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REPUBLICA DEMOCRATICA DE TIMOR-LESTE
SECRETARIA DE ESTADO DOS RECURSOS NATURAIS

Tasi Mane Project – Betano Petroleum Refinery and Beaco LNG Plant

Strategic Environmental Impact Assessment

EXECUTIVE SUMMARY

301012-01504-EN-REP-0005
June 2012

EXECUTIVE SUMMARY

Overview

The Government of the Democratic Republic of Timor-Leste (GoTL), through the Secretaria de Estado dos Recursos Naturais (SERN) has commissioned a study to assess the likely environmental and social impacts of the possible development of a petroleum refinery and petrochemicals complex near the town of Betano, and an LNG Plant near the town of Beaco; both located on the south coast of Timor-Leste.

This proposed development forms part of the strategic vision for the nation and is central to securing new commercial and industrial activities that can contribute to sustainable social and economic growth for Timor-Leste (Strategic Development Plan (SDP) 2011-2030).

The implementation of this vision starts with the Tasi Mane project - a collection of three, shore-based petroleum-related facilities that are of strategic importance to the GoTL. The SDP identifies the careful management of the petroleum sector as a key source of the nation's future development:

> *'This sector is critical not only to our economic growth and strength, but also to our future progress as a successful, stable nation. While developing the sector, we must ensure that Timor-Leste's natural resource wealth is used to build our nation and support our people.'* (SDP, 2011).

The Tasi Mane project is intended to facilitate the onshore processing of gas and condensate reserves in the Timor Sea and comprises (Figure ES-1):

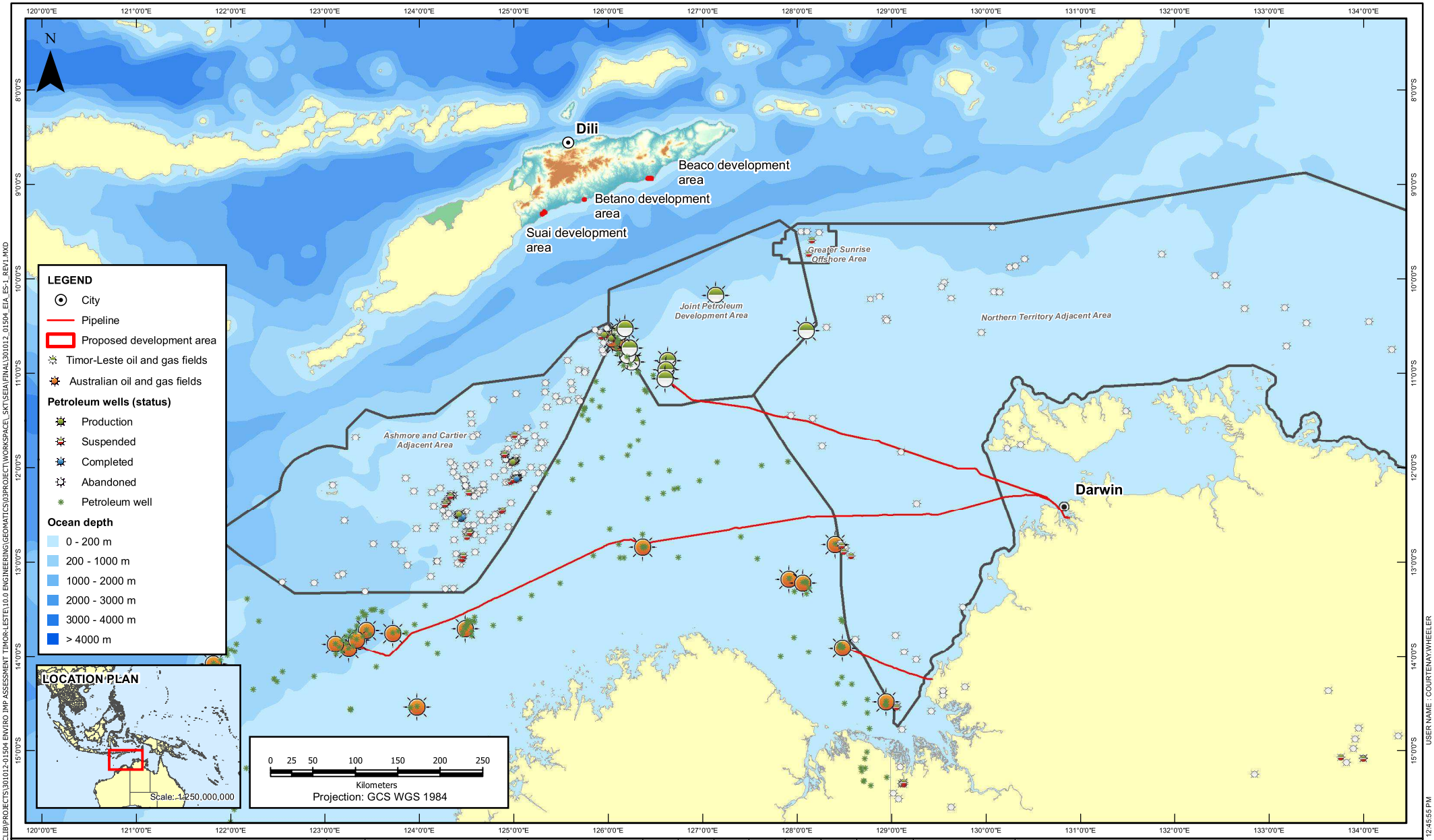
- Suai Supply Base.
- Betano Petroleum Refinery and Petrochemicals Complex.
- Beaco LNG Plant.

For each site, there are additional facilities planned including new towns to accommodate the workforce and some relocated local residents and, upgrades of existing airstrips.

This document relates to the planned development of the Betano Petroleum Refinery and Petrochemicals Complex and the Beaco LNG Plant. A separate environmental impact statement has been prepared for the Suai Supply Base.

For clarity, the executive summary has been divided into three sections:

- Common sections that apply equally to all sites such as the introduction, the role of government, stakeholder consultation and the environmental management framework.
- A summary of the study of the Betano development area.
- A summary of the study of the Beaco development area.



NOTES:
This map consists of:
1. DEM: SRTM (2011)
2. Petroleum wells: Department of Mines and Petroleum, Western Australia

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TASI MANE PROJECT - BETANO AND BEACO STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT

Figure ES-1
Petroleum developments in the Timor Sea

This Strategic Environmental Impact Statement

This strategic environmental impact statement is based on engineering design studies that are, in part, conceptual in nature or entirely absent hence, as detailed design proceeds, much of the project description on which the predicted impacts are based could change. In some instances, generic information has been used to guide field studies and to inform the discussion to at least provide an indication of the scale and type of development that may eventually occur when the projects do proceed.

As a result, this strategic environmental impact assessment statement should be regarded as preliminary in nature as it is expected that, as detailed design proceeds, further studies and consultation with the affected communities will be required and some of the conclusions reported herein, will also change.

Nevertheless, we can state with confidence that the majority of the *types* of environmental and social impacts are reasonably predictable although, some variances in the quantum and location of these predictions are inevitable subject to:

- The provision of information relating to the key infrastructure proposed, scale and production technology.
- The inclusion of additional, project-related works such as quarries, laydown areas, temporary accommodation camps, dredging areas and dredge spoil dumps.
- The accumulation of seasonally-based or long-term data.
- The passage of time.
- Probable changes in the actual plant design or product mix compared to those that form the basis of the study.

What is most likely to vary is the actual scale and location of those impacts and, for this reason, a quantitative assessment could not be undertaken. For example, the amount of groundwater consumed, actual area of vegetation clearance, estimated emissions of noise, dust or greenhouse gases or, changes to the number of vehicles on the local road system.

It is expected that, once commercial arrangements have been finalised and the project design progressed sufficiently, a separate environmental impact assessment will be carried out.

The Role of Government

Unlike the Suai Supply Base, where the GoTL is the project proponent, it is expected that development of the petroleum refinery and LNG plant will be commercial ventures operated by private companies. At this stage, neither the proponent nor the development timetables have been confirmed.

There are two principal laws governing the development of the Betano and Beaco sites; one relating to the environmental impact assessment and the other relating to licensing of the downstream petroleum industry:

- Environmental Decree Law No.5/2011. Under Part V, Annex 1, Category A projects defined by the decree law require an environmental impact assessment. For the Betano and Beaco sites, this law has been triggered by:
  - Port and port facilities are of a scale > 500 gross tons.
  - Storage sites for oil, natural gas, petrochemicals or chemicals ≥ 1,000,000 L.
  - Oil and gas refineries.
- Decree Law 1/2012 on the downstream sector. Under this law, it is anticipated that a single licence application will be made to cover the Betano petroleum refinery and petrochemical complex, and the Beaco LNG plant and jetty.

In addition, port licences will need to be granted under Decree Law 3/2003 prior to the commencement of construction and other sundry approvals may be required.

Stakeholder Consultation

In the two project areas, the stakeholder consultation process has commenced with district, subdistrict and local village leaders; however, to date, there has been little more widespread engagement with the affected communities within the project area and their understanding of the proposals is limited.

Stakeholder consultation is no less important at these sites as it is at Suai and the amount of consultative effort applied to Suai simply reflects the immediate priorities of development of the three sites. Effective stakeholder consultation is a crucial component of work on the project to ensure that the proposed works are understood and any concerns addressed. It is expected that the consultation program in the Betano and Beaco development areas will be expanded as part of the future EIA once commercial arrangements are at a more advanced stage.

The limited stakeholder consultation for Betano and Beaco that has been conducted to date has been led by SERN and has largely been aimed at informing community leaders about the nature and location of the planned development. The involvement of senior members of the GoTL, including the Prime Minister, in stakeholder consultation undertaken to date provides an indication of the importance placed on the project by the government. It is recognised that the consultation process for the Betano and Beaco sites has not been as thorough as what has been undertaken at Suai due to the project's construction timeline, with both the Betano Petrochemical Complex and the Beaco LNG Plant to be built after the Suai Supply Base.

Feedback from the consultation program to date reflects some community support for the project, particularly, the potential for jobs for local residents. However, it was also clear that very little was known about what was planned at either site which has heightened concern about who would be affected.

Betano Petroleum Refinery and Petrochemicals Complex

Project Description

Located on the coast in the Manufahi District, approximately 70 km south of Dili and 5 km to the east of the Rio Caraulun, the proposed Betano Petroleum Refinery is expected to produce approximately 30,000 BPD of petroleum products from petroleum condensate piped to site from gas fields in the Timor Sea (see Figure ES-2).

The refinery and petrochemical complex will convert condensate to a range of fuels and other products; however, the actual product range and expected rate of production across that range has not been confirmed.

Development of the refinery will be supported by construction of a new town, Nova Betano which will house up 14,500 staff, contractors and their families and cover an area of approximately 1,065 ha. The town area will include schools, hotels, commercial areas, recreation facilities and ancillaries such as water, waste, sewage and power plants. The existing Betano airstrip will be upgraded to the status of regional airport with a new runway and terminal facilities.

Nova Betano is located approximately 7 km inland of the sea adjacent to Rio Caraulun (see also Figure ES-2).

Existing Environment

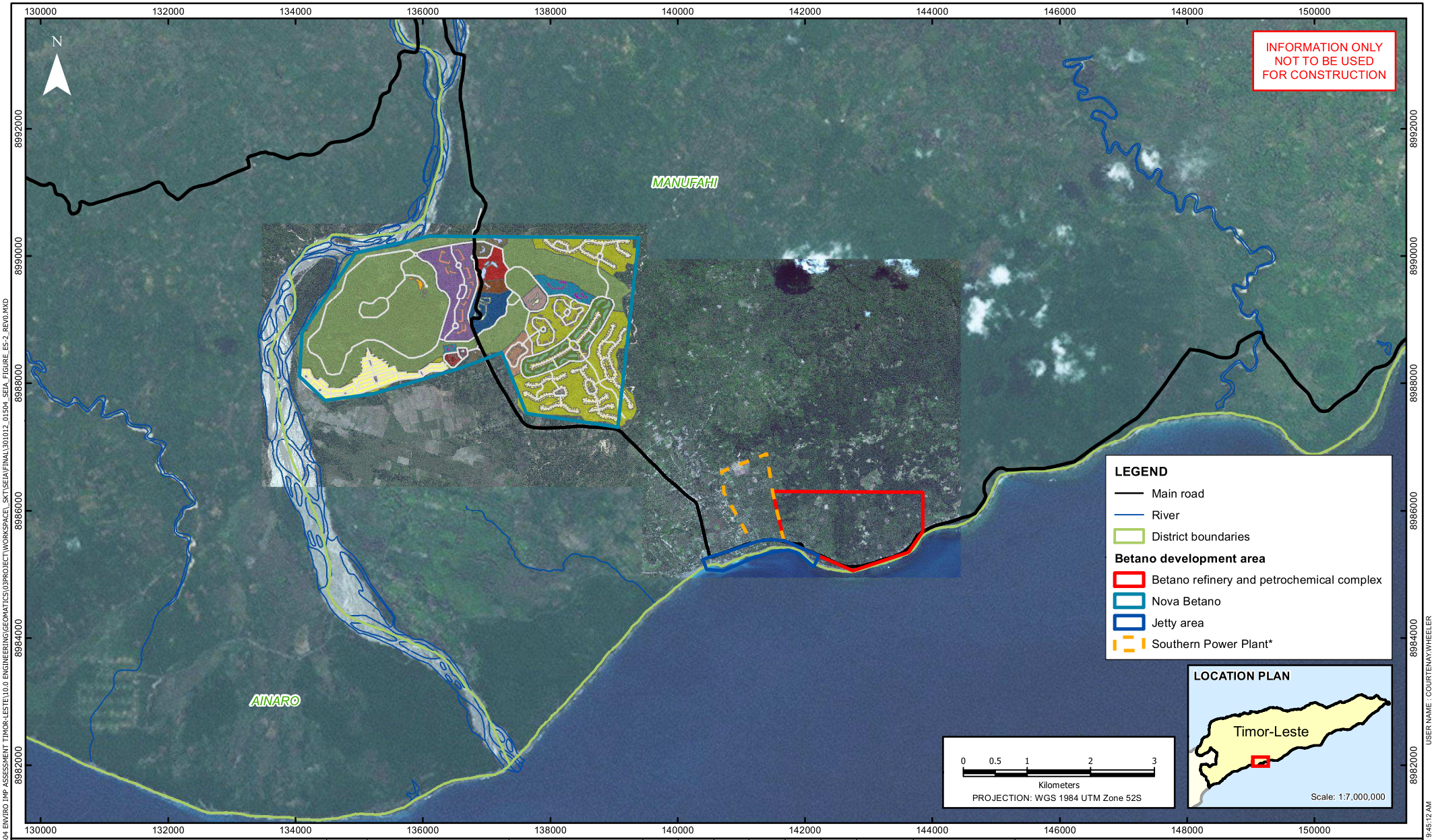
Climate and Meteorology

The project area has a typical tropical monsoonal climate with distinct wet and dry seasons. Seasonal variation in temperature is minimal, with the diurnal temperature variation often greater than the seasonal variation. Daytime temperatures are typically in the low to mid 30's and night-time temperatures are in the mid 20's. Humidity is consistently high, typically above 75% and ranging up to 85% while mean annual rainfall in the area is 1,387 mm with the lowest monthly rainfall occurring during the months from August to November. Long-term multi-year rainfall trends are generally dictated by El Niño / La Niña effects; however, shorter-term annual rainfall patterns are monsoonal in nature experiencing a 7 to 9 month wet season with two peak months, December and May (CSIRO, 2010).

Little historic wind speed and wind direction information was available therefore, generalised trends cannot be determined at this time. Since 1920, two cyclone events have been reported to be within 100 km of the Betano study area and an additional nine cyclone events within 200 km.

Land Use and Visual Amenity

The project area comprises a mosaic of rural subsistence farms serviced by a small network of roads and tracks. In some hilly areas, the farmland has been terraced. Where they occur, villages and towns are clustered around the inter-regional roads while scattered housing is also prevalent. A variety of animals (chickens, pigs, cattle and goats) and food crops (corn, cassava, peanuts, long beans, papaya, watermelon and bananas) are raised. Trees such as mango, coconut, teak, kapok, sago and banana are also farmed and artisanal fishing in the sea is common.



NOTES:
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1. Imagery: DigitalGlobe (2008-2011)
2. Imagery: Google Earth (2010)
3. Rivers: Geographic Information Group TimorLeste (2010)
4. Roads: DivaGIS (2010)
5. Town layouts: RDTL (2011)

*Not part of this scope
**Detailed layouts are included in Figures 4-1 and 4-2

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TASI MANE PROJECT - BETANO AND BEACO
STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT

Figure ES-2
Betano development area

LOCATION: I:\PROJECTS\301012-01504 ENVIRO_IMP ASSESSMENT TIMOR-LESTE\10.0 ENGINEERING\GEOMATICS\03PROJECTWORKSPACE_SKT\SEIA\FINAL\301012_01504_SEIA_FIGURE_ES-2_REV0.MXD
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The change from the current land use to that proposed for the refinery and the associated works is profound as the only comparable works in Timor-Leste are parts of the urbanized areas of Dili. The new industrial and urban land use planned will replace some current farm and village areas; however, this change is consistent with the objectives of the SDP.

The expected increase in population associated with the Betano development may result in pressure on existing land uses and potentially increase the rate of land degradation (forest clearance, erosion, water harvesting). Management measures to reduce any potentially adverse impacts will require further consideration during the detailed design stage of the project.

Due to the relatively flat topography and the open coastal location, the refinery and petrochemical complex is likely to be highly visible from both higher vantage points and some lower areas (e.g., local roads and settlements) in the immediate vicinity although, the existing vegetation and topography may offer some screening.

The assessment of visual amenity was based on a combination of visual sensitivity, visual impact significance and visual exposure and considered the known attributes of the plant, the current environment and the scale of the development. The significance of the impact of the refinery and petrochemical complex on nearby land users is likely to be significant due to the scale and nature of the proposal, the likely visibility from sensitive receptors. The significance of the impact of Nova Betano is likely to be ‘moderately adverse’ for local residents and nearby land users.

Topography, Geology and Soils

The geology of Timor-Leste comprises predominantly limestone and metamorphosed sediments overlying ancient Proterozoic basement rocks. Topographically, the project area slopes southwards towards the Timor Sea and merges with a wide, flat, coastal plain on which most project-related facilities are located. The refinery and petrochemical site stretches from the high water mark above the beach, inland along the narrow coastal plain, before intersecting a few low hills which occupy the northern part of the site.

In contrast, Nova Betano (located approximately 5 km northwest of the refinery site) is draped over a pair of prominent hills, bisected by the road to Viqueque and separated by a prominent valley into two sections; Nova Betano East and Nova Betano West. Gradients in Nova Betano are generally moderate to fairly steep.

The refinery and petrochemical site is underlain by the Suai Formation which is comprised of unconsolidated sediments ranging from silts to conglomerates. Construction on the refinery site will need to consider the potential effects of soil shrinkage and swelling on foundation design due to the presence of some clayey horizons. The central core of Nova Betano East is underlain by the Baucau Limestone Formation while the central core of Nova Betano West is underlain by the Bobonaro Scaly Clay Formation. Due to the high proportion of montmorillonite (bentonite) in this formation it is unstable even when vegetated. When covering vegetation is cleared, it is prone to severe erosion. The Nova Betano West site is likely to be experience ongoing problems with slope stability and an alternate site has been recommended.

Air Quality

The existing air quality in the project area has been sampled and, in the absence of Timor-Leste standards, has been compared against World Health Organisation, US EPA or Australia's National Environment Protection Council (Ambient Air Quality) standards.

The assessment shows that most existing sources of air pollutants (dust particles as $PM_{2.5}$ and PM_{10} and gases such as nitrogen dioxide, sulfur dioxide and carbon monoxide) originate mainly from human activities such as burning of the vegetation, vehicular traffic and, to a lesser extent, power generation exhausts although, aspects such as total suspended particulates are likely to vary widely during the year due to seasonal effects. Naturally occurring sources of pollutants such as methane emissions from cattle are unlikely to be a significant influence on air quality. Current air quality indicators are, with the exception of Freon 12 (a refrigerant gas), all below the limit of reporting or the assessment criteria set in the standards.

During construction, the exposure of large areas of soil accompanied by vehicular traffic will cause localised increases in airborne dust particles. During operations, the potential impacts of emissions of gaseous pollutants will need to be assessed (including BTEX, VOCs, and NO_x).

Noise

The main existing sources of anthropogenic (i.e., caused by human activity) noise in the project area are talking, the play of children, use of power tools, music and electrical generators. Non-anthropogenic sources include the weather (wind, thunder and rain) and animals such as chickens and dogs also contribute to the current noise environment.

Project-specific noise limits have been developed based on the Western Australian Environmental Protection (Noise) Regulations 1997. These limits recognise the need to have varying permissible noise levels depending on the time of day (e.g., to protect sleeping patterns) and the sensitivity of the affected premises (residence, commercial premises or industrial site). Based on the existing background noise levels, the calculated allowable noise levels range from 45 to 57 dB (A)L_{A1} for noise-sensitive sites such as residences to 75 dB(A)L_{A1} for commercial premises and 80 dB(A)L_{A1} for industrial and utility premises.

Computer-based predictions of actual noise emissions from project-related activities at any of these sites are not possible at this point due to the unknown plant design although, the character of the noise will change between construction and operational phases. For example, construction is likely to include impulsive sounds such as pile-driving and will largely be confined to daylight hours. Operational noise will be continuous and largely unchanging throughout the day except during periodic shutdowns for maintenance.

Hydrology, Drainage and Water Quality

The refinery site itself is situated within the Clere and Belulic Hydrologic Unit and is situated 5 km east of the largest river in the catchment, the Rio Caraulun, which has a catchment of approximately 554 km^2. Within the Rio Caraulun catchment, the mean annual streamflow is 385,000 ML while mean annual irrigation demand- the main source of water consumption- is only 33,000 ML.

Estimated peak flows on the Rio Caraulun are expected to have 10-year average recurrence intervals (ARI) rates of 800 m^3/s and 1,502 m^3/s for a 100-year ARI.

Surface waters are suitable for human consumption; however, water quality varies widely during the year due to changes arising from sometimes intense seasonal rainfall.

Hydrogeology

In the project area, at a regional scale, groundwater recharge occurs in the Ramelau mountain range to the north and generally flows southwards towards the Timor Sea where it discharges through the unconsolidated sediments of the Suai and Dilor formations.

Groundwater is the principal source of drinking water in Timor-Leste and natural groundwater springs are the dominant sources of water supply in rural areas, supplying potable water to approximately 60% of the population (ADB, 2001). Shallow wells (2 to 10 m) are used extensively in villages such as Betano and other rural areas; especially those near the sea or on river plains.

The Clere and Belulic hydrological region is estimated to have a total AGWR budget of 26 million m^3 while estimated groundwater withdrawals per capita within the Clere and Belulic area were 57 m^3 per year, less than 0.5% of the total water resources per capita (12,486 m^3; ADB, 2004) in an average year. However, during a dry (1 in 5 low flow) year, groundwater withdrawals can account for up to 1% of total water resources due to limited water availability (7,863 m^3 per year). Within that same hydrologic region, a total sustainable yield of 25.5 M m^3/year (809 L/s) and a total storage of 6,800 M m^3 were calculated based on an average aquifer extent of 340 km^2 and 100 m in thickness. These values indicate an abundance of groundwater within the region; however, they should be considered very approximate estimates of deep (>100 m) aquifers.

Groundwater samples were analyzed for total dissolved solids (TDS), salinity and turbidity. Results for TDS are all below WHO drinking water guidelines while half of the samples were at, or above, WHO guidelines for turbidity. Turbidity values reported above the WHO guideline value indicate the presence of silt, sand, mud, bacteria and/or chemical precipitates, which may adversely affect water treatment systems, such as sedimentors or gravel filters. It is also important to control turbidity in drinking water supplies for both health and aesthetic reasons (WHO 2011).

Terrestrial Biodiversity

The coastal plain of southern Timor-Leste has largely been cleared in association with swidden (‘slash and burn’) agriculture, sandalwood harvesting, plantation estates and timber plantations. Remnant native vegetation exists as highly fragmented and secondary communities. Most of the understory within remnant vegetation and agricultural land is dominated by invasive species, particularly Siam weed (*Chromolaena odorata*) and cogon grass (*Imperata cylindrica*). Grasses are actively farmed by the local communities by grazing cattle, water buffalo, pigs and goats.

Nova Betano is located within an extensive area of secondary moist deciduous forest and a proportion of the western area of the Nova Betano site is relatively undisturbed dense forest although, the majority of the central and eastern area is secondary open forest.

Nova Betano is also adjacent to a government-operated irrigation channel that comprises undisturbed forest in good condition and according to local guides, this area is ‘lulik’ (sacred). This undisturbed

site has a canopy cover of 50% and a well-developed understory. Orchids and stag horn ferns (*Platycerium* sp.) were observed high in the canopy.

A total of 201 species were identified, two of which are listed on the IUCN Red List as Vulnerable; ai-na (its Tetum name) *Pterocarpus indicus* and sandalwood *(Santalum album).* There are nine major weed species present including Siam weed and cogon grass both of which are recognised as major weeds across all of Timor-Leste. Seven species of reptiles and 40 species of birds were noted, of which, the two most common families were the *Columbidae* (pigeons and doves) and the *Meliphagidae* (honeyeaters). There are also 13 species of mammal and 5 species of bat including Canut's horseshoe bat (*Rhinolophus canuti)* which is listed as Vulnerable on the IUCN Red List, and the little long-fingered bat (*Miniopterus australis)* which is listed as being of Least Concern.

The best means of protecting both commercially valuable species and conservation-significant native species is to situate project facilities in previously cleared land.

Marine Biodiversity

The southern Timor-Leste coastline consists of a combination of sandy beaches and limestone rock ledges that extend from the shoreline as intertidal reef flat areas that then slope steeply downwards. In some places along the southern coastline, water depths of 200 m can be found less than 1 km offshore.

The sandy beaches at Betano consist of medium to fine sand with silt. During heavy rains, sediments are mobilised from the surrounding catchment and enter the ocean causing large sediment plumes. Related to this phenomenon, the benthic habitat within the study area is dominated by sediment although, some corals and algae in various forms are also present. The greatest diversity of corals was generally found within 3 to 8 m of the surface.

Bottom sediments show little in the way of any contaminants compared to ANZECC/ARMCANZ (2000) criteria. Concentrations of total nitrogen and phosphorus were relatively high in coastal sediments and have been interpreted as being of organic origin.

With respect to water quality, results collected during the field investigation indicate that marine water quality conditions at Betano are generally typical of a tropical marine ecosystem at that time of the year (Kirono, 2010). Few trends in water quality parameters were apparent across sites or between offshore and inshore sites; indicative of well-mixed waters and a relatively constant water quality.

Concentrations of nutrients and metals (total and dissolved) in water samples were generally below levels prescribed in ANZECC/ARMCANZ (2000) although, there were some elevated results for ammonia at all sites and, in several instances, copper.

Construction will unavoidably disturb and alter habitats in some areas of the site. The consequence of these changes are likely to be confined to the jetty footprint and can be minimised by locating the development site in an area where habitats are likely to have a relatively high tolerance to turbidity and disturbance and, lower conservation value.

Operation of the desalination plant is not expected to have any noticeable impacts, provided discharge of brine occurs in deeper waters away from shore. Similarly, suitable treatment of

wastewater generated by the refinery should be undertaken prior to any discharge into the marine environment if adverse impacts are to be avoided.

The risks of spills, antifoulant contamination and marine pest incursions can be greatly reduced through the implementation of specific management plans as part of an environmental management system.

Land Transport

The current poor condition of the existing road network in the project area at both Betano and Beaco reflects the heavy rainfall, low maintenance budgets and the geological conditions on which the roads are built. Within the project area, the major means of transport are buses, trucks, motorcycles and horses. Pedestrian traffic on roadsides and informal tracks is also widespread while cars are relatively uncommon.

A brief transport study has shown that the existing road network will be challenged by the likely increase in heavy vehicle traffic during the construction phase and both light vehicle (predominantly) and heavy vehicles during operations. The current road system will require substantial investment to upgrade existing roads and divert and maintain new roads away from town centres. Drainage management will be a key aspect.

Once construction has been completed, it is thought that the most frequent vehicle trips will be between the new towns and the workplace (i.e., petroleum refinery) and the majority of workers will travel by bus.

Socio-economic

Socio-economically, if it proceeds, the project will have a profound impact on both the local community and the whole country. With a population of 5,151, the nearest village- Betano- is typical of many south coast villages in that households typically have around 5 members, 41% are aged between 0 to 14 years, they rely on subsistence farming, 60% own a mobile telephone and 34% own bicycles while only 15% owned a motorcycle. Cars are quite rare; only 2% of households owned one. Most people relied on one of the 100 wells in Betano for their drinking water and 94% cooked over a wood fire. Nearly half of the population (47%) aged 5 or older does not have any formal education and less than 1% had a tertiary education. Malaria is common.

The community is generally looking forward to the job creation afforded by the new facilities; however, they have some concern about the influx of outsiders and what the project may bring in terms of competition for jobs, disturbance to sacred sites, loss of agricultural land, changes to transport linkages, communicable disease and competition for available services. All of these aspects will need proactive management in order to minimise any adverse effects.

The likely large-scale relocation of local residents represents the most significant social challenge to both the GOTL and the affected communities.

Economically, the local impacts include financial benefits of a scale unprecedented in the area.

Waste Management

With the exception of sewage from Nova Betano, the predominant source of all wastes will be gaseous, solid and liquid wastes from the petroleum refinery and petrochemicals plant. These wastes will largely contaminated by hydrocarbons but, will include inorganic wastes such as mercury, incinerator ash and gaseous wastes emitted to the atmosphere from vehicle exhausts and stationary plants sources such as gas turbines.

The exact volume and inventory of wastes will not be known until the actual plant design of both the refinery and the petrochemicals complex has been confirmed.

A waste management plan should be implemented in accordance with the waste hierarchy of reduce, reuse and recycle.

Beaco LNG Plant

Project Description

The proposed development site is located near the coastal village of Maluru in the Viqueque District approximately 100 km southeast of Dili and will be comprised of four distinct developments (see also Figure ES-3):

- LNG plant and jetty. A single gas train with a capacity of 5 Mtpa.
- Nova Beaco. A new town on approximately 100 ha that can accommodate up to 1,900 residents.
- Nova Viqueque. A new town on a 216 ha site that can accommodate up to 6,400 residents.
- Viqueque Airstrip upgrade.

Each of the new towns will have a commercial centre, recreation facilities, schools and civil infrastructure such as water, waste, power and sewage plants while the currently abandoned Viqueque airstrip will be upgraded to the status of regional airport with a new runway and terminal facilities.

The LNG plant is expected to be expanded with the addition of successive 5 Mtpa trains to a total capacity of 20 Mtpa at some point in the future.

Existing Environment

Climate and Meteorology

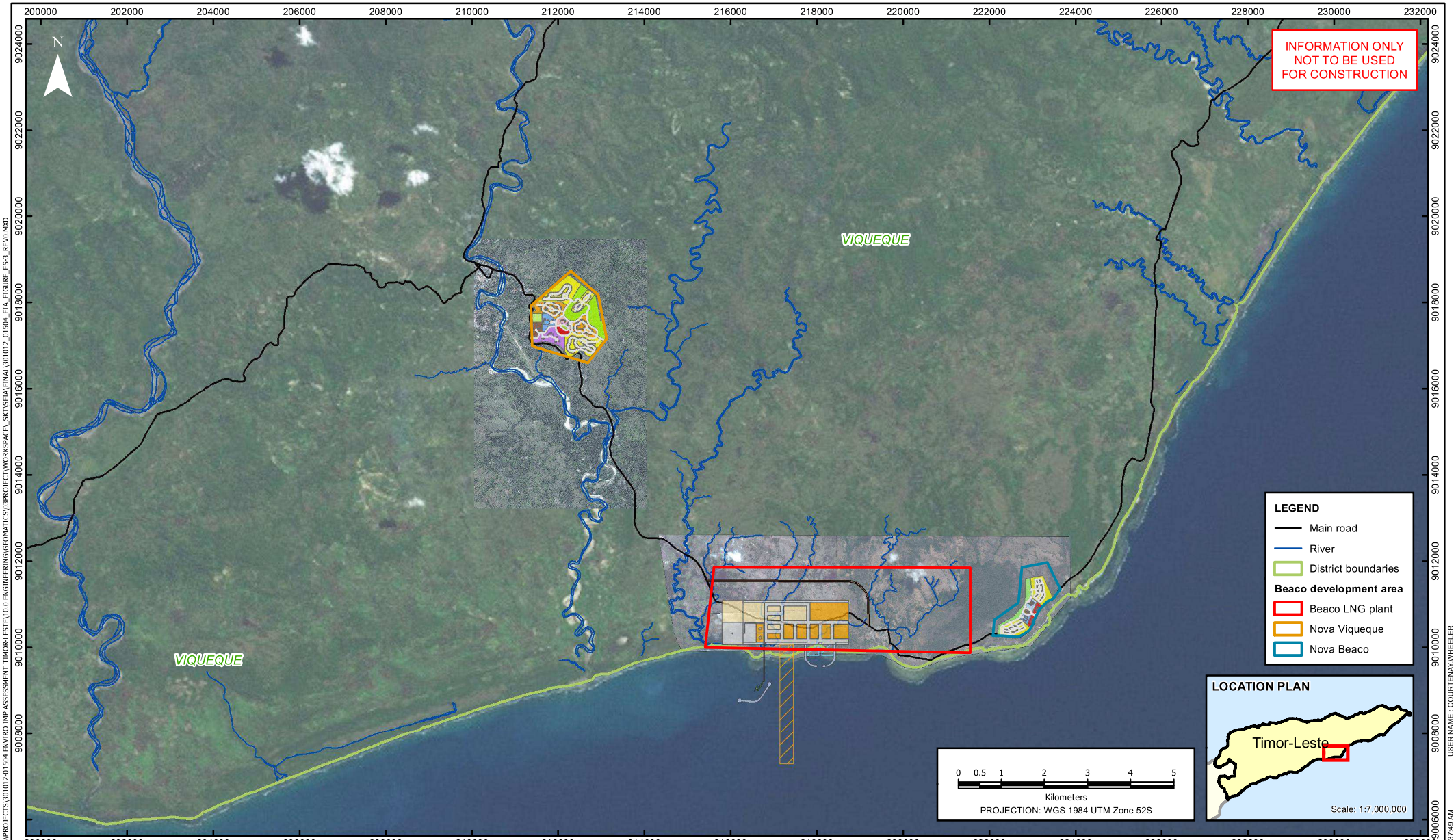
The climate at Beaco is broadly similar to Betano; however, the Beaco/Viqueque region often receives far more rainfall than other lower-lying regions on the southern coast, including torrential rain events. Mean annual rainfall is 1,879 mm and, on average, six months of the year it receives more than 100 mm of rain per month.

A more extensive (range of parameters and duration) meteorological data set will be beneficial to future mathematical modelling of air quality and noise emissions.

Land Use and Visual Amenity

Currently, Maluru village and various scattered houses are situated within the proposed area of the LNG plant while land use within the areas proposed for Nova Beaco and Nova Viqueque comprises grazing land, plantations and scattered farm houses. These houses and towns are connected by a small network of roads and tracks. Where they occur, villages and towns are clustered around the inter-regional roads and farming in the area typically involves a variety of animals (chickens, pigs, cattle and goats) and food crops (corn, rice, cassava, coconuts and bananas). Trees such as teak, rosewood and sandalwood are also farmed and artisanal fishing is common.

The change in land use will be profound and permanent as there is no comparable type of development anywhere in the region. Some ameliorative work could be used to soften the change in viewsheds (e.g., screen planting) nevertheless, the rising ground to the north and the size of the likely developments means that the developments will be readily visible from many vantage points.



NOTES:
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1. Imagery: DigitalGlobe (2008-2011)
2. Rivers: Geographic Information GroupTimorLeste (2010)
3. Roads: DivaGIS (2010)
4. Town layouts: RDTL (2011)
5. LNG Plant layout: KBC (2011)

**Detailed layouts are included in Figures 4-4, 4-6, 4-8

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STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT

Figure ES-3
Beaco development area

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The significance of the impact of the LNG plant on nearby land users is likely to be significant due to the scale and nature of the proposal. The significance of the impact of Nova Beaco and Nova Viqueque is likely to have be 'moderately adverse' on nearby land users.

Topography, Geology and Soils

The topography of the project area slopes southwards towards the Timor Sea and merges with a wide, flat, coastal plain on which most project-related facilities are located. The LNG plant site stretches from the high water mark above the beach, inland (northwards) along the coastal plain, before intersecting a few low hills which occupy the central and northern parts of the site. These low hills, with gentle to moderate gradients, coincide with a change in the geology. Nova Beaco, located about 1 km to the east of the LNG Plant site, occupies a comparable position in the landscape.

In contrast, Nova Viqueque (located approximately 6 km north-west of the LNG Plant site) is draped over a prominent set of ridges dissected by incised valleys. Gradients in this area range from moderate to steep, with many landslips in evidence.

At the LNG Plant site and Nova Beaco, the coastal plain is underlain by the Suai Formation, with the hills emerging to the north comprising the Baucau Limestone Formation. The limestone is; however, generally overlain by clay washed down from the higher-lying Bobonaro Scaly Clay Formation to the north.

The eastern two-thirds of Nova Viqueque are underlain by the Bobonaro Scaly Clay Formation, whilst most of the western third is underlain by the Viqueque Formation. The lower south-western corner of this site extends onto the coastal plain, which is underlain by the Suai Formation. Gradients at Nova Viqueque are typically fairly steep and, as a result of this and the Bobonaro Scaly Clay Formation, this site will, in all likelihood, be permanently plagued by geotechnical problems and development of this site should be reconsidered. Nova Viqueque, as well as the upper reaches of Nova Beaco and the LNG site, are potentially vulnerable to soil erosion.

The soil test results from the LNG plant site and Nova Beaco indicate consistently alkaline pH values and very low moisture, electrical conductivity and nutrients including total organic carbon in all samples. These results are consistent with coarse-textured, non-saline, low productivity soil developed on calcareous parent materials. Soils from Nova Viqueque are similar but, have a higher moisture content.

Additional challenging soils may also be present as acid sulphate soils and karstic limestones are also present and will need further investigation. No evidence of soil contamination was found.

Air Quality

The existing air quality in the project area has been sampled using the same study methods at Betano and showed that all measured indicators were well below the referenced air quality benchmarks. Across the study area, particularly around Viqueque, most pollutants originate from vehicular traffic and, to a lesser extent, smoke produced from refuse disposal.

During construction, the exposure of large areas of soil accompanied by vehicular traffic will cause localised increases in airborne dust particles. During the operational phase, dust emissions will

diminish and the emission of pollutant gases arising from fixed or mobile plant and equipment (power generation and vehicles) will take on a greater significance.

Noise

The main existing sources of anthropogenic noise in the project area are motor vehicles. Using the same study methods as at Betano and based on the existing background noise levels, the calculated allowable noise levels range from 45 to 49 dB(A)L_{A1} for noise-sensitive sites such as residences to 75 dB(A)L_{A1} for commercial premises and 80 dB(A)L_{A1} for industrial and utility premises.

Computer-based predictions of actual noise emissions from project-related activities at any of these sites are not possible at this point due to the unknown plant design although, the character of the noise will change between construction and operational phases.

Hydrology, Drainage and Water Quality

The proposed site for the Beaco LNG Plant is located within the Irabere Hydrologic Unit and approximately 2 km to the east of the Rio Cuha. It is traversed by three minor waterways (Ribeira Buaran, Ribeira Benaro and Ribeira Beaco). Nova Viqueque is located approximately 10 km inland on the banks of Rio Cuha, which has a catchment area of 268 km^2.

Within the catchment, the mean annual streamflow is 198,000 ML while mean annual irrigation demand- the main source of water consumption- is only 12,000 ML.

Estimated peak flows on the Rio Cuha are expected to have 10-year average recurrence intervals (ARI) rates of 750 m^3/s and 1,370 m^3/s for a 100-year ARI.

Surface waters are suitable for human consumption; however, water quality varies widely during the year due to changes arising from sometimes intense seasonal rainfall. Water sampling indicated elevated levels of nutrients, biological oxygen demand and pathogens and has been attributed to agriculture and human occupation.

Due to the low-lying nature of the terrain, the Beaco study area is defined to be in a high flood risk region.

Hydrogeology

At a regional level, the circumstances of Betano and Beaco project areas are very similar in that groundwater resources are generally abundant and are used by the local populace as a source of potable water. Estimates of groundwater withdrawals per capita within the Clere and Belulic area were 57 m^3 per year, less than 0.5% of the total water resources per capita (12,486 m^3; ADB, 2004) in an average year.

Groundwater samples were analyzed for total dissolved solids (TDS), salinity and turbidity. Results for TDS are all below WHO drinking water guidelines while the majority of samples were at, or above, WHO guidelines for turbidity. Turbidity values reported above the WHO guideline value indicate the presence of silt, sand, mud, bacteria and/or chemical precipitates, which may adversely affect water treatment systems, such as sedimentors or gravel filters. It is also important to control turbidity in drinking water supplies for both health and aesthetic reasons (WHO 2011).

Terrestrial Biodiversity

The proposed site of the Beaco LNG plant lies on a coastal plain largely cleared for grazing, agriculture, teak and coconut plantations. The low lying coastal plain area is often inundated during the wet season. Remnant vegetation in this area exists as a narrow strip of coastal vegetation and small areas of coastal mangroves, riparian mangroves and remnant moist deciduous forest along the eastern boundary. Remnant moist deciduous forest comprises the western portion of the Nova Beaco site.

Nova Viqueque is situated on rolling hills with some limestone outcropping visible. Vegetation is largely cleared for agriculture and grazing and remnant vegetation exists as patches of very open secondary vegetation or scattered trees on hill tops and along drainage lines.

In the Beaco LNG Plant area a single coastal mangrove community was recorded as well as two areas of riparian mangrove communities on estuarine rivers. In addition to this, secondary vegetation there is characterised by very open 'regrowth' forest, over grassland and introduced weed communities. This community is common in the area and results from repeated cycles of swidden agriculture. Most trees are deciduous at the end of the wet season. Dominant trees include *Borassus flabellifer*, *Corypha utan*, *Schleichera oleosa* and *Ziziphus mauritiana*.

Two Vulnerable listed flora species were recorded in the Beaco development areas, *Pterocarpus indicus* and *Santalum album*. Thirteen species were identified in the Beaco development area as having local and economic importance and nine major weed species. Siam weed (*Chromolaena odorata*) is the most widespread.

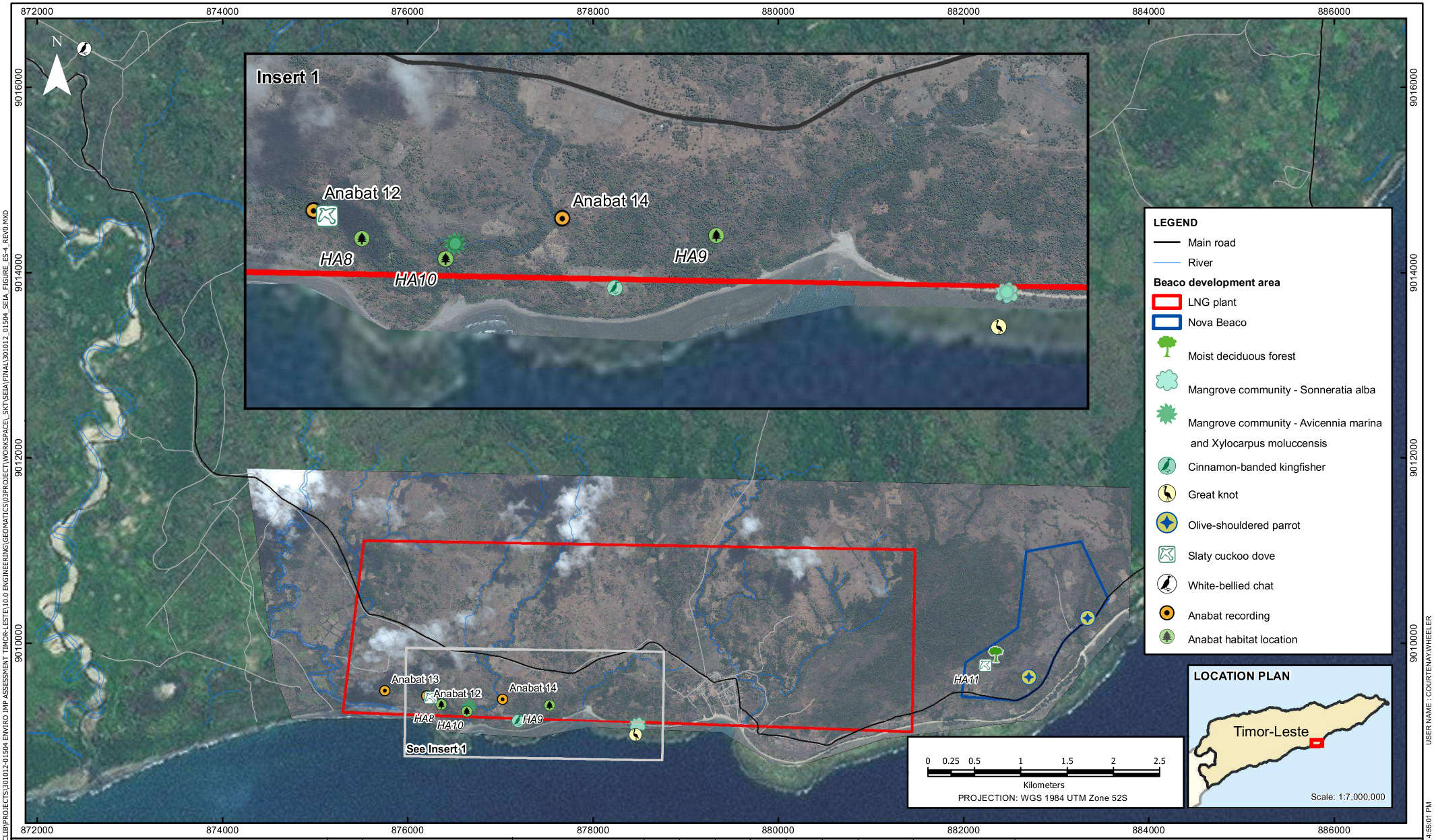
Within the Beaco development area, a total of 80 vertebrate fauna species were recorded, including 2 species of amphibians, 9 species of reptiles, 59 species of birds and 10 species of mammals. Of the 10 mammal species, five species were bats, including Canut's horseshoe bat (*Rhinolophus canuti)* which is listed as Vulnerable on the IUCN Red List. Six species of conservation significance were recorded in the Beaco development area, while 29 other species that either had the potential to occur, or had been previously recorded, in Timor-Leste were noted as either being 'Likely', 'Possible' or 'Unlikely' to occur in the development area (Figure ES-4).

Marine Biodiversity

Within the Beaco study area, algae, coral and invertebrates made up the biotic benthic community, which were primarily associated with hard substrate. The fringing reef identified adjacent to the Beaco study area is typical of the fringing reef systems found in South East Asia (Burke et al. 2002). The reef generally consisted of a low diversity reef flat which falls steeply into deep water. The greatest coral diversity was generally found within 5 to 8 m of the surface.

Similar to Betano, water quality sampling at Beaco indicates well-mixed water and relatively constant water quality. Ammonia and copper are again elevated compared to ANZECC/ARMCANZ (2000) standards whereas all other indicators are below them.

Sedimentary metal concentrations were generally below the ANZECC/ARMCANZ (2000) sediment quality guidelines with the exception of nickel which was just above the guideline value. Hydrocarbon levels in sediments were very low.



NOTES:
This map consists of:
1. Imagery: Digital Globe (2008-2011)
2. Rivers: Geographic Information Group TimorLeste (2010)
3. Roads: DivaGIS (2010)
4. Vegetation communities: WorleyParsons (2012)

REV	DATE	REVISION DESCRIPTION	DRN	CHK	DES	ENG	APPD	CUST	A4 SHEET	SCALE
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PROJECT No: 301012-001504

WorleyParsons resources & energy

TIMOR GAP, E.P. TIMOR GÁS & PETRÓLEO

REPUBLICA DEMOCRATICA DE TIMOR-LESTE
SECRETARIA DE ESTADO DOS RECURSOS NATURAIS

OneWay to zero harm

TASI MANE PROJECT - BETANO AND BEACO
STRATEGIC ENVIRONMENTAL IMPACT ASSESSMENT

Figure ES-4
Beaco study area biodiversity key sites

LOCATION: \\PERWORFIL11\INFSTRUCL1\BV\PROJECTS\301012-01504 ENVIRO IMP ASSESSMENT TIMOR-LESTE\10.0 ENGINEERING\GEOMATICS\03\PROJECT\WORKSPACE_SKT\SEIA\FINAL\301012_01504_SEIA_FIGURE_ES-4_REV0.MXD

USER NAME : COURTENAY.WHEELER

PLOT DATE & TIME : 05 JUN 2012, 4:55:01 PM

Similar to Betano, it is not possible at this point to quantify the impacts associated with development of either the onshore facilities via marine discharges or direct impacts associated with establishment of the materials offloading facility (MOF).

Socio-economic

Overall, the expected socio-economic impacts arising from the development of the LNG plant are as profound for Beaco and Viqueque as the petroleum refinery is to the area around Betano.

The two villages that will be most affected by the developments are Uma-Uain Craik (population 2,787) and Maluru (population 678) (Census 2010). The number of households present in Uma-Uain Craik is approximately three times greater than that of Maluru although both had average household sizes of just over five persons.

As for Betano, over 40% of the population in each village is aged between 0 to 14 years and relied on subsistence farming, the majority of households owned a mobile telephone, around 10% owned a motorcycle while car ownership remained a rarity (3%). Unusually, only 27% of households in Uma-Uain Craik grew crops.

Between 40% and 60% of the total population were literate in the two villages (RDTL, 2010).

The most common diseases present in Maluru and Uma-Uain Craik are malaria, tuberculosis, diarrhoea and leprosy

Waste Management

The predominant source of all wastes will be gaseous, solid and liquid wastes from the LNG plant. These wastes will largely be contaminated by hydrocarbons but, will include inorganic wastes such as mercury, incinerator ash and gaseous wastes emitted to the atmosphere from vehicle exhausts and stationary plants sources such as gas turbines and the acid gas removal unit. Significant volumes of sewage will also be generated from the new towns.

A waste management plan should be implemented in accordance with the waste hierarchy of reduce, reuse and recycle.

Environmental Management Framework

Integral to the SEIA process has been the identification of the likely adverse impacts on the existing environment and community and specific measures to avoid, manage and mitigate those impacts. This assessment has been limited to the consideration of generic impacts associated with a petroleum refinery and LNG plant of a similar size and hence, the framework has been developed commensurate with the current level of knowledge. When the final EIA is prepared, this framework will be further refined and specific management measures, in the form of an environmental and social policy, environmental management plans, work instructions and monitoring programs will be developed.

Implementation of the management framework will see a regular program of monitoring against defined standards, auditing to confirm compliance and opportunities for improvement and, reporting to GoTL regulators and community stakeholders. A key component of the framework will be the preparation of a range of environmental management plans that will include diverse topics such as air

quality management, groundwater management, chemical management, employment and training, stakeholder engagement, traffic management and, water (both surface and groundwater). These plans will be the key management mechanism to ensure that the issues identified during the environmental impact assessment process are managed effectively into the future.

For both the Betano refinery and the Beaco LNG plant the likely program of monitoring would include: dust particulates, air quality, noise, community attitudes, water quality (surface and groundwater) and biodiversity.