a potential increase in risk from releases of hazardous materials into the ground and groundwater in an area where older power stations already pose a risk to local land and water quality.

For the Ghana Bridge Power Project, good environmental management measures to meet EPA and international requirements will be implemented during construction and operation of the project to minimise any potential impacts to land and water quality. A construction environmental management plan will be developed to set out the mitigation measures required during construction in detail, including those required to manage the localised contamination at PPS2. The plan will include emergency response plans identifying how any accidental discovery or release of contaminants will be dealt with. An operations environmental management plan will also be developed to capture and monitor the mitigation measures required during the project's operation.

The design of the power plant sites, tank farm and pipelines will meet Ghana and international standards and will include appropriate structures for storage of LPG and other potentially hazardous substances. When the plant is operating, appropriate emergency response and clean up

procedures will be in place in the event of accidental releases of potentially contaminating substance.

### 3.2 Air Quality

An air quality assessment was carried out to determine the potential impacts on air quality resulting from the construction and operation of the power plant on sensitive human and ecological receptors. The assessment also considered 'cumulative' impacts of the EPL plants' emissions in combination with other existing and proposed plants in the Tema area.

The main pollutants considered were dust generated during construction activities, and oxides of nitrogen (NO<sub>x</sub>) and carbon monoxide (CO) generated from combustion of fuel during operation on LPG. In addition, the assessment considered particulate matter (PM) and sulphur dioxide (SO<sub>2</sub>) for any temporary/emergency periods of operation on DFO. A range of data sources and techniques were used to carry out the assessment.

Data on the existing air quality in the local area was sourced through consultation with the VRA and baseline monitoring undertaken by EPL at the project sites and in the surrounding areas during two six-month periods in 2015 and 2016. The results indicated that the area is not currently within a degraded air-shed for nitrogen dioxide (NO<sub>2</sub>), but is likely to be degraded for PM.

The assessment of construction impacts considered the effect of dust through activities such as vehicle movements and general construction activities. The assessment found that there would not be any significant impacts, as dust fallout will occur within the industrial area and will not travel far enough to affect the surrounding residential areas. Nonetheless, as activities have been identified that could give rise to dust, on-site good practice dust prevention and control measures should be implemented during the construction phase. Similar impacts and prevention / control measures would be expected during decommissioning.

The effect of emissions from combustion processes during the operating phase was assessed by modelling the emission dispersion in the area around the plant. This was undertaken using an internationally recognised dispersion model (ADMS) and the results compared against national and international air quality standards at 20 residential locations around the industrial area, as well as at locations within the industrial complex.

Because it may be necessary to utilise DFO as a fuel in the event of a disruption to LPG supply, the assessment considered the impacts when the plants will be fuelled on LPG, as well as scenarios for firing on DFO or a combination of periods on LPG and DFO.

The assessment of the air emissions from the proposed power plants from operation using LPG found that pollutants at nearby residential and industrial receptors are within the ambient air quality guidelines when considered in addition to existing concentrations in the baseline data.

Under LPG operation, the plant is also compliant with the IFC requirements for non-degraded air-sheds if cumulative emissions from other proposed plants are added in. Improvements in the plant design, including the use of taller (30m) stacks for Stage 1a and incorporation of heat recovery on the TM2500+ units, have substantially reduced the predicted impacts in comparison to earlier design iteration.

In DFO and LPG/DFO operating scenarios, the assessment predicted that there could be exceedances of some ambient air quality guidelines for SO<sub>2</sub> concentrations and PM, based on the existing baseline data. However, any operation by the project on DFO will only be for temporary / emergency purposes.

The cumulative air quality assessment predicts that the airshed may also be degraded for SO<sub>2</sub> as well as PM by the time the EPL project starts operations, due to other plants in the area operating on fuels that are less clean and sustainable than LPG. Therefore, in the event of significant disruption to LPG supply to the Ghana Bridge Power Project, any temporary/emergency backup operation on DFO will be closely monitored in consultation with the Ghana EPA.

Once the operation is converted to natural gas, the predicted impacts on air quality from the EPL project will reduce significantly. The process contributions from the plant under natural gas operation are predicted to be well within the relevant national and international requirements.

### 3.3 Carbon / Greenhouse Gas Emissions

Carbon dioxide is released during combustion of carbon-based fuels with the quantity released dependent on the carbon content of the feedstock. Although not in itself a toxic gas, it is widely accepted as being the most significant contributor to the 'global warming' effect. During operation of the plant, combustion sources (LPG and ultimately natural gas) will release carbon dioxide (CO<sub>2</sub>), while vents and other fugitive emissions will lead to the release of other greenhouse gasses.

The total carbon emissions arising from the plant are a direct product of the amount of gas combusted, the combustion conditions and the specification of the gas. The direct combustion emissions from the project relating to fuel consumption have been estimated as 1.74 million tCO<sub>2</sub>e (total emissions that have an impact equivalent to CO<sub>2</sub>) per year when the plant is operating using LPG during Stage 2, and 1.56 million tCO<sub>2</sub>e per year when the plant is operating using natural gas.

Comparison with 2015 Electricity Company of Ghana data for other existing plants in Ghana showed that the emissions performance of the Ghana Bridge Power plant during Stage 2 is in line with 2015 grid electricity average emissions for all power plants apart from wind and solar. Performance of the EPL plant will improve further when it is operating on natural gas.

The project will develop targets within the environmental management system for reducing carbon/greenhouse gas emissions. The carbon emissions will be calculated and disclosed on an annual basis using international standard methodologies.

### 3.4 Noise

A noise assessment was carried out in order to determine the potential noise impacts of construction and operation of the project. Baseline noise data was collected as part of the ESIA and this included the operational noise from existing facilities. Noise modelling has been undertaken and impacts assessed in consideration of baseline noise levels.

Due to the nature of the construction process, noise levels will fluctuate with the combination of machinery being used at any one time, time, and distance, particularly along linear infrastructure i.e. the pipeline. Construction works may generate high noise levels i.e. above 70 dB L<sub>Aeq</sub>.

However, given the separation distances of 2km to the nearest residential dwellings, the construction noise levels are not predicted to exceed 40 dB  $L_{Aeq}$  at residential noise sensitive receptors for any significant duration.

There are various commercial/industrial receptors in the vicinity of PPS1 and PPS2 which may contain noise sensitive uses, such as offices, and some existing kiosks on the Stage 2 site, which are scheduled to relocate. Any such receptors that lie within 60m of the construction works could potentially experience noise levels above 70 dB(A) at certain times during the construction process, and could therefore experience adverse noise impacts. However, any such impacts would be of short duration and during the day. Noise associated with the construction of the pipeline is expected to be moderate, and will only impact receptors for a short duration, and will therefore not be significant.

Throughout the construction phase, good management practices will be employed by the construction contractor to ensure the health and safety of workers. Noisy activities will be staggered to manage cumulative impacts. Construction works will take place in daytime working hours. Given the management techniques to be employed, it is not expected that there will be any significant long-term noise impacts associated with construction activities.

During operation, the main sources of noise will be: gas turbines, air inlet filters, electrical transformers, air cooled condensers and steam turbines. Noise modelling has indicated that the relevant limits for industrial areas in the Ghanaian EPA regulations can be met at relevant industrial/commercial noise receptors surrounding the development (e.g. offices associated with neighbouring power generation facilities).

Equipment will be specified to ensure that regulatory limits are not exceeded due to noise from the development.

During Stage 1a, when the turbines at PPS1 are operated in open cycle mode, the predicted noise levels are below the assessment threshold noise levels at the majority of the nearest identified residential receptors. The calculated levels exceed slightly the IFC limit of 45 dB(A) at five receptor points to the northeast and south. The model does not, however account for screening provided by buildings between the sites and local receptors, and is a conservative assessment. The project will include a standard level of noise control measures for this type of development, including the use of items such as relief silencers, valve casing, discharge silencers and physical barriers. The cost associated with further reducing the noise from the exhaust has been investigated and is not considered proportionate to the temporary and marginal exceedance of the noise guideline.

Based on these considerations, the very small exceedance predicted, and the temporary nature of the operation, the temporary and marginal potential exceedance of the noise criteria is not considered a significant noise impact at local receptors.

Although the project sites are located in a heavy industrial area, it was confirmed during 2016 consultations with the owners of a nearby commercial premises that buildings on the premises are being used for overnight accommodation for some factory workers. The assessment indicated that exceedances of the WHO recommended threshold for sleep disturbance would likely occur at these locations during the temporary Stage 1a operational period without mitigation, but not for Stage 1b

or Stage 2. Proactive consultations with the business about a mitigation solution are ongoing and may include the use of a temporary noise barrier.

### 3.5 Water Resources and Wastewater

An assessment of impacts to water resources and from discharge of wastewater from the project was undertaken.

Water for construction use will be provided initially by tanker/other bulk container or temporary connection to the local VRA clean water tank until the Ghana Water Company pipeline is constructed. The Ghana Water Company has assured the project that an adequate supply is available and that supply to the project will not be detrimental to other water users.

Construction activities are not expected to result in significant water requirements. Hydrostatic testing of storage tanks and pipelines will require the use of water and discharge of the effluent. Other potential impacts to surface and groundwater during construction activities include the generation of sediment laden runoff, alteration of the hydrological flows of watercourses and the mobilisation or release of contaminants to watercourses and/or groundwater.

During operation, water use of the project has been minimised through the use of Air Cooled Condensers for cooling; as such, water supply needed for operation will be minimal, for process activities only. Sanitary wastewater will be removed from the sites by tanker for off-site treatment and discharge.

The project includes a waste water treatment plant which will treat the process wastewater to control the concentrations of various compounds to within the limits prescribed by the Ghana EPA. The resulting effluent will then be discharged to the storm drain adjacent to the eastern boundary of PPS1 and the southwest boundary of PPS2. This will ensure that there are no significant impacts due to operational discharges.

Run-off water from potentially contaminated surfaces will pass through an oil-water separator and then into the waste water treatment plant. Other run-off water will be discharged directly into the storm drain, and will be monitored to ensure that Ghana EPA and international water quality standards are met.

During both construction and operation there is the possibility that accidental spills of fuel, etc. could cause considerable contamination of watercourses. Appropriate modern construction design mitigation will be implemented to prevent accidents, and oil and fuel areas will be bounded. All workers will be trained in the handling, storing, and disposal of hazardous materials. In the event of an accidental release there will be emergency procedures in place so that the spill can be contained immediately. Emergency spill containment material and clean up equipment will be distributed and stored in appropriate places so that any spill can be cleared up as quickly as possible to minimize any adverse effects.

Any contaminated wastewaters/stormwaters following a spill, will be contained as far as practicable through the use of spill containment and clean up measures. Any effluent will be treated by the waste water treatment system on site and discharged, or appropriate off-site treatment arranged, as appropriate, in order to reduce the potential for harm to the environment

### 3.6 Ecology

An assessment of the potential effects on ecological features arising from the construction and operation phases project has been undertaken. Information relating to terrestrial ecological receptors in the project sites and adjacent land has been obtained using desk-based and field-based methods.

Ghana is a country with an extremely rich biodiversity component, with 83% of Ghana's species located within its forests. The sites have been deemed of poor biodiversity importance. The nearest site of ecological importance is the Sakumo Lagoon Ramsar site, approximately 6km west of the power plant sites, and the project will have minimal impact on the overall biodiversity of Ghana.

Desk-based research indicated that 87 wildlife species are found within the Greater Accra area; two are noted to be of conservation importance, however these were not viewed during the field survey. The chaff flower (*Achyranthes sp.*) was the only plant which may be of conservational importance to be found during the field survey; however, it was rare and only present in a single stand. Monitoring will be undertaken during the construction phase to ensure this species is conserved.

The field ecology survey report found Neem trees within the sites, an invasive species which spreads quickly and out-competes native species. Measures will be taken during the construction and operational phase to ensure that the development activities do not encourage this species to spread.

Given the limited biodiversity of the brownfield land, the lack of significant species found during field surveys and the measures to be implemented during construction, the impacts on ecology at the project sites are expected to be minimal. The field survey report recommends that, if possible, construction works should begin in the dry months to reduce even further the minimal damage that the project may cause and avoid clearance work during the breeding season.

### 3.7 Flood Risk

A scoping flood risk assessment (FRA) was carried out to assess the potential for flooding and the potential for the development to increase the flood risk elsewhere. This was subsequently updated by a more detailed numerical modelling assessment for the fluvial flood risk associated with Watercourse 2, the storm drain adjacent to the power plant sites. The assessment considered flood risk from scenarios including the potential worst level of flood in a 100 year period and within a 1000 year period, and a 'sensitivity scenarios' with additional flood flows to account for potential climate change or urbanisation-related increases in flood levels in the future.

The conservative modelling assessment undertaken for Watercourse 2 predicted a minor fluvial flood risk to small localised areas within PPS1 and PPS2. This is mainly predicted due to the reduced capacity of culverts on the water course 1km downstream of the power plant sites, along with overtopping of the banks of the water course, immediately upstream of the power plant sites. The tank farm site is not considered at risk of flooding as it is at a higher elevation than the power plant sites.

Given the conservative nature of the model and the mitigation proposed, flood risk to the proposed development sites is not considered significant, but is likely to become greater over time, as a result of both climate change and changes to land use within the catchments upstream of the site.

Mitigation proposed includes raising the site and/or sensitive infrastructure at the power plant sites by 600mm above the predicted flood levels for a 1 in 1000 year event and use of perimeter and internal drainage to help protect against possible flooding.

The FRA did not indicate that building up of the new plant on land which might have flooded in the past would likely result in significant increase in flooding elsewhere adjacent to and downstream of the site.

The assessment concluded that whilst an extreme event was predicted to flood the main site access road to the south (Valco Road), it will still be possible to access the site from the north, through areas which are unlikely to flood.

The assessment also identified that rainfall related water flowing across the land could be a problem for the sites and local access roads if not properly controlled. It was recommended that perimeter and internal storm drainage is installed to prevent this problem and that the drainage design should restrict the flow of water discharging from the site so that there is not an increase in the storm drain water level and flow during heavy rainfall. It was also recommended that the project considers installing roadside storm drainage next to the sites, to help prevent water ponding and erosion which could restrict access to the sites.

### 3.8 Socio-economic

A detailed socio-economic and community health and safety assessment has been undertaken for the project. The assessment included discussions with key stakeholders including nearby businesses and representatives of the nearest communities, located approximately 2km from the project sites at the nearest extent.

The main socio-economic impacts are positive in terms of a small number of employment opportunities during construction and operational phases, and indirect economic improvements for nearby communities and the wider Tema area through procurement of services and provision of more power for businesses. Potential minor adverse social impacts, include:

- risks associated with workers moving to the area during construction, with issues including increasing pressure on local services and potentially increasing communicable disease transmission;
- the need to relocate a small number of kiosks along the pipeline route, as well as one abandoned structure on the tank farm site, some farmers and a small commercial business on the PPS1 and PPS2 sites; and,
- potential community health and safety impacts associated with the construction traffic and operation of the pipeline.

It is not currently anticipated that there will be a worker camp and so it is expected that there will not be a significant influx of temporary employees to the Tema area. However, some new employees may still come from outside the local area, which could result in a slight increase in the demand for local housing and services, slight increases in road traffic and potential for accidents, and an increase the chance of community disturbance due to new people moving into the area. These risks will be managed through implementation of a Construction Environmental Management

Plan and Transport Management Plan to minimise land and community disturbance, and the development of a Workforce Development Strategy to maximise employment opportunities for local people.

A total of 5 informal kiosks along the pipeline route and a small number of farmers on the PPS1 site will be impacted as well as a small area of active farming on PPS2. A 10-bedroom residence on PPS2 is scheduled to be relocated by the land owner(s) prior to project construction, as well as two kiosks/businesses on PPS2.

Along with experiencing economic displacement, at least two kiosk vendors residing in their kiosks and a family living in the residence on PPS2 will be physically displaced by the project. In total, 12 businesses and 8 farmers for both Stages of the project will be displaced by the project and need to be compensated and relocated accordingly. This will be done according to Ghanaian and international standards, including IFC Performance Standard 5 which considers involuntary resettlement. A combined Livelihood Restoration Plan and Abbreviated Resettlement Action Plan (ARAP) has been developed for the Stage 1 site and kiosks on the pipeline route. An ARAP for the Stage 2 site is also under development, so that affected people will be compensated and (where appropriate) relocated prior to the commencement of project construction. EPL will also monitor the relocation of existing residents by the the land owners to ensure that they are treated fairly and to the standards expected by EPL.

The identified potential community safety impacts include the existing risks of leaks from the above-ground section of the pipeline (from Tema jetty to TOR), community safety during construction of the pipeline (and to a lesser due to their remote locations, the plant and tank farm sites), increased traffic volumes and potential for worker influx increasing the risk of communicable diseases.

Potential impacts from increased traffic and workforce were not found to be significant as they will be short-term and localised, even during the peak construction period (see Section 3.10) and any residual construction traffic impacts will be minimised through development of a Traffic Management Plan.

During operation, there are potential safety risks for the above-ground sections of pipeline including unintentional impacts (e.g. transport accidents), intentional impacts (e.g. deliberate acts of vandalism, tapping into pipelines) and other external factors (e.g. earthquakes). Damage to the pipeline could result in a fire or explosion.

The revised route of the LPG pipeline has been developed to minimise impacts on kiosk operators in relation to resettlement and safety. The current alignment has been modified to avoid a significant number of kiosks located on the south side of Valco road, opposite Sentuo Steel. However, this is subject to further surveying of the route to make sure it is still feasible.

The project will be developed in line with international standards and guidelines to ensure inherent safety in design and appropriate barriers, signage and security measures will be deployed where necessary during construction and operation. An emergency response plan will be developed in accordance with international standards and guidelines.

To help improve the safety along the TOR pipeline right of way, EPL will work with TOR, TDC and other stakeholders to install crash barriers at the sides of roads where they cross over the TOR

pipelines. EPL will work in partnership with TOR and the stakeholders regarding pipeline safety issues going forward.

Overall adverse impacts associated with displacement (physical and economic), community health and safety would be counterbalanced by beneficial employment impacts of the project. The number of informal businesses to be resettled is small and there are a number of measures that can be implemented to increase the economic benefits of the project. Implementation of appropriate community health and safety measures if properly implemented would significantly reduce project effects and calm community concerns.

A social investment strategy is currently being developed for the project that will assist the project's ongoing commitment to working with the local community, including women and youth groups where possible, to enable further positive project support to local communities.

### **3.9 Solid Wastes**

Solid wastes will be generated both during construction and operation of the project. These wastes will range from excavated materials during construction to a range of operational wastes.

Detailed waste management plans and procedures will in place for all phases of the project in accordance with the requirements of the EPA and the project's Environmental and Social Management Plan. An Environmental Control Officer / Manager will be appointed to ensure the management systems are implemented correctly.

Management of waste will follow a good practice hierarchy with the objective to reduce, reuse and recycle materials in preference to disposal. Following segregation, inert wastes will be reused as far as possible.

Provisions will be made for segregation of waste materials on the plant and tank farm sites. For general wastes, receptacles will be provided for different waste streams (e.g. for food wastes, plastics, metals etc.). The receptacles will be clearly marked and fit to hold the type of waste they will contain. There will be frequent emptying of waste receptacles and transfer to appropriate storage facilities on site and/ or transfer and disposal by suitable waste disposal contractors.

A residual impact is inevitable given that waste will be generated throughout the lifespan of the project; however, the implementation by the project of the required waste management procedures will mean that the significance of this effect from the project will be minor.

### **3.10 Traffic and Transport**

Transport and transportation impacts that will result from the proposed project have been assessed. Given the surrounding good road network, the relatively small increase in volumes of traffic during the construction period is not predicted to produce any significant impacts.

One primary access route for project traffic is expected, with a potential alternative route to via Kpone Road also considered.

Traffic increases will be short term, limited to the construction period and the road network has sufficient capacity to accommodate the marginal increase in daily traffic movements. Any hazardous loads will be managed in conjunction with local transport authorities. Given the low

number of operational movements (including approximately 30-35 shift workers and fairly infrequent movements associated with general site visitors, waste disposal movements and stationery deliveries, as well as servicing/maintenance and parts delivery), the magnitude of the increase in operational traffic flow is considered to be negligible. The effect on the capacity of local roads for both the construction and operational phase is not significant and is therefore not likely to cause severance or congestion effects on the local community.

There will be a negligible increase in marine vessel movements during the construction phase, with one shipment every 2 to 4 weeks required during mobilization and civil works to transport materials. The current facilities at Tema Port handle all types of cargo including containerized cargo, dry and liquid bulk, iron/steel, machinery/equipment, palletized items and vehicles. The current jetty capacity is sufficient to meet this project's requirements.

During operation traffic movements will be minimal, associated mainly with staff travel. Marine movements will also be negligible in the context of the operating Tema port.

### **3.11 Landscape and Visual**

A landscape and visual assessment was carried out in order to recognise, understand and interpret the character and value of the landscape setting of the project. Landscape impacts are changes on the landscape resource and perception of the landscape, and differ from visual impacts, which relate to the appearance of these changes and the resulting impact on visual amenity.

The project is located within an existing industrial area and will not significantly alter the character of it. In regard to visual amenity, the project will be viewed within the midst of the existing industrial developments and, seen in the context of the existing industrial structures, will have only a minor effect on the visual amenity experienced from the surrounding residential areas (the nearest of which are over 2km from the power plant sites). The project sites are likely to be visible to some extent from distributor roads surrounding the industrial area including Valco Road, Harbour Road, and the N1 (Accra to Alfoa Road) and also from the from the Accra/Tema railway. Views of the project from these routes are likely to be partial and intermittent, the project viewed within the industrial area and exerting limited influence on visual amenity.

The resulting visual effects from the project are not likely to be significant and no mitigation is required.

### **3.12 Climate and Climate Change**

There is unequivocal evidence that the global climate is changing. On a global scale, this could lead to warmer temperatures, higher sea levels, intensification of natural water cycles and enhanced severity of extreme weather events. At a local level, climate change will vary depending on the geography and local conditions.

Due to its potentially long operational life, climate-sensitive risks for the Ghana Bridge Power Project may change and/or increase with time so it is important to make sure the design considers the potential for future change. This is known as 'climate resilience' to help make sure the project and infrastructure performs as required over the project lifetime.

However, given the relatively short timescales of the project design life in relation to timescales for significant climate change, significant climate change impacts are not expected for the project.

It is possible that some changes (e.g. small temperature increases or increases in the amount or frequency of rain and associated increase in flood risk) might happen. However, on the condition that mitigation recommended for flood risk issues and other mitigation as detailed in the project Environmental and Social Management Plan (ESMP) are implemented, no further specific mitigation is required for climate change issues.

EPL will also engage with local authorities and GWC to highlight the risks of climate change and associated impacts on utilities and to promote climate change adaptation activities in long term planning.

### **3.13 Cumulative Impact Assessment**

Cumulative impacts can result when one or more developments are constructed at similar times (e.g. more construction transport) or will add additional emissions to air or water compared to the existing conditions. Where relevant, the ESIA assessments provide discussion and impact assessment for cumulative impacts.

The key potential cumulative environmental impacts identified are traffic movement in the construction phase and air quality impacts during the operational phase when the plant is operating on LPG.

Following the confirmation of construction timescales for this project and other proposed projects, a Construction Traffic Management Plan will be compiled to reduce impacts on the local community and local road users to as low as practicable. If many other developments are happening at the time of construction, a cumulative traffic management plan will be developed to reduce associated impacts where practicable.

For air quality, the contribution of emissions from the following existing, new and expanded power plants were identified as relevant for cumulative assessment: the AKSA HFO power plant, the LCO/diesel/gas fuelled Cenpower KIPP, the proposed 450 MW capacity Karpower ship, and the completed Sunon Asogli plant expansion which may now also fire LCO. Significant cumulative impacts were not predicted when the EPL plant is operating on LPG. However, the assessment indicated that the local airshed in the area could be degraded in future for other parameters such as SO<sub>2</sub> and PM as a result of other power plants in the area. Therefore, in the event of significant disruption to LPG supply to the Ghana Bridge Power Project, any temporary/emergency backup operation on DFO will be closely monitored in consultation with the Ghana EPA.

EPL has confirmed with the EPA and other generators during consultation that it is committed to working collaboratively with other emitters regarding long term ambient air quality within the air shed.

Once a reliable supply of natural gas becomes available, EPL and other operators will convert their operations and impacts to residential areas will reduce to levels well below the relevant air quality standards.

In addition to the above, the combined effects of similar projects could increase the magnitude of social, health and safety impacts. This could mean higher risk of road accidents, a larger worker influx into the area and associated health risks or increased demand on public services. In this context, the importance of proper stakeholder engagement, including with other projects, and understanding of community concerns is paramount.

The assessment has concluded that, with appropriate mitigation, cumulative impacts will not be significant.

## 4 Summary and Conclusions

The Ghana Bridge Power Project is a brownfield power project located in the industrial / commercial THIA that will produce 418 MW of electricity. The project will initially use LPG as the fuel source with the expectation that natural gas will be used once a reliable source becomes available from Government of Ghana, expected to be within 5 years of project completion. In addition to the power plant facilities, the project will include a new LPG pipeline, DFO pipelines and tank farm, and new pipelines to transport water to the power plants from the GWC municipal supply network.

The ESIA was carried out to assess the potential impacts associated with the project and found that the impacts were mainly minor or negligible in nature and therefore not significant. The recommended adoption of good practice measures through following appropriate regulations, guidance, international standards and other appropriate measures will serve in many cases to further reduce these non-significant impacts.

The project will have positive direct effects through creation of a small number of jobs, and many indirect benefits to the economic and social development of the region through provision of power and supply chain opportunities.

Identified potential adverse social impacts include the need to move some a small number of kiosks along the pipeline route and a small number farmers on the PPS1 site, and a business and a family who reside on the PPS2 site. EPL is implementing an appropriate ARAP process to support the affected people and ensure they are treated fairly, in line with Ghanaian and international standards.

Potential adverse environmental impacts included issues associated with air emissions under temporary DFO operation, localised temporary noise emissions during Stage 1a, minor flood risk and potential community health and safety risks associated construction transport and construction and operation of the LPG pipeline within the TOR pipeline right of way.

No potentially significant air quality impacts were identified under operation on LPG. However, the assessment concluded that operation of the project on DFO and different durations of a mix of LPG and DFO would potentially exceed some of the air quality criteria. The cumulative air assessment also concluded that the air shed would likely already be degraded for both PM and SO<sub>2</sub>, due to the operations of other plants on fuels less clean than LPG used for the EPL project. Therefore, in the event of significant disruption to LPG supply to the Ghana Bridge Power Project, any temporary/emergency backup operation on DFO will be closely monitored in consultation with the Ghana EPA.

Significant noise impacts are not anticipated for the long term operation of the project. Mitigation measures to address temporary noise impacts to an adjacent commercial facility (during Stage 1a operation) are under discussion and may include the installation of a temporary noise barrier.

Minor localised flood risks on the power plant sites will addressed through the raising of the sites and utilisation of appropriate perimeter and internal site drainage and storm drainage along the adjacent access roads.

Potential community health and safety risks associated with construction and operation of the above ground section of the pipeline (from the TOR jetty to TOR) will be addressed in collaboration with TOR. This will include the adoption of appropriate construction safety management measures and as a minimum, the installation by the project of road safety crash barriers at road crossings over the TOR pipelines.

EPL will continue to consult with key stakeholders including relevant statutory bodies and representatives of the local communities to ensure that the project is conducted in line with national and international requirements.

#### **4.1 Ongoing ESIA Activities**

As the project has progressed and detailed design is concluded, a greater level of certainty has become available regarding the project's impacts and the environmental and social aspects that will require management during construction, operation and construction, as detailed within this revised ESIA. These issues are addressed in the updated ESMP, which summarises the key environmental and social actions that will be implemented throughout the project, and which underpin the project's environmental management system. The ESMP will continue to be developed as the project develops.

A number of key actions are also ongoing in relation to the development of a Stage 2 LRP/ARAP, final implementation of the Stage 1 LRP/ARAP, and associated resettlement and compensation activities.

Consultation activities will also progress throughout the lifecycle of the project with key stakeholders and affected parties.