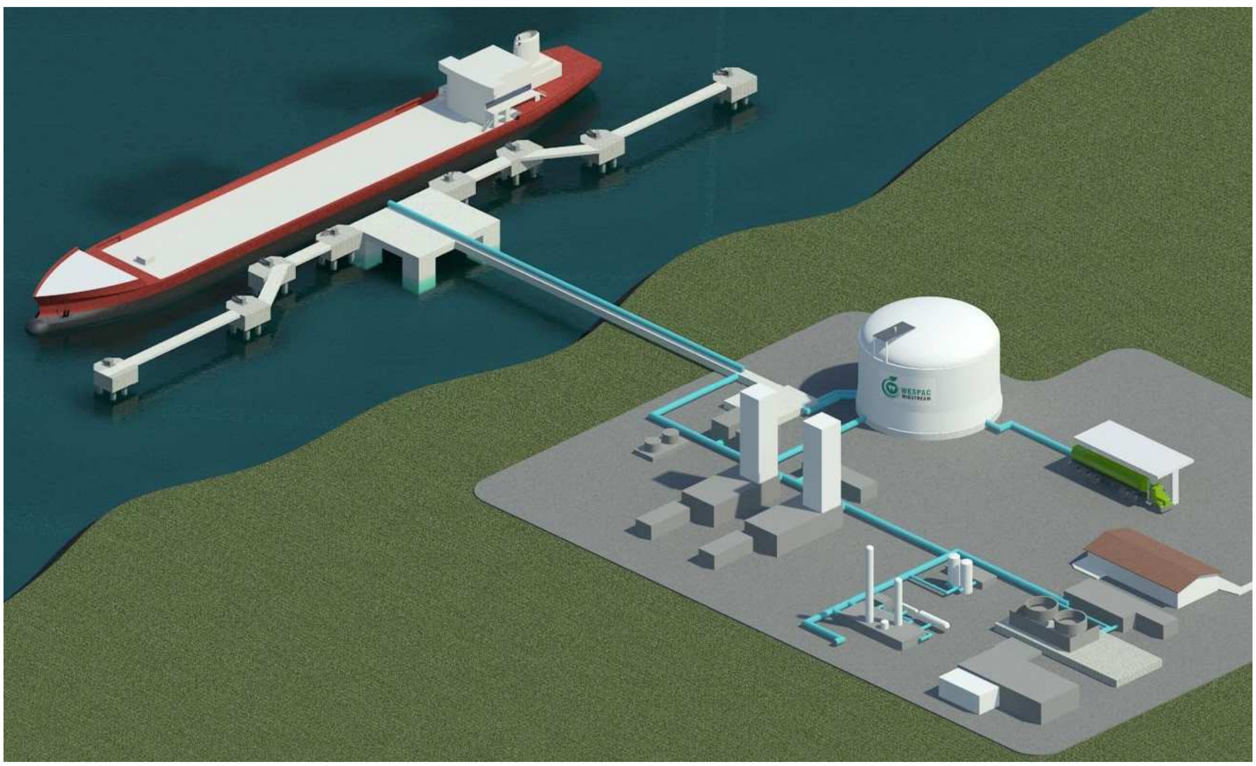
Belize National Gas Company (BNCG) Terminal and Regional Depots

Limited Level Environmental Study (LLES)



Submitted by:

Belize Natural Energy Limited
3 Mls Spanish Lookout Road
Iguana Creek Area, Cayo District
Belize Central America

November, 2017

Table of Contents

EXECUTIVE SUMMARY 14

BACKGROUND 14

STRUCTURE OF LLES REPORT 16

PROJECT PROPOSAL 16

PROJECT LOCATION 16

OBJECTIVE OF THE STUDY 17

SCOPE OF THE STUDY 17

PROJECT DESCRIPTION 17

Firefighting facilities 18

PROCESS DESCRIPTION 18

DESCRIPTION OF ENVIRONMENT & IDENTIFICATION OF ANTICIPATED IMPACT 18

Land Environment 18

Climate & Meteorology 19

Air Environment 19

Existing Air Quality 19

Sources of Pollution 19

Noise Environment 20

Water Environment 20

Biological Environment 21

Socio-Economic Environment 21

ENVIRONMENTAL MONITORING PROGRAMME 21

Ambient air quality 21

Fugitive Emissions 22

Noise level 22

PROJECT BENEFITS 22

Improvement in Physical Infrastructure 22

Improvement in Social Infrastructure 22

ENVIRONMENTAL MANAGEMENT PLAN 23

Construction Phase 23

Operation Phase 23

Air Emissions 23

Wastewater 23
Solid Waste Management 23
Preventive Maintenance / Planned Inspection 23
Compliance of Terms of Reference 24
INTRODUCTION 25
PROPERTIES OF LIQUID PETROLEUM GAS (LPG) 25
Applicable Standards 26
1 PROJECT DESCRIPTION AND PLAN 27
Terminal Description 27
Shipping and Ship Requirements: 27
- Damage limitations to cargo and ship survival in case of 27
- Safety arrangement requirements for such ship: 27
- Cargo containment and cargo handling procedure: 27
- Material of construction for containment and carriage facility: 27
- Requirements for cargo loading and discharging: 28
- Fire protection 28
- Pollution control requirements: 28
- Provision for thermal expansion and contraction is provided 28

Regional Depots 28
1.1 Location: 29
1.1.1 Overall Location of the BNGC Terminal Facility 29
1.1.2 Location of the BNGC Storage Facility 30
1.1.3 Location of Reception/Berthing Facility 32
1.1.4 Location of Regional Depots 34
1.1.4.1 Central Region Depot – Belmopan 34
1.1.4.2 Northern Regional Depot 35
1.2 Detailed Description 37
BNGC Terminal 37
1.2.1 Tank Farm 39
1.2.2 Pipelines 41
1.2.2.1 Berthing Facility to Storage Facility 41
1.2.2.1.1 Pipeline Route Markers 47

1.2.2.2 Storage Tanks Piping to Blending/Loading Facility 48
1.2.3 Administration Facilities 49
1.2.3.1 Administrative Office 49
1.2.3.2 LPG Quality Control/Testing Facility 50
1.2.3.3 Other Supporting Infrastructure – Utilities 52
Water Supply 52
Waste Management – Liquid 52
Solid Waste 52
Power - Electricity 52
Communication - Telephone and Internet 53
1.2.4 Fire Fighting Equipment 54
1.2.4.1 Fire Protection Design Considerations 54
1.2.5 Pumping Facilities 59
1.2.5.1 Berthing Facility 60
1.2.5.2 Tanker Truck Loading Facility 60
1.2.5.3 Fire Suppression System - Pump 62
1.2.6 Loading Areas – Tanker Truck 64
1.2.7 Pathways and Roads 65
1.2.8 Muster or Assembly Points 66
Regional Depots 69
1.2.9.1 Tank Farm 70
1.2.9.2 Pipelines: 71
1.2.9.3 Administration Facilities 71
1.2.9.4 Fire Fighting Equipment 71
1.2.9.5 Pumping Facilities 71
1.2.9.6 Loading Areas and Pathways 71
1.2.9.7 Muster Points 72
1.3 BNGC Terminal Tank Farm 73
1.3.1 General Safety Requirements for Storage of LPG in LPG Storage Tanks: 73
1.3.1.1 Design Specifications and Fittings 73
1.3.2 Regional Depots Tank Farm 75
1.4 Process Flow 76

1.4.1 Overall Description: 76
1.4.2 Berthing of Gas Carrier 76
1.4.3 Berthing Facility to Storage Tanks 76
1.4.4 Manifold System to Storage Tanks 77
1.4.5 Storage Tanks to Blending Facility 78
1.4.6 Blending Facility to Blended Product Storage Tank(s) 78
1.4.7 Blended Product Storage Tanks to Loading Bay Facility 78
1.4.8 Injection of Odorant 78
Process Flow of Regional Depots 80
1.5 Chemicals Used in LPG Operations 80
1.5.1 Butane 80
Properties 80
Reactivity of Butane 82
Uses 82
Health Effects 82
1.5.2 Propane 83
Properties 83
Reactivity of Propane: 84
Uses: 85
1.5.3 Mercaptan 85
Properties 85
Uses: 87
1.5.4 Use of Chemicals at Regional Depots 87
1.6 Storage, Blending & Transportation of LPG 88
1.6.1 Storage: 89
1.6.2 Blending of Propane and Butane 90
1.6.3 Blended Product Distribution 93
1.7 Organizational Structure 97
Receive LPG 97
Store LPG 97
Blend LPG 97
Test LPG 97

Distribute LPG Countrywide........97
1.7.1 BNGC Administrative Organizational Structure........98
1.7.2 BNGC Operations Organizational Structure........99
1.7.3 Regional Depots Organizational Structure........101
1.8 Liquefied Petroleum Gas (LPG) Safety........102
1.8.1 Properties of LPG........102
1.8.2 LPG Safety........103
1.8.2.1 Elimination and Substitution........104
1.8.2.2 Engineering Controls........105
1.8.2.2.1 Leak Detection Systems:........105
Pressure Gauges:........105
Hydrocarbon/Gas Leak Detectors........106
Monitoring Cameras........106
Control Room – Remote Monitoring........107
Physical Inspections........108
1.8.2.2.2 Pipeline Leak Detection System........109
Pipeline Inspections........109
1.8.7 Regional Depots and Safety........111
1.9 Prevailing Wind Conditions at BNGC Terminal........112
1.9.1 Wind Direction - Regional Depots........115
General........115
1.9.1.1 Central Region Depot........115
1.9.1.2 Northern Region Depot........115
2.0 THE PHYSICAL and SOCIAL ENVIRONMENT........117
2.1 Physical Environment........117
Regional Depots – Physical Environment........121
Central Region Depot........121
Northern Region Depot........122
2.1. 2 Zone of Influence........123
2.1.2.1 Zone of Influence - LPG Release without Fire........126
2.1.2.2 B.L.E.V.Es........127
Regional Depots - Zone of Influence........131

Central Region Depot 131
Northern Region Depot 133
2.1.2.3 Safety Distance as per NFPA 135
2.1.3 Prevention of BLEVEs 136
2.1.3.1 Sloping Ground 136
2.1.3.2 Cooling with Water 136
2.1.3.3 Pressure Reduction 137
2.1.3.4 Protection from Mechanical Impacts 137
2.1.3.5 Overflow 137
2.1.3.6 Minimum Separation Distances 137
2.2 Topography 138
2.2.1 Slope, Drainage and Flooding – BNGC Terminal 138
2.2.2 Soil 142
2.3 Zone of Influence 143
2.3.1 – Communities 143
2.3.2 Villages 145
2.3.3 Protected Areas 146
Impacts to Protected Areas 148
2.4 Climate, Hydrology and Meteorology: 149
2.4.1 Climate 149
2.4.2 Hydrology 153
2.4.3 Meteorology 156
2.5 Land Use 158
Topography – Central Region Depot 161
Slopes, Drainage and Flooding 162
Impact on Protected Areas 163
Climate, Hydrology and Meteorology 163
Land Use 164
Topography – Northern Region Depot 168
Slopes, Drainage and Flooding 169
Impact on Protected Areas 170
Climate, Hydrology and Meteorology 170

Land Use 171
2.6 Waterbodies 174
2.7 Air Quality 175
3.0 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK 181
3.1. Introduction 181
3.1.1 The EIA Process 181
3.1.2 Legal Framework 182
3.1.2.1 The Environmental Protection Act SI 22/1992 and 328/2003 and 2009 182
3.1.2.2 Environmental Impact Assessment Regulations SI 107/1995 184
3.1.2.3 Environmental Impact Assessment Regulations (amendment) SI 24/2007 184
3.1.2.4 Pollution Regulations SI 56/1996 and Pollution (Amendment) Regulations, 2009 184
3.1.2.5 The Mines and Minerals Act (Chap 226/ 2000) 185
3.1.2.6 Belize Public Health Act Revised Edition SI 40/2000 185
3.1.2.7 National Lands Act (No. 6 of 1992) and SI 191 of 2000 185
3.1.2.8 Petroleum Act (Chap 225 /2003) 186
3.1.2.9 The Forest Act SI 213/2000 186
3.1.2.10 The Land Utilization Act (Chapter 188 of revised edition 2007). 186
3.1.2.11 The Wildlife Protection Act (Chap 220/2000) 186
3.1.2.12 National Park System Act SI 215/2000. 186
3.1.2.13 Ancient Monuments and Antiquities Act SI 330/2000 187
3.1.2.14 Institute of Culture and History (Amendment) Act (No. 20 of 2003) 187
3.1.2.15 Solid Waste Management Authority Act SI 224 of 2000 187
3.1.2.16 Effluent Limitation Regulations SI 94/1995 187
3.1.2.17 Dangerous Goods Act Chapter 134 187
3.1.2.18 Forest Act 188
3.2 Administration 188
3.3 International Conventions and Agreements 189
Permits, Licenses and Penalties 190
B. ENVIRONMENTAL ISSUES 191
ENVIRONMENTAL IMPACTS 191
1.1 Flora 191
Grassland / Sedge 192

Palmetto – Acoelorraphe wrightii 193
Blackberry, Eugenia sp., MYRTACEAE 194
Mangoes 194
Elephant Grass 194
Sea Grapes (Cocoloba uvifera) 195
1.2 Fauna195
Birds 195
Mammals: 196
Regional Depots 196
Flora 196
Peltophorum Pterocarpum 197
Eugenia sp., MYRTACEAE 197
Peltophorum Pterocarpum 197
Fauna 197
1.2 Environmental Impacts & Mitigation Measures 198
Impacts to Vegetation and Mitigation 198
Impacts to Fauna 199
2.0 CHEMICALS MANAGEMENT 200
2.1 BLENDING PROCESS 200
2.1 Safety during Blending Process 201
2.1.1 Administrative 201
Trained Staff 201
Standard Operating Procedures (SOP) and Checklists 201
Signage Program 202
Drug Tests 202
Emergency Plans 202
2.1.2 Engineering 202
Safety Devices 202
Monitoring 203
Fire Suppression System 203
2.1.3 Personal Protective Equipment (PPE) 203
2.2 CHEMICALS USED IN BLENDING OPERATIONS 204

2.2.1 Propane 204
Hazards of Propane 205
2.2.2 Butane 205
Hazards of Butane 206
2.2.3 Hazards of LPG 207
2.2.4 Mercaptan 209
Hazards of Mercaptan 210
2.2.5 Environmental Impacts of LPG 210
2.3 HANDLING AND STORAGE OF LPG 212
2.3.1 Butane & Propane Storage – Terminal 212
3.2 Mercaptan (Methanethiol) 212
Regional Depots – Handling and Storage 213
3.3 Mitigation Measures for Chemicals 213
2.4 IMPACTS OF TERMINAL OPERATIONS ON NEARBY WATER BODIES 215
Big Creek 216
Marina/Docking Area 216
Regional Depots – Impacts on Water 217
3.0 DISASTER MANAGEMENT & SOCIAL ENVIRONMENT 218
3.1 Safety Infrastructure 218
3.2 Risks to Adjacent Infrastructure 220
Accidental Release without Fire (Small) 221
Accidental Release without Fire (large) 221
Accidental release with Fire 221
Regional Depots – Impact to Adjacent Properties 222
3.2.1 Potential Social and Economic Impacts 222
3.2.1.1 Social Impacts 222
Regional Depots – Social Impacts 223
3.2.1.2 Economic Costs: 223
3.3 Safety Measures to Reduce Risk of Fires/Explosions 224
1. Compatible Material/Equipment 224
2. Leak Detection Systems: 224
3. Monitoring Cameras 225

4. Control Room – Remote Monitoring 225
5. Physical Inspections 225
6. Pipeline Leak Detection System 225
Physical Protection - Below Ground Pipeline 226
Physical Protection – Aboveground Pipelines 227
Additional Protection - Depth of Pipeline 228
Additional Protection – Traffic 228
Additional Protection – Pipeline Route Markers 229
Pipeline Inspections 229
7. Tank Safety 230
8. Fire Suppression System 232
9. Loading Safety Devices: 232
Loading Arms/Hoses 233
3.4 Natural Disaster Management Plan 234
Hurricane & Flood 234
Earthquakes 235
Bush Fire 235
3.5 Shipping Route & Cargo Transfer 236
3.5.1 Shipping Route 236
3.5.2 Cargo Transfer – Ship To Shore 237
Discharging: 238
Discharge of Product from Gas Carrier 238
3.6 Ground Transportation Safety 239
4.0 NOISE AND AIR QUALITY 242
4.1 Noise 242
Loading of LPG Bob Tail Truck 243
Discharging of LPG Tanker: 243
Loading of Crude Oil Tanker Truck 244
4.2 Air Quality 245
4.2.1 BTEX 245
BTEX Analysis 246
4.2.2 NOSO 246
NOSO Analysis 248

4.3 Air Pollution Risk 248
Regional Depots – Air Pollution 249
C. CONCLUSION / RECOMMENDATIONS 250
1.0 ALTERNATIVE FOR DEVELOPMENT 250
Site Selection and Cost 250
Socio-economic Situation – LPG Sector 252
“No Action Alternative” Option 252
2.0 MITIGATION AND MONITORING PLAN 255
2.1 Construction Phase 255
2.2 Operational Phase 257
2.3 Decommissioning Phase 259
Summary of Aspects, Impacts and Mitigation/Management for BNGC Project 261
Environmental Monitoring and Reporting 262
CONCLUSION: 264
REFERENCES 265
List of Figures 267
LIST OF PHOTOGRAPHS 271
LIST OF TABLES 275
APPENDICES 277
APPENDIX I 278
Survey Plan of 15 acre Plot – Port of Big Creek 278
APPENDIX II 280
Survey Plan of 5 Acre Plot – Belmopan 280
APPENDIX III 283
Survey Plan of 10 Acre Plot – Orange Walk District 283
APPENDIX IV- SDS BUTANE 286
APPENDIX VI – SDS PROPANE 294
APPENDIX VI – SDS EHTYL MERCAPTAN 306
APPENDIX VII – BNGC TERMS OF REFERENCE 314

EXECUTIVE SUMMARY

BACKGROUND

Over the last 10-15 years, the use of LPG (butane) in Belize has grown exponentially, and as can be noted from the chart below *(Figure 1)* there has been an annual gradual increase in the importation of butane into Belize from 2013 to 2016. The data for 2017 is only for the first quarter (Jan-Mar) and if that trend holds, the annual trend will continue with another increase over 2016. LPG is one of the cheaper forms of energy available to Belizeans, so a stable, cost-effective supply is critical to economic growth and national energy security.

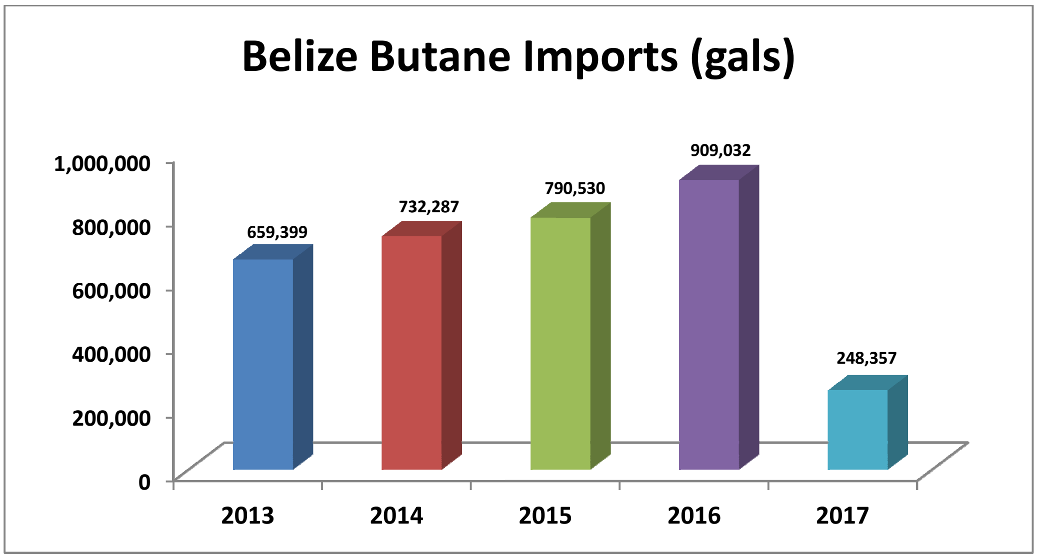


Fig 1 – Butane Imports into Belize

Presently all of Belize's Liquefied Petroleum Gas (LPG) comes from the Gulf Coast of the United States (USGC). However, marine LPG terminal infrastructure to receive direct imports from the USGC does not exist. Instead LPG must be shipped by sea to Honduras, Guatemala or El Salvador, and trucked hundreds of miles (mostly through Guatemala) before it crosses the border into Belize. A total of 93% of Belize's LPG is supplied through Guatemala; the remaining 7% is produced locally by Belize Natural Energy Ltd. Mexican LPG imports are not currently cost effective.

The LPG supply chain into Belize is controlled by three local companies GAS TOMZA Ltd. (a subsidiary of Grupo TOMZA, Guatemala), Zeta Gas (a subsidiary of Grupo Zeta, Guatemala), and Belize Western Energy Ltd (BWEL) (a subsidiary of Western Energy Inc. Transport, SA, Panama). These three companies control the price of LPG delivered to the Belize border. Terminals are operated with antiquated and uncertified equipment.

Independent tests have shown that LPG sold often does not comply with local regulations, which require a blend of 30% Butane to 70% Propane. Instead, higher propane LPG blends are sold, resulting in high vapor pressures in Belize's hot climate; these unsafe pressures can lead to tank ruptures in households, restaurants, or other LPG storage locations.

The existing LPG supply system is meeting all of Belize's current demand, but it does so in an unsafe and unregulated manner and does not favor industrial growth. The bulk LPG supply chain is controlled from outside Belize, so there is no price and quality transparency for the fuel being offered. Industrial growth and economies of scale cannot be achieved under the current system because trucking LPG limits the logistical efficiencies that can be achieved as the local market grows.

The current state of the LPG economy in Belize creates a great opportunity for improving the industry while empowering the local population. To improve the industry, local infrastructure must be developed and the industry stringently regulated. The current project is the first step (and a large step) towards this. The project will develop and build an LPG terminal capable of receiving LPG directly from the USGC (US Gulf Coast) and storing 150% of Belize's monthly demand. This terminal will include new LPG tanks, an LPG testing laboratory for regulators, offices, state-of-the-art fire suppression equipment, and loading and unloading facilities. This large development will be the cornerstone of modernizing the industry and serve as a base for regulators.

The GOB will receive 25% ownership of the terminal from its inception and will receive 100% after 25 years through a Build-Own-Operate-Transfer (BOOT) mechanism. GOB participation and ownership is critical because this project will convert the current LPG industry into a utility-scale industry. Belizeans will receive construction contracts, trucking contracts, and the opportunity to invest via bonds and direct investment into the company.

As per the Environmental Protection Act of 1992 and its subsequent Environmental Impact Assessment Regulations 1995; which was amended in 2007 via Statutory Instrument 24/2007, it gives the Department of the Environment (DOE) the authority to request that a Limited Level Environmental Study (LLES) be conducted for such a project, as it falls within the list of Schedule II projects. As per the above Regulation, the proposed project will have to obtain environmental clearance from Department of the Environment subsequent to conducting its LLES.

BNGC initiated the LLES study in the month of May 2017. The primary and secondary data generation work was carried by deploying a team of experts to the proposed sites and reviewing data available from various agencies and departments.

STRUCTURE OF LLES REPORT

The LLES report has been prepared and reviewed as per the Terms of Reference agreed to between BNGC and the DOE as per the conditions stipulated in the EIA Regulations. The salient features of the report have been projected by identifying the environmental and ecological stressors. The Impact Assessments have been compiled and reviewed by analyzing existing data and conducting in-situ assessments and tests.

PROJECT PROPOSAL

The project proposal comprises the establishment of a Terminal to receive Propane and Butane as separate products, via a Gas Carrier at the Big Creek port facility, and have the capability to blend the two gases in formulating a LPG product that will comply with local standards and also produce propane/butane blends to meet the requirements of specific customers. This project will also entail the establishment of two additional bulk plants (Regional Depots) to facilitate the distribution of the LPG product country-wide. The BNGC Terminal will have a maximum storage capacity of approximately 1.5 million gallons propane/butane and the two bulk plants will each be capable of storing 60,000 gallons of LPG.

PROJECT LOCATION

The proposed project sites will be located in:

I. Terminal – the terminal will be located just at the entrance of the Big Creek Port Facility approximately 1 mile south of Independence/mango Creek Village in the Stann Creek District. This site is adjacent to other businesses some of which stoe chemicals and others petroleum products.

II. Regional Depots/Bulk Plants – the Central Region Bulk Plant will be located approximately 1 mile south of the City of Belmopan, nestled between some hills, immediately adjacent to the Hummingbird Highway. The nearest residential building is some 400m away behind some of the hills in the area.

    The Northern Region Depot/Bulk Plant will be located approximately 1 mile north of Orange Walk Town at Mile 57along the Phillip Goldson Highway. The nearest building to this site is some 200 meters to the east-south-east of where the storage tanks will be placed. Besides that, the Northern Depot project site is surrounded by some undeveloped cleared area, some agricultural lands, but mostly by lands under secondary growth vegetation.

OBJECTIVE OF THE STUDY

The objective of the LLES study is to identify and evaluate the potential impacts (beneficial and adverse), from the proposed Terminal and bulk plants and preparation of an impact statement in accordance with existing guidelines of DOE. The LLES report will present the existing environmental setting vis-à-vis contribution of pollutants and other factors from the proposed installations. The report provides information on the environmental implications, which could be used for environmental safeguards. LLES study report shall be used a supporting document for getting environmental clearances from the Department of the Environment and obtaining the relevant licenses and permits from other relevant agencies.

SCOPE OF THE STUDY

The scope of this LLES study includes detail characterization of pre-project status of environment in the immediate and surrounding areas of the three sites with the following important tasks:

- To assess the existing status of air, noise, water, land, biological and socio-economic components of the existing environment.
- To identify and quantify significant impacts of various operations on environmental components during construction & operation phases with respect to pre-project status.
- To evaluate proposed pollution control measures.
- To prepare Environmental Impact statement outlining additional control technologies to be adopted for mitigation of adverse impacts.

PROJECT DESCRIPTION

The proposed Terminal will be designed to receive via ship and store just over 1.5 million gallons of propane and butane, combined; in eighteen (18) 90,000 gallons tanks (6 tanks for butane and 12 tanks for propane). There will be one additional 90,000 gals tank for the storage of the blended LPG product. The terminal site will utilize the existing berthing facility at the Port of Big Creek and will have an administrative building and a 3-lane loading facility for road tanker trucks. Apart from the aforementioned, the Terminal will also have some additional ancillary facilities such as a pipeline system to transport the gases from the port to the storage facility, a shed for housing the Fire-kill System pump for supplying water to nine hydrants and monitors; parking lots, a truck weigh scale; a water retention pond, etc.

Both Regional Depots will be similarly constructed and apart from having the two 30,000 gals storage bullet tanks, they will also have a small office area, truck weigh scales, security booths and discharging/loading area for tanker trucks.

Firefighting facilities

The firefighting facilities at the Terminal in Big Creek shall be put in place as a requirement of both local and international guidelines/standards. The firefighting facilities at the Terminal shall cover the berthing facility area, LPG Storage area, LPG Pump area, Tank Truck Loading Gantry, Pump house, and the administrative office building.

The Regional Depots will, as much as possible be self-reliant for firefighting purposes, but will most likely also entail the use of the resources from the National Fire Service. Each site will be equipped with several ABC fire extinguishers including at least one 300 pound Purple K fire-fighting wheeled cart.

PROCESS DESCRIPTION

The main Terminal facilities shall comprise receipt of LPG via a certified Gas Carrier, storage of propane in twelve 90,000 gallons tanks and butane in six 90,000 gallons tanks, with an additional tank for the storage of blended product. LPG shall be made available country wide through the use of road tankers with BNGC's supplying the Central and Northern Depots for further distribution; with the Terminal doubling as the supply depot for the southern portion of the country.

The Regional Depots will only be able to receive and store a maximum of 60,000 gallons of blended product. This product will then be sold to other local vendors in the central and northern region of the country.

DESCRIPTION OF ENVIRONMENT & IDENTIFICATION OF ANTICIPATED IMPACT

Description of pre-project status and the impact on the existing environment after construction and operation of the proposed project have been discussed with respect to the following components of the environment with reference to pre-project environmental status. The status of important components of the environment and its impact on them has been summarized below:

Land Environment

The proposed Terminal facility shall be installed on a 15-acre plot of land within the Port of Big Creek property and will be adjacent to the existing "Petro-fuel" tank farm. As the proposed site is within the industrial complex and has already been declared as area for industrial development, including the storage and handling of hazardous substances, there will be no significant change in existing land use pattern. There is no solid and hazardous waste generation during project activities and consequently any adverse impact on land is not envisaged. Thus, there will be minimal changes to the landscape but no change in the soil characteristics and land use pattern due to the construction & operation of the facilities.

As with respect to the two depots, both sites, especially the Central Depot site, have been very much disturbed/cleared and both sites bear no major significance as it relates to flora and fauna, as all species found on these sites are considered generalists and occur country-wide.

Climate & Meteorology

The meteorological data with respect to wind speed, wind direction, relative humidity and rainfall has been collected during the study period and no deviation is expected as a result of the terminal and the two depots as it is related to meteorology and micro-climatic conditions. The proposed project is a non-polluting developmental project and no adverse impact on the climate has been envisaged.

Air Environment

The baseline ambient air quality status and expected air quality status for the proposed Terminal project are characterized using the following sources of data.

- Ambient air quality data from selected sampling locations within 300 m radius of study area.
- Meteorological data collected for project site during study.

Existing Air Quality

To evaluate the baseline ambient air quality, a review of data collected at three sampling sites at the Belize Natural Energy's Bulk Storage Facility located some 300m south-east of the proposed Terminal site, was conducted. The review of the data showed that the concentration of air pollutants namely BTEX, SO2 and NO2 concluded that the measured values of the air pollutants, as stated above, are well within the limits specified under International Standards (US EPA and UK NIOSH) for ambient air.

As for the two depots, although there were no air quality records for those sites, in-situ tests done for VOC's (LEL), H2S, CO and O2, showed that the levels were also within normal ranges as per international standards.

Sources of Pollution

Due to the proposed project activities, the source of pollution may be primarily categorized in three phases:

- Construction Phase
- Operation Phase
- Decommission Phase

During construction and decommission phases, the concentration of dust, BTEX, SO2 and NO2 at all three locations may increase temporarily during the day time. The existing ambient air quality levels at all sites, are quite capable of assimilating the rise in dust, BTEX, SO2 and NO2 well within the threshold limit. In an attempt to reduce the impacts from dust, the conservative method of dust suppression by sprinkling water shall be practiced. With respect to the annual average concentration, the pollutants are expected to remain well below the threshold limits. Hence, the construction phase would not produce any stress on the existing ambient air quality.

During operation phase, the main source of emission of air pollutants from the proposed facilities will be from gas leaks, from pressure relief valves due to over-filling or pressure build up, and accidental releases of gases; but these are anticipated to be very much intermittent (if any at all) and will be insignificant.

It is therefore, concluded that there is no point or nonpoint sources of continuous emission of air pollutants as stated above. The emission of above system shall be controlled as per standard fail-safe practices adopted by BNGC.

Noise Environment

A comparative noise monitoring program was conducted at the BNE Iguana Creek Storage Facility near its LPG production and loading facility. The noise monitoring survey revealed that the noise levels varies from the mid 50's dB(A) to the lower 90's during the night and day time respectively primarily due to movement of vehicles on the roads near the site and surroundings. A little increase in the noise level during construction and operation has been envisaged and the duration during the construction phase shall be 8 to 12 hours with maximum incremental noise level equivalent to 3 to 4 dB(A) on day and night levels. Hence impact on the air due to noise shall be practically insignificant during all phases of the project but especially during the construction and operation phase.

Water Environment

Of the three locations, only the proposed Terminal site environment had surface water (Big Creek and the port marina) near its vicinity, as well as a high water table which was about 1 meter below the surface. The Terminal site fell within the area which received some 80 inches to 100 inches of rainfall annually; whilst the Central and Northern Region Depots received an average of 60 inches to 80 inches and 40 inches to 60 inches of rainfall annually, respectively. The rainfall at all three locations regulates the hydro environmental balance of each area.

For treatment of wastewater at each facility, a septic tank and soak-away pit with leach field have been considered. The septic tank and soak pit shall be designed in such a way to restrict vertical percolation of the wastewater to protect the existing quality of ground water in the surrounding area. The project will not discharge any effluent directly into the environment at any of its locations.

The water supply for the three locations will either be from local supply systems and or rain water catchment systems.

Biological Environment

At all three locations, but especially at the Terminal location, the proposed project is expected to have no point and nonpoint of emission or discharge of pollutants sources hence no adverse impact on the biological environment is envisaged due to the proposed project activities and operation. Moreover, wherever possible, BNGC will maintain as much plant cover; which will provide food and habitat to birds and smaller mammalian species. These green areas will also contribute to the nullification of the potential impact of pollutants which may be generated. Thus, no significant negative impact on fauna is foreseen.

Socio-Economic Environment

The proposed project activity is limited to importation, storage, loading, transporting & distribution of LPG country-wide. Although bulk depots are existent throughout the country, for retail sale of LPG, the proposed Terminal is a new venture and there will be a scope for generation of direct/indirect employment. During the construction phase, local people may be employed temporarily for construction works at all three locations. Thus, there would be a significant positive impact on the socio - economic environment for the proposed project is foreseen. Moreover, the proposed project, during its operational phase would be able to bridge the gap between the demand and supply of LPG for domestic use in surrounding areas which would help in the development of quality of living.

Most importantly, though, energy security will be greatly improved as this terminal will allow LPG to be sourced from various suppliers by sea and if necessary, by land. With the current uncertainty in Guatemala/Belize relations, the importance of having multiple supply chain options is vital.

ENVIRONMENTAL MONITORING PROGRAMME

A monitoring schedule will be developed for the main BNGC Terminal and will be prepared in consultation with the DOE. The results of the monitoring program will be forwarded as requested, to DOE and shall be maintained for the following environmental parameters:

Ambient air quality: An adequate number of sampling stations, as deemed fit by DOE shall be established for monitoring of ambient BTEX, SO2 and NO2. The measurements will be performed monthly for the first year and quarterly thereafter. Should an anomaly be discovered during the monitoring program, monthly monitoring will resume until such anomaly no longer exists.   Additional daily monitoring of LEL on the facility will be done by personnel on site.

Fugitive Emissions**:** Evaluation of hydrocarbons (butane & propane) in work zone area shall be carried out weekly.

Noise level**:** Noise generated by different sources and noise level within work zone & near property boundary shall be measured periodically as agreed to with the DOE.

PROJECT BENEFITS

The benefits of the proposed BNGC Terminal and Regional Depots may be summarized as under:

- Establishment of the proposed LPG Terminal at the Port of Big Creek will provide Belize another mode of receiving LPG to make Belize self- sufficient and provide a stable supply of LPG for Belize.
- The proposed Terminal will also provide for Belize to provide its residents with the regulated blend of LPG as per the Bureau of Standards Guidelines and will also allow for customers to obtain the specific blend of propane/butane they require.
- The use of a Gas Carrier will also not only reduce the risks taken with importing the product by road, but will should also reduce the transportation costs, thus making the fuel cheaper.
- The establishment of the Terminal and depots will produce employment opportunities throughout the country.

Improvement in Physical Infrastructure

One the major physical infrastructural change or improvement envisaged due to establishment of the proposed project, will be that at the Port of Big Creek, which will now be able to receive LPG via gas Carrier. As the distribution of LPG will be primarily by tanker trucks, the upgrading of the Coastal Highway may need to be considered as an alternative route to deliver LPG to the biggest urban area in the country, Belize City.

Improvement in Social Infrastructure

Due to establishment of proposed project, especially the Regional Depots, retailers will have to travel less distances to obtain bulk LPG supply. This should greatly reduce the amount of time LPG trucks are on the Highways and thus should have some improvement in the safety of our transportation system, which in turn will bring improvement in social infrastructure.

ENVIRONMENTAL MANAGEMENT PLAN

Construction Phase

During construction phase, all precautionary measures would be made for dust suppression, soil erosion and noise reduction. The effects due to construction will be of a temporary nature and will have no permanent effect on the environment.

Operation Phase

Environmental impacts associated with the operation phase include minor leakage of hydrocarbons during transfer of LPG (and Mercaptan at the main Terminal site). Leakage may also occur from relief valves provided on the storage tanks in the event of rise in temperature or pressure. To prevent such leakage and or releases, Best Available Technologies (BAT) will be used and storage tanks will be filled to a maximum of 85% or in accordance with the NFPA Guidelines. Hence if there is any release that will be insignificant and shall remain within the threshold limit.

Air Emissions

In the absence of accidental releases and apart from the intermittent release from pressure valves, there is practically no source of air pollution from the proposed facilities. All the storage tanks are leak proof and products are handled through closed pipes and the adoption and implementation Best Available Technology and Best Practices. The sources of atmospheric emissions will be limited to within the threshold limits.

Wastewater

Apart from normal sewage water, no other waste water shall be generated from the proposed LPG facilities. At the main Terminal site, a small quantity of water runoff from the fire hydrant system as a result of mock fire drills may be expected. That, though, shall be collected in the retention pond through surface drains.

Solid Waste Management

Some solid waste generation during construction of the proposed project cannot be ruled out. The wastes generated during the construction phase (stones, cement, etc.) will be utilized for land filling/leveling in the low lying areas within the Terminal and Regional Depot sites. During the Operational Phase, regular office waste will be disposed of at the local municipal disposal site and any hazardous waste will be dealt with as per DOE guidelines.

Preventive Maintenance / Planned Inspection

Preventive Maintenance and planned inspection of the facilities will be done in accordance with NFPA safety guidelines and the DOE Guidelines for Depots. BNGC will encourage and keep proper maintenance records. Reports on the intermittent inspections conducted and maintenance schedules will be prepared and kept on file.

Compliance of Terms of Reference

The BNGC Terminal and Regional Depot Project will comply with the EPA and EIA Regulations and will require Environmental Clearance from the DOE prior to any development work commencing. As part of its compliance, BNGC has developed this LLES for review and approval by the Department of the Environment and the National Environmental Appraisal Committee (NEAC).

In addition to obtaining environmental clearance, BNGC will need to obtain additional Licenses and permits from the Geology Department for its mining and soil movement activities; Trade Licenses from the relevant authorities in which each facility is located; Salvage Permit from the Forest Department for the salvaging of usable wood material from vegetation being cleared and a Dangerous Goods License, for the handling of dangerous goods (LPG).

INTRODUCTION
PROPERTIES OF LIQUID PETROLEUM GAS (LPG)

Liquefied petroleum gas or liquid petroleum gas (LPG or LP gas), also referred to as simply propane or butane, are flammable mixtures of hydrocarbon gases used as fuel. Its applications and uses range from cooking and refrigeration to transportation, heating, and power generation, making it an all-purpose, portable and efficient energy source.

LPG is colorless and odorless; therefore an odorant (eg. Mercaptan) is normally added to it making it possible for humans to detect leaks. LPG consists of light hydrocarbons (propane, butane, propylene, or a mixture) with a vapor pressure of more than 40 psi at 100ºF. At standard temperature and pressure, LPG is a gas. It is liquefied by moderate changes in pressure (i.e., in a process vessel) or by a drop in temperature below its atmospheric boiling point. The unique properties of LPG allow it to be stored or transported in a liquid form and used in a vapor form.

Apart from being very portable and convenient to use; LPG has significant health, safety and environmental benefits compared to traditional fuels i.e. wood, kerosene, coal and charcoal. Although burning LPG releases carbon dioxide, a greenhouse gas and some carbon monoxide, it does, however, release less CO^2 per unit of energy than does coal or oil. It emits 81% of the CO^2 per kWh produced by oil, 70% of that of coal, and less than 50% of that emitted by coal-generated electricity distributed via the grid. Being a mix of propane and butane, LPG emits less carbon per joule than butane but more carbon per joule than propane. Overall, LPG burns more cleanly than higher molecular weight hydrocarbons because it releases less particulates. It is possibly the cleanest and most efficient fuel available today.

Other characteristics of LPG include

- LPG exerts a cooling effect as a result of vaporization resulting from releases at low pressure (also called auto-refrigeration).
- The density of LPG is almost half that of water; therefore, water will settle to the bottom in LPG.
- Very small quantities of liquid will yield large quantities of vapor.
- When vaporized, LPG leaves no residue.
- When LPG evaporates, the auto-refrigeration effect condenses the surrounding air, causing ice to form. This is usually a good indication of a leak.
- LPG is odorless; agents such as ethyl mercaptan are added to commercial grades in most countries for better detection.

Applicable Standards

Various sources of standards and codes exist for dealing with LPG facilities and proper fire protection. Some of these sources include:

- National Fire Protection Association (NFPA) 54, *National Fuel Gas Code.*
- NFPA 58, Liquefied Petroleum Gas Code.
- NFPA 59, Utility LP-Gas Plant Code.
- American Petroleum Institute (API) 2510, Design and Construction of LPG Installations.
- API 2510A, Fire-Protection Considerations for the Design and Operation of Liquefied Petroleum Gas (LPG) Storage Facilities.
- IP Code of Practice for LPG.
- DOE Guidelines for the LPG Industry

1 PROJECT DESCRIPTION AND PLAN

Terminal Description

The Belize National Gas Company (BNGC) Terminal will be a modern LPG receiving, blending, testing, storage, and loading facility able to receive LPG by sea (via ship) or land (via truck). As mentioned earlier, Belize consumes approximately one million gallons of LPG on a monthly basis; and thus this facility must be able to ensure that at minimum 150% of the monthly requirement of LPG is available for Belize.

Shipping and Ship Requirements:

The BNGC Terminal will obtain the services of a certified Gas Carrier as per International Maritime Organization Standards/Guidelines, which requires that a liquefied gas ship can only run in international waters if it is constructed and operated as per International Gas Carrier (IGC) 1986 code and complies with SOLAS 74 chapter VII part C –"construction and equipment of ships carrying liquefied gases in bulk.

Some of the items to be complied with from the IGC code are:

- ***Damage limitations to cargo and ship survival in case of collision or grounding*****:** This will be addressed by ensuring the depth of the channel (which has recently been done) provides for the safe transit of the vessel into and out of the berthing area. A minimum draft depth of 6 meters will be provided for by the Big Creek Port to facilitate such Gas Carrier vessels.

- ***Safety arrangement requirements for such ship:*** As the ship itself will comply with maritime safety procedures along its route from the USGC to Belize, there will be little to no concern. As the berthing facility/terminal will be near or the same area presently utilized by the crude oil tanker; this facility is well within the fenced/secured area of the Big Creek Port.

- ***Cargo containment and cargo handling procedure:*** BNGC will ensure that the vessel will comply with all best practices as it relates to cargo containment and handling on board the ship. As it pertains to berthing and offloading at the BNGC Terminal, BNGCT will develop a ship LPG offloading procedures that will comply with international standards for the safe offloading of the butane and propane from the gas Carrier.

- ***Material of construction for containment and carriage facility:*** As this facility will be the first of its kind in Belize, only the services of qualified contractors will be obtained for the construction of the necessary loading and off-loading facilities, as well as the tank farm storage facility. The 17 tanks and its associated piping system that will be put in place, will be purchased from approved LPG construction companies and all tanks will be certified.

- ***Requirements for cargo loading and discharging:*** As the importation of LPG will now be more controlled, it is anticipated that the Government of Belize along with BNGCT will be able to put in place standards for the loading and discharging of cargo, within the port and throughout the country of Belize.

- ***Fire protection requirements:*** The carrier vessel itself will be compliant with the minimum requirements necessary for fire protection. When in dock, BNGC will provide addition fire suppression coverage in case of a fire incident.

- ***Pollution control requirements:*** The carrier vessel will be equipped with monitoring systems to detect leaks. The BNGCT will also be built with pollution prevention and control mechanisms/technology. A pressure monitoring system will be put in place to detect any leaks in the system.

- ***Provision for thermal expansion and contraction is provided*** – The vessel carrier will also be equipped to address the expansion and contraction of the LPG product being transported.

The contracted shipping carrier will also comply with other IGC codes and will have:

- A well-insulated and refrigerated LPG tank
- A compressor room and refrigeration plants
- A nitrogen bank as well as an inert gas generator with dryer system
- A cargo temperature and environment data monitoring system
- A Tank atmosphere and temperature data is monitoring system

Regional Depots

A key component of the entire project will be the installation of two BNGC Regional LPG Depots. Both depots will be capable of receiving and storing (in two 30,000 gals tanks) a total of 60,000 gallons of LPG and re-distributing/selling same to customers. Although the plot of land for the Northern Region Depot is twice that of the Central Region Depot, both foot prints will be practically similar in size and layout, and will have the same facilities on site: a gated entrance, a truck weighing scale, an office building, parking for both small vehicles and LPG tanker trucks, two loading lanes and two storage tanks with pumping facilities.

These two depots will be the main supply of LPG for the rest of the country and will serve the central and northern regions of the country, whilst the main BNGC Terminal will also double as the regional depot for the southern part of the country.

1.1 Location:

1.1.1 Overall Location of the BNGC Terminal Facility

The Belize National Gas Company (BNGC) Terminal will be located in Belize which in turn is located in the northern hemisphere above the equator. Belize is bounded on the north by Mexico, the south and west by Guatemala, and to the east by the Caribbean Sea (see Figure 2 below).

Belize is 176 miles long at its longest point, 88 miles at its widest point and covers 8,867 square miles (23,000 square kilometres), including 450 small coralline islands lining the coastline known locally as cayes (pronounced "keys") having a combined land area of 266 square miles. It is approximately one-tenth the size of the United Kingdom, and larger than all of the former British Caribbean countries combined.

Belize's geographic coordinates are between:

- 15° 52' 9" and 18° 29' 55" north latitude
- 87° 28" and 89° 13' 67" west longitude

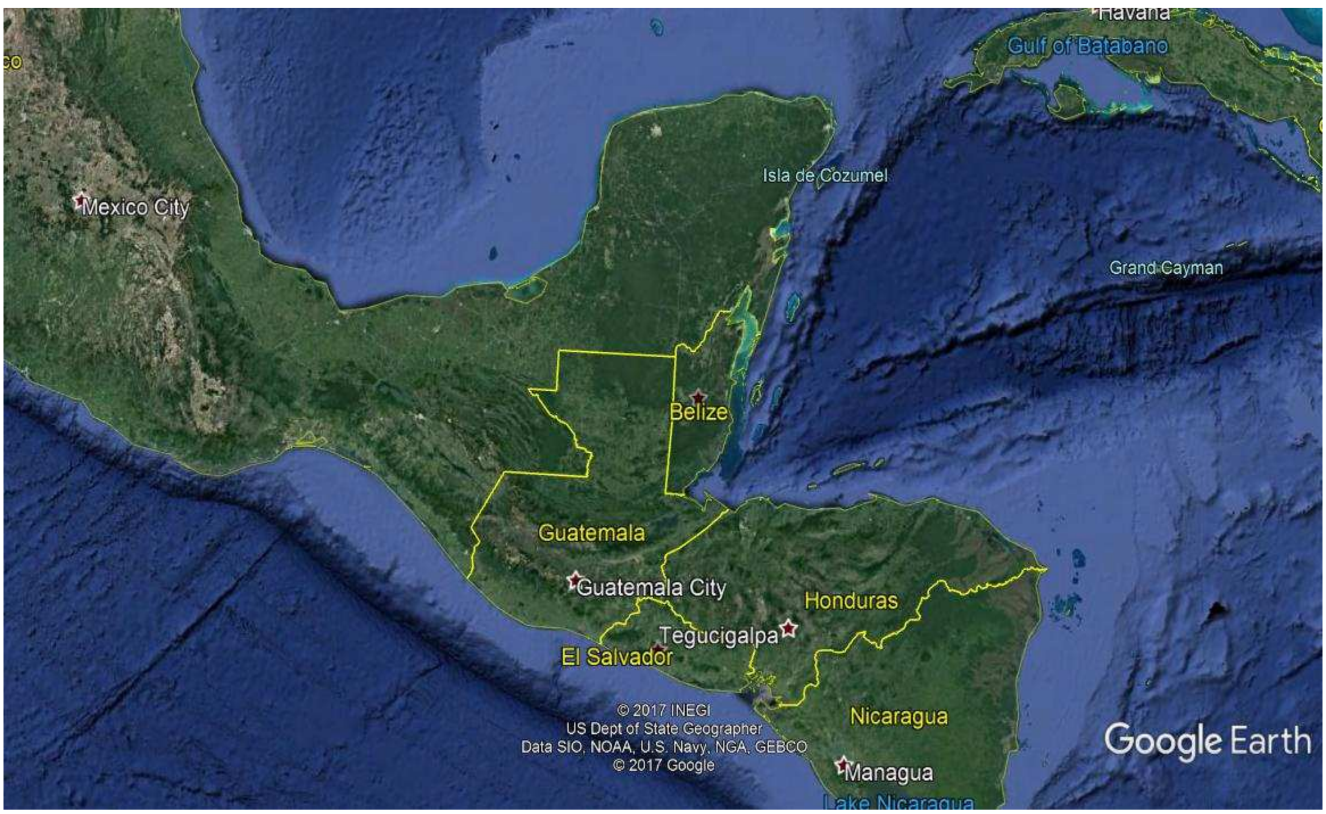


Figure 2: Map showing location of Belize

The country has varying land topography from north to south. In the north it has mostly flat terrain with swampy coastal plains, and as one travels further south and inland, the topography gradually raises from the low mountain ranges of the Maya Mountains until it reaches its zenith at Victoria Peak, at a height of 3,675 feet (1,120m). Belize is also home to the largest living barrier in the world, which extends the entire length of it coastline.

1.1.2 Location of the BNGC Storage Facility

The proposed site for the National Liquefied Petroleum Gas Terminal (BNGC) will be located in the more southern region of the country of Belize approximately 100 miles south of the City of Belmopan, the capital of Belize at approximate Coordinates 16°31'4.81"N and 88°24'27.61"W (see Survey Plan at Appendix 1). The site itself will be located just north of the geo-political boundary of the Stann Creek and Toledo Districts border (see Figure 3 below).

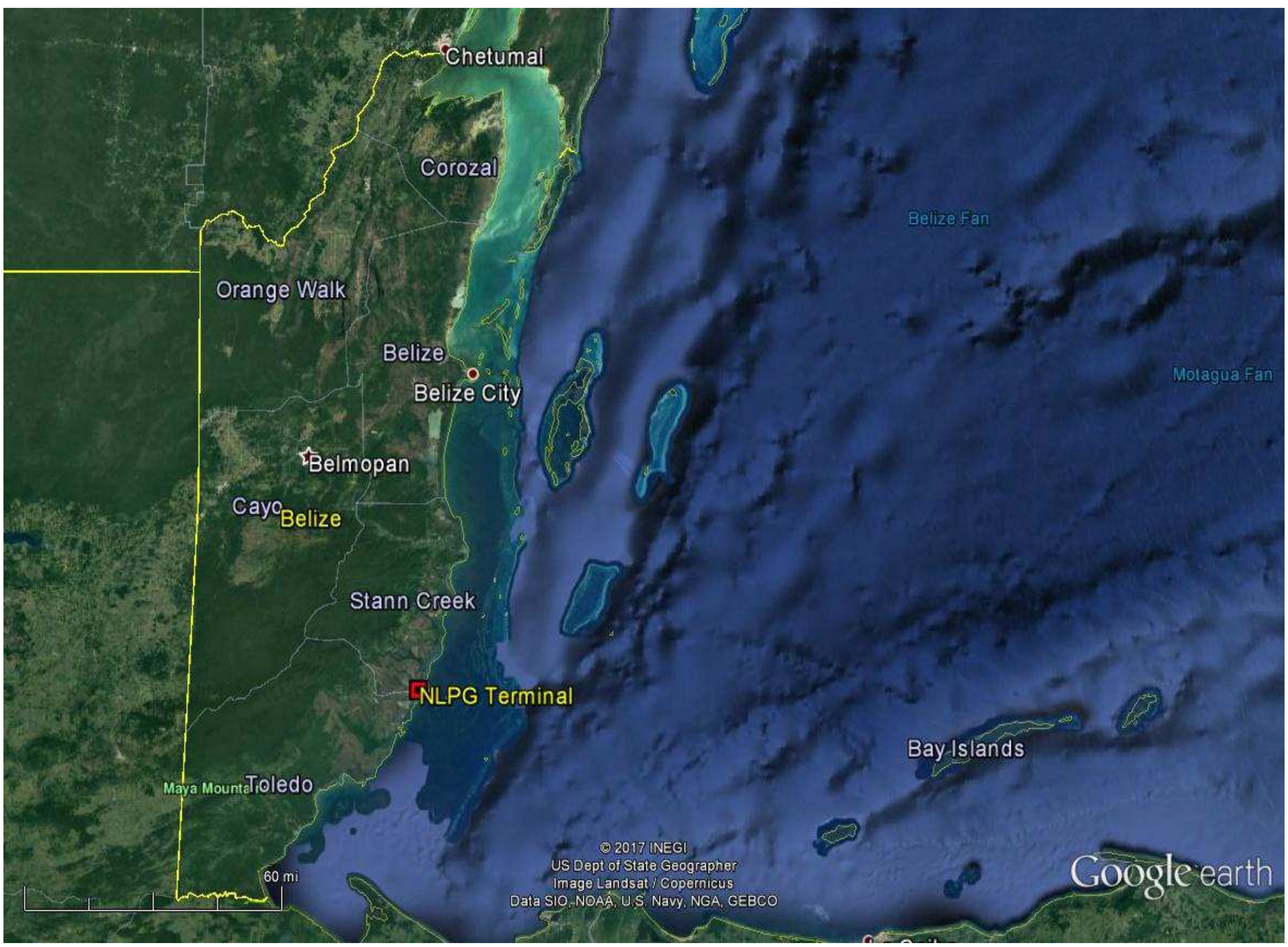


Figure 3: ***Map of Belize showing location of BNGC Terminal***

The BNGC Storage Facility *(highlighted in red within the circle in Figure 4 below)* will be located within the property of the Port of Big Creek, approximately one mile south of the villages of Independence and Mango Creek, Stann Creek District; just north of the southern geo-political border of the Stann Creek District.

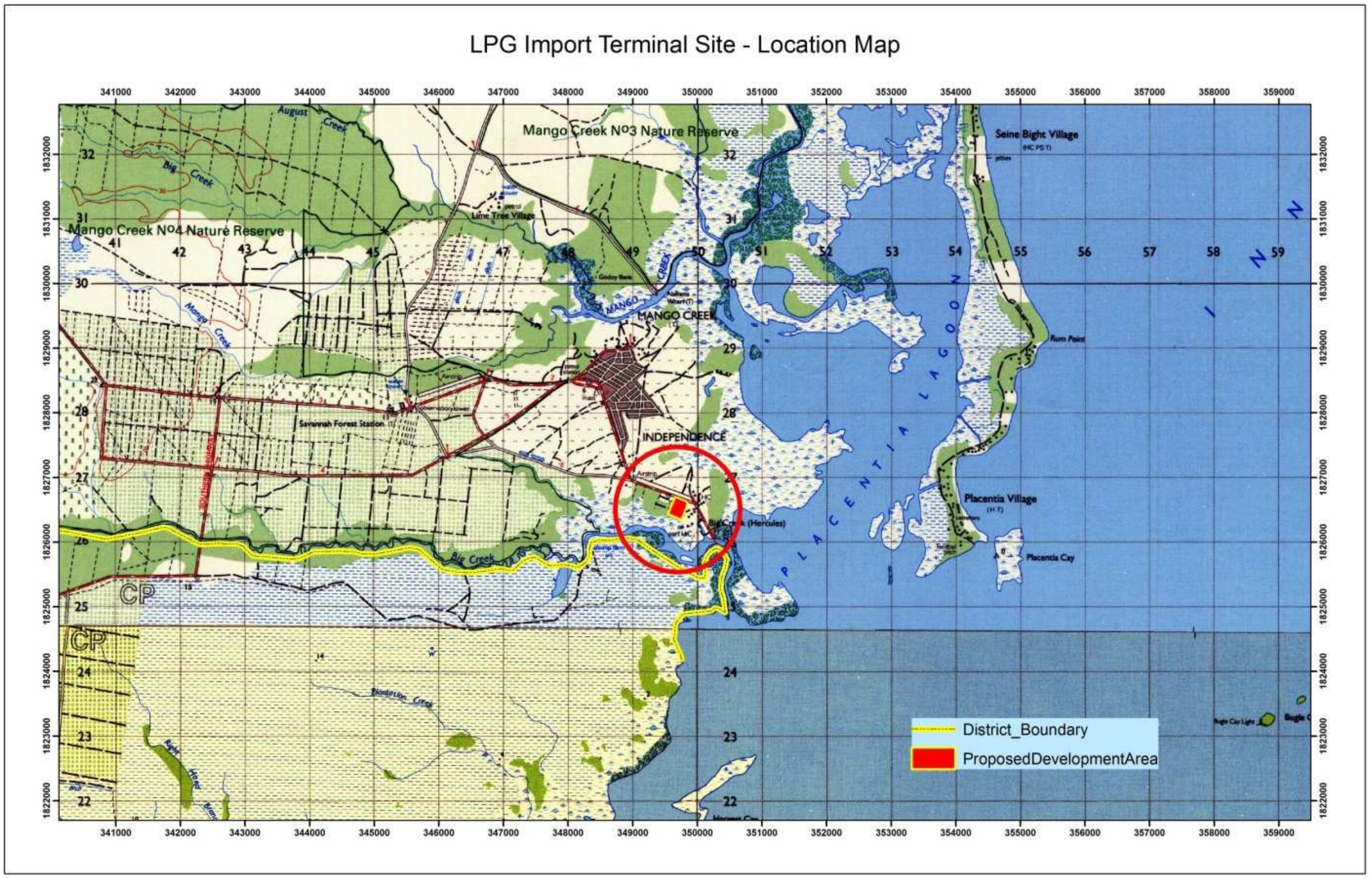


Fig. 4 - ***Proposed location of BNGC Terminal Storage Tank Farm (area highlighted in green)***

The site itself is on a fifteen acre plot of land located adjacent (south) of the Big Creek Port Road (highlighted in green below) about one-quarter mile north-west of the existing BNE Big Creek Crude Oil Storage Facility *(see Figure 5 below).*

The proposed site is bordered to north by the Big Creek Port road and an airstrip that seems to be no longer in use. To the east, it is bordered by the *"Petro-fuel"* storage facility for which the storage tanks are presently being utilized by Santander Ltd. for the storage of molasses. An office building which houses the offices for one of the banana companies is located approximately 200 feet from the north-east corner of the property. To the west and south of the property lies some additional vacant Port of Big Creek properties, which is presently being filled with dredged material from the shipping channel.

These undeveloped lands presently have some mangroves, shrubs and a few trees growing on it and extend for at least another 1,500 feet past the boundary line for the proposed storage facility.

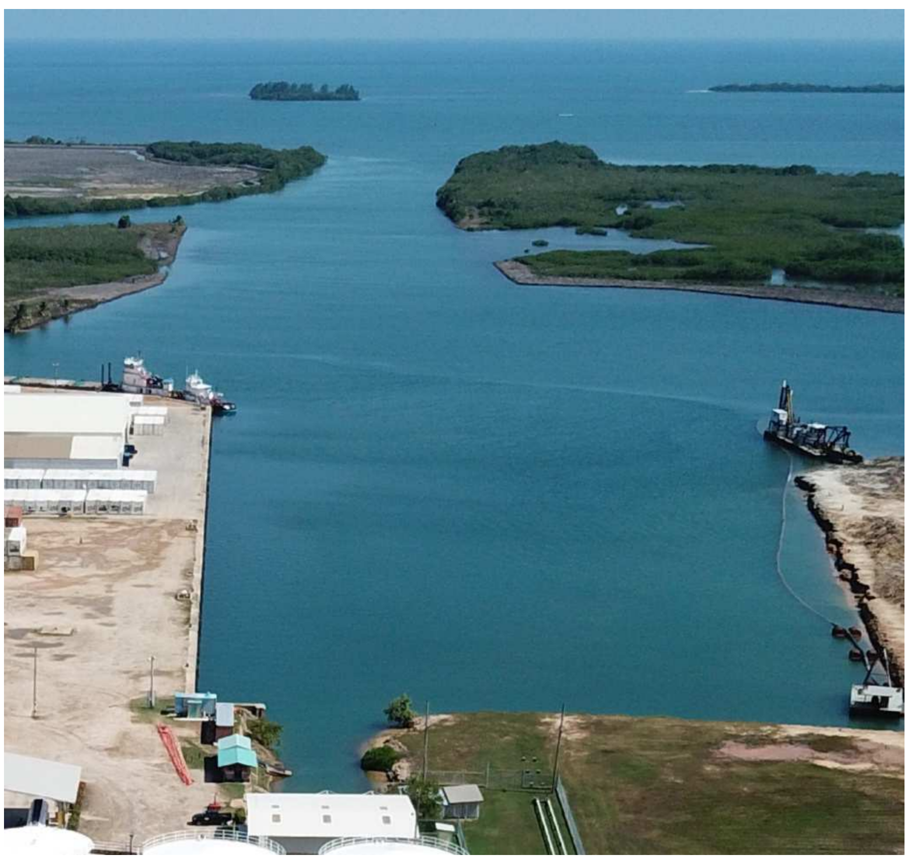
Fig. 5 - ***Proposed location of BNGC Terminal Storage Tank Farm (area highlighted in green)***

1.1.3 Location of Reception/Berthing Facility

An important aspect of the entire BNGC Terminal Facility is its reception/berthing facility, where the raw LPG products will be received from a certified gas carrier tanker ship (see Photograph 1 below). The berthing facility for the BNGC Facility will be located approximately 1,100 feet south-east of the proposed storage facility, along the existing berth presently being utilized by Belize Natural Energy (BNE) for the loading of the crude oil tanker (see Photograph 2 below).

As the transfer will entail the use of pumps from the Gas Carrier itself, no pumping station will be necessary at the berthing facility and BNGC will determine whether a metering station will be necessary as well. Should one be necessary, BNGC will ensure that a safe and adequate location is identified for the placement of the said metering unit.

Photograph 1: Example of a LPG Gas Carrier Tanker Ship



Photograph 2: Berthing Facility at Port of Big Creek

As both the proposed storage area and the pumping facility adjacent to the berth are within the Port of Big Creek property, BNGC will sign a rental agreement with the Port of Big Creek for the use of the lands, similar to that signed between the Port of Big Creek and BNE for the establishment of the Big Creek Crude Oil Storage Facility.

1.1.4 Location of Regional Depots

The two Regional Depots will be located on the outskirts of the City of Belmopan (Central Region) and that of Orange Walk Town (Northern Region). Each site will have an area of 5 acres and are basically isolated.

1.1.4.1 Central Region Depot – Belmopan

The Central Region Depot will be located on a 5 acre parcel of land near Miles 50 on the Hummingbird Highway (just across from the old Belmopan dumpsite). This site is located at approximate Coordinates 17°13'26.14"N and 88°46'38.37"W, some three kilometers southwest of the center of the City of Belmopan and approximately 1 kilometer southwest of the outskirts of the city. This land is held by BNE under Land Certificate No. 7807, Parcel No. 20-17-1774 and shown in Appendix II in the Survey Plan as Entry No. 9746.

Figure 5A: Proposed Location of Central Region Depot

Figure 5B: Central Region Depot opposite the old Belmopan Dump Site.

The site is located just south of the Old Belmopan Quarry about 1 mile out of Belmopan and just across from the old Belmopan garbage dump site. The site itself has recently been cleared of its vegetation and only a few trees remain on site, mostly cohune.

1.1.4.2 Northern Regional Depot

The proposed location for the Northern Regional Depot is on a 10-acre plot of land Parcel No. 769B Entry No. 6397 (Block No. 4, RIM Sheet No. 4/10/3000) surveyed for a Ms. Bertha Alonzo (but is presently under the receivership of the Belize Bank). This plot is situated about 5 kilometers north of the center of Orange Walk Town and about 1 kilometer north of the outskirts of the town (see Appendix III). It is situated at miles 57 on the western side of the Phillip Goldson Highway just outside the village of Trial Farm (now joined to the town). Its approximate coordinates are 18° 6'59.45"N and 88°33'43.81"W.

Figure 5C: Northern Regional Depot north of Orange Walk Town

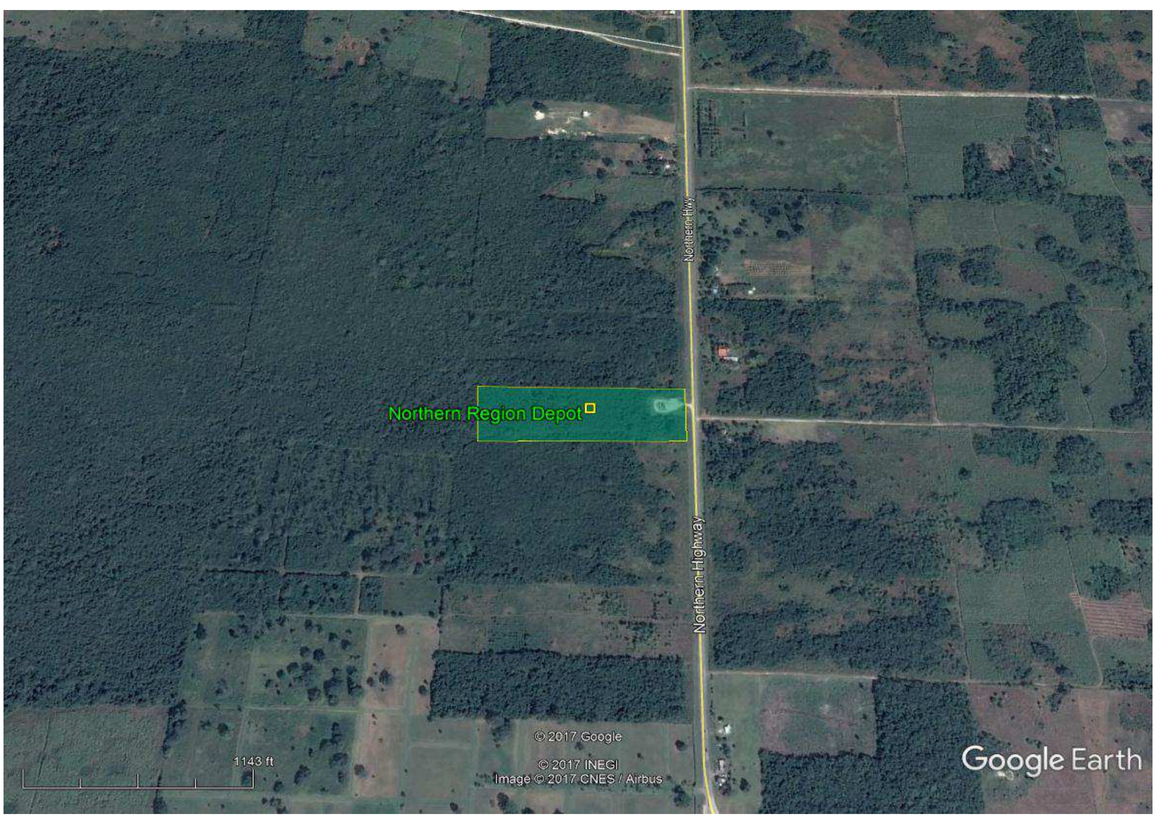


Figure 5D – Northern Regional Depot Located at Mile 57 on the Phillip Goldson Highway

1.2 Detailed Description

BNGC Terminal

The entire BNGC Terminal will be comprised of two major components; the storage facility, which will be sited on the 15 acre plot of land; and the pipeline/berthing facility located approximately 1,100 feet south-east of the storage facility *(See Figure 6 below)*.

The storage facility on the 15 acre plot of land will comprise of the following:

- Tank farm;
- Administration facilities;
- Fire Fighting Equipment;
- Pumping Facilities (loading of road tankers and mixing of products);
- Loading areas;
- Pathways and roads.
- Muster Points

The pipeline/berthing facility will comprise of the:

- Berthing area;
- Pipelines;
- Pumping Facility (offloading of gas carrier)

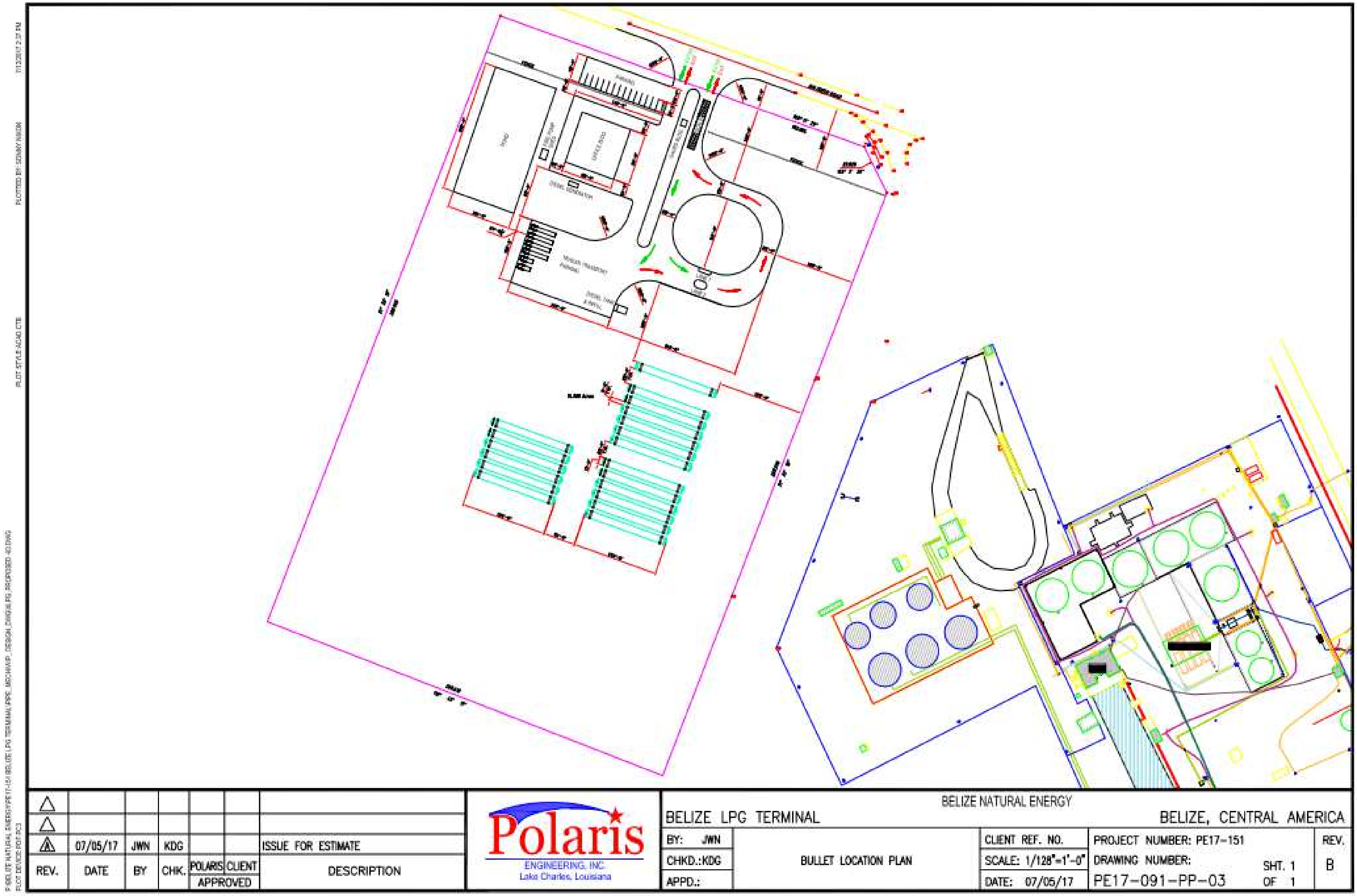


Fig 6 – Proposed Layout Plan for BNGC Terminal in Big Creek

1.2.1 Tank Farm

The tank farm, as previously mentioned, will be located within the property of the Port of Big Creek, just south and adjacent to the Big Creek Port road, approximately 1,100 feet north-west of the existing BNE Crude Oil Storage Facility. As can be seen in Figure 7 below, the storage component of the facility will be comprised of a total of nineteen (19) storage tanks, each with a capacity of 90,000 gallons and each tank measuring 123 feet 6 inches in length and 10 feet 10 inches in diameter.

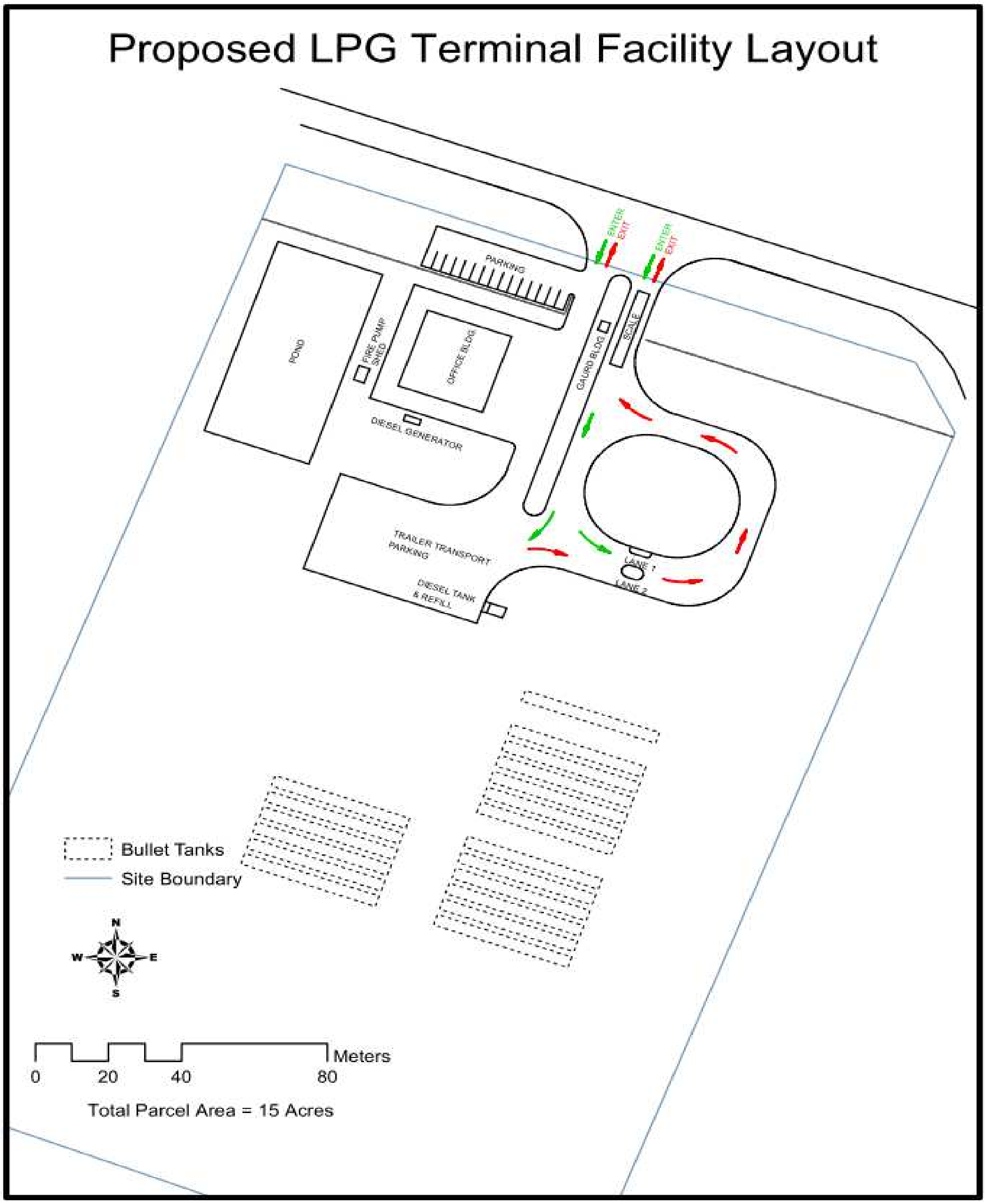


Figure 7: Layout of BNGC Terminal Facility

Eighteen (18) of the nineteen (19) storage tanks will be used for receiving and storing butane and propane; and will be placed in two 6-tank batteries for Propane storage (1,080,000 gals) and one 6-tank battery for Butane (450,000 gals), similar to that pictured below (*Photograph 3 below*). http://www.transtechenergy.com/hubfs/New_Menu_Pics/Terminals_Engineering_%2B_Construction/5_-_SNG_Power_Generation_-_Engineering_Construction_.jpg?

Photograph 3 – Example of 6-tank batteries

The remaining storage tank will be used for the mixing and storage of the final LPG product and from which the butane/propane mixture will be loaded into the road tanker trucks for local distribution. One of the storage tank from the butane tank battery, will be fitted with plumbing so that it itself can also be used as a second storage tank for the finished mixed product; thus making two tanks capable of being used for the sole purpose of storing the propane/butane mixture.

The total installed storage will therefore be approximately 1,710,000 gallons following initial construction and can then be gradually increased to meet market growth. This total, though, is inclusive of the blended final product mixture; therefore the facility will be able to receive shipments of approximately 1,620,000 (18 storage tanks) but will be less as the storage tanks will only be filled to approximately 85% capacity.

For increased safety and fire protection, these tank batteries will be placed some 125 feet away from the property boundary line. There will be a 5.5 feet space between each tank and a 25 feet space between each tank battery. There will also be a 50 feet space left between rows, to allow adequate spacing for pertinent piping and other infrastructure *(see Figure 6 above)*.

1.2.2 Pipelines

1.2.2.1 Berthing Facility to Storage Facility

As mentioned earlier, one of the most crucial components of the entire operation is the pipeline network necessary to transport the butane/propane from the berthing facility to the storage facility. It is anticipated that the pipelines for receiving the product will originate at a location along the present docking facility presently being utilized by BNE for the loading of the crude oil tanker. Figure 8 below shows the route of the proposed pipeline from the said berthing/docking facility, to the storage tank facility.

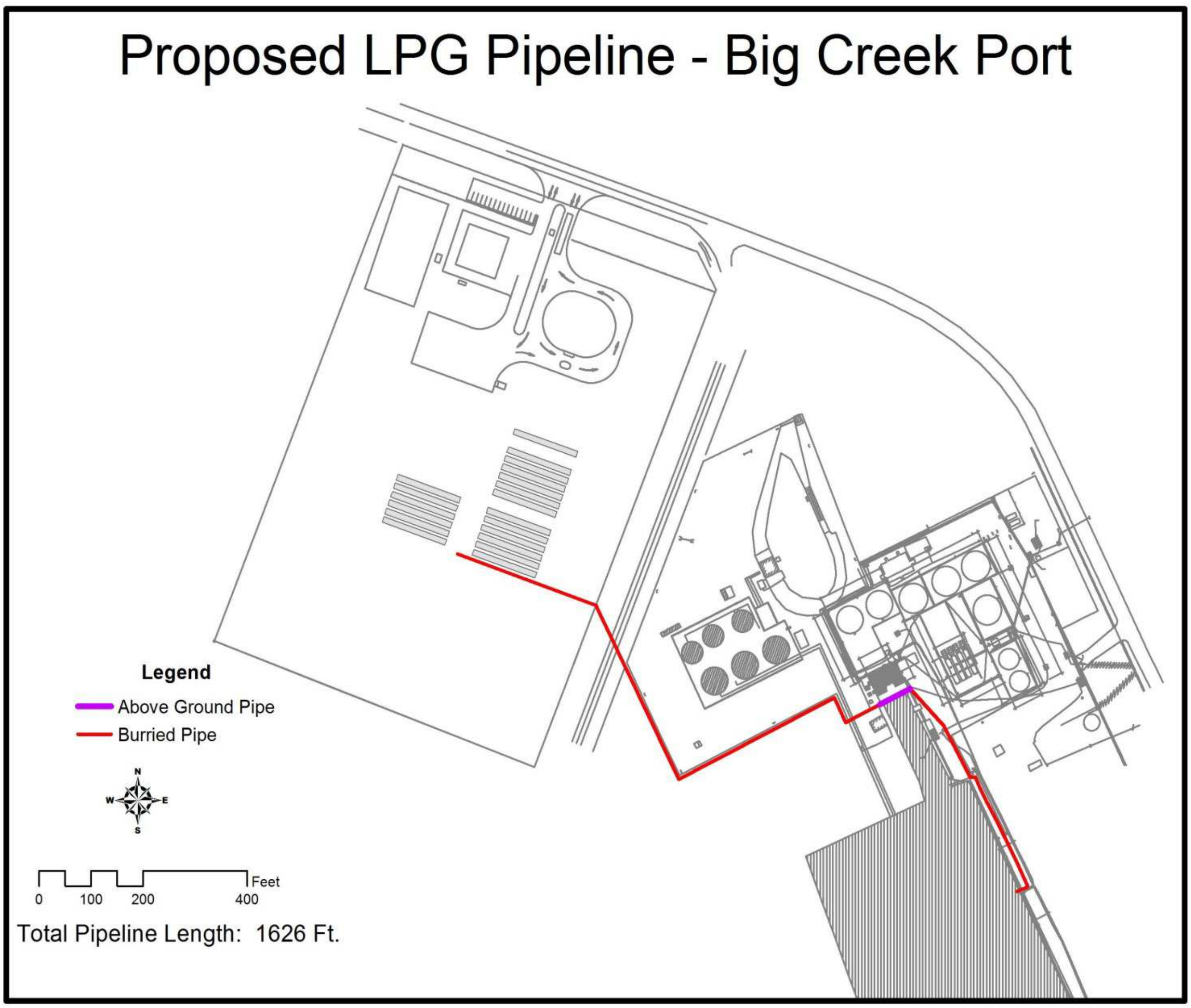


Figure 8: ***BNGC Pipeline Route***

The pipeline network for the BNGC Terminal will consist of four pipelines leading from the docking area to the tank farm. All pipelines will be constructed of solid schedule 80 black steel capable of withstanding pressures of 250 psi (this is the international standard for pipelines transporting propane which has a higher pressure rating than butane). The pipelines to be installed will be as follows:

- 1 - 8" Pipeline for Propane Liquid
- 1 - 4" Pipeline for Propane Vapor
- 1 - 6" Pipeline for Butane Liquid
- 1 - 4" Pipeline for Butane Vapor

Although not shown in the figure above, there will be several pipelines leading from the docking area to the tank farm. Commencing from the berthing/docking area, these pipelines will run underground (shown in red in Figure 8 above and pictures below) along the berth towards the present BNE Office building, where it will then become exposed (shown in purple in the Figure 8 above and in the photographs below) and cross over a small water channel on top of ferro-concrete pillars *(see Photograph 4 below)*.

Photo 4 – Example of elevated LPG Pipelines crossing waterway

As it crosses over the water channel the pipelines will then continue underground and as they leave the BNE facility, they will traverse a narrow portion (approximately 50 feet wide) of the "Petrofuel facility" *(shown as yellow in Photographs 5 & 6 below).*

Photograph 5: Showing Pipeline Route from the Berthing facility over the water channel and through Petro-fuel facility.

Photo #6: Proposed route of underground Pipelines traversing Petro-fuel Facility (in yellow)

The pipelines then continue underground just along the outer perimeter of the "Petrofuel facility" until it reaches the BNGC terminal and emerge from the ground some 1,626 feet from its origin at the berthing facility. Here it will be connected to a manifold system that will allow the operator(s) to direct flow and fill any of the storage tanks *(see photographs 7, 8 & 9 below)*.

Photos #7: Proposed Pipeline route along outer perimeter of Petro Fuel Facility leading to BNGC tank farm

Photos #8: Proposed Pipeline route along outer perimeter of Petro Fuel Facility leading to BNGC tank farm

Photo #9: Pipeline route from berthing area to BNGC Storage Facility

Presently the only locally legal document that addresses environmental issues as it relates to LPG depots, is the **Department of the Environment's Environmental Guidelines for Depots and Distribution Outlets for Liquefied Petroleum Gases (LPG)**. This guideline though, addresses only general concerns and mostly issues such as housekeeping and maintenance/inspection of equipment. As BNGC intends to install and operate a modern, environmentally sound and safe facility, it intends to construct the facility using the United States Department of Transport Guidelines and Standards.

As such types of facilities fall under the jurisdiction of the U.S. Department of Transportation (DOT) Pipeline and Hazardous Materials Safety Administration (PHMSA), the pipelines must then be designed per 49 CFR Part 195 for hazardous liquid pipelines and Part 192 for gas pipelines. The design requirements of these codes address such issues as:

i. the required strength of the pipe;
ii. the design of components that are attached to the pipe;
iii. the special requirements that specifically address construction issues such as how the welding is performed and the qualifications of the welder;
iv. the limitations on pipe bending;
v. the installation of pipelines in trenches; and
vi. the required depth of burial.

In light of the above, the pipelines will at least be made of steel of the carbon, low alloy-high strength, or alloy type that is able to withstand the internal pressures and external loads and pressures anticipated for the pipeline system.

BNGC is cognizant of the type of soil and environment in which the pipelines will be placed in and thus the lines will also have to be inspected more frequently than a normal above ground hydrocarbon line. Thus, the pipelines will have had to be made in accordance with a written pipe specification that sets forth the chemical requirements for the pipe steel and mechanical tests for the pipe to ensure the pipelines are suitable for the use intended and the environment in which it will be placed. Therefore, prior to the burying of the pipelines, BNGC will ensure that the pipelines are properly treated with anti-corrosion paint and wrapped in a protective layer to prevent the pipelines from having direct contact with the soil. Also, the pipelines will have long radius elbows and will contain the least number of reducers or expanders so that the line can be inspected with a "smart" pig that can take ultrasonic thickness readings as it is pushed along the length of the pipeline. Such testing would be done at least once every 5 years, or as necessary.

As stated above, all piping will conform to international standards (NFPA) and the US DOT PHMSA Guidelines and Standards for the LPG Industry and will be welded and not threaded, to prevent leaks. The LPG will be pumped from the ship to the storage tanks using the Gas Carrier's pumps. The approximate distance from the offloading facility to the LPG storage tanks is about 1,628 feet.

1.2.2.1.1 Pipeline Route Markers

As one of its safety precaution, BNGC will install pipeline markers, where feasible, along the route of the buried and exposed pipeline. Although the entire route of the markers is within the Port of Big Creek compound, the pipeline will be traversing at least one waterway, a rented portion of property and an access road.

As with any underground pipeline, a plastic tape will run at least one foot directly above the pipelines and markers will be placed at each road crossing and in sufficient number along the remainder of each buried line so that their location is accurately known. The marker will state, on a background of sharply contrasting color, either the word "Warning," "Caution," or "Danger" and followed by the words "Petroleum (Butane or Propane) Pipeline." The marker will also have the name of the operator and the telephone number (including area code) where the operator can be reached at all times *(see Photograph #10 below)*.

Photo #10: ***Examples of Gas Pipeline markers*.**

1.2.2.2 Storage Tanks Piping to Blending/Loading Facility

Additional pipelines of the same schedule and ratings will then be used to interconnect the tanks and tank batteries to the blending facility *(see photograph 11 below)*. As a precaution and a code of good practice, each tank will have several pipelines leading to/from it, in order that each tank can be isolated for maintenance/inspection and/or repairs, if the need so arise.

Photograph 11: LPG Tanks Interconnected with several pipelines

From the blending facility, LPG pipelines will then lead to the storage tank(s) for the mixed (blended) product, and thereunto the tanker truck loading facility. Another pipeline will be put in place for the vapor return line for the recirculation of gas/vapor.

1.2.3 Administration Facilities

1.2.3.1 Administrative Office

To ensure that the administrative activities of the BNGC Terminal run efficiently, an administration building will be constructed on the 15 acre plot. This bungalow building (highlighted in green in Figure 9 below) will measure some 80 feet by 80 feet (6,400 sq. feet) and made of ferro-concrete *(see photograph #12 below)* and located close to the northwest corner near the entrance of the facility. The building will house the administration office which will handle the day-to-day business activities related to personnel, finance, logistics, record keeping, and billing and will be managed by an office manager.

Photograph #12: ***Example of Ferro-concrete structure with cement roof***

The building will be built to withstand hurricane force winds of a Category 4 Hurricane and may be used as a hurricane shelter for such storms. It will have an "I" beam steel frame with exterior concrete walls and a concrete flat roof instead of the usual zinc roofing. The building will be designed to withstand fire and the blast from an explosion, should there ever be an incident. This building will have all the amenities necessary for such an industry and will include bathrooms, kitchenette, and shower stalls.

BNGC is also contemplating the construction of an additional building to house personnel who will be staying on site as well. This, though, will be decided upon after construction of the facility has been completed and operation has commenced.

Although not yet certain of the numbers, additional staff such as a receptionist, pumpers/loaders, engineers, maintenance personnel, etc., will be obtained to assist the manager. BNGC will try and source some competent and trained personnel from the nearby communities.

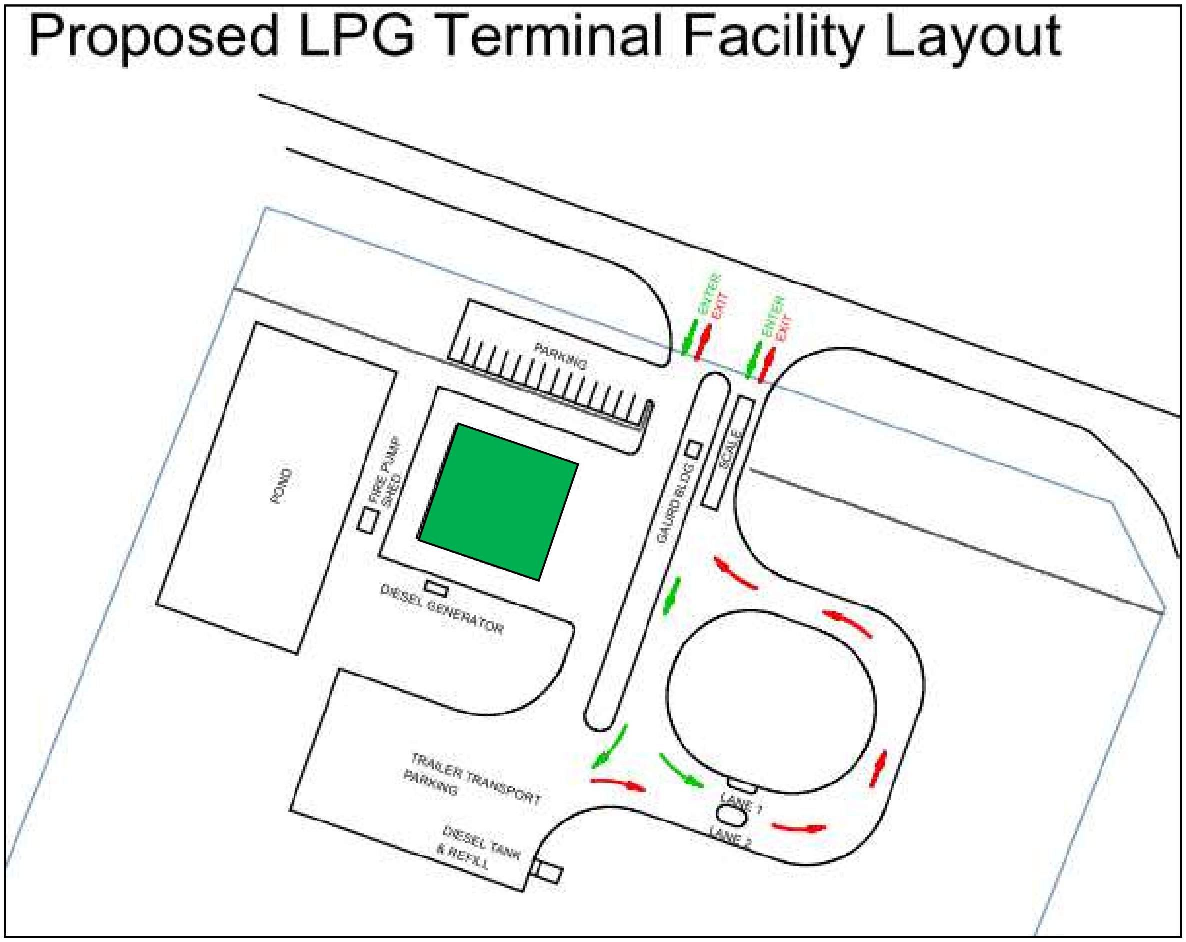


Figure 9: Location of the Administrative Building for the BNGC Terminal

1.2.3.2 LPG Quality Control/Testing Facility

Even after passing the Specification for Liquefied Petroleum Gas (LPG) Standard in 2012 to promote and establish the sale of a safe and efficient product, at present the Government of Belize has no control over the quality of the LPG being imported and/or sold in Belize. As such only Belize Natural Energy have been able to provide such quality and comply with GOB's set standard of a 30% Butane and 70% Propane blend.

The inability to have such control has resulted in a large number of complaints, not only from the importers/distributors themselves but primarily from the Belizean customer base.

BNGC will put in place a state of the art blending facility to ensure that BNGC will be complying with Belize's standards *(see photograph 13 below)*.

Photograph 13 – Example of Butane/Propane Blending Facility/Skid

In light of the above, also located within the administrative building/structure will be a laboratory equipped with a state of the art gas chromatographer, similar to that shown below in Photograph 14, for the testing of the raw and blended products; to ensure compliance with national LPG Standards which requires a propane/butane mixture of 70%-30% respectively.

This laboratory will have an on-site trained lab technician, to collect samples and test all LPG blends prior to any sales being made. The ability for such testing and quality control will make the facility versatile and can immediately make any necessary adjustments.

This lab facility will be readily accessible for inspection by Government of Belize personnel.

Photograph 14 – Gas Chromatographer used in Laboratory Analysis of LPG Blends

The establishment of this testing facility will not only provide the Government with some oversight over the quality of the LPG being sold, but will also address the issue of over pressurizing cylinders due to LPG blends with excess propane, that is presently on the market.

1.2.3.3 Other Supporting Infrastructure – Utilities

Water Supply

The proposed storage facility area is located along the Independence Village water supply pipeline that supplies the Port of Big Creek. BNGC will tap into this water supply for its domestic use within the facility, primarily for the administrative building.

Waste Management – Liquid

As the facility will have some staff working on a daily basis, the only liquid waste apart from storm water run-off, will be grey water from the kitchen area and black water from the bathroom facilities. To address grey water disposal, proper plumbing will be done and a leach field put in place to provide some treatment. Black water will be treated via a sealed multi-chambered septic system also complemented with a leach field.

Solid Waste

BNGC will develop and implement a solid waste management plan for this facility which will entail the separation of wastes (hazardous & non-hazardous, proper storage and disposal of such wastes. To achieve this, BNGC will put in place adequate waste receptacles and any hazardous waste material or waste will be incinerated, whilst the non-hazardous wastes will be disposed of at the locally approved disposal site.

Also, as this project will have several phases (Pre-construction, construction, operation and post operational) the construction plan will include the separation of re-usable inert construction material from the rest of the material. Inert construction waste such as sand, concrete blocks etc. will be used for land filling. The remaining waste will be collected and stored for later transportation to the designated dump site.

Power - Electricity

As the project is located within the Port of Big Creek, which is also already supplied with power from the Belize Electricity Limited's electrical grid, BNGC will also tap into this supply. But due to the fact that sometimes there will be power outages, BNGC will also install a 100KW power generator on site, to ensure that the facility has power when needed. This back-up generator will be located on the south-side of the administrative building and will be in an enclosed shed to protect the generator from the natural elements. The base of the shed will be constructed of ferro-concrete and will double as a containment bund, should there be any spill of oil and/or fuel.

Communication - Telephone and Internet

BNGC will also use the communication networks already available in the area from both Belize Telecommunications Limited (BTL) and Smart.

1.2.4 Fire Fighting Equipment

As propane and butane and any mixture of both are considered highly flammable and hazardous materials, BNGC will put in place both administrative and engineering controls to ensure that these materials are stored and transported in an environmentally sound and safe manner. Despite such precautionary steps, BNGC will, in the event that an incident does occur, put in place a fire suppression system to efficiently and effectively prevent such an incident from escalating.

When first conceptualizing the development and establishment of a liquefied petroleum gas (LPG) bulk storage facility, BNGC was cognizant that a massive failure of a vessel containing a full inventory of LPG, would be one of the greatest risk/hazard. Although, the probability of this type of failure occurring can be mitigated or at least controlled to a reasonable and tolerable level by engineering itself, this can be greatly complemented with an appropriately designed and operated fire suppression system, as well as with a well-trained and dedicated fire team.

1.2.4.1 Fire Protection Design Considerations

LPG vapors are heavier than air and tend to collect on the ground and in low spots. After LPG is released, it readily mixes with air and rapidly expands. As it expands and mix, it could form a flammable mixture that could ignite and cause a fire and/or vapor cloud explosion (VCE). A VCE can occur when a large amount of flammable vaporizing liquid or gas is rapidly released into the surrounding air and is ignited before being diluted. As a release occurs, there will be an area closest to the release that is above the flammable range or Upper Explosive Limit (UEL), an intermediate area that may be in the flammable range, and areas that will be below the lower flammable limit (LFL) or Lower Explosive Limit (LEL) *(see Figure 10 below)*. Mixing via natural currents and diffusion of LPG vapors affect the size and extent of these areas. If these processes continue, eventually the mixture is diluted to below the LFL/LEL. The LEL and UEL for LPG ranges around 2.0% to 10% LPG/air.

TYPICAL NATURAL GAS COMPONENTS

COMPONENTS	PERCENT BY VOLUME
Methane	89.5 - 92.5
Ethane	5.1 - 2.0
Propane	2.1 - 0.7
Butanes	1.6 - 0.5
Nitrogen	0.6 - 1.9
Carbon Dioxide	1.1 - 2.4
Total	100.0 - 100.0

Figure. 10 – Upper & Lower Explosive Limits

To reduce the fire/explosion risk at its LPG storage facility and to ensure that all safety precautions are taken, BNGC will adhere to various design considerations and requirements such as layout, spacing, and distance requirements for vessels, drainage, and containment control, to help limit the extent of fire damage, should there be such an incident. Additional considerations such as fireproofing, water-draw systems, and pressure relief systems are also important with respect to the integrity of the installation and risk reduction. These considerations address the various ways to prevent leaks or releases that may lead to a fire.

BNGC is also cognizant that equally as important to the prevention of a leak or release, is a properly designed, installed, and maintained fire protection system. This system attempts to minimize or limit the fire damage once a fire occurs. In a situation in which a fire does occur, the levels of required fire protection are affected by several factors such as location and remoteness of the fire and the availability of water.

In light of the above, BNGC will install a state of the art fire suppression system (designed by a certified engineering company from the US) consisting of at least nine fire hydrants with monitors connected via underground pipeline *(shown in yellow in Figure 11 below)* to a fire kill pump capable of supplying some 4,000 gallons of water per minute *(see Photograph 15 & 16 below).*


Photo 15 & 16 – Fire Hydrant with Monitor and Fire Suppression Foam Supply System

The hydrants with a fire suppression foam supply system, represented by the blue circles in the Figure below, will be strategically installed throughout the entire BNGC Terminal to ensure 100% fire coverage, to protect its offloading berth facility, pipeline, storage tanks facility, office/laboratory building and tanker truck loading facility (see Figure 11 below).

Although not shown in the figure below, the berthing area will be protected by a mobile hydrant connected to the BNE Fire kill System at the Crude Oil Storage Facility. This mobile hydrant will be put in place each time the Gas Carrier is in dock offloading.

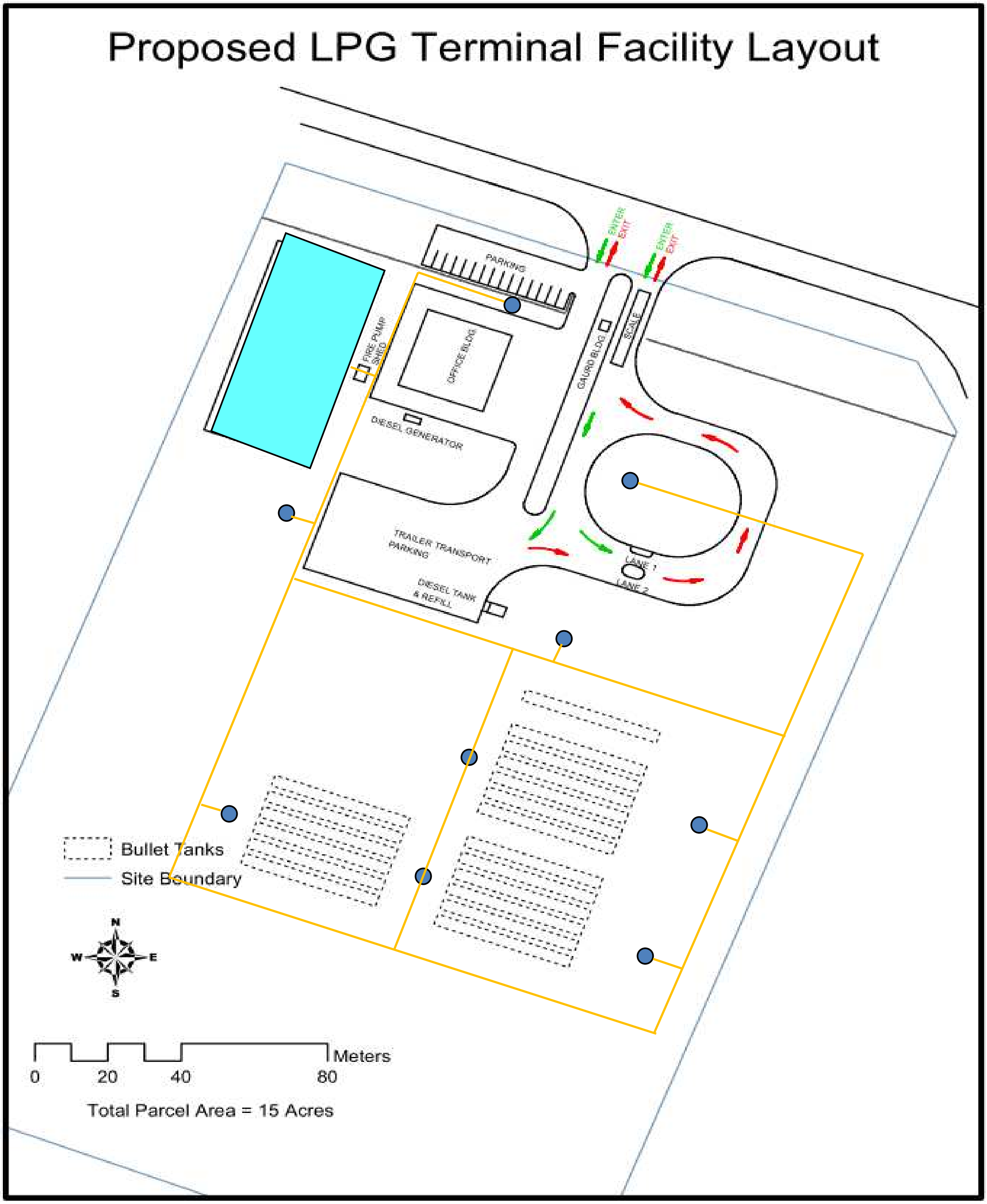


Figure 11: ***Layout of Fire Hydrants and Water supply Pipeline***

To ensure that there will be an adequate supply of water to combat any incident on the facility, should one occur, BNGC will construct an onsite water retention pond. This pond *(highlighted in light blue in Figure 12 above)* will be situated along the northwest border of the property and will measure 200 feet long by 100 feet wide and 15 feet deep; capable of storing approximately 2,500,000 gallons of water allowing almost eight hours of fire fighting time. BNGC will also consider complementing the fire suppression system by inter-connecting the water supply with the fire-suppression system already in existence at the BNE Big Creek Crude Oil Storage Facility. Such interconnection will then allow access to water supply directly from the sea; thus providing fire fighters with an unlimited supply of water.

The fire suppression system will be maintained and operated by a team of internationally certified fire-fighters that have been specifically trained to combat petroleum fires. The fire team will conduct daily inspections of the fire suppression system and hold frequent fire drills to test the readiness of the team and BNGC personnel. The BNGC fire team will also work in conjunction with the local National Fire Service Team based in Independence Village, to ensure that both parties are cognizant of their roles and responsibilities should the need to work together ever arise.

As part of its response and to complement this state of the art fire suppression system, BNGC will also have in place a dynamic Emergency Response Plan for the Terminal and the two Regional Depots/Bulk Plants. This plan will be kept up-to-date and will include the following:

- Facility name and location.
- Map of facility.
- Emergency phone numbers for key facility personnel.
- Emergency phone numbers for focal points of relevant Government Agencies.
- Emergency contact for local fire department and BC Port personnel.
- Hydrant layouts and capacities.
- Additional water supplies-e.g., ponds, canals.
- Hose-lays and lengths required.
- Multiple response approaches (wind-dependent).
- Vessel inventories.
- Fixed fire protection information.
- Scenarios for both un-ignited and ignited leaks.
- Internal Response Structure (Roles & Responsibilities).
- Unified Incident Command Structure (if it becomes necessary).

The Emergency Response Plan will be tested frequently and updated as necessary. The ERP will be made easily accessible to all personnel, especially to those who play vital roles in the implementation of the plan.

1.2.5 Pumping Facilities

For the movement of products (butane/propane) from off-shore (Gas Carrier) to on-shore storage tanks and within the facility itself; as well as for the use of water in fighting a fire, etc.; there will be the need for several pumps, ranging in size, capacity and purpose.

For such a facility like the proposed BNGC Storage Facility, it will take several pumping units to ensure that the facility operates efficiently and safely. It is anticipated that at least eight (8) pumps and three (3) compressors will be utilized at this facility *(see Table 1 below)*. Of the eight pumps, one will be for the fire-suppression system (Fire Kill Pump), two for the LPG Blending/ loading facility; whilst the remaining pumps/compressors will be used for the movement of product (butane/propane) and/or the supplying of pressurized air to the system (P-101, P-102, P-103, P-104, C-101, C-104 & SP-101).

Name	Type	Service	Specs
C-101	Compressor	Propane	Capacity: 28.7 SCFM 100F @ 30PSID Power: 25 HP
P-101	Pump	Liquid Propane	Capacity: 200 GPM @ 100PSID TDP
P-102	Pump	Liquid Propane	Capacity: 200 GPM @ 100PSID TDP
C-104	Compressor	Instrument Air	Capacity 10 SCFM @ 90PSI
SP-101	Air Dryer	Instrument Air	Capacity 10 SCFM @ 100PSI
C-102	Compressor	Butane	Capacity: 28.7 SCFM 100F @ 30PSID Power: 25 HP
P-103	Pump	Liquid Butane	Capacity: 100 GPM @ 150PSI TDP
P-104	Pump	Liquid Butane	Capacity: 100 GPM @ 150PSI TDP
P-105	Pump	LPG Blend	Capacity: 400 GPM @ 100PSID TDP
P-106	Pump	LPG Blend	Capacity: 400 GPM @ 100PSID TDP
Fire Kill Pump	Pump	Fire Water	Capacity: 4,000 GPM @ 150 PSI Driver: Patterson MAA12 x 8

Table#1: *Showing List of Pumps to be used throughout BNGC Terminal*

1.2.5.1 Berthing Facility

It was originally the plan for BNGC to install a pumping and metering facility along the berthing/docking area, but after careful consideration and consultation with the Polaris Engineering Team, BNGC was advised that such a facility would not be necessary as the Gas Carrier always utilizes its own on-board pumping and metering system. Therefore, for now, there will be no need for a building/shed to house the pumping/metering facility along the berthing area at the port. If the need does arise in the future requiring BNGC to place a metering system at the port side, such a meter will most likely be a Coriolis Mass Flow Meter *(see Photograph #17 below)*, which has been industry tested and is the recommended meter for such operations.

Photograph # 17: ***Example of a Coriolis Mass Flow Meter***

1.2.5.2 Tanker Truck Loading Facility

Another key component of the BNGC Terminal will be the tanker trucks loading facility, which will be located more on the north side of the property approximately 300 feet away from the main Port of Big Creek Road. In order to have an efficient loading facility, there will be three loading skids with pumps installed for the loading of trucks. Each skid will measure approximately 6 feet high by 8 feet wide and 30 feet long (photograph #18 below).

Photograph #18: ***Example of Skid Mounted LPG Loading Facility.***

These skid mounted loading and metering systems, include: pump, flow-meter (flow sensor) and the instrumentation required for a fully or partially automated facility and can be linked with BNGC's customer data system for invoicing and inventory control.

These skid-mounted and measuring systems all come factory tested and are very practical for improving quality and delivery lead time. Their design allows for them to be easily installed even if there's space constraint; which is not a factor at this facility, and most notably, they can easily be maintained and serviced. Of most importance is the fact that they comply with pressure vessels code stamped ASME Section VIII and the National Board Register and their piping are designed to ANSI B31.1 and B31.3; amongst other standards/regulations.

These skid mounted truck loading system normally comes complete with a/an:

- System controlled with PLC and Flow Computer or batch controller (Preset);
- Inlet and outlet manual operated isolation gate valves;
- Back flow preventer (check valve);
- Basket in-line strainer with pressure differential indicator;

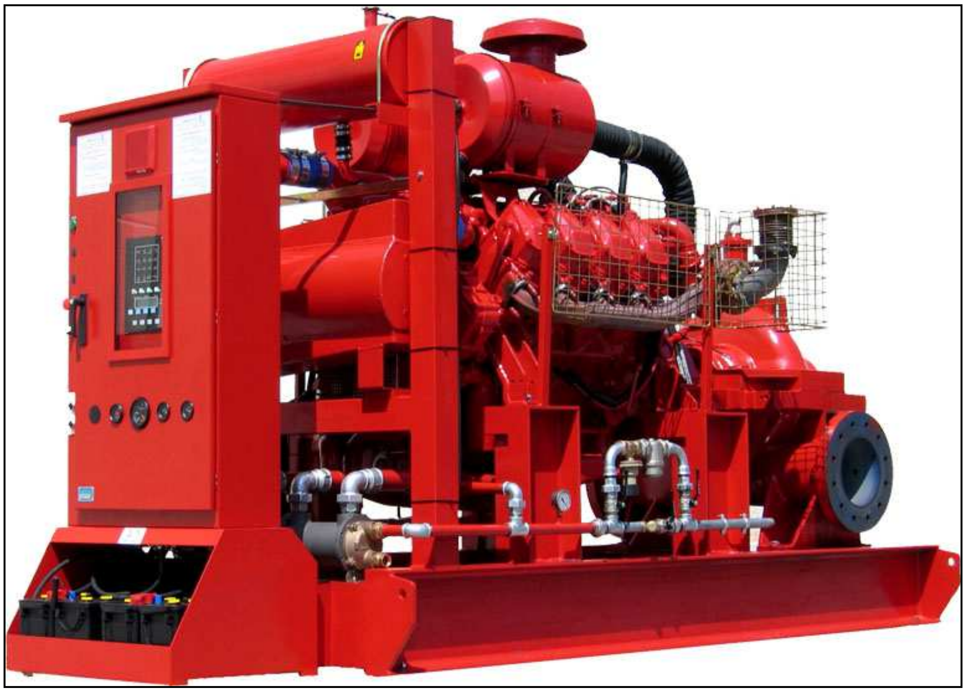
- Flow meter (Custody transfer approved);
- Digital flow control valve with external pilot control loop NO/NC solenoids, strainer and opening/closing speed control;
- Pressure safety/thermal relief valve;
- Resistance Temperature Detector (RTD) with thermo-well;
- Pressure indicator;
- Static ground monitoring;
- Drain connections with manual operated isolation ball valves;
- High quality industrial powder coating piping and base frame;
- Factory Acceptance Test (FAT) and Hydro-testing of all piping;
- System rated for National Electric Code 500 (NEC500) area classification (Cl1 Div1 or Cl1 Div2 are common). ATEX & other area classifications available.
- Prover connections with one DB&B valve and two isolation gate valves;
- Loading arm with break-way;
- Emergency Shut Down (ESD) valve with actuator and ESD pushbutton;
- Operator Human Machine Interface (HMI) with network switch;
- Densitometer;
- Pressure transmitter with local LCD;
- Temperature transmitter with local LCD;
- Complete tank monitoring;
- Differential pressure switch/transmitter across basket strainer;
- Overflow level switch;
- Vapor recovery line;
- Base frame with flat plate decking and containment lip;

The pumps on the systems that BNGC will be utilizing will have the capacity to load the road tanker trucks at rates of 400 Gallons Per Minute at 100 Pounds per Square Inch Differential Thermal Design Point (GPM @ 100PSID TDP). All pumps will be used simultaneously on a daily basis, and will double as a backup to one another should one pump go down and or is under repair/maintenance.

1.2.5.3 Fire Suppression System - Pump

As mentioned earlier, BNGC will be installing nine hydrants complete with monitors and fire-fighting foam system; and to complement this system will be the installation of a Patterson MAA12 x 8 water pump, capable of pumping 4,000 gallons of water per minute or approximately 450 gallons per minute per monitor *(see photograph # 19 below)*.

The Patterson Pump comes with it' own fuel tank as its base and is capable of storing 50 gallons of diesel fuel providing some 6 hours of run time on one tank.



Photograph #19: ***Patterson Horizontal Split Case MAAA 12 x 8 Pump***

This pump will be located to the west of the administration building and will be housed in a covered and semi-enclosed area near the water retention pond on the BNGC Storage Facility *(highlighted in red in Figure 12 below)*.

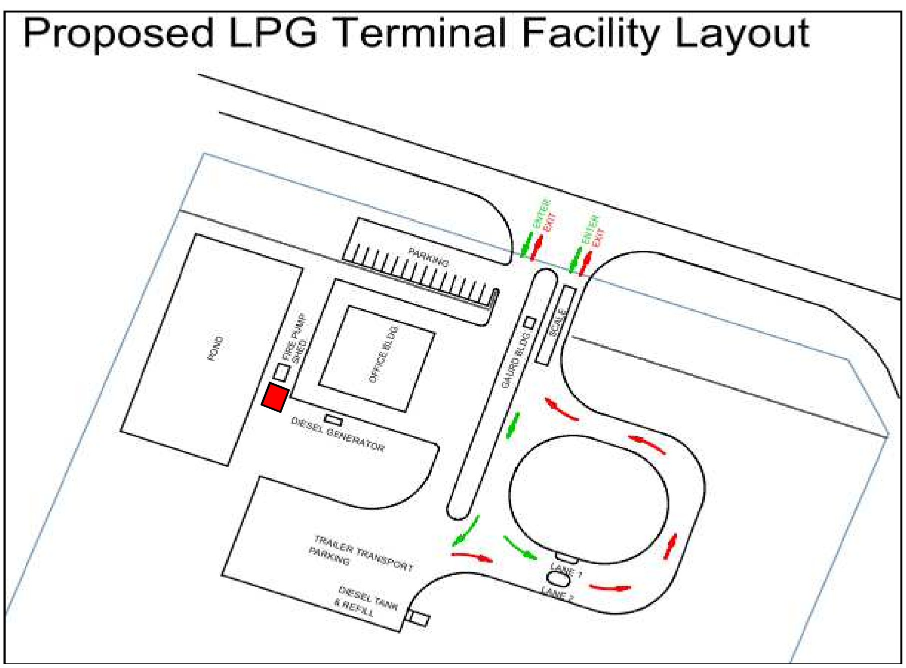


Figure # 12: L*ocation of Patterson MAA12 x 8 Fire Suppression Pump (red)*

1.2.6 Loading Areas – Tanker Truck

As mentioned above, one of the key operations of the entire facility will be the main loading bay facility for the LPG tanker trucks. This facility will be comprised of a covered loading area, similar to those used by BNE to load crude oil tankers *(see Photograph 20 below)*, and will have three loading lanes to facilitate the loading of three tankers simultaneously. The loading bays will be located north of the storage tanks, closer to the main road and will have a truck scale to ensure that the tanker trucks are not being under and or overfilled.

Photo 20 – Example of a Multi-Lanes Tanker Truck Loading Facility

This facility will have industry approved loading arms/hoses for the safe filling of tanker trucks *(see Photograph 20 left)* and will either be operated by trained tanker truck operators and/or trained technicians, well versed in handling the equipment and in following all loading procedures that will be put in place for this facility.

Photograph 20 A: Example of LPG Tanker Truck Loading Arm

All safety precautions will be put in place at this facility, including the necessary vapor recovery system to recover vapors from the tanker trucks that are being filled. Another safety feature of this facility will be the installation of collar release break-away systems that are designed to eliminate spillage and damage associated with drive and/or pull away incidents when loading and unloading hazardous liquids such as LPG. When used with loading arms the break-away is engineered to disconnect if the arm travels past the designated breakage position. The actual collar is linked via a break cable to the loading arm so that once the break position is reached, the collar splits, closing the valves off. In addition to reducing any potential environmental impact from a break, the loading arm is safeguarded and potential costly downtime is also avoided.

1.2.7 Pathways and Roads

The roads and access areas within the main tank farm storage area (15 acre plot) will be designed to ensure the safe operation of vehicles and or tanker trucks within the facility. These roads, parking areas and access points, will be built in conformity with the Ministry of Works Road construction regulations. It is anticipated that the main entrance to the facility will be directly off the main Big Creek Road on the northern boundary of the property (see Figure below). There will be two entrances, one for regular vehicles and the other for LPG tanker trucks. These entrances will be separated by an abutment which will also house a security hut, for the processing of visitors and vehicles.

Each lane will have a minimum width of 12.5 feet making each of the two entrances 25 feet wide. There will be two designated parking areas; the first parking area will have at least 15 parking spots for small vehicles and will be located outside the main fenced area of the facility. Here the drivers will need to exit their vehicle and enter the facility on foot after being processed at the security building. The second parking area will be for the LPG tanker trucks, where upon reaching the facility and after the initial weighing and processing, they will proceed to a *Trailer Transport* parking area and await their turn to proceed to the loading bay area.

As mentioned earlier, there will be two loading bays and upon completion of loading and disconnecting from the loading arms, the driver will then pull away from the loading bay and go around an open area (almost like a round-about) towards the gate where the tanker will again be weighed and processed *(see Figure 13 Below)*.

LPG terminal Layout Showing Parking Areas, Major Roads and Driveways

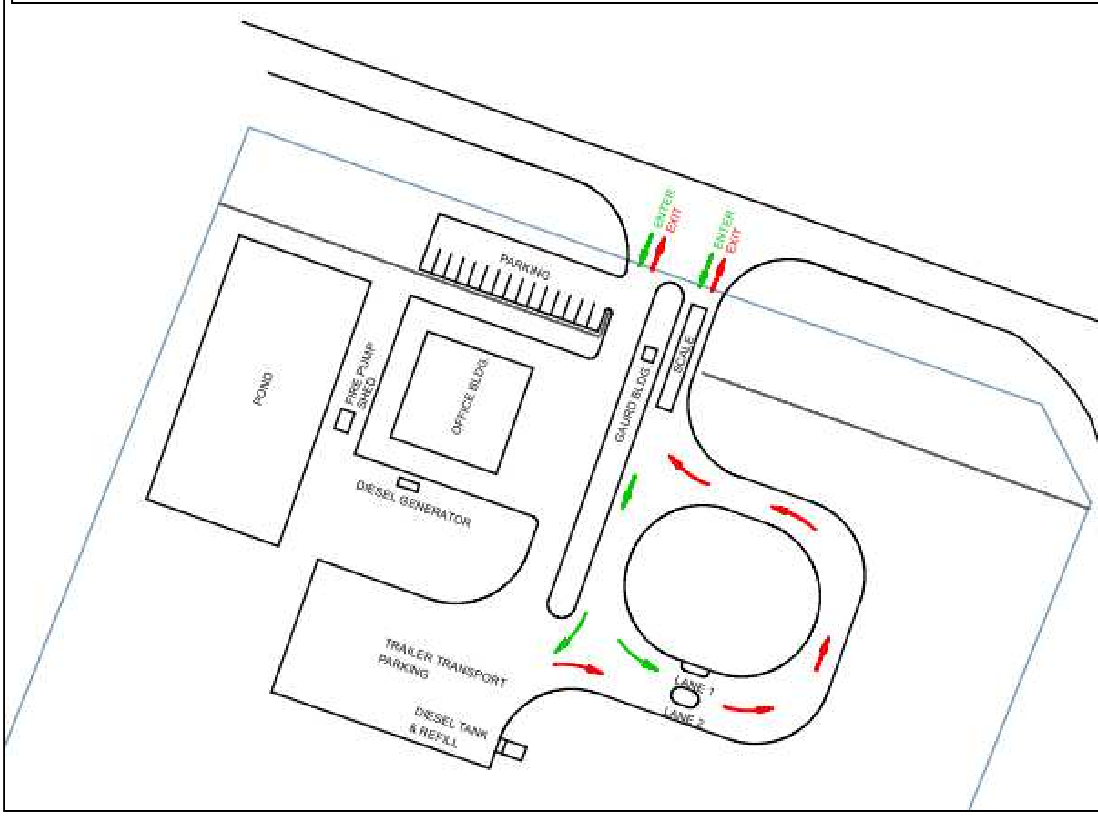


Figure #13: ***Entrance/Exits, Parking Lots, Roads and Pathways at BNGC Terminal***

Apart for the main roads for heavy traffic, there will be graveled and compacted access areas leading to and around the tanks within the storage tank farm area. The reserve for the Pipeline route will also include adequate space to allow for machinery to be able to access the entire length of the pipeline.

1.2.8 Muster or Assembly Points

As mentioned in Section 1.2.4 above, BNGC will develop an Emergency Response Plan for the facility. This ERP will address several types of emergencies such as:

i. Spills and Leaks;
ii. Fires this will be for both on site & off site (possible bush fires);
iii. Hurricanes;
iv. Earthquakes; and
v. Flooding, etc.

As with any type of emergency, especially in cases of massive leaks and or fire/explosion, there must be pre-designated locations where personnel (from both BNGC Terminal and adjacent offices), truck drivers and or visitors can gather and be accounted for. It is thus naturally anticipated that within the BNGC Terminal ERP, several muster points will be designated for the various emergencies.

As the facility will be storing propane and butane, which are two very flammable gases and which can form an explosive vapor cloud when released; muster points will initially be at a minimum of 300 meters away from the source, in both directions (green icons). For an incident involving a large uncontrollable release of gas and if it is believed that the situation can become even more volatile, additional muster points (labelled blue) will be designated a minimum of 800 m along the road in either direction *(see Figure 15 on following page)*.

Each Muster/Assembly point will be clearly marked with a sign similar to that shown below in Figure 14. These signs will be secured to poles and all personnel will be made familiar with these assembly points.

Figure #14: ***Example of Muster/Assembly Point Sign***

Figure 15: ***Muster Points for BNGC Terminal Initial and Secondary***

Regional Depots

As the two Regional Depots will be fitted on 5 acres of land (the Northern Region Depot will have an extra 5 acres), they will both have the same basic design. Each site will have the following facilities:

- Perimeter Fencing;
- Tank farm area for the 2 – 30,000 gals tanks;
- A small office building for administration purposes;
- Pumping Facilities (loading of customer road tankers);
- Loading lane;
- Pathways, parking lots and roads.
- Muster Points

Figure 15A – Layout of BNGC Central Regional Depot, Hummingbird Highway

Figures 15A (above) shows the layout of the Central Region Depot, which includes the facilities mentioned above. The Northern Region Depot will have the same facilities on site.

1.2.9.1 Tank Farm

Both Regional Depots will have two 30,000 gallons aboveground LPG storage tanks placed on concrete bases. Tanks will be located away from the main entrance and will have either a secondary security fence around the key components (piping, pump, etc.) of the operation and or simply have protection pillars around the tanks to prevent them from being hit by heavy equipment (see Photographs 20B & 20C below).

Photograph 20B – Security fence around LPG Tanks

Photograph 20C – Protection Barrier/Pillars around LPG Tanks

Each tank will be fitted with the following safety devices:

- Internal Combination Excess Flow Shutoff Valves
- Manual, Fire-Rated Isolation Valves
- Relief Valves
- Pressure, Temperature, and Level Indicators

1.2.9.2 Pipelines:

As both depots will be only for sale purposes, piping will be limited to the tank farm area for the interconnection of both tanks and from the tanks to the loading pumps. The pipelines to be installed will be 4" Schedule 80 Black Steel pipeline for both the LPG loading line and the vapor return line.

1.2.9.3 Administration Facilities

Both Regional Depots/Bulk Plants will have an office building near its entrance where customers will be processed when entering and or exiting the facility. It is anticipated that the office will be fitted with the necessary facilities such as electrical power, water, bathroom facilities, waste disposal facilities, communication (either phones, internet, VHF/UHF radios, etc.) and office furniture.

1.2.9.4 Fire Fighting Equipment

As both regional depots will be within a 5-mile range of a National Fire Service district facility, BNGC, as part of its overall Emergency Management Plan will put in place a fire fighting plan along with the NFS to effectively and efficiently respond to any fire incident at one of the depots.

Each depot, apart from having a series of strategically placed ABC fire extinguishers on site, will also have a 250 lbs Purple K fire extinguisher, especially manufactured for petroleum based fires. To assist the NFS in responding to a fire emergency at any of the depots, BNGC will consider putting in place a water retention pond, a 500 barrels tank and or installing a hydrant (hooked up to the BWSL water supply line) to provide for an adequate supply of water. Should an incident occur at the Central Region Depot near Belmopan, the NFS will also be aided by the BNE Fire Fighting Team and their Fire Apparatus.

1.2.9.5 Pumping Facilities

Both Regional Depots will only require the use of a pump for loading of the road tanker trucks and a compressor for the movement of vapors to/from the storage tanks and tanker trucks. It is anticipated that these pumps and compressors will be of the same make and size as those used at the BNGC Terminal in Big Creek.

1.2.9.6 Loading Areas and Pathways

As both depots will have the same layout, each will at the start of operations, have a single loading lane located at the rear near the tank farm. There will be a proper road network within the facility to allow for the safe entering, parking, loading, parking and exiting of the facility. These roadways will also be built in accordance with Ministry of Works guidelines and standards.

1.2.9.7 Muster Points

In case of an emergency, whether a gas release or a fire incident, the original muster point for both depots will be the entrance/exit gate, where employees and or visitors will meet and then moved to safe distances along the highways away from the facilities. Similar to that of the Terminal, muster points will be clearly marked with a sign and will be located at a minimum 800 meters away.

1.3 BNGC Terminal Tank Farm

As previously mentioned there will be a total of nineteen (19) LPG tanks at the BNGC Terminal, with a storage capacity of 90,000 gallons each. These tanks will measure 123 feet six inches in length and 10 feet 10 inches in diameter. Twelve of the tanks will be used to store propane (colored brown in figure below), 6 will be used to store butane (colored blue in figure below) and the remaining tank will be used to store the final product of propane/butane. If necessary, one of the other storage tanks will be used as additional storage of finished product (colored yellow/blue in Figure 16 below).

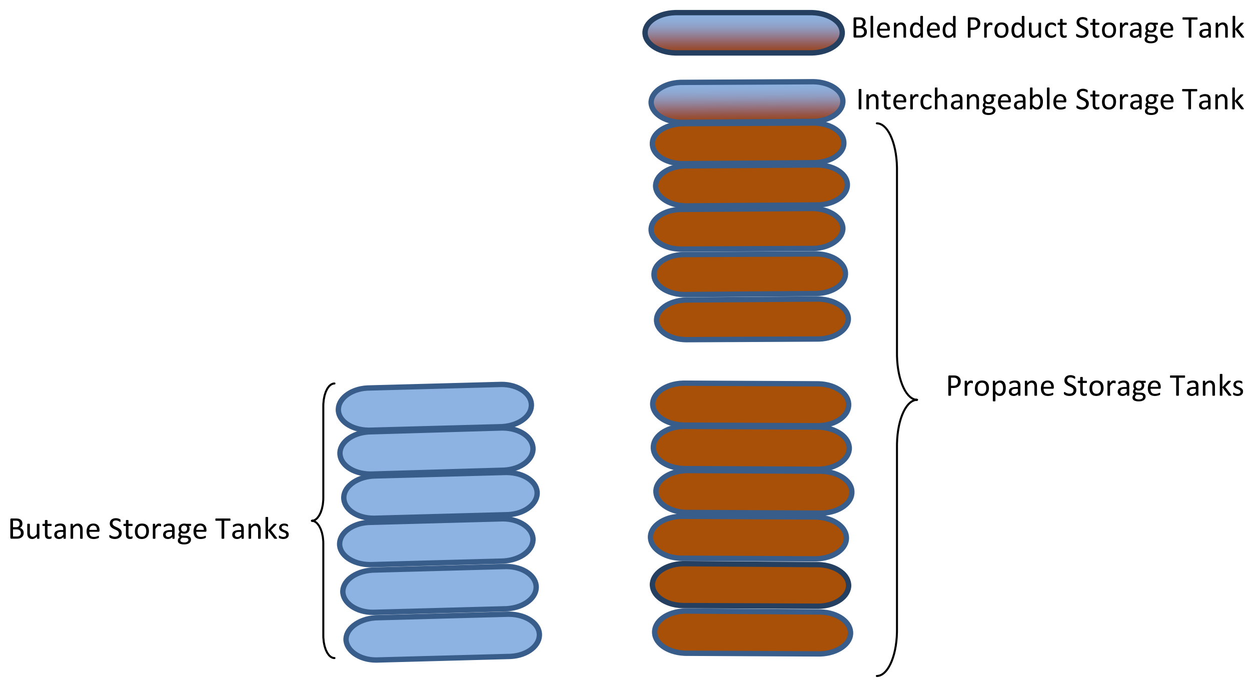


Figure #16: ***Color Coded Diagram showing Butane (blue), Propane (brown) & Blended Product (yellow) Storage Tanks***

1.3.1 General Safety Requirements for Storage of LPG in LPG Storage Tanks:

BNGC will purchase LPG storage tanks from a certified provider and will ensure that each tank is certified and that they will all follow the following general specifications:

1.3.1.1 Design Specifications and Fittings

- Tanks obtained by BNGC for the storage of Liquefied Petroleum Gas shall be designed for a working pressure corresponding to the vapour pressure at the highest temperature that the tanks are likely to reach. Since the gas with the highest pressure that BNGC will be handling is propane, all 19 tanks will be designed to work under the pressure and maximum temperature requirement for propane.

- Each storage tank will be fitted with a pressure gauge and devices for measuring the liquid content and its temperature. BNLGP will ensure that the maximum quantity of Liquefied Petroleum Gas stored in anyone tank will be according to the NFPA's "Maximum Permitted Liquid Volume for Aboveground Containers Over 1200 gals" shown in Table 1A below.

LP-GAS LIQUID TRANSFER 58–51

Table 4-4.2.2(b) Maximum Permitted Liquid Volume (percent of total water capacity): Aboveground Containers Over 1200 Gal (0 to 4.5 m³)

	Specific Gravity		Propane		Blend						Butane		
Liquid Temperature °F (°C)	0.496 to 0.503	0.504 to 0.510	0.511 to 0.519	0.520 to 0.527	0.528 to 0.536	0.537 to 0.544	0.545 to 0.552	0.553 to 0.560	0.561 to 0.568	0.569 to 0.576	0.577 to 0.584	0.585 to 0.592	0.593 to 0.600
−50 (−45.6)	75	76	77	78	79	80	80	81	82	83	83	84	85
−45 (−42.8)	76	77	78	78	79	80	81	81	82	83	84	84	85
−40 (−40)	76	77	78	79	80	80	81	82	83	83	84	85	85
−35 (−37.2)	77	78	78	79	80	81	82	82	83	84	84	85	86
−30 (−34.4)	77	78	79	80	80	81	82	83	83	84	85	85	86
−25 (−31.5)	78	79	79	80	81	82	82	83	84	84	85	86	86
−20 (−28.9)	78	79	80	81	81	82	83	83	84	85	85	86	87
−15 (−26.1)	79	79	80	81	82	82	83	84	85	85	86	87	87
−10 (−23.3)	79	80	81	82	82	83	84	84	85	86	86	87	87
−5 (−20.6)	80	81	81	82	83	83	84	85	85	86	87	87	88
0 (−17.8)	80	81	82	82	83	84	84	85	86	86	87	88	88
5 (−15)	81	82	82	83	84	84	85	86	86	87	87	88	89
10 (−12.2)	81	82	83	83	84	85	85	86	87	87	88	88	89
15 (−9.4)	82	83	83	84	85	85	86	87	87	88	88	89	90
20 (−6.7)	82	83	84	85	85	86	86	87	88	88	89	89	90
25 (−3.9)	83	84	84	85	86	86	87	88	88	89	89	90	90
30(−1.1)	83	84	85	86	86	87	87	88	89	89	90	90	91
35 (1.7)	84	85	86	86	87	87	88	89	89	90	90	91	91
*40 (4.4)	85	86	86	87	87	88	88	89	90	90	91	91	92
45 (7.8)	85	86	87	87	88	88	89	89	90	91	91	92	92
50 (10)	86	87	87	88	88	89	90	90	91	91	92	92	92
55 (12.8)	87	88	88	89	89	90	90	91	91	92	92	92	93
60 (15.6)	88	88	89	89	90	90	91	91	92	92	93	93	93
65 (18.3)	88	89	90	90	91	91	91	92	92	93	93	93	94
70 (21.1)	89	90	90	91	91	91	92	92	93	93	94	94	94
75 (23.9)	90	91	91	91	92	92	92	93	93	94	94	94	95
80 (26.7)	91	91	c92	92	92	93	93	93	94	94	95	95	95
85 (29.4)	92	92	93	93	93	93	94	94	95	95	95	96	96
90 (32.2)	93	93	93	94	94	94	95	95	95	95	96	96	96
95 (35)	94	94	94	95	95	95	95	96	96	96	96	97	97
100 (37.8)	94	95	95	95	95	96	96	96	96	97	97	97	98
105 (40.4)	96	96	96	96	96	97	97	97	97	97	98	98	98
110 (43)	97	97	97	97	97	97	97	98	98	98	98	98	99
115 (46)	98	98	98	98	98	98	98	98	98	99	99	99	99

*See 4-4.3.3(a).

4-4.3 Compliance with Maximum Permitted Filling Limit Provisions.

are not subject to DOT jurisdiction (such as, but not limited to, engine fuel cylinders on vehicles not in interstate

Table 1A: NFPA Chart on Permitted Liquid Volumes

- Remote controlled pneumatically operated shut-off valves will be fitted to each storage tank.

BNGC will also ensure that its storage LPG tanks are equipped with the following fixtures:

- filling valve,
- intake valve of the gas phase,
- pressure gauge,
- maximum overflow valve,
- intake valve of the liquid phase,
- level sensor,
- safety relief valve(s).

• **Pressure Relief Valves**—Propane tanks are protected by pressure relief valves that open and close to prevent excessive internal pressure due to abnormal conditions.

• **Excess Flow Valves**—These valves will be placed on the storage tank, the loading facility known as the "bulk head" and on the delivery vehicle. They provide protection during product transfer or anytime that propane flows through them, including during normal operating periods. Should the flow of propane exceed the valve's setting, which might occur if the piping downstream of the valve is broken, the valve will automatically close and shut off the flow of propane.

• **Line Valves**—These manually operated valves are used to control flow into or out of the system or to isolate piping for maintenance purposes. Other valves are used with bulk storage tanks and tank trucks where special attention and protective measures are needed.

• **Passive Shutoff Systems**—To ensure additional precautionary steps are taken, BNGC tanks will be protected with a "passive" product control system that will automatically stop the flow of propane/butane if a line separation occurs.

1.3.2 Regional Depots Tank Farm

As mentioned above, the Regional Depots will only have two 30,000 gallons providing for a maximum storage capacity of 60,000 gallons (note that since tanks will only be filled to about 85% capacity, it is very unlikely that 60,000 gallons will ever be on site).

Similar to those at the Terminal, the tanks will be built of the same material and will be pressure rated to that for propane gas; i.e., it will be rated well above the expected operating pressure. All the safety features mentioned above (pressure relief valves, liquid level & temperature gauges, excess flow valves, emergency shut-off valves, etc.) will be installed at both depots.

1.4 Process Flow

1.4.1 Overall Description:

The overall description of the operations of BNGC Terminal is very similar to most LPG Terminals (see Figure 17 below). The following will try to explain the entire process:

1.4.2 Berthing of Gas Carrier:

The bulk products (Propane & Butane) will be brought in by a Gas Carrier which will dock at the berthing facility that is presently being used by BNE to load the crude oil tanker. When the vessel arrives at the discharge terminal, BNGC will ensure that cargo tank pressures and temperatures are at values appropriate to the terminal requirements to allow maximum discharge rates to be achieved.

Before the discharge operation begins, the pre-operational ship/shore procedures will be carried out, i.e. ship/shore information exchange and the ship/shore safety check list will have been completed and all important factors satisfactorily met. All the relevant national and international agencies will be involved in this part of the operations.

The following information will be supplied to set the principle discharge parameters:

- Which side is the ship to berth?
- Will there be a vapor return line?
- What size is the vapor and discharge lines?
- What are the normal and maximum permitted back pressures?
- Required temperature of the cargo.
- Slow down, speed up and emergency procedures.

BNGC will always advise the chartered gas carrier prior to using the shore vapor return as this may have important implications affecting the Gas Carrier.

1.4.3 Berthing Facility to Storage Tanks

From the berthing/docking area, there will be a total of four pipelines leading to a manifold system near the storage tanks, similar to that shown in Photograph 21 below. These four pipelines are as follows:

- 1 - 8" Pipeline for Propane Liquid
- 1 - 4" Pipeline for Propane Vapor

- 1 - 6" Pipeline for Butane Liquid
- 1 - 4" Pipeline for Butane Vapor

There will be two pipelines for each product (butane & propane), the larger pipeline being for the liquid product (8 inch pipeline for liquid propane and 6 inch pipeline for liquid butane) and the smaller pipelines (both 4 inches) being for the recovery of propane and butane vapor.

Photo #21: Example of a manifold system

This manifold system or gathering system, will be designed and fabricated with schedule 80 black steel and will have pressure and temperature rated valves to divert and control flows. The manifold system will also have pressure gauges to ensure that maximum pressures of the pipelines are not exceeded.

1.4.4 Manifold System to Storage Tanks

From the manifold system, a network of pipelines will then lead to each tank allowing for the products to be diverted to their respective tanks without the interruption of flow. Each tank will also be connected to a vapor recovery line back to the manifold system. This pipeline system will also allow for each individual tank to be isolated for whatever reasons there may be, such as tank repair and or maintenance.

Also, if there's a need to increase the production and storage of the blended product (as there's only one designated tank), any other tank can easily be converted to the storage of the blended product.

1.4.5 Storage Tanks to Blending Facility

Subsequent to the products (propane and butane) being transported and stored in their respective storage tank batteries, both propane and butane will be pumped simultaneously via a blending facility (skid) at the prescribe ratio to obtain a 70% propane and 30% butane blend (the legally prescribed percentage as mandated by the Belize Bureau of Standards).

1.4.6 Blending Facility to Blended Product Storage Tank(s)

After the blending is completed the mixed product is pumped to one or more storage tanks specifically designated for the final blended product. The blended mixture is then stored and tested to ensure compliance with the local regulations regarding composition of the LPG.

1.4.7 Blended Product Storage Tanks to Loading Bay Facility

After the blended product has been tested and found to comply Belize's the national LPG composition standard, it will then be loaded into LPG road tanker trucks via three (3) LPG loading skids. These tankers will then deliver the LPG product to the various LPG storage Depots in the various districts around the country of Belize.

1.4.8 Injection of Odorant

As part of the final portion of the operations, is the addition of the odorant. BNGC will be using the most common LPG odorant known as Mercaptan. This will be injected at the point when the tanker trucks are being loaded. A Mercaptan injection unit/skid, will systematically inject the calibrated amount of Mercaptan into the LPG pipeline as the tankers are being filled.

The Flowchart below depicts the basic steps involved in the operation of the terminal, commencing with the discharge of the products from the ship, to storage of the different ingredients (propane and butane), to the blending of the two ingredients, to the storage of the blended products and finally to the loading and distribution of the LPG product.

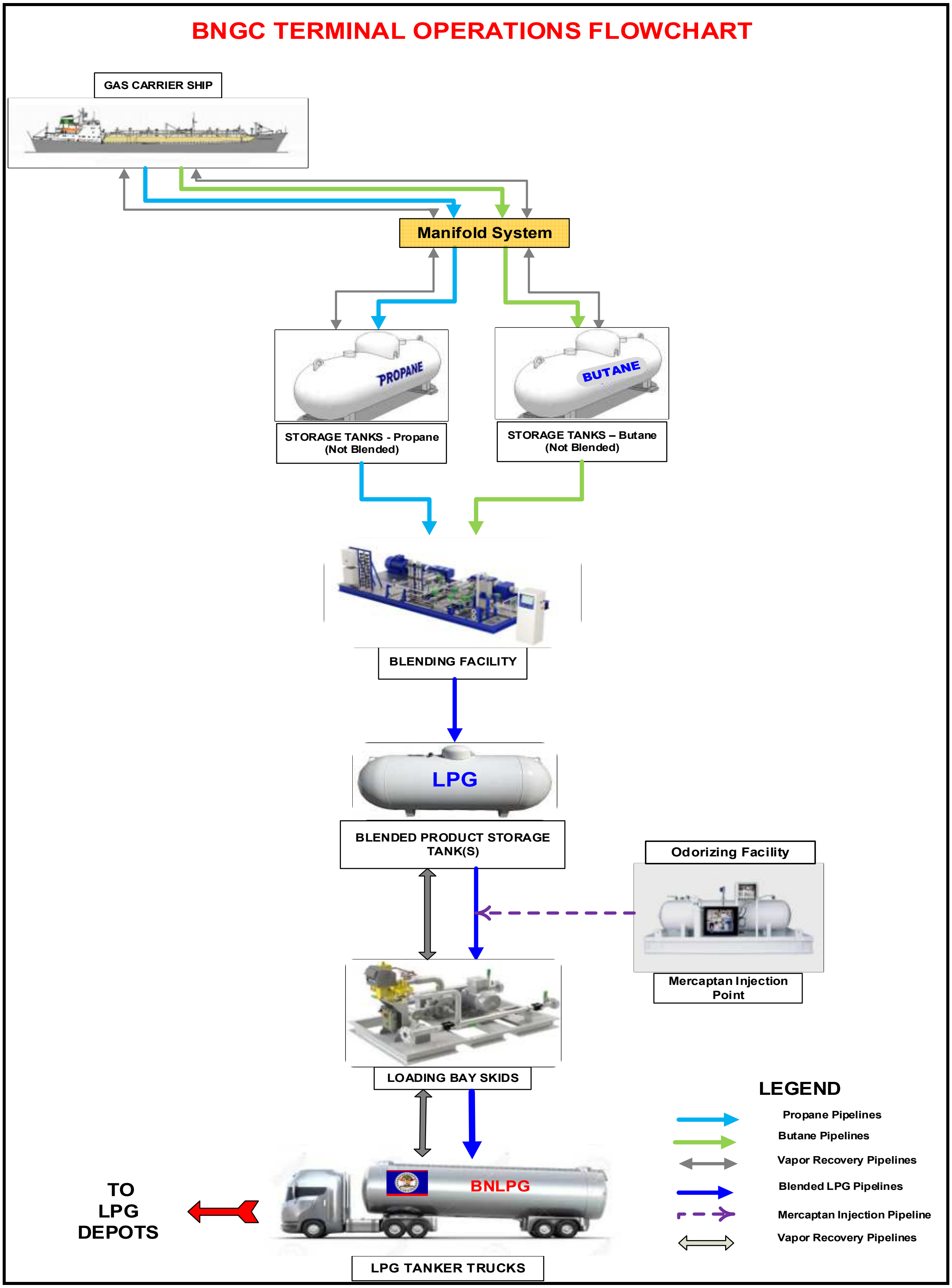


Figure 17: BNGC Terminal Operations Flowchart

Process Flow of Regional Depots

The process flow of material at the Regional Depots is very much similar to any existing LPG depot in Belize. LPG will be brought to the Regional Depots in BNGC road tanker trucks, they will be weighed on the scale at the entrance of the facility, processed and then will proceed to the tank farm area where the tanker will be discharged into the storage tank(s). Subsequent to discharging into the storage tanks, the tanker truck will then proceed to the gate and then processed.

Customers purchasing LPG from the depots will go through the same process at the BNGC Tankers, with the exception that they are loading from the storage tanks and not discharging product to the tanks.

1.5 Chemicals Used in LPG Operations

Liquefied petroleum gas, also called LP gas, or LPG, is any of several liquid mixtures of the volatile hydrocarbons propene, propane, butene, and butane. It is produced as a by-product of natural gas processing and petroleum refining. The components of LPG are gases at normal temperatures and pressures. It was used as early as 1860 for a portable fuel source, and its production and consumption for both domestic and industrial use have expanded ever since.

The two main components of the LPG utilized in Belize are Butane and Propane which are blended together at a 30% to 70% ratio, respectively. The exact proportion of this combination varies by country, depending on international prices, on the availability of components and, especially, on the climatic conditions that favor LPG with higher butane content in warmer regions and propane in cold areas.

1.5.1 Butane

Properties

Butane is an organic compound with the formula C_4H_{10} that makes it an alkane. Butane is a gas at normal room temperature and atmospheric pressure. Butane is highly flammable, colorless, easily liquefied gas that quickly vaporizes at room temperature. The name butane comes from the roots but- (from butyric acid, named after the Greek word for butter) and -ane. It was discovered by the chemist Edward Frankland in 1849.

Normal butane can be used for gasoline blending, as a fuel gas, fragrance extraction solvent, and as a feedstock for the manufacture of ethylene and butadiene, a key ingredient of synthetic rubber. Isobutane (a form of butane) is primarily used by refineries to augment the octane number of motor gasoline. Butane is also used as a petrol component, as a feedstock for the production of base petrochemicals in steam cracking, as fuel for cigarette lighters and as a propellant in aerosol sprays such as deodorants.

Table 2 below provides an overview of some of the properties and hazards of butane:

Properties	
Chemical formula	C_4H_{10}
Appearance	Colorless gas
Odor	Gasoline-like or natural gas-like[1]
Density	2.48 kg/m^3 (at 15 °C (59 °F))
Melting point	−140 to −134 °C; −220 to −209 °F; 133 to 139 K
Boiling point	−1 to 1 °C; 30 to 34 °F; 272 to 274 K
Solubility in water	61 mg L^{-1} (at 20 °C (68 °F))
Vapor pressure	~170 kPa at 283 K [4]
Hazards	
Safety data sheet	*See: Appendix I* V
GHS signal word	DANGER
Flash point	−60 °C (−76 °F; 213 K)
Auto-ignition temperature	405 °C (761 °F; 678 K)
Explosive limits	1.8–8.4%
US health exposure limits (NIOSH):	
PEL(Permissible)	none
REL(Recommended)	TWA 800 ppm (1900 mg/m^3)
IDLH (Immediate danger)	N.D.

Table2: Properties of Butane

Reactivity of Butane

When oxygen is plentiful, butane burns to form carbon dioxide and water vapor; when oxygen is limited, carbon (soot) or carbon monoxide may also be formed.

When there is sufficient oxygen:

$$\underset{\text{butane}}{2\,C_4H_{10}} + \underset{\text{oxygen}}{13\,O_2} \rightarrow \underset{\text{carbon dioxide}}{8\,CO_2} + \underset{\text{water}}{10\,H_2O}$$

When oxygen is limited:

$$2\,C_4H_{10} + 9\,O_2 \rightarrow 8\,CO + 10\,H_2O$$

The maximum flame temperature of butane with air is 2,243 K (1,970 °C; 3,578 °F).

Uses

Very pure forms of butane, especially isobutane, can be used as refrigerants and have largely replaced the ozone-layer-depleting halomethanes, for instance in household refrigerators and freezers. The system operating pressure for butane is lower than for the halomethanes, such as R-12, so R-12 systems such as in automotive air conditioning systems, when converted to pure butane will not function optimally and therefore a mix of isobutane and propane is used to give cooling system performance comparable to R-12.

Butane is also used as lighter fuel for a common lighter or butane torch and is sold bottled as a fuel for cooking and camping stoves. In this form it is often mixed with small amounts of hydrogen sulfide and mercaptans which will give the unburned gas an offensive smell easily detected by the human nose. In this way, butane leaks can easily be identified. While hydrogen sulfide and mercaptans are toxic, they are present in levels so low that suffocation and fire hazard by the butane becomes a concern far before toxicity.

Health Effects

Inhalation of butane can cause euphoria, drowsiness, narcosis, asphyxia, cardiac arrhythmia, fluctuations in blood pressure and temporary memory loss, when abused directly from a highly pressurized container, and can result in death from asphyxiation and ventricular fibrillation.

A small amount of nitrogen dioxide, a toxic gas, results from burning butane gas, along with any combustion in the earth's atmosphere, and represents a human health hazard from home heaters and stoves

1.5.2 Propane

Properties

The other main component of the LPG used in Belize is Propane. Propane was discovered by the French chemist Marcellin Berthelot in 1857. It was first identified as a volatile component in gasoline by Walter O. Snelling of the U.S. Bureau of Mines in 1910. Although the compound was known long before this, Snelling's work was the beginning of the propane industry in the western hemisphere. The volatility of the lighter hydrocarbons caused them to be known as "wild" because of the high vapor pressures of unrefined gasoline.

The name Propane is derived from the following: "prop-" found in "propane" and names of other compounds with three-carbon chains was derived from "propionic acid", which in turn was named after the Greek words protos (meaning first) and pion (fat).

Unlike butane, Propane is a three-carbon alkane with the molecular formula C_3H_8. And just like butane it is a gas at standard temperature and pressure, but is compressible to a transportable liquid. It is also a by-product of natural gas processing and petroleum refining, and is commonly used as a fuel. Additionally, oil refineries produce some propane as a by-product of cracking petroleum into gasoline or heating oil.

The table below provides an overview of some of the properties and hazards of Propane:

Names	
Preferred IUPAC name	**Propane**
Systematic IUPAC name	**Tricarbane**
Identifiers	
CAS Number	74-98-6
UN number	1978
Properties	
Chemical formula	C_3H_8
Appearance	Colorless gas
Odor	Odorless
Density	2.0098 kg/m^3 (at 0 °C, 101.3 kPa)
Melting point	−187.7 °C; −305.8 °F; 85.5 K
Boiling point	−42.25 to −42.04 °C;

	−44.05 to −43.67 °F; 230.90 to 231.11 K
Vapor pressure	853.16 kPa (at 21.1 °C (70.0 °F))
Hazards	
Safety data sheet	See: *Appendix V*
GHS signal word	**DANGER**
Flash point	−104 °C (−155 °F; 169 K)
Auto-ignition temperature	470 °C (878 °F; 743 K)
Explosive limits	2.37–9.5%
US health exposure limits (NIOSH):	
PEL(Permissible)	TWA 1000 ppm (1800 mg/m^3)
REL(Recommended)	TWA 1000 ppm (1800 mg/m^3)
IDLH (Immediate danger)	2100 ppm

Table 3: Properties of Propane

Reactivity of Propane:

Propane undergoes combustion reactions in a similar fashion to other alkanes. In the presence of excess oxygen, propane burns to form water and carbon dioxide.

$$\underset{\text{propane}}{C_3H_8} + \underset{\text{oxygen}}{5\ O_2} \rightarrow \underset{\text{carbon dioxide}}{3\ CO_2} + \underset{\text{water}}{4\ H_2O} + \text{heat}$$

When not enough oxygen is present for complete combustion, incomplete combustion occurs, allowing carbon monoxide and/or soot (carbon) to be formed as well:

$$\underset{\text{propane}}{2\ C_3H_8} + \underset{\text{oxygen}}{9\ O_2} \rightarrow \underset{\text{carbon dioxide}}{4\ CO_2} + \underset{\text{carbon monoxide}}{2CO} + \underset{\text{water}}{8H_2O} + \text{heat}$$

$$\underset{\text{propane}}{C_3H_8} + \underset{\text{oxygen}}{2\ O_2} \rightarrow \underset{\text{soot}}{3\ C} + \underset{\text{water}}{4\ H_2O} + \text{heat}$$

Complete combustion of propane produces about 50 MJ/kg of heat.

Propane is generally stored and transported in steel cylinders as a liquid with a vapor space above the liquid. The vapor pressure in the cylinder is a function of temperature. When gaseous propane is drawn at a high rate, the latent heat of vaporization required to create the gas will cause the bottle to cool. (This is why water often condenses on the sides of the bottle and then freezes). In addition, the lightweight, high-octane compounds vaporize before the heavier, low-octane ones. Thus, the ignition properties change as the cylinder empties. For these reasons, the liquid is often withdrawn using a dip tube. Propane is used as fuel in furnaces for heat, in cooking, as an energy source for water heaters, laundry dryers, barbecues, portable stoves, and motor vehicles.

Uses:

Propane is also instrumental in providing off-the-grid refrigeration. Compared to fluorocarbons, propane has a negligible ozone depletion potential and very low Global Warming Potential (having a value of only 3.3 times the GWP of carbon dioxide) and can serve as a functional replacement for R-12, R-22, R-134a, and other chlorofluorocarbon or hydro-fluorocarbon refrigerants in conventional stationary refrigeration and air conditioning systems. Because its global warming effect is far less than current refrigerants, propane was chosen as one of five replacement refrigerants approved by the EPA in 2015, for use in systems specially designed to handle its flammability.

Propane is also being used increasingly for vehicle fuels. It is the third most popular vehicle fuel in the world, behind gasoline and Diesel fuel.

The advantage of propane in cars is its liquid state at a moderate pressure. This allows fast refill times, affordable fuel cylinder construction, and price ranges typically just over half that of gasoline. Meanwhile, it is noticeably cleaner (both in handling, and in combustion), and results in less engine wear (due to carbon deposits) without diluting engine oil (often extending oil-change intervals. The octane rating of propane is relatively high at 110.

More recently, there have been lawn care products like string trimmers, lawn mowers and leaf blowers intended for outdoor use, but fueled by propane in order to reduce air pollution.

1.5.3 Mercaptan

Properties

LPG (butane & propane blend), though, on its own is odorless and since it is classified as a dangerous and explosive gas, a leak can go undetected until it reaches a source of ignition and cause an explosion. To combat such an issue, an odorant or odorant is added to the LPG (propane & Butane) blend to make it possible for humans to detect such leaks before an incident occur.

The most common odorant used today is Methyl Mercaptan (simply called Mercaptan), also known as methanethiol and is a harmless but pungent-smelling gas which has been described as having the stench of rotting cabbages or smelly socks. It is an organic substance, made of carbon, hydrogen and sulphur, and is found naturally in living organisms, including the human body where it is a waste product of normal metabolism. It is one of the chemicals responsible for the foul smell of bad breath and flatulence. Mercaptan is classified as a thiol and is sometimes abbreviated as MeSH

The great advantage of mercaptan for industrial purposes is that it can be detected by most people in extremely small quantities, less than one part per million. This makes it an ideal additive to odorless gases, and, like natural gas, it is flammable.

MeSH is released as a by-product of kraft pulping in pulp mills. It (Methanethiol) is also released from decaying organic matter in marshes and is present in the natural gas of certain regions, in coal tar, and in some crude oils. It occurs in various plants and vegetables, such as radishes.

The table below provides an overview of some of the properties and hazards of Mercaptan (Methanethiol):

Names	
Preferred IUPAC name Methanethiol	
Other names Methyl mercaptan Mercaptomethane Methiol Thiomethyl alcohol Methylthiol	
Identifiers	
CAS Number	74-93-1
UNII	2X8406WW9I
Properties	
Chemical formula	CH_4S
Appearance	colorless gas[1]
Odor	Rotten cabbage, flatulence
Density	0.9 g/mL (liquid at 0°C)[1]
Melting point	−123 °C −189 °F 150 K
Boiling point	5.95 °C 42.71 °F 279.10 K

Solubility in water	2%
Solubility	alcohol, ether
Vapor pressure	1.7 atm (20°C)[1]
Acidity (pK_a)	~10.4
Hazards	
R-phrases	R12, R23, R50/53
S-phrases	S16, S25, S33S60, S61
Flash point	−18 °C; 0 °F; 255 K [1]
Explosive limits	3.9%-21.8%[1]
Lethal dose or concentration (*LD*, *LC*):	
LD_{50} (median dose)	60.67 mg/kg (mammal)[2]
LC_{50} (median concentration)	3.3 ppm (mouse, 2 hr) 675 ppm (rat, 4 hr)[2]
US health exposure limits (NIOSH):	
PEL(Permissible)	C 10 ppm (20 mg/m^3)[1]
REL(Recommended)	C 0.5 ppm (1 mg/m^3) [15-minute][1]
IDLH (Immediate danger)	150 ppm[1]

Table 4: Properties of Mercaptan

Uses:

Mercaptan / Methanethiol is mainly used to produce methionine, which is used as a dietary component in poultry and animal feed. Methanethiol is also used in the plastic industry as a moderator for free-radical polymerizations and as a precursor in the manufacture of pesticides.

Mercaptan is also used in the natural gas industry as an odorant, due to its ideal compatibility with methane. Its characteristic "rotten eggs" smell is widely known by natural gas customers as an indicator of a possible gas leak, even a very minute one.

1.5.4 Use of Chemicals at Regional Depots

As the Depots will simply be for receiving and distributing the mixed LPG product or blend, there will be no other chemicals used at these facilities, only LPG.

1.6 Storage, Blending & Transportation of LPG

As mentioned earlier, the BNGC Terminal will be a full service terminal capable of receiving, storing, blending, testing, and dispatching LPG. The overall services offered by the terminal are diagramed in Figure 18 and described below:

Receive LPG

The facility will be designed to receive bulk LPG primarily by sea but will also be able to receive LPG by land transportation as well.

Store LPG

The terminal will increase national LPG storage capacity and energy security. The facility will be able to provide up to a six week national supply of LPG at current usage volume.

Blend LPG

The terminal will be designed to maximize LPG blend flexibility, able to receive commercial propane and or butane and then blend to the mix ratio required by law and/or requested by the customer (as long as it meets the minimum requirement required by GOB).

Test LPG

The terminal will be equipped with a state-of-the-art gas testing facility, which the Belize Bureau of Standards (BBS) will have access to.

Load LPG Trucks

The facility will be able load LPG delivery trucks for distribution nationwide. Distributors and truckers who load their trucks at the terminal will need to ensure that their trucks meet all safety requirements to enter the facility. As the importation of LPG will now be more controlled, it is anticipated that the Government of Belize along with BNGC Terminal will be able to put in place standards for the loading and discharging of cargo, within the port and throughout the country of Belize.

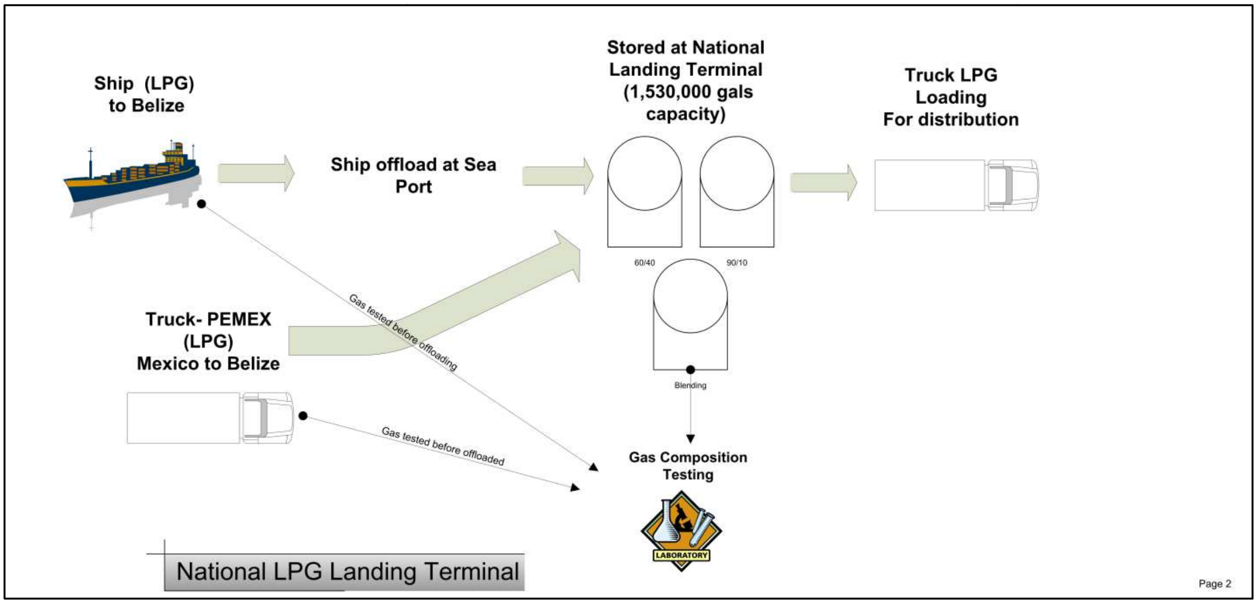


Fig. 18 - BNGC Process/Services Flow Chart

1.6.1 Storage:

Butane and propane will be brought in on the same gas carrier as separate products. Subsequent to the ship docking and all safety and paper works have been completed, pipelines will then connect the ship to the shore-based storage tanks.

Propane and butane are discharged from the ship's tanks, via the cargo piping system to the main ship's manifold usually situated amidship, on either port or starboard side. From there by means of shore-based loading arms propane and butane is transferred to the shore manifold and is then distributed to shore-based storage tanks in the LPG Terminal. The loading arm hose will be flanged air-tight to the ship's manifold so that spills and leaks can be avoided.

These products will then be stored in nineteen (19) storage tanks, each measuring 123 feet 6 inches in length and 10 feet in diameter. These tanks will be set in three main tank batteries of 6 tanks each (as shown below (Figure 19 below). Two tank batteries (or 12 tanks) will be for the storage of propane (brown tanks) and one tank battery (or 6 tanks) will be for the storage of butane (blue tanks). Each thank has a capacity to hold 90,000 gallons of product.

The remaining tank will be for the storage of the blended product of 70% propane and 30% butane (yellow tank) for the general public or whatever blend a specific customer may require. Because of the piping system, one tank from either the butane and/or propane tank battery will be able to be converted to blended product storage tank; should the need ever arise for such (shown as yellow/brown).

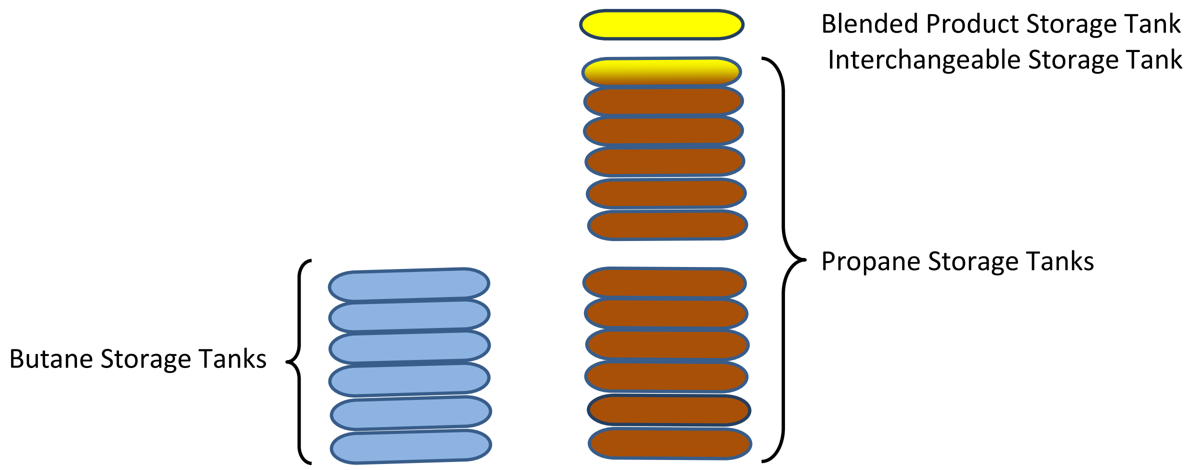


Figure # 19: ***Color Coded Diagram showing Butane (blue), Propane (brown) & Blended Product (yellow) Storage Tanks***

The use of the additional storage tank for blended product may be necessary due to the fact that the demand for blended LPG (propane and butane blends) is always increasing because of the growth in CFC free propellant and liquid gas based fuel production and use.

1.6.2 Blending of Propane and Butane

According to the Bureau of Standards Guidelines of 2012, LPG in Belize should contain 70% propane and 30% butane and thus to achieve such BNGC will put in place a LPG blending facility.

Blending can either be done by batch blending (tank mixing) or in-line blending. BNGC will conduct its blending operation using the tank mixing method. This will entail the following processes:

1. The propane and butane storage tanks will be connected to the blending facility/skid via separate 4 inch schedule 80 black steel pipelines.
2. The blending facility/skid will in turn be connected to the designated blended product storage tank(s) via one of the same type of pipeline.
3. The blending facility will then be calibrated to pump propane and butane simultaneously into the blended product storage tank at a preset ratio of 70% propane and 30% butane. As Butane has lower vapor pressure than propane and LPG has in between vapor pressure; both will be mixed/blended in a proportion so that the mixture will meet the vapor pressure requirement for LPG. To accomplish this, BNGC will use several standards such as the ASTM D 2598 for blending.

4. When the LPG blending process is started the required flow rate and component ratio is set by the control system based on the ratio entered in the recipe. A density analyzer, installed on the system, generates a control signal, which is used to continually optimize the component ratio. This ensures that the blended product is always produced as specified.
5. The blending skid to be used by BNGC is designed to ensure maximum reliability and a minimal pressure drop to avoid any flashing of the propane and butane. These blending skids instantly respond to changes in process conditions or feedstock quality. The feedstock and blended product are continuously measured and adjusted during the batch to ensure optimum quality. Blended LPG products are volume corrected to local standard conditions using API 2540/ IP 200.
6. This blending process will continue until the designated blended storage tank reaches a storage capacity of about 70% to 80%, at which time the blending operation will stop and a sample taken for testing to ensure the blend complies with local standards.
7. Should the blend be in compliance, then the blending operation will continue until the tanks reaches a maximum storage capacity of 85%, after which blending is stopped and final testing done. If the initial testing (when the tank is at 70%-75% capacity) shows that the blend is not compliant with the local standard, then the necessary adjustments and additional testing will be done until the blended product is compliant and the tank reaches 85% storage capacity.
8. After the blending operation is completed the product will then be loaded into the road tankers at the 3-lane loading bay via three skids with loading arms/hoses. During this loading process and before the LPG is pumped into the truck, mercaptan/methanethiol, and odorant, will be systematically injected into the line to ensure that the loaded product can be easily detected by smell should there be any release.

   Figure 20 below shows the six basic steps described above:

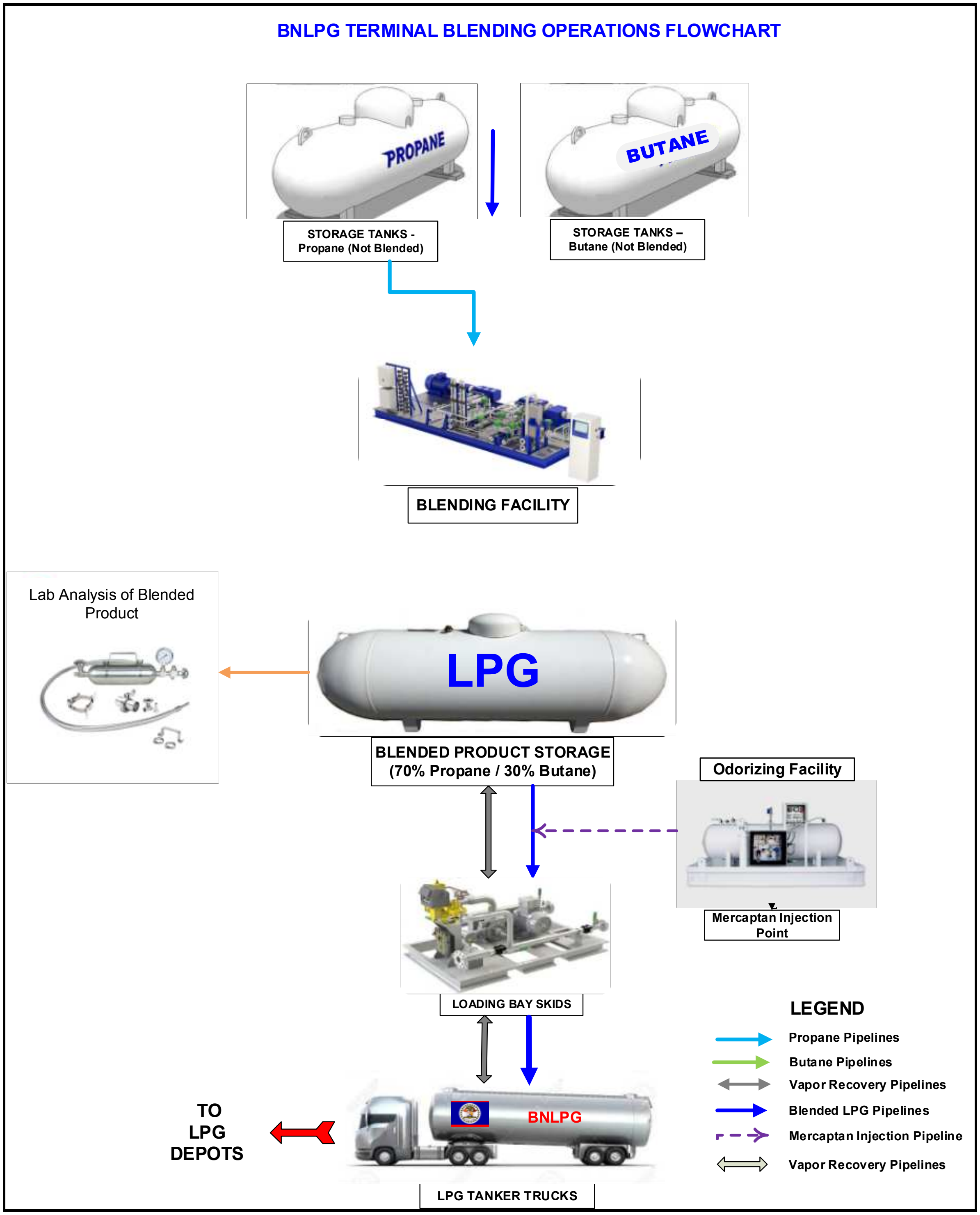


Figure 20: BNGC Blending Operations Flowchart

1.6.3 Blended Product Distribution

Following the blending and the approval of the blend stock, the final product will then be ready for distribution from the terminal to the rest of the country. To achieve this, BNGC will initially commence with four company owned tanker trucks to deliver the said product to two regional depots (other existing tanker trucks will also be loaded at the terminal); one located just on the outskirts of Belmopan, to supply the central and west region of the country (Belize & Cayo Districts); and another situated on the outskirts of Orange Walk Town, to supply the northern region of the country (Orange Walk & Corozal Districts) (see Figure 22). The main terminal will double as the regional terminal to supply the southern part of the country (Stann Creek and Toledo Districts) (See Figure 21 below).

As for the loading of the trucks, the following processes will take place:

1. Upon arrival at the facility, the tanker trucks will wait for security and or personnel for directions when to approach the weigh scale.
2. BNGC personnel will do the necessary paperwork and record name of driver, date, time, truck license plate number, tanker trailer license plate number, and weight of the entire truck and trailer.
3. Subsequent to being processed at the entrance/exit gate, the tanker truck will then proceed, either to an available lane or to a parking area, designated solely for the LPG tanker trucks. As soon as a loading lane frees up, BNGC personnel will signal the truck to approach the loading bay.
4. Once parked under the loading bay canopy area, either the well trained truck driver and or BNGC site personnel will connect the loading arm/hose and the vapor recovery line to the truck and commence the loading process.
5. Upon completion and the loading arm/hose has been depressurized, the truck will be disconnected from the loading system and after completing his walk around, the tanker truck driver will proceed to the weighing scale for final weighing and processing.
6. After all paper works have been completed, the tanker truck drivers then exits the facility and heads towards one of the two regional depots in Belmopan or Orange Walk.

The flow chart below shows the steps described above:

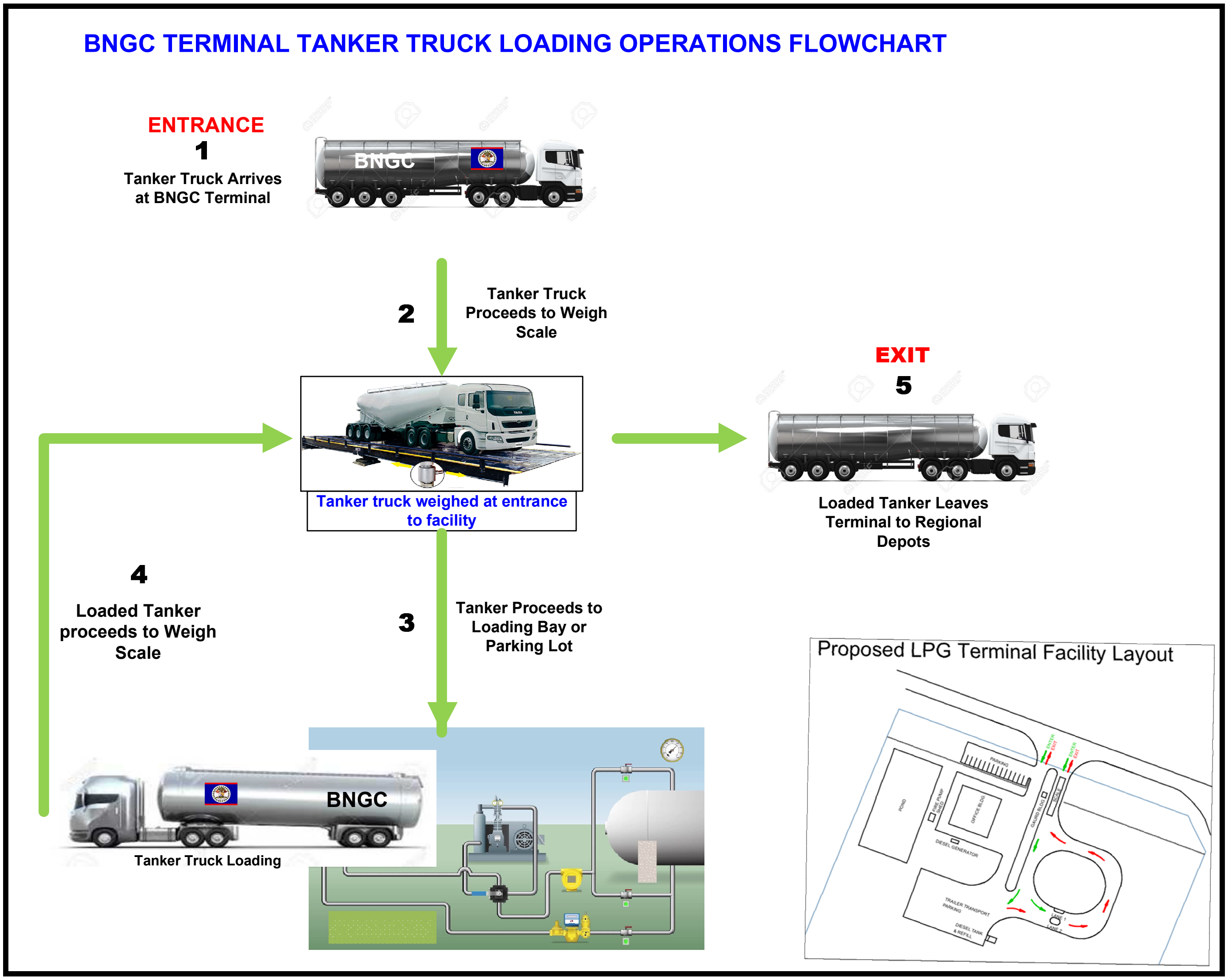


Figure 21: Flowchart of Tanker Truck Loading

As BNGC will be the sole importer of LPG into Belize, it has to ensure that the operations of the Terminal are very much efficient and cost effective. To accomplish this BNGC will also install and operate, to industry standards, two other regional depots as was mentioned above. Each depot will have the capacity to store 60,000 gallons of LPG in two storage tanks of 30,000 gallons each. Clearance for these two facilities is also being sought under this cover.

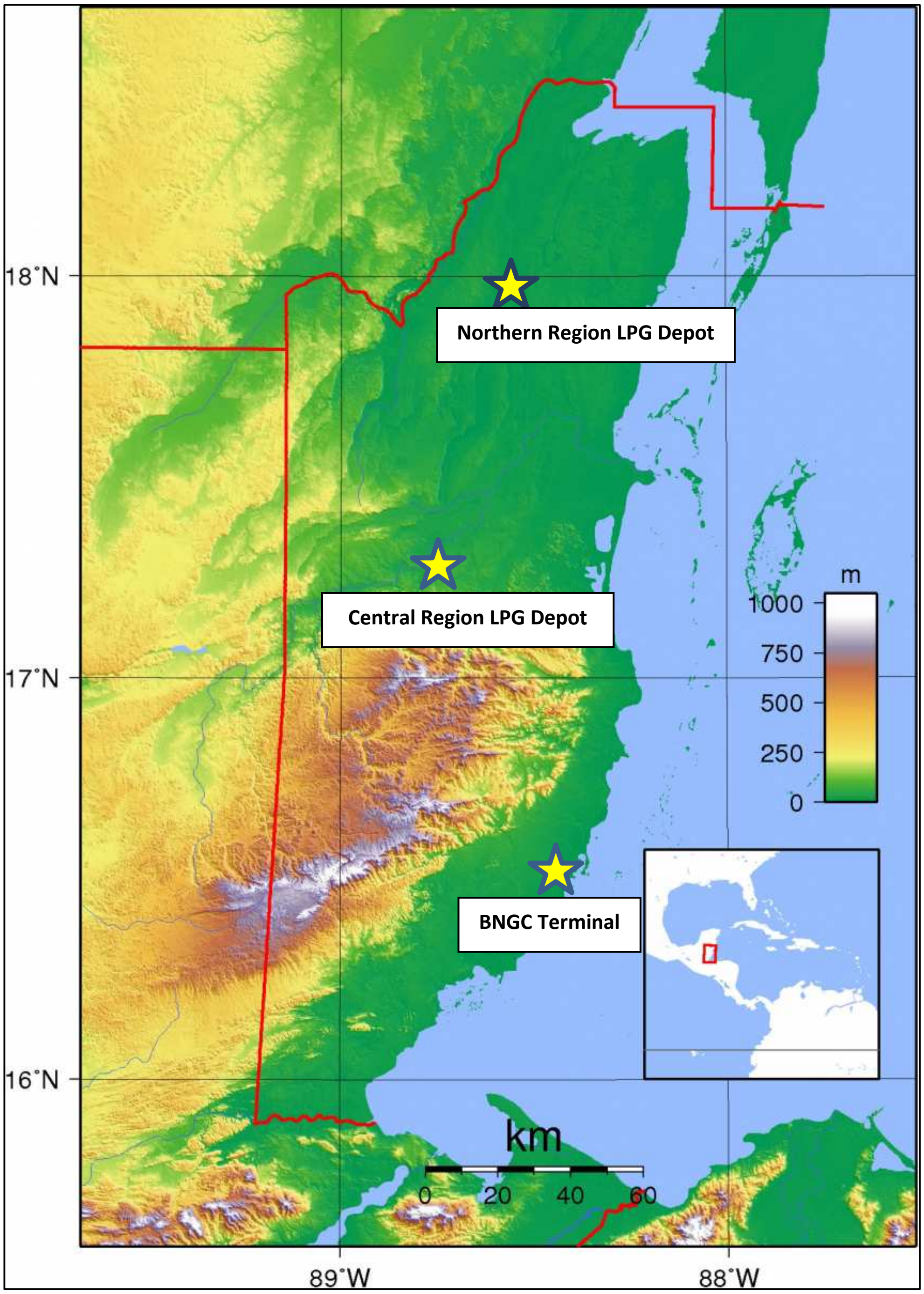


Figure 22: Map showing General location of BNGC Terminal and Depots

The road tanker trucks to be used for the distribution and transportation of the blended LPG product, will all be required to meet both local and some international standards as it relates to road worthiness. All drivers will be trained in LPG handling and transportation and health and safety; and they will be made to understand the operations of the terminal facility and undergo periodic health and drug tests.

Prior to the loading of any tanker truck with LPG, BNGC personnel will inspect the truck for the following:

1. Wheel and Tires (ensure they have enough threading)
2. Steering and Suspension
3. Brakes
4. Seats and Seatbelts
5. Lamps, signals, Reflectors, etc.
6. Windscreen and Windows
7. Windscreen wipers, washers, etc.
8. Body and Chassis
9. Extinguishers
10. Safety Signs/Placards
11. Other items

1.7 Organizational Structure

As mentioned earlier, the BNGC Terminal will be a full service terminal capable of receiving, storing, blending, testing, and dispatching LPG to the Belizean local market. The overall services offered by the terminal are diagramed in Figure 5 and described below:

Receive LPG

The facility will be designed to receive bulk LPG primarily by sea but will also be able to receive LPG by land transportation as well.

Store LPG

The terminal will increase national LPG storage capacity and energy security. The facility will be able to provide up to a six week national supply of LPG at current usage volume.

Blend LPG

The terminal will be designed to maximize LPG blend flexibility, able to receive commercial propane and or butane and then blend to the mix ratio required by law and/or requested by the customer (as long as it meets the minimum requirement required by GOB).

Test LPG

The terminal will be equipped with a state-of-the-art gas blending and testing facility, which the Belize Bureau of Standards (BBS) will have access to.

Distribute LPG Countrywide

The facility will be able load LPG delivery tanker trucks for distribution nationwide. Distributors and truckers who load their trucks at the terminal will have to meet all environment, health and safety requirements to enter and operate at the facility.

To do all of the above, BNGC will need to have trained and experienced personnel on hand to ensure that all operations are conducted effectively and efficiently, but taking into account all the environmental, health and safety concerns with regards to the handling of LPG.

Below are two organizational structures, with respect to how BNGC will be managed and operated. The first organizational flowchart is the NGC Administrative Organizational Structure and the second is the NGC Operations Organizational Structure

1.7.1 BNGC Administrative Organizational Structure

As BNGC will be primarily owned by investors, the major shareholders will form the NGC Board of Directors (of which the Government of Belize will be a member, having a 25% stake ownership); that will be responsible for hiring of the General Manager of the company and assess the overall direction and strategy of the company (see Figure 23 below). The Board if Directors will be responsible for steering the company towards a sustainable future by adopting sound, ethical, and legal governance and financial management policies; as well as making sure the company has adequate resources to advance its mission.

Administratively, next in line is the General Manager (GM), who will be responsible for initially overlooking the hiring of all the other employees and eventually overseeing the day-to-day operation of the company. A major part of the GM's activities involves leading and directing the employees and delegating administrative tasks, such as accounting, paperwork and payroll, while providing the room for employees to take initiatives to address other issues.

Under the General Manager will be an overall and company-wide Accountant, who will be responsible for, among other duties, preparing asset, liability, and capital account entries by compiling and analyzing account information. The Accountant will document financial transactions by entering account information and make recommendations as it pertains to financial actions by analyzing accounting options.

As mentioned earlier BNGC will have three main facilities where it will be conducting business; primarily at the main BNGC Terminal in Big Creek (which will double as the regional depot for the southern portion of the country; and two additional bulk plants/depots that will be servicing the central and northern regions of the country of Belize. Therefore, under the General Manager and the country-wide Accountant, there will be three additional Administrative Clerks (AC), one for BNGC Terminal and one each for the bulk plants. The clerk will provide administrative support on site for the General Manager and address customer queries. The Administrative Clerk will also be responsible for managing office stock, preparing regular reports (e.g. expenses and office budgets) and organizing the site facility records.

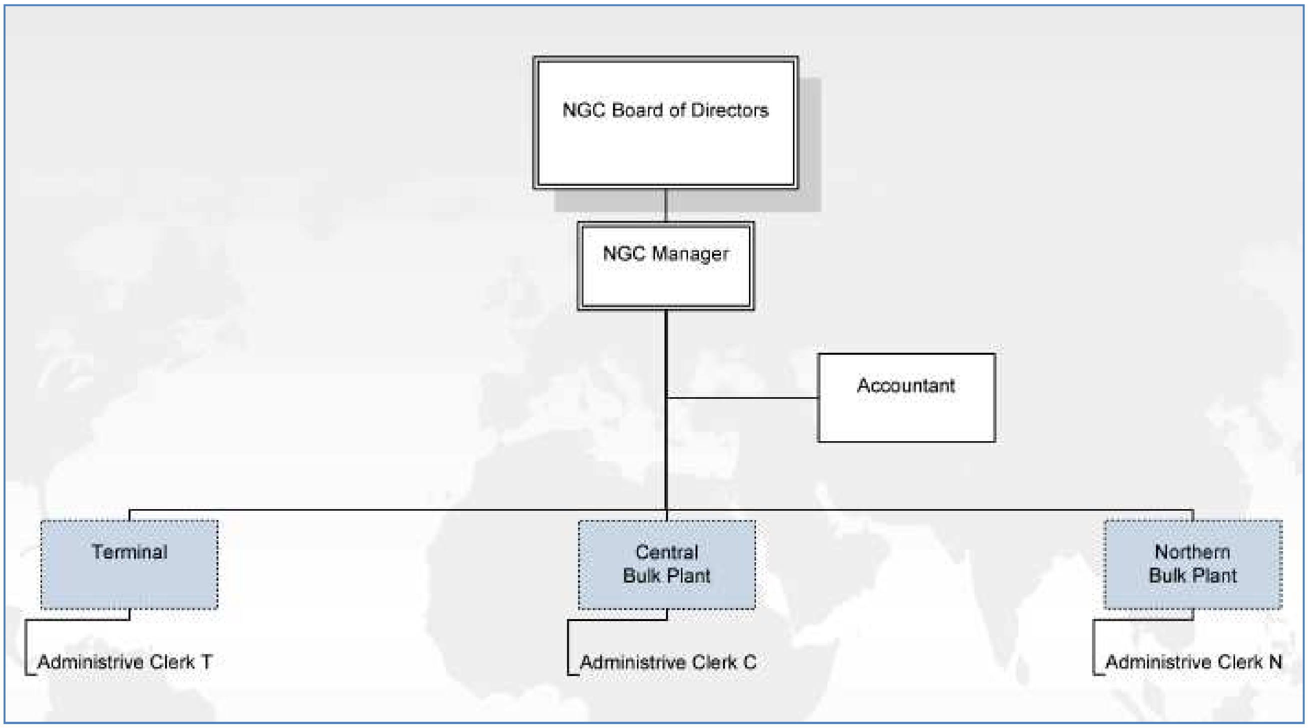


Fig. 23 - NGC Administrative Organizational Structure

1.7.2 BNGC Operations Organizational Structure

Apart from the main BNGC Terminal located within the Port of Big Creek facility compound, BNGC will also be proposing and constructing two bulk plants/depots, but the terminal remains the heart of the entire project. As mentioned above, there will be the need to have in place an administrative structure at the management level, and then another operational structure at the facilities level.

As with any company of that size and magnitude, it is anticipated that at the top of the chart will be a **Chief Executive Officer** who will be responsible to oversee the overall management of the operations. Similar to the duties of the Board of Directors and General Manager's post mentioned above, the CEO will be responsible for the overall management of the operations (administratively) and the overall direction of the company (see Figure 24 below). The CEO will be responsible for directing the operational activities of the company to ensure it is being done in a sustainable manner and formulate policies for distribution and sale of products to wholesale and retail outlets. The CEO will also make sure that the operational aspects of the company have adequate resources to conduct day to day activities in an environmentally friendly and safe manner. The CEO will work closely along with the Board of Directors and the General Manager.

Next in line is the **Terminal and Bulk Plants Manager**, who will be responsible to oversee the day to day overall operations of all three facilities. This person will also be an employee (engineer) of BNE who will be responsible for formulating policies in regard to storage, distribution, and other operating activities. This Manager will assist in determining the type and quantities of products according to consumer demand that may be needed. The Terminal and Bulk Plant Manager will work closely with the Administrative Clerks, as well as with the Operations Supervisors at each facility.

Each facility then will have an **Operations Supervisor** who will always be on site and will manage the daily operations as well as administrate over personnel working on site. The Operations Supervisor at the Terminal will administrate over at least eleven personnel; namely, two Operations Technicians, two Maintenance Technicians, four Transport Drivers, a Mechanic, a Janitor, and a Security Guard.

As the facilities at the two Bulk Plants will be on a much lesser scale, the Operations Supervisor at these locations will each have overall responsibility of the facility and administrate over the Operations Technician. These Operations Supervisors will work very close with the BNGC Terminal & Bulk Plants Manager in ensuring the proper management of the daily operations at all three facilities. They will also assist in scheduling shipment of products, and establish operating procedures for all operational activities.

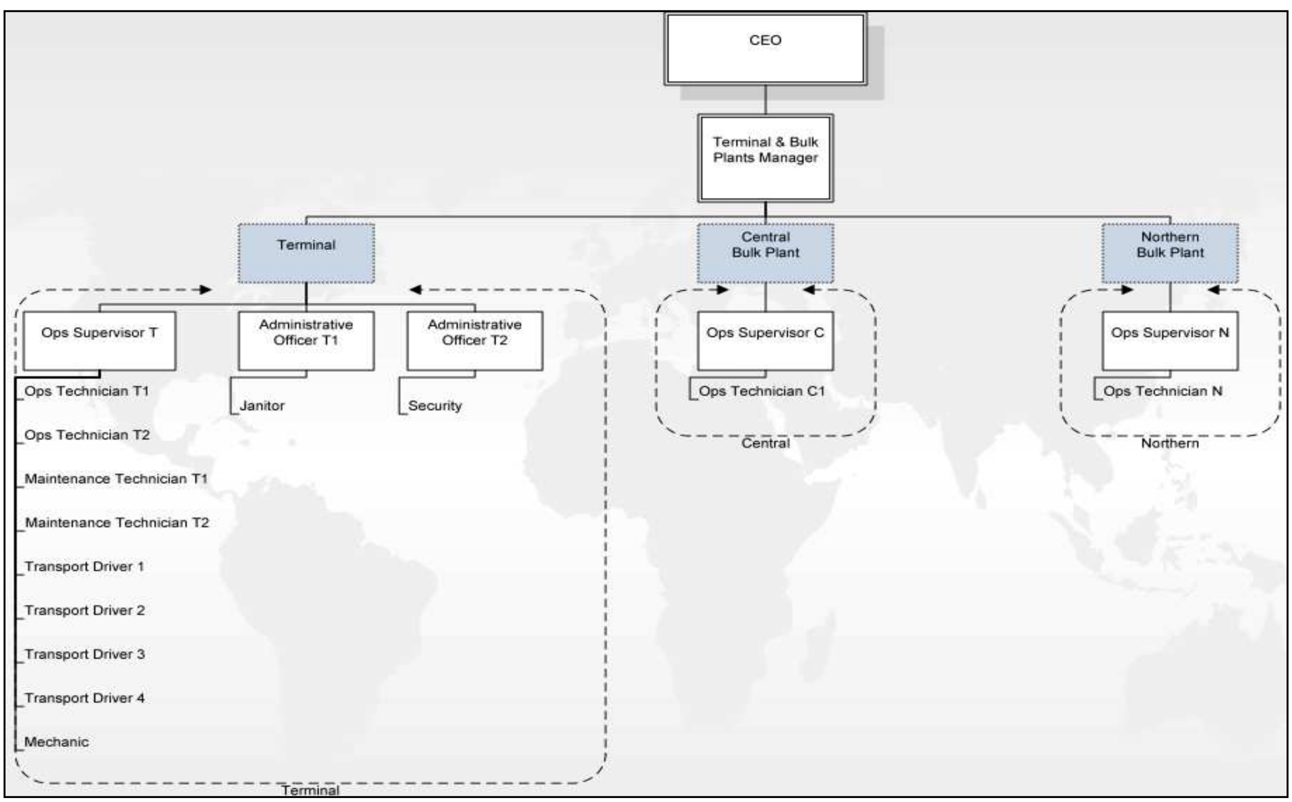


Fig. 24 - NGC Operations Organizational Structure

1.7.3 Regional Depots Organizational Structure

As can be seen from Figure 24 above, both the Central and Northern Regional Depots will, similar to the Terminal, be managed by an Operations Supervisor who will be aided by the Operations Technician. As the operations will be relatively much less when compared to the Terminal, BNGC is of the opinion that the two personnel on site should be sufficient to effectively and efficiently operate the facility.

The Operations Supervisor will have similar duties as that of the Terminal Supervisor (oversee maintenance, place orders, oversee refilling operations, loading operations, etc.) and will be responsible to ensure that the facility is always in good repair.

1.8 Liquefied Petroleum Gas (LPG) Safety

1.8.1 Properties of LPG

Liquefied petroleum gas or liquid petroleum gas (LPG or LP gas), also referred to as simply propane or butane, are flammable mixtures of hydrocarbon gases used as fuel. Its applications and uses range from cooking and refrigeration to transportation, heating, and power generation, making it an all-purpose, portable and efficient energy source.

LPG is colorless and odorless; therefore an odorant (eg. Mercaptan) is normally added to it making it possible for humans to detect leaks. LPG consists of light hydrocarbons (propane, butane, propylene, or a mixture) with a vapor pressure of more than 40 psi at 100ºF. At standard temperature and pressure, LPG is a gas. It is liquefied by moderate changes in pressure (i.e., in a process vessel) or by a drop in temperature below its atmospheric boiling point. The unique properties of LPG allow it to be stored or transported in a liquid form and used in a vapor form.

Apart from being very portable and convenient to use; LPG has significant health, safety and environmental benefits compared to traditional fuels i.e. wood, kerosene, coal and charcoal. Although burning LPG releases carbon dioxide, a greenhouse gas and some carbon monoxide, it does, however, release less CO^2 per unit of energy than does coal or oil. It emits 81% of the CO^2 per kWh produced by oil, 70% of that of coal, and less than 50% of that emitted by coal-generated electricity distributed via the grid. Being a mix of propane and butane, LPG emits less carbon per joule than butane but more carbon per joule than pure propane. Overall, LPG burns more cleanly than higher molecular weight hydrocarbons because it releases less particulates. It is possibly the cleanest and most efficient fuel available today. Other characteristics of LPG include:

- LPG exerts a cooling effect as a result of vaporization resulting from releases at low pressure (also called auto-refrigeration).
- The density of LPG is almost half that of water; therefore, water will settle to the bottom in LPG.
- Very small quantities of liquid will yield large quantities of vapor.
- When vaporized, LPG leaves no residue.
- When LPG evaporates, the auto-refrigeration effect condenses the surrounding air, causing ice to form. This is usually a good indication of a leak.
- LPG is odorless; agents such as ethyl mercaptan are added to commercial grades in most countries for better detection.

1.8.2 LPG Safety

As mentioned above, Liquid Petroleum Gas is a highly flammable gas that will burn and may even explode when ignited; but when the risks are properly identified and managed, LPG can be safely used as a fuel source for many applications. It is paramount then that anyone or company, using and or handling LPG, must be cognizant of its properties in order to have a safe operation.

Controlling exposures to occupational hazards is the fundamental method of protecting both the environment and humans. Traditionally, a hierarchy of controls (Figure 25 below) has been used as a means of determining how to implement feasible and effective hazard control solutions in the workplace, as with respect to exposure by humans; but the same method can be applied to any project to make it a safe and environmentally sustainable one.

One representation of this hierarchy is as follows:

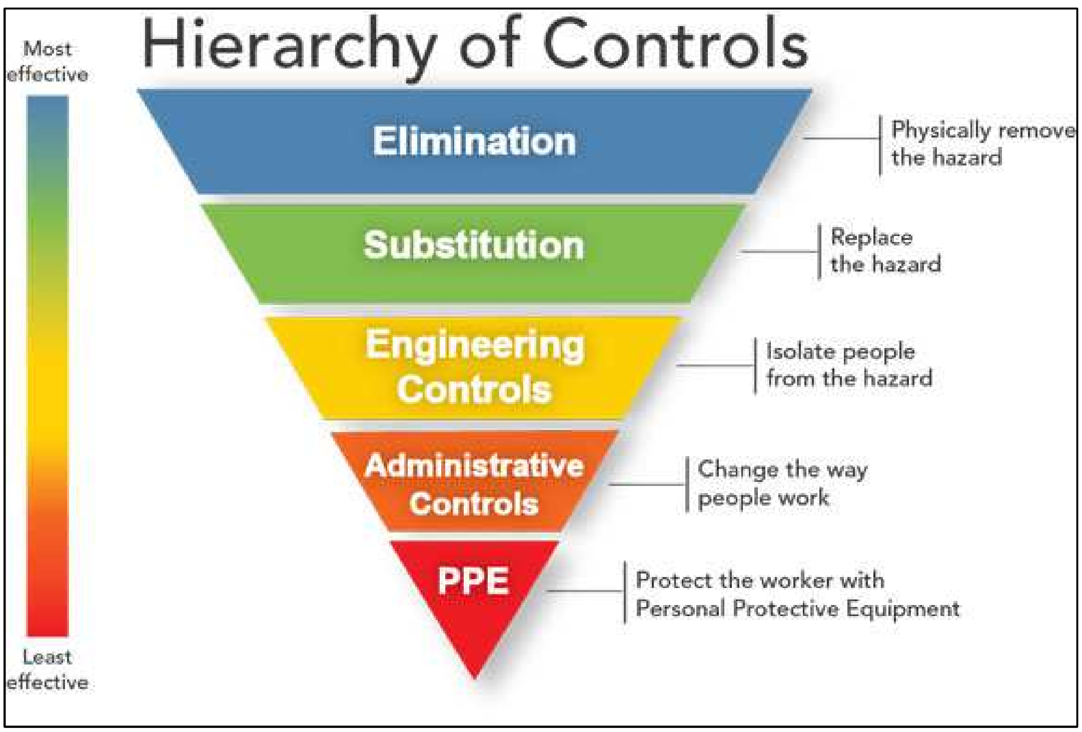


Figure 25: Diagram of Hierarchy of Hazard Controls

The above figure depicts the idea of ***Prevention through Design*** **(PtD)**, in that the control methods at the top of graphic are potentially more effective, preventive and protective than those at the bottom. Anyone following this hierarchy normally implements an inherently safer operation, where the risk of illness or injury and or environmental pollution has been eliminated and or substantially reduced to “**As Low As Reasonably Possible (ALARP)”**.

Based on the above, the following are some of the steps and safety mechanisms that BNGC will take to ensure that its operations are conducted in the safest and environmentally friendly manner.

1.8.2.1 Elimination and Substitution

Elimination and substitution, while most effective at reducing hazards, also tend to be the most difficult to implement in an existing process and in some cases in new operations as well. Even though BNGC is still at the design or developmental stage, and because of the known properties of the materials that BNGC will be handling (propane & butane); the elimination and substitution of hazards may be relatively impossible and thus will have to rely more so on the other forms of controls to eliminate and or reduce the hazards to “As Low As Reasonably Possible (ALARP)”.

It must be noted and as has been stated before, as with any type of fuel; there will always be a risk of leaks, spills, fire, and explosion that could result in injuries, fatalities and or environmental pollution. As it pertains to leaks, spills fire and explosion, LPG can be and has been in use for decades and some of the best safety mechanisms have been developed over time to allow LPG to be safely handled with very little exposure and or risks.

As it pertains to the environment, LPG is considered one of the cleanest sources of fuel in the modern era; it is cleaner than the diesel and gasoline presently used in Belize; two fuels that not only burn less cleaner than LPG and cost more, but they also cause greater environmental pollution when there’s a leak and spills occur.

Therefore and in light of the above, the use and substitution of LPG as a main source of fuel in Belize does eliminate some of the environmental hazards one might have when using conventional fuel such as lubricants, diesel and gasoline.

Also, as it pertains to the detection of leaks and compromised pipelines or valves, BNGC will at the onset conduct a review of leak detection systems, pipelines and valves; and utilize the very best of these monitoring devices; as recommended by BNGC’s certified contractor Polaris Limited. In doing this, BNGC will from the very onset eliminate any equipment and or material that may later on create situations that can pose a danger to both humans and the environment.

1.8.2.2 Engineering Controls

In a case like the one BNGC is in, Engineering Controls is the much favored type of control over Administrative Controls and the use Personal Protective Equipment (PPE) because they are designed to remove the hazard at the source, before it comes in contact with the worker and the environment. BNGC is cognizant that well-designed engineering controls can be highly effective in protecting the workers, environment and surroundings; and will typically be independent of human interactions thus providing a high level of protection. Although the initial cost of engineering controls is higher than the cost of administrative controls or PPE, BNGC realizes that over the longer term, operating costs are frequently lower, and in some instances, can provide a cost savings in other areas of the process.

The following are some of the Engineering Controls that BNGC will be putting in place to detect leaks and compromised pipelines and valves.

1.8.2.2.1 Leak Detection Systems:

BNGC will install two types of leak detection systems throughout the entire operation and especially along the pipelines.   These too types are as follows:

Pressure Gauges:

There will be pressure gauges (both digital and analogue) installed throughout the pipeline system and tank farm area, where any drop in pipeline and or tank pressure that could signify a leak (release) or malfunction and will be quickly detected and addressed *(see Figure 26 & 27 below)*.

Figure 26 & 27: Examples of Different Types of Digital and Analogue Gauges

During the transfer of product from the ship to shore storage tanks, the Gas Carrier will also be utilizing its own monitoring system to measure the pressure in the transfer pipelines. These pressure gauges can be made to be binary gauges in that should there be a drop in pressure (at a calibrated quantity), the gauges would trigger an automatic Emergency Shutdown Button (ESB) that would shut down the process until the cause of the drop in pressure can be determined.

Hydrocarbon/Gas Leak Detectors

Apart from having pressure gauges to detect a leak via a drop in pressure, BNGC will also have Hydrocarbon Leak Detection Sensors put in place at strategic throughout the entire operation area. This system can either be wired and or wireless (see Figure 28 below).

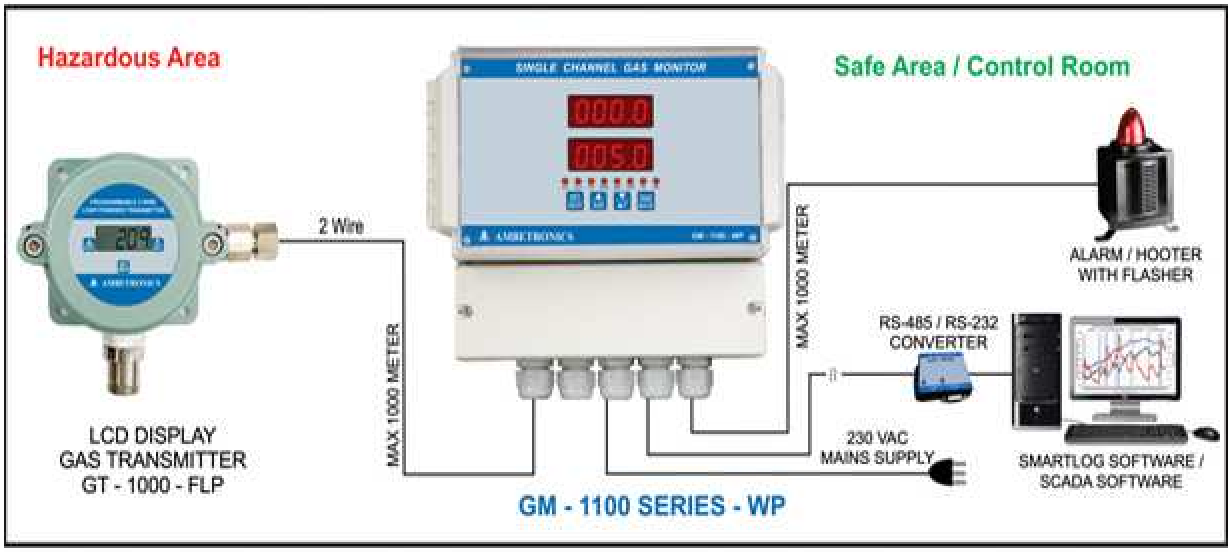


Figure 28: Example of a Schematic of a Gas Leak Detection System

Similar to the pressure gauge system, the Hydrocarbon Leak Detection system will be able to detect any gas leak and transmit a signal to a Control Room and or trigger an automatic Emergency Shutdown Button (ESB), stopping the flow of LPG gas.

Monitoring Cameras

Similar to the present monitoring system in place at BNE's facilities, and as a back-up to the pressure gauges and leak detectors mentioned above, BNGC will also have in place numerous cameras that will be monitored by trained personnel. Cameras will be constantly reviewed to see if any visible leaks can be detected on screen (see Figure 29 below).

Figure 29: Example of Monitoring Camera

BNGC will consider obtaining the cameras that have special sensors that can detect unauthorized movements and trigger an alarm system. This is excellent for security purposes but may be applicable should there be any substantial leak, it will easily be detected as movement by the camera and will signal the Control Room Operator that some abnormality has been detected. The Control Room Operator can then take the appropriate steps to address the situation.

Control Room – Remote Monitoring

BNGC will install a Control Room (similar to that of BNE) within the same administrative building that will be manned by at least one Operator on site. All digital pressure gauges, Hydrocarbon Leak Detection System and cameras will be connected to the Control Room, where should any alarm be activated, the Control Room personnel can either request for actions to be taken, and or immediately shutdown pumps, close valves, etc. to prevent a major incident from occurring (See Figure 30 Below).

Figure 30: Example of a Control Room with Monitoring Displays

Physical Inspections

BNGC will also have on the ground personnel throughout its operations and especially when transfers, blending or loading operations are being conducted. The technicians at each facility, but especially at the Terminal, will conduct routine inspections of the pipelines and tanks and the monitoring systems (gauges, cameras, Detectors, etc.). Personnel will also be equipped with both personal gas meters and gas leak detectors equipment whilst doing routine inspection of the facilities (See Figure 31 & 32 below).

Figure 31: Physical inspection of LPG Tanks and Aboveground Piping

Figure 32: Example of a Gas Leak Detector

1.8.2.2.2 Pipeline Leak Detection System

Firstly, and in accordance with the DOE's Environmental Guidelines for LPG Depots and the U.S. Department of Transportation (DOT) Pipeline and Hazardous Materials Safety Administration (PHMSA), the pipelines will be designed per 49 CFR Part 195 for hazardous liquid pipelines and Part 192 for gas pipelines. The design requirements of these codes address such issues as:

vii. the required strength of the pipe;
viii. the design of components that are attached to the pipe;
ix. the special requirements that specifically address construction issues such as how the welding is performed and the qualifications of the welder;
x. the limitations on pipe bending;
xi. the installation of pipelines in trenches; and
xii. the required depth of burial.

As most of the pipeline leading from the ship docking area to the storage tank farm area will be underground, and cognizant of the environment that the pipelines will be installed; BNGC will from the very onset procure the best quality and most durable pipelines that will work best in such environment. BNGC will utilize the Schedule 80 Black Steele Pipeline and will install the said pipelines according to both local and International standards. Apart from all the monitoring mentioned above, BNGC will conduct periodic are as follows:

Pipeline Inspections

Because most of the pipelines, especially those leading from the berthing area to the storage tank terminal, will be below-ground, BNGC will comply with the US Department of Transport International Standards and have the underground pipelines regularly inspected for corrosion and or damage, with the use of a pigging system .

Pigging, as it pertains to pipelines, refers to the practice of using devices known as "pigs" to perform various maintenance operations such as cleaning and inspecting the pipeline for corrosion and or damages from the inside (see Figure 33 & 34 below). These devices contain electronic and magnetic sensors to check the interior condition of pipe walls. If they detect any cracks, or other problems, that section of the pipeline can be easily identified, dug up and either repaired or replaced.

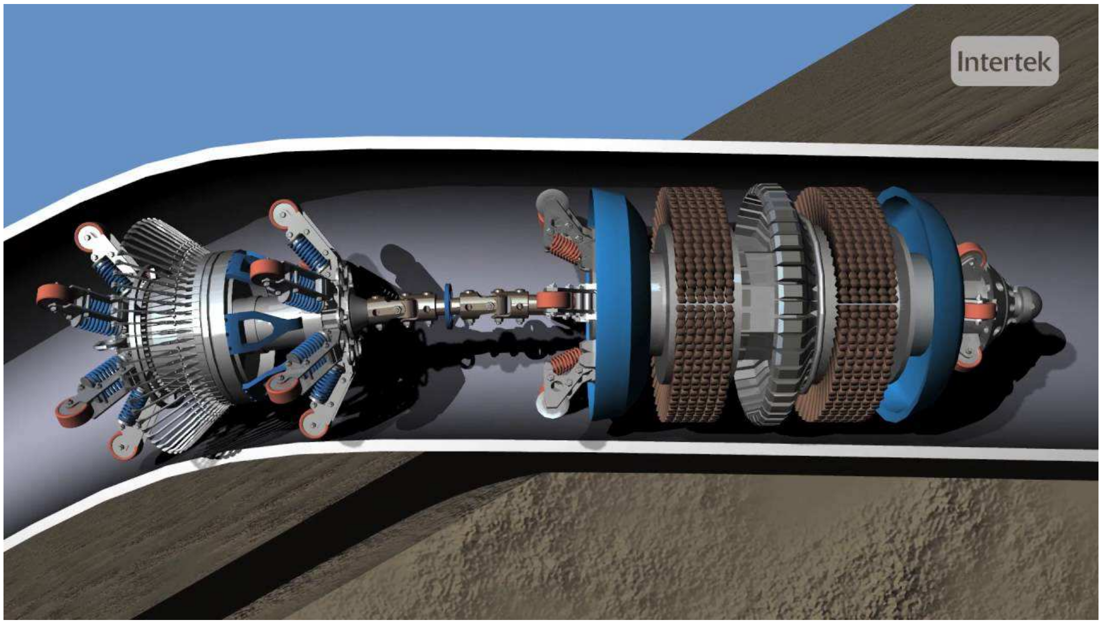


Figure 33: Example of a Pigging Device used to inspect underground pipelines

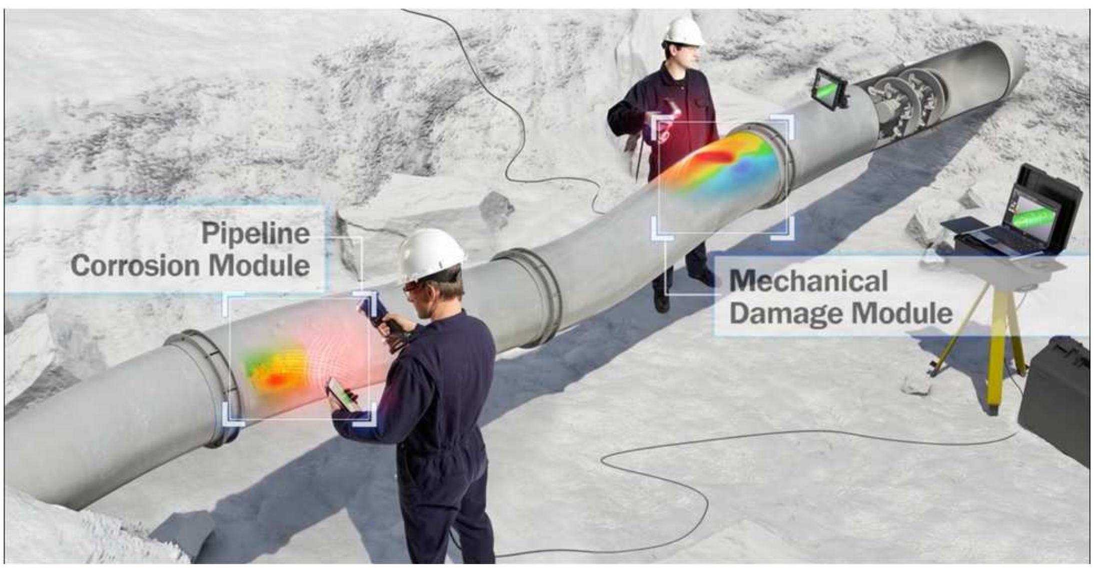


Figure 34: Pigging Device are capable of showing corrosion or mechanical damage to pipelines

In case of a pipeline or valve becoming damaged and or springs a leak, such integrity failure should be caught either by the pressure monitoring system, the Hydrocarbon Leak Detection system and or by physical inspection (pigging or otherwise).

1.8.7 Regional Depots and Safety

Although the operations at the regional Depots are going to be relatively much less than those at the main Terminal, BNGC will still implement its operations in the safest way possible and reducing all hazards and risks to "As Low As Reasonably Possible" (ALARP).

Firstly, all storage tanks, hoses and pipelines on the facility will be pressure rated for the mixed LPG product being stored/handled on site. Pipelines will be similar to that of the Terminal and will be Schedule 80 black steel pipe that will be regularly and thoroughly inspected for damage, corrosion and leaks.

BNGC will also develop an inspection program for each Depot, which will include pipelines, hoses, valves, gauges, tanks, etc. If found to be necessary, the pipelines will either be placed in cemented troughs and or also be wrapped with densyl tape (tape with tar-like or waterproof substance).

1.9 Prevailing Wind Conditions at BNGC Terminal

Wind direction in Belize depends on location and time of the year. Located less than one mile from the coastline of Belize and about 500 m from the nearest water way; it is anticipated that the prevailing wind conditions will be primarily from the east and or southeast direction due to the prevailing trade winds coming in from the east or southeast (see Figure 35 below). In some instances and during very rarely does the wind blow north and or east, except during cold fronts and hurricanes.

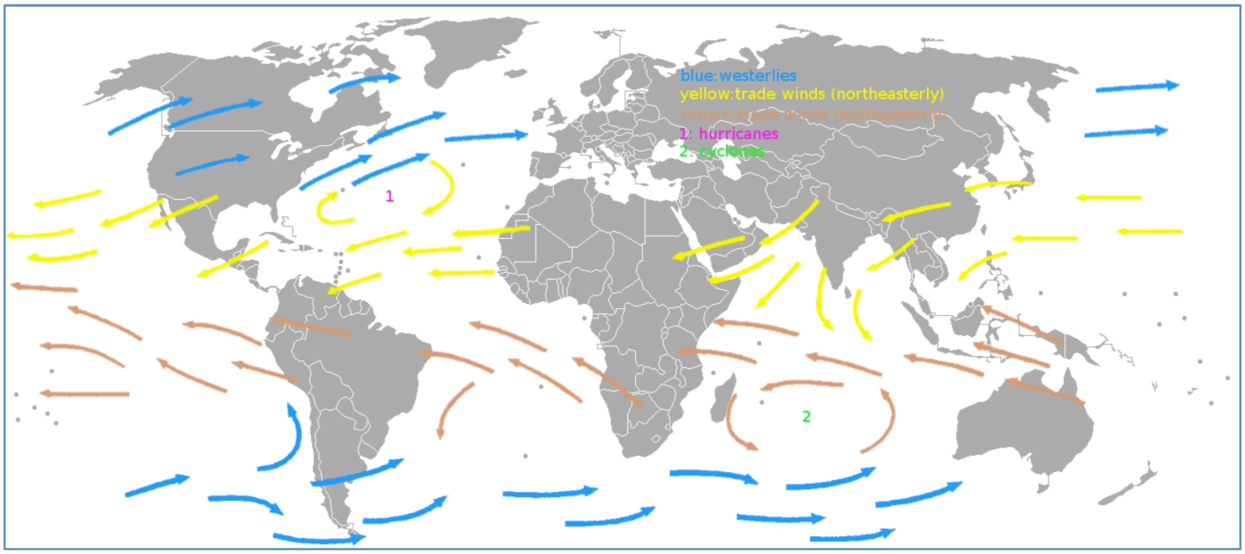


Figure 35: Diagram of Predominant Trade Winds over Belize

Although the most reliable and only wind data in Belize is documented at the Philip Goldson International Airport (PSWGIA), it is located some 120 km north of the Project Area. The prevailing frequency of wind direction at the PSWGIA is from the east south east (20%), east (16%), south southeast (9%) and east northeast (7%) while calm winds are experienced during 18% of the year. The range of wind speeds for these frequencies are 1(0.50 m/s) to 10 knots (5 m/s). Wind speeds up to 20 knots (10 m/s) were recorded for all annual frequencies that are presented. The annual mean wind speed is 5 knots (2.6 m/s).

From the historical data obtained from the Belize Meteorological Department Phillip Goldson International Airport weather station for the past 30 years, shown in Table 5 below, it can be seen that wind direction is predominantly from the south-east or east. For seven (7) months (February, March, April, May, June, September, and October) out of the year the wind blows from a south-easterly direction; whilst for four months (January, July, August & December) it blows from the east; and in November it blows from the north.

Table 5: Monthly Wind Speed/Direction for the last 30 years (PGIA)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years
Monthly WNDSPD (kts)	4	5	6	6	6	6	6	5	4	4	4	4	5	30
Monthly WNDDIR	E	SE	SE	SE	SE	SE	E	E	SE	SE	N	E	SE	30

Source of the above data: *Historical and current records at the National Meteorological Service located at Philip S.W. Golson International Airport in Ladyville, Belize District. Latitude 17° 32 N, Longitude 088° 18 W elevation of 5 meters*

In terms of the location of the BNGC Terminal, should there be a release from the terminal, the wind direction would most likely be blowing in a westerly or more so in a northwesterly direction. This would take any plumes of released gas away from the port where the majority of businesses and buildings housing company offices or residential areas within the Port of Big Creek property, lies towards the east or south-east of the terminal (see Figure 36 below).

Figure 36: BNGC Terminal in relation to prevailing wind direction & residential areas to the west and south west.

Presently, there are two residential buildings due west of the Terminal, with the closest one being approximately one kilometer away. Should the wind direction be blowing to the north-west, the plume would then be headed towards the mostly undeveloped western outskirts of Independence Village which is a little over two kilometers NW of the terminal.

Although LPG is one-and-a-half (1.5) times heavier that air, once released in the open environment it will readily disperse and expand to approximately 270 times its original volume. It will tend to dissipate in all directions but mostly upwards and will move in the general direction of the prevailing wind. LPG tends to accumulate and sink into low lying areas when there is little wind and especially if it is in an enclosed or confined area. This is when it poses the biggest threat of causing an explosion, as it is able to create an atmosphere that has the ideal range (approximately 2.0% to 10% LPG/air) for it to be ignited.

As mentioned earlier, the nearest residence west of the facility is approximately 1 kilometer (1,000m) away. There are large open spaces with low lying and sparse vegetation in between the terminal and the said residential homes, which would provide more than enough open space for the gas to dissipate completely or remain well outside the explosive range (See Figure 37 below). As the western portion of the village is two km away, it is anticipated that even a major release from the plant would not cause any negative impact on those areas.

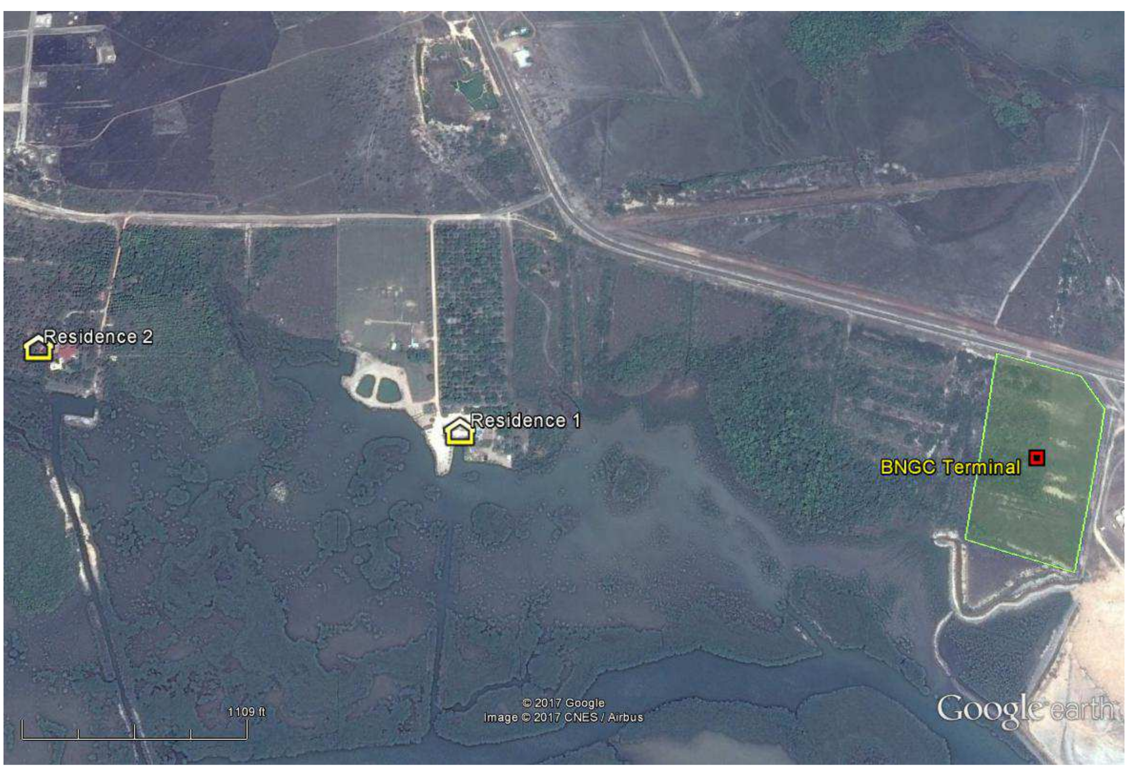


Figure 37: Map showing Residences in relation to BNGC Terminal

In case of any emergency, though, where there is a massive leak, although it is expected that the predominant wind would take any leaked gas west and or northwest of the port, most of the offices within the Port's compound would fall within the 800m evacuation criteria and would therefore still need to evacuate. All residences to the west and within the western end of the village would also be alerted in case of an accidental release.

1.9.1 Wind Direction - Regional Depots

General

As the wind direction recorded at the Phillip Goldson International Airport (PGIA) is considered the standard for the entire country, it is anticipated that the wind Direction at the Central and Northern Region Depots will for the most part be similar to that recorded at the PGIA.

Prevalent wind direction in Belmopan and Orange Walk Town, will then be from the South-east and east for most of the year with some slight changes in direction in November when the "norths" or "cold fronts" come in and wind direction is then prevalent from the north.

1.9.1.1 Central Region Depot

In the case of the Central Region Depot near Belmopan a westerly or south-easterly wind means that in the event of a major gas escape the predominant winds would take the gas in a westerly to north-westerly direction. This would be in an area that is still very much uninhabited and undeveloped, although in recent years a few more residents have moved into the area (see Figure 37A below). The only major concern in a large gas release would be the Hummingbird Highway, where traffic would need to be stopped until the situation has been brought under control.

1.9.1.2 Northern Region Depot

In the case of the Northern Region Depot, just on the outskirts of Orange Town the predominant wind would take any released gas in the same direction as the other two facilities. In this case though, there would be much less impact or disturbance to humans as the area west and north-west of the Northern Region Depot, except for a couple of subsistence farms located some 1.5 km away, is very much uninhabited (see Figure 37B below). In the case of such a release from the depot, the feeder road bordering the site would have to be temporarily closed until the situation has been brought under control and the gas is no longer a threat.

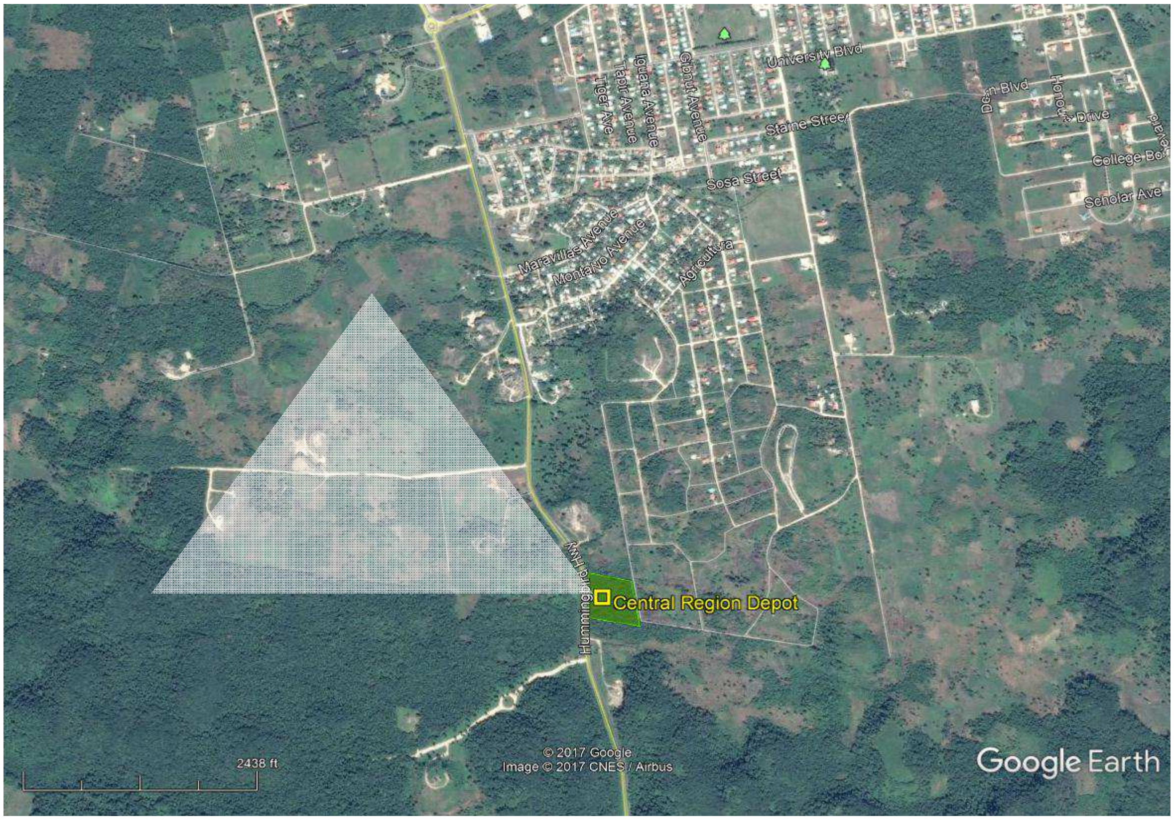


Figure 37A: Area predominant winds would carry released LPG - Central Region Depot.

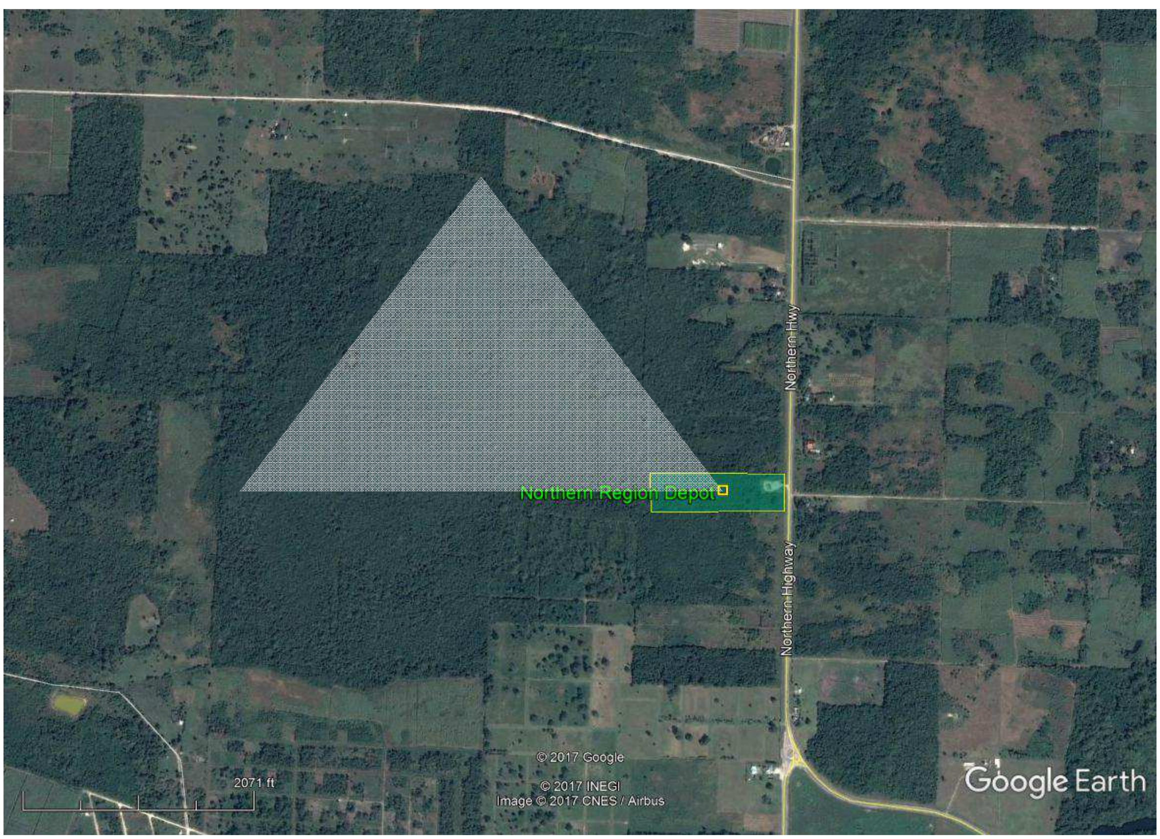


Figure 37B: Area predominant winds would carry released LPG – Northern Region Depot.

2.0 THE PHYSICAL and SOCIAL ENVIRONMENT

2.1 Physical Environment

At the conception of the BNGC Terminal, engineers were looking for an area that would not only be the safest possible are to place the terminal, but also one that would have the least environmental impact. At first an area west of the present BNE Crude Oil Storage facility was looked at, since it had recently been cleared of all vegetation, but had only recently been land filled with dredged material as well. This could pose some future settling issues with the base of the tanks and buried pipelines shifting. Thus the area just south of the Port of Big Creek Road was chosen as it had little vegetation and the ground is settled and solid.

Presently, this 15 acre plot of land has some sparse vegetation covering approximately 40% of the proposed BNGC Terminal area. The majority of the vegetation within this area (40%) are mango, black berry, trumpet trees and coco-plum trees *(see Photograph 22 and 23 below),* which have a lot of open spaces in between them. At the rear of the property are a few very small patches of red mangroves, which would presently fall within the setback distance that is required by the DOE and NFPA along the boundary line of such a facility; and would more than likely not be disturbed. Also, some patches of palmettos and elephant grass can be found throughout the sparsely vegetated area.

Photograph 22 – Mango, black berry and coco-plum trees on portion of proposed BNGCT site

Photo 23– Sparse vegetation covering about40% of the proposed site

Noteworthy is the fact that about 60% of the proposed site is open grassland, with majority of the proposed facilities falling within this area. A small portion of the open area is being used as a scrap metal storage site which will be relocated *(see Photographs 24, 25 and 26 below)*.

Photo 24 – Grassland area on proposed BNGCT Terminal area

Photo 25 – Approximately 60% of proposed BNGC Terminal site is grass/open land.

Photo# 26: Scrap metal being stored on small portion of proposed BNGC Terminal site

Overall, from an ecological point of view, the area has been greatly disturbed with less than half of the project site having vegetation cover and even within the vegetated area, there can be found a considerable amount of garbage, old household equipment and old machinery strewn in between.

As mentioned before, the site is located within the Port of Big Creek compound which is about 1 mile south-east of Independence Village. The village is the most populated area closest to the site with a population of 4,014 (2010 Census) and if the growth trend has continued, it is expected to have an estimated population close to 6,000 inhabitants today (SIB). As for the Port of Big Creek, on any given workday (weekday) there may be a workforce of about 150 people and considerably less over the weekends as most businesses that operate within the port are closed on Saturdays and Sundays

Photograph 27: BNGC Terminal with Surrounding Open Areas

As can be seen from aerial photograph #27 above and Figure 38 below, apart from the operations of the businesses within the Port of Big Creek facility, there is basically no development for more than half-a-mile and only two households within a one mile radius. This again makes the selected area a very optimum site for the establishment of the terminal.

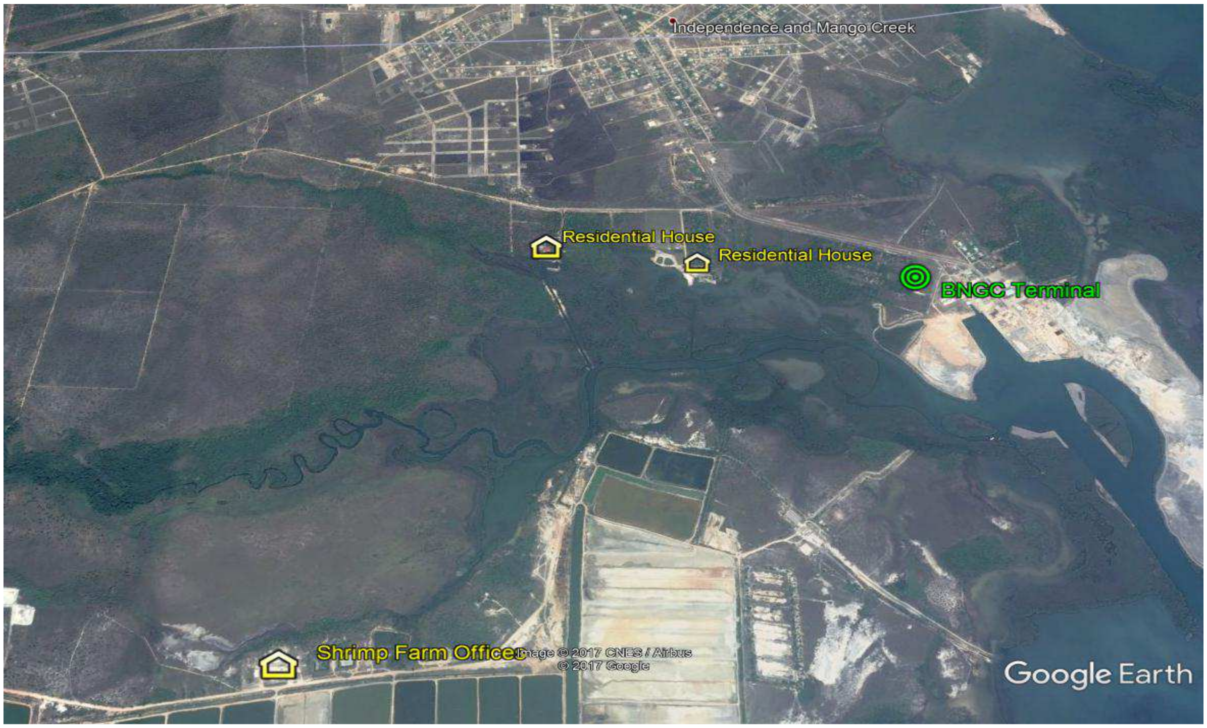


Figure 38: Map showing very little to no development near proposed BNGC Terminal

Overall, apart from the very few red and black mangrove trees (that will mostly remain untouched and intact), no species of plant on the proposed site falls under any CITES restriction or under any other conservation restrictions.

Regional Depots – Physical Environment

Central Region Depot

The Central Region Depot site, similar to most of its adjacent properties, have been largely cleared and devoid of trees except for a few trees, most of which are cohune trees remaining near the southern corner of the property (see Photograph 27A below). None of the few remaining trees on the site are of economic importance and are not listed on the CITIES endangered species list. During the assessment of the site, the vegetation found on the proposed site, was similar to that of the adjacent sites.

The site itself is somewhat part of a rolling terrain with the southwest area being a bit lower that the northeast portion of the site. From the highest point to its lowest point, the site has a 2% to 5% slope. To the far south eastern corner is a four-foot drop where some karst limestone rocks becomes exposed and form a small ridge within the property.

Photograph 27A: Cleared site for Central Region Depot

Northern Region Depot

The proposed location for the Northern Region Depot is located on the western side adjacent to the Phillip Goldson Highway just north of Orange Walk Town. The site itself has a 0% to 2% slope and is relatively flat like the terrain around it. Much of the area has been disturbed and is presently covered with some grass, a few fruit trees and some secondary growth forest comprised mostly of trees of non-economic importance (see Photograph 27B below). An area just over one acre has been completely cleared and backfilled and is presently being used as a LPG depot for Belize Western Energy Limited (BWEL).

Some of the vegetation found on site apart from some grassy open areas are Bayleaf Palm, Madre de Cacao, Bay Cedar Tree, Blackberry Tree, Trumpet Tree, Indian Plum Tree, Warree Cohune, Bullet Tree, Calabash Tree and a host of shrubs etc.

Photograph 27B – Orange Walk LPG Depot Site

Photograph 27C – Orange Walk LPG Depot Site - Aerial

2.1. 2 Zone of Influence

As mentioned above, the establishment of the BNGC Terminal will have various impacts on the project site (environment), the nearby communities (Independence and Mango Creek Villages and the Port) and the overall economy of Belize. Environmentally speaking, the terminal can have a small zone of influence if constructed and operated under strict guidelines/standards; or it could have a large zone of influence should there be a major accidental release and or explosion.

As with any activity involving the handling of LPG, one of the greatest risk is that of a major release leading to an explosion. BNGC, although being in a semi remote area, is cognizant that should an explosion occur, it could have some negative impacts not only to its own facility but to other buildings and operations within the Port of Big Creek Facility.

Calculating the "Zone of Influence" from an accidental release involving LPG (propane and butane) greatly depends on various factors such as, composition of LPG, quantity released, weather conditions (temperature, wind direction, etc.), actual quantity of gas involved in the release and or the explosion and size/shape of storage container; among other elements. Also, each situation will differ from one another and thus the actual area of influence cannot be determined for certain, but only estimated.

Table 6 below shows the percentage of the actual causes of BLEVE's over the years:

Cause	%
Fire	26
Derailing	20
Overfilling	18
Runaway reaction	12
Collision	10
Overpressure	6
Other	8

Table 6: Predominant Causes of BLEVEs

As can be seen, fire and overfilling are the two highest types of accidents that would be of concern here in Belize. Therefore with the implementation of the project following both local and international standards; as well as the installation of safety devices, these two risks can be greatly reduced. Figure 39 (right) shows the most common causes as it relates to LPG accidents. As can be seen, the various types of accidents (Structural Failure, Truck accidents, Filling Operations, Heat Radiation, Catastrophic, etc.) all have various identified causes as to why they occur.

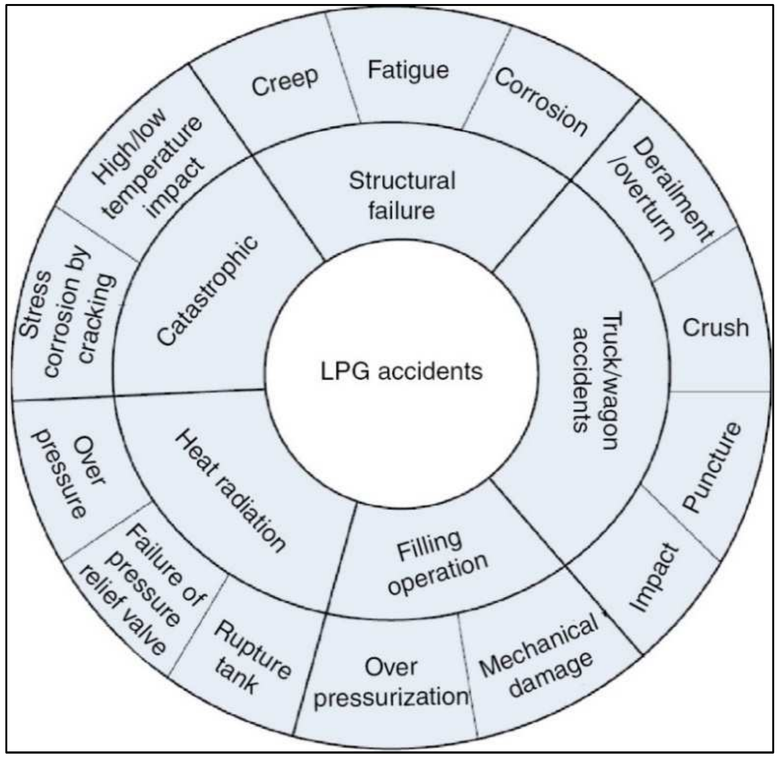


Figure 39: Diagram showing Causes of Major LPG Accidents

2.1.2.1 Zone of Influence - LPG Release without Fire

Figure 40: 800m Area that would be evacuated in case of a large accidental release – BNGC Terminal

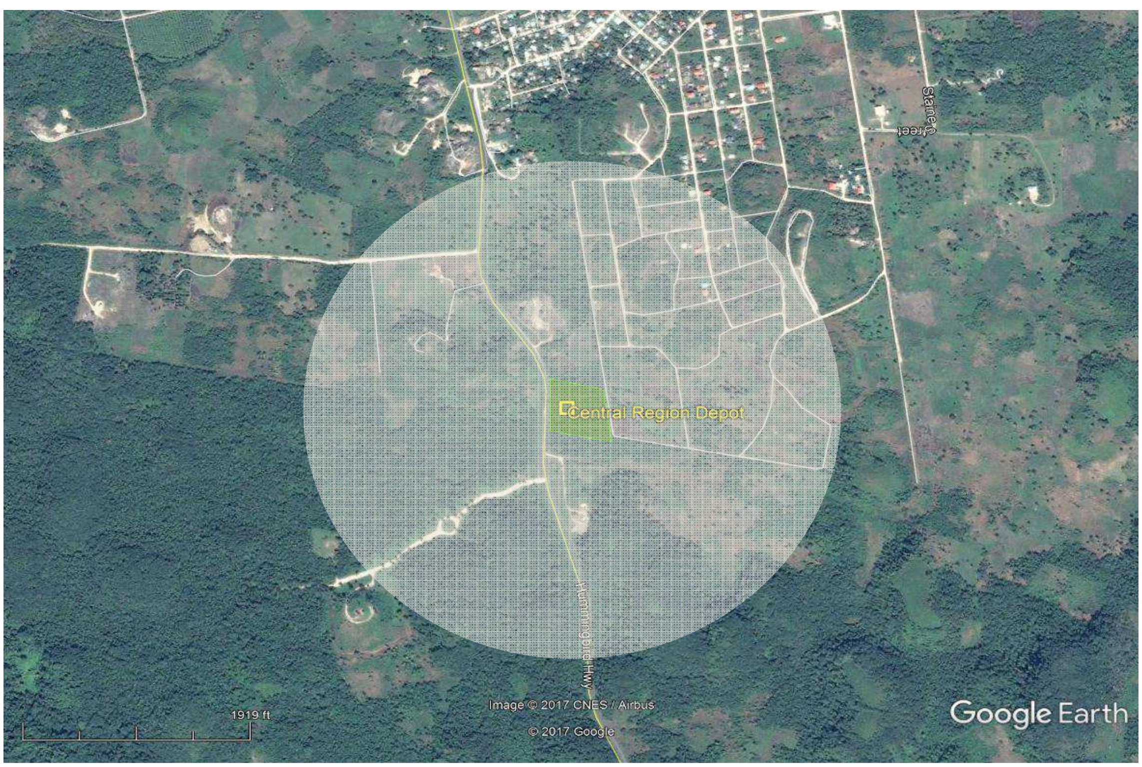


Figure 40A: Area to be evacuated in case of large release of LPG - Central Region Depot.

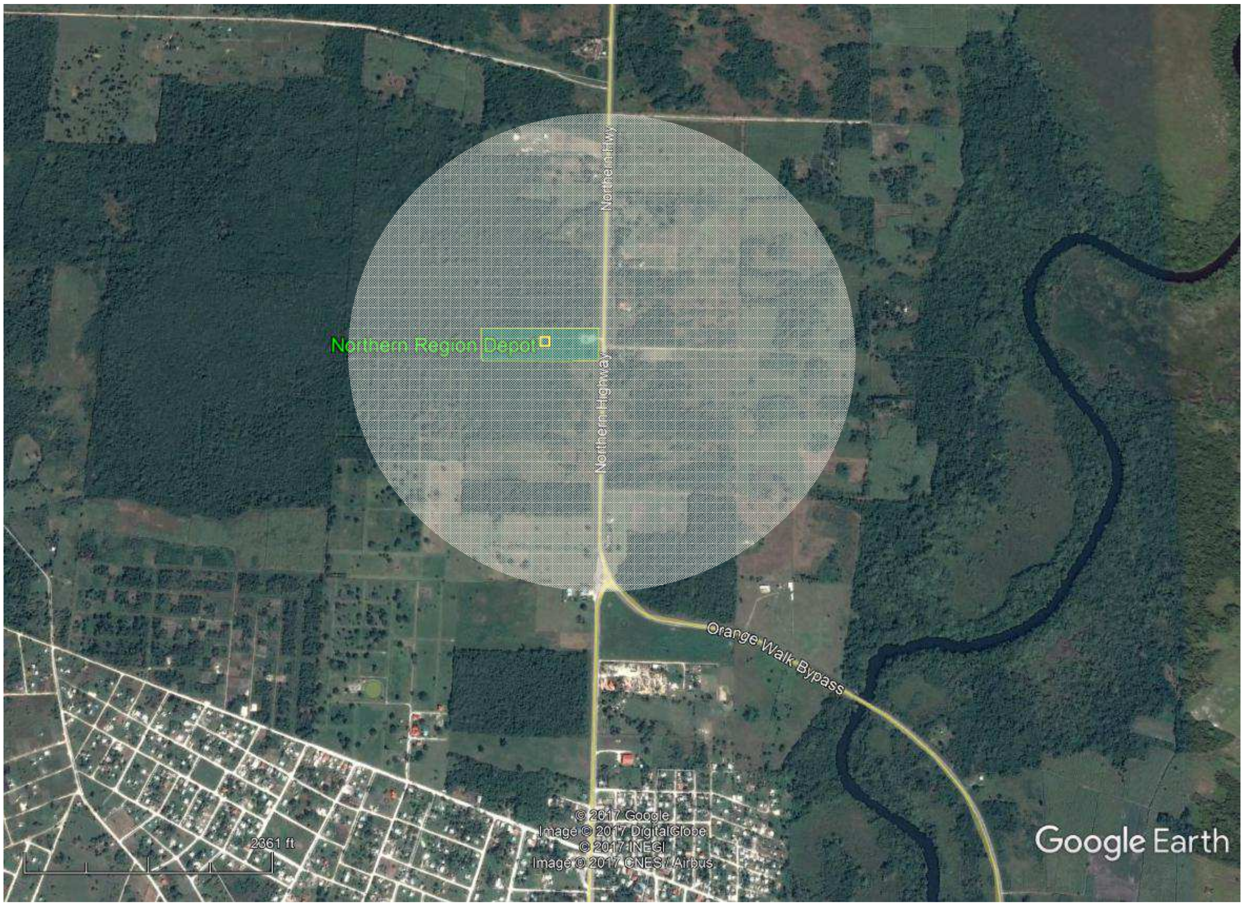


Figure 40B: Area to be evacuated in case of large release of LPG – Northern Region Depot.

In the event of a major release at any of the three facilities, an 800 meter area all around the facilities (see Figure 40, 40A & 40B above) will be evacuated despite the fact that the predominant wind would take the gas in a westerly to north-westerly direction (see Figure 36, 37A and 37B). As part of the Emergency Management Plan and depending on the time of the year and the predominant wind at the time (a windsock on site would indicate wind direction at the time of release), those directly in the path of the release would first be informed and evacuated.

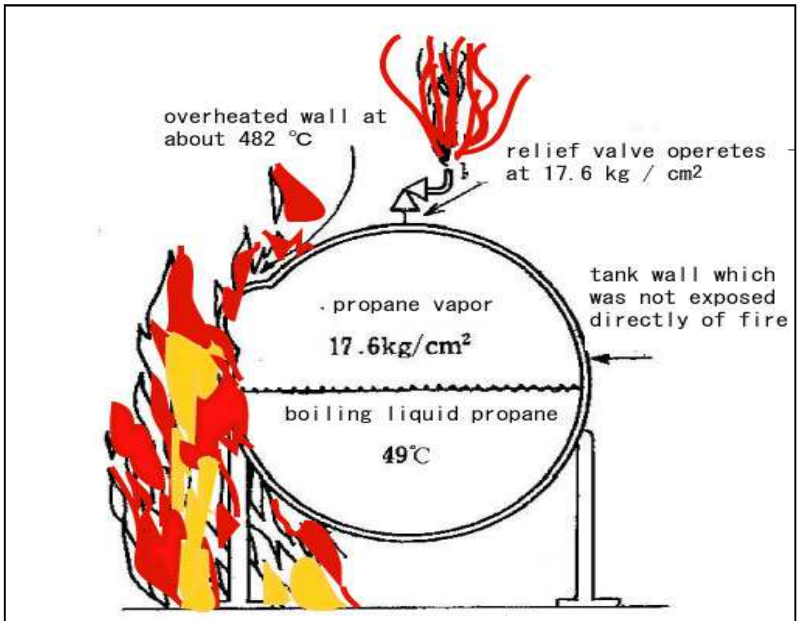
2.1.2.2 B.L.E.V.Es

As seen from Figure 40 and Table 5 above, one of the most severe accidents that can occur in the LPG industry is an accidental fire that can lead to Boiling Liquid Expanding Vapor Explosions (BLEVEs) during processing, storage or the transportation of such hazardous materials. Although BLEVEs do not necessarily imply thermal effects, in most cases the substance involved is a fuel that causes a severe fireball after the explosion. Usually BLEVE refers to the combination of two phenomena, the BLEVE itself and a fireball, i.e., an accident simultaneously involving mechanical and thermal effects.

First of all a BLEVE occurs when a tank containing a pressurized liquid (such as LPG) is heated—for example, due to the thermal radiation from a fire, which causes the pressure inside the pressurized vessel to increase. At some point, if the fire is not put out, the tank walls will not be able to withstand the high stress and they will collapse (the steel typically used for the construction of LPG vessels may fail at pressures of about 15 atm, when the temperature of the walls reaches approximately 650C).

This failure mostly occurs in the top section of the container, where the walls are not in contact with the liquid and therefore not cooled by it; and when the temperature of the walls increases, their mechanical resistance decreases (Birk, 1995).   Instead, the wall in contact with the liquid will transfer heat to the liquid, thus maintaining a much lower temperature. If a safety valve opens, the boiling liquid will have a stronger cooling action due to the heat of evaporation.

In this unstable condition the temperature of the liquid will be great and it will become a superheated liquid. When this liquid reaches its superheat temperature limit (different for each substance), a violent and instantaneous flash of a fraction of the liquid and a superheated liquid vapor explosion will take place; a biphasic liquid/vapor mixture will then be released. The significant increase in the liquid's volume when it vaporizes – about 250 times in the case of propane—plus the expansion of the previously existing vapor, will give rise to a strong pressure wave (explosion, bursting of the container) as well as to the breaking of the container into several pieces, which will be propelled considerable



Process of BLEVE phenomena occurring

distances (see Figure 40C below).

Figure 40C: Diagram of a BLEVE

It is normal that the mixture of liquid/gas released by the explosion will ignite, giving rise to a fireball of an approximately hemispherical shape, initially at ground level. The effect of the thermal radiation in this first stage, which is usually only a couple of seconds, is very important. The whole mass of fuel will burn only at its periphery because there is no air inside the mass (the mixture is outside the flammability limits). Also, it must be noted that not all the fuel initially contained in the tank is involved in this fire and thus decreases the amount of fuel contained in the fireball and also affects its dimensions and the duration of the fire. The combined action of BLEVE and fireball can be summarized therefore in the following effects; Thermal radiation, Pressure wave and Flying fragments.

In trying to determine the area of influence should a BLEVE occur, BNGC reviewed various equations and case studies but found that none of them were able to provide an exact area or zone of influence, due to the many variables mentioned above. A study done "Modeling and Understanding BLEVEs" by J. Casal et al, in trying to determine the area of influence for a 250 m^3 propane storage tank explosion at 80% capacity, utilized some 10 different equations and actual incident scenarios and came up with the following numbers:

Mass of Propane involved	100,000 kg
Thermal Radiation / Diameter of Fireball	259m
Duration of Thermal Radiation (Fireball)	20.5 seconds
Height of Fireball	194 meters

From the above table it could be determined that the immediate area within a 259m radius would be very much affected by a BLEVE involving 100,000 kg of LPG. It must be noted that a BLEVE takes time to occur and as such a considerable amount of the fuel content in the tank would have either been released through the pressure relief valves and or would have been burnt off, thus decreasing the amount of actual LPG involved in the BLEVE, therefore reducing the area of influence. In any case, another concern would then be the Crude Oil storage tanks at the BNE facility, also becoming ignited.

From the review of past incidents and reports of BLEVEs, it has been determined (assumed) that the fragments of a cylindrical storage tank, in the wake of a BLEVE, normally travel between 400m to 500m. Thus for an incident involving similar quantities of material or a bit more, and to be on the safe side, it is recommended that evacuations be made for at least one kilometer in all directions and if possible to as much as two kilometers (see Figure 41 below).

Figure #41: One Kilometer Zone to be evacuated in a large release with fire scenario.

Figure #42: Estimated 300 meter Zone of Influence with greatest impacts in a BLEVE incident.

As one tank at the BNGC terminal can store approximately 145,000 Kg (at an average of 85% capacity), it is anticipated that the area to be impacted would be slightly larger than the incident cited above. In Figure 42 above, the area of influence shown is one with a 600 m diameter or a Zone of Influence of 300m from one of the tank itself. This is already 50 meters more than the Zone of Influence given in the example above. As mentioned earlier, no exact area of influence can be determined but from past cases and some modeling, safety distances can be preset to lessen the impacts within the zone of influence.

Regional Depots - Zone of Influence

As both Regional Depots are somewhat in isolated areas, their Zone of Influence in the event of a release with fire would have very minimal effect, as with respect to the number of persons who could or would be directly impacted by the event itself.

Central Region Depot

The nearest residence to the Central Region Depot is approximately 250 meters to the south-west of the facility, but it remains mostly unoccupied. The more permanent residence is approximately 400 meters north-east of the depot (see Figure 42A below) and although it would fall well within the 1 kilometer evacuation area, there would be very minimal risk to the said residence as it is located on the opposite side of two hills that would shelter it from any fire and/or explosion.

Figure 42A – Nearest Residential Home sheltered by Hilly Terrain – Central Region Depot

As can be seen from Figure 42B below, most of the residence to be evacuated in case of a large release with fire, would be those to the north and north-east who would more than likely experience little to no impact, as they are not only away from the predominant wind area, but they also lie in the 800m – 1,000m range away from the facility. Apart from this and most importantly is the fact that these residential homes also lie behind some hilly areas which would act as excellent barriers between them and the depot.

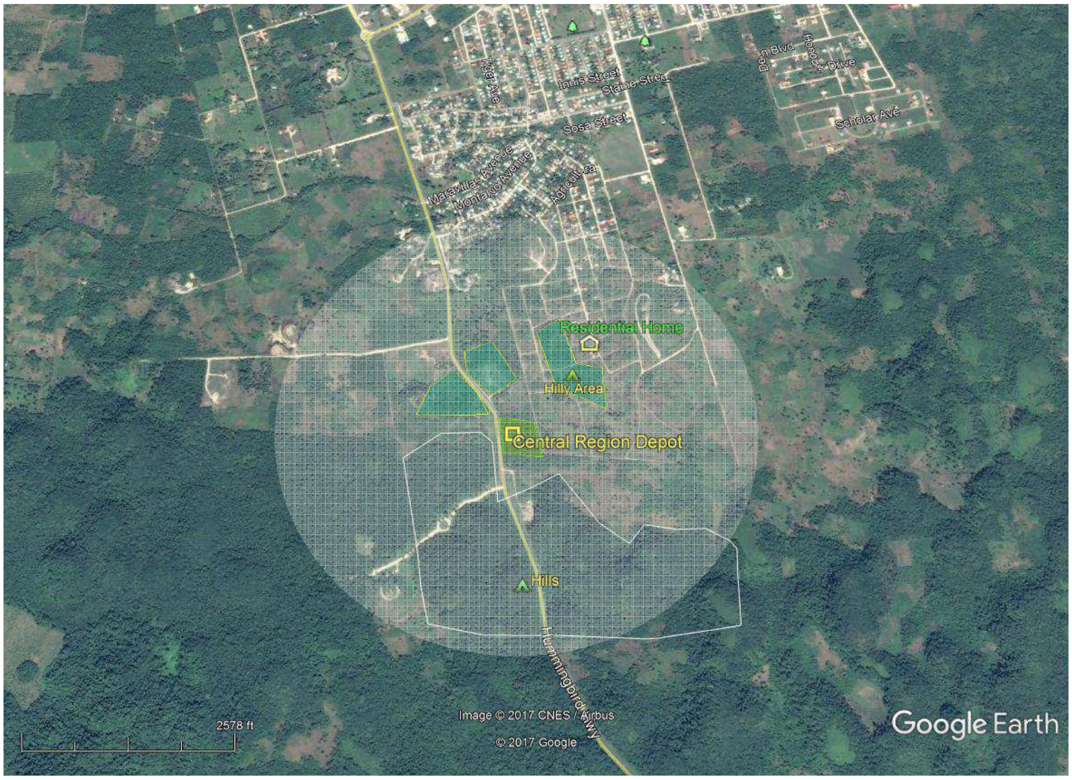


Figure 42B – Area to be evacuated in case of a major release – Central Region Depot

Northern Region Depot

The nearest residential buildings to the Northern Region Depot are located some 250 meters south-east and north-east of the facility. These residential buildings are located approximately 100 meters on the opposite side of the highway and have a few trees in front of them acting as a buffer. There are another two houses about 350 meters north of the proposed location (see Figure 42C below).

Figure 42D below shows that apart from the three residential buildings to the east and north-east, only another 3-5 or two building to the south of the depot would fall within the 1 kilometer evacuation area. Similar to that of the Central Region Depot, should there be a large release and or fire at the Northern Region Depot, the Phillip Goldson Highway would need to be closed until the situation is brought under control and poses no threat to human life.

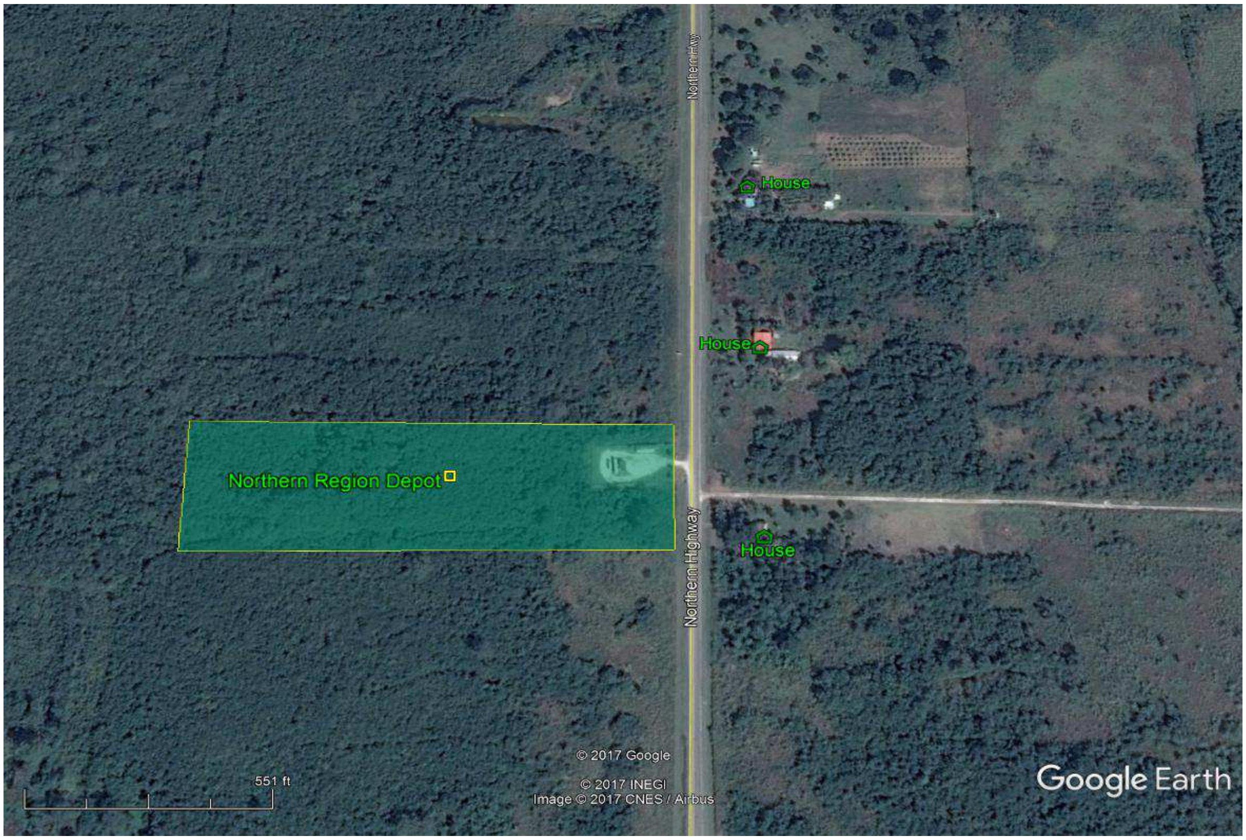


Figure 42C: Scrap metal yard and abattoir near Northern Region Depot

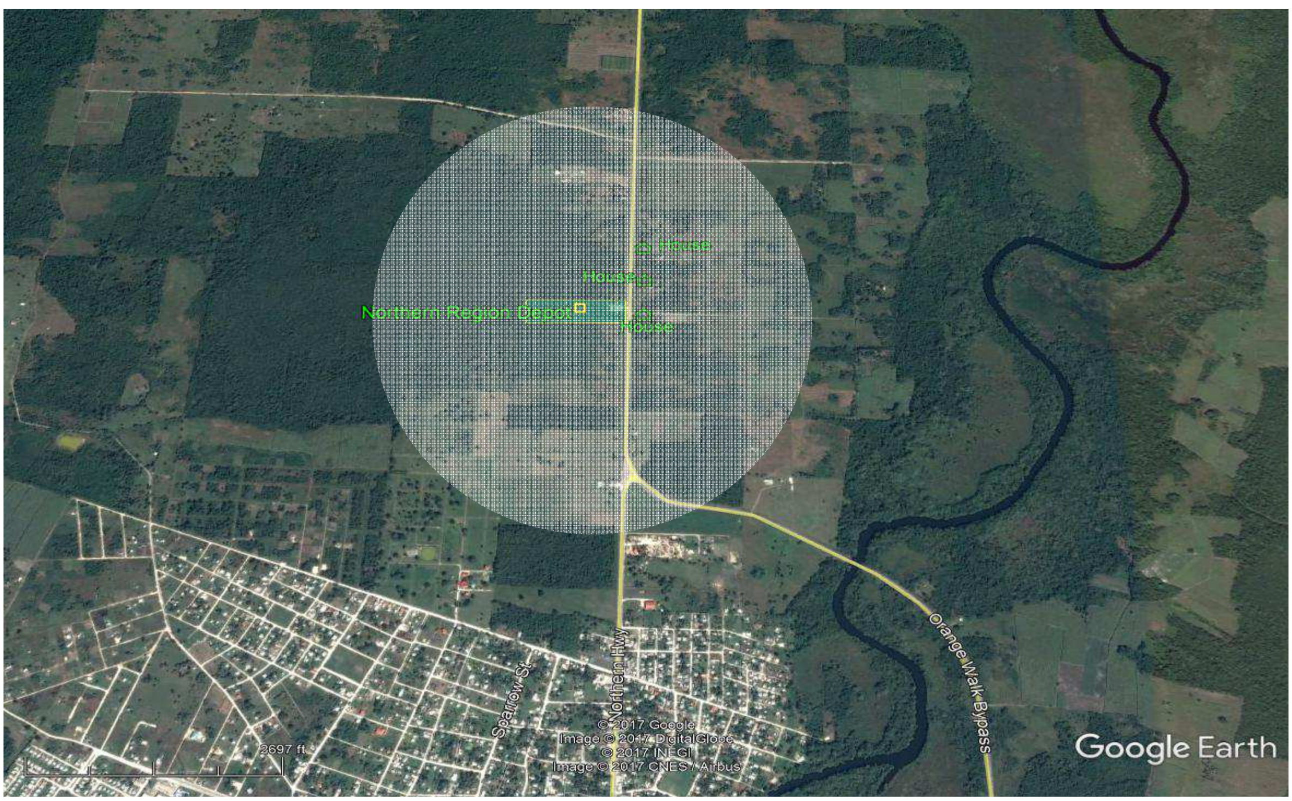


Figure 42D: 1 Km Area to be evacuated in case of release - Northern Region Depot

2.1.2.3 Safety Distance as per NFPA

As per the NFPA Liquefied Petroleum Gas Code, 1998 Edition, it has a minimum setback limit of 100 ft (30m) from which an above-ground tank with liquid (water) capacity of 70,001 to 90,000 gals (265+ to 341 m^3) can be from a building (see Table 7 below).

Water Capacity per Container gallons (m³)	Minimum Distances ft (m)		
	Mounded or Underground Containers *[see 3-2.2.2(f)]*	Aboveground Containers *[see 3-2.2.2(h)]*	Between Containers *[see 3-2.2.2(g)]*
Less than 125 (0.5) *[see 3-2.2.2(a)]*	10 (3)	None *[see 3-2.2.2(b), (c), and (d)]*	None
125 to 250 (0.5 to 1.0)	10 (3)	10 (3)	None
251 to 500 (1.0+ to 1.9)	10 (3)	10 (3)	3 (1)
501 to 2000 (1.9+ to 7.6)	10 (3)	25 (7.6) *[see 3-2.2.2(e)]*	3 (1)
2001 to 30,000 (7.6+ to 114)	50 (15)	50 (15)	5 (1.5)
30,001 to 70,000 (114+ to 265)	50 (15)	75 (23)	¼ of sum of diameters of adjacent containers
70,001 to 90,000 (265+ to 341)	50 (15)	100 (30)	
90,001 to 120,000 (341+ to 454)	50 (15)	125 (38)	
120,001 to 200,000 (454 to 757)	50 (15)	200 (61)	
200,001 to 1,000,000 (757 to 3785)	50 (15)	300 (91)	
Over 1,000,000 (3785)	50 (15)	400 (122)	

Table 7: Safety Setback Distances as per NFPA

From Table 7 above, the NFPA after careful considerations and understanding of accidents within the LPG industry, determined that despite the risks and hazards associated with LPG, that a buffer of 100 feet from any building is considered safe. With the current plan, the closest building to any of the storage tanks at the BNGC Terminal will be the administrative building on site (built to withstand a blast) which would be almost 330 ft (100m) away; three times the NFPA recommended setback distance.

The closest building outside the facility will be some 500 feet (150m) to the north-east from the nearest storage tank, five times the NFPA recommended distance.

At the Central Region Depot and the Northern Region Depot, the closest building will be the administration building within the facility which would be about 75m to 100 meters away from the storage tanks. The nearest occupied building outside the Central Region Depot is approximately 400 meters to the north-east of the facility. The nearest occupied building outside the Northern Region Depot is approximately 250 meters to the north of the facility (storage tanks).

2.1.3 Prevention of BLEVEs

In the case of an emergency that can lead to an accident of the BLEVE fireball type, it is very difficult to improvise adequate actions to control the situation. Any plan requiring the presence of people will be very dangerous because it is impossible to foresee when the explosion will occur. BNGC will therefore take some preventative measures to reduce the risk of a BLEVE to tolerable levels by implementing some of the measures stated below at all its facilities:

2.1.3.1 Sloping Ground

BNGC will look at designing the facility in such a way that any leak of a liquid (for example, liquefied petroleum gas) could be immediately removed from the area in which there are the tanks that must be protected. The ground will have a slope of 2.5% (1.5% minimum); a drainage system that will lead to a trench or a tank at a distance, enough to avoid contact between the flames and the tank.

2.1.3.2 Cooling with Water

The usefulness of water in protecting vessels exposed to the direct action of fire has been proven over many years. It is important to use the water from the first moments, with a layer of a certain thickness totally covering the wall to be cooled, especially those areas directly in contact with a flame. The required flow rate of water should be kept constant.

To protect a fire-engulfed tank, the water flow rate will depend on the circumstances. If the safety valve is correctly designed and works normal, a flow rate of 2,500 gallons per minute is recommended (Londiche and Guillemet, 1991; Nazario, 1988; V´ılchez et al., 1993). If there is flame impingement on the wall, the thermal flux will depend on the type of flame (for a pool fire it can be approximately 100 kW m^2, while for a highly turbulent flame it can reach 350 kW m^2). In this case, for the zone of the wall located above the liquid surface, flow rates even larger than 3,500 per minute may be required.

Another aspect to be taken into account by BNGC is that all safety elements (valves, pipes, etc.) will be designed to resist the action of fire and the high temperatures that will be reached during the emergency; otherwise, these can collapse in the first moments, especially if there is direct contact with the flames.

2.1.3.3 Pressure Reduction

If pressure is reduced, the walls of the vessel will be exposed to less force and the risk of explosion if the temperature increases will be lower. As a general criterion, API recommends the installation of devices able to reduce the pressure up to approximately 7 bar (relative) or up to half of the design pressure in 15 minutes. If the ground is sloped and the vessel is thermally insulated, this time can be longer. The depressurization can require a remote control valve besides the safety valve. The released material should be eliminated in safe conditions (Shebeko et al., 1996), e.g., with a torch. It should also be taken into account that in some cases a strong depressurization can cause extremely low temperatures, leading to fragile conditions in the steel.

2.1.3.4 Protection from Mechanical Impacts

BNGC will ensure that its storage tanks containing LPG will be protected from impacts from cranes or other equipment or moving vehicles. As such the tank farm areas will only be accessible to authorized personnel and equipment and the installation of barriers to prevent damage to the tanks will be constructed.

2.1.3.5 Overflow

This is an incident that has caused a number of BLEVEs. Although nowadays it is much less common, BNGC will ensure that adequate level monitoring and safety devices are installed to avoid overflows (level controls, safety valves).

2.1.3.6 Minimum Separation Distances

The minimum distances between vessels are usually established by regulations and for this Terminal, BNGC will follow the recommended distance of 5.6 feet between each tank and 25 feet between each tank battery. This is important from the point of view of thermal radiation, and particularly to avoid direct contact between the flames from the fire in one piece of equipment and the wall of another vessel. Although spacing may assist with open flame control, it does not guarantee protection, however, in the case of an explosion (blast, projectiles).

2.2 Topography

2.2.1 Slope, Drainage and Flooding – BNGC Terminal

The project area is generally flat, with a few areas to the rear or south-west of the property becoming periodically inundated. The property has a gradual slope from the northeast to southwest towards the Big Creek located about 300m to the west of the property. In the peak of the rainy season several sections of the property may become soggy and the far southwestern portion of the proposed 15 acre plot becomes inundated. From geological tests done by GeoTech Belize on the property and measurements taken, most of the property is just over 1 meter above sea level with sections of the property nearer to the Big Creek (south-western portion) being much lower (see Figure 43 below).

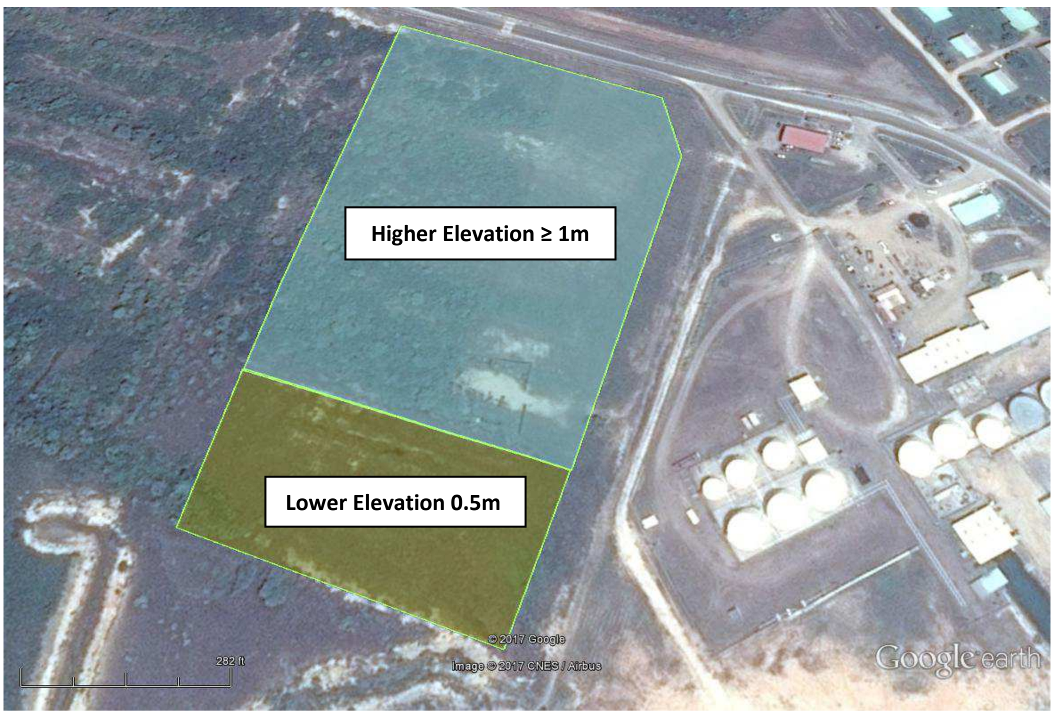


Figure 43: Map showing Elevated area (blue) and Low Lying area (olive green) of BNGC Terminal Property

Because of the terrain being relatively flat, with a very gentle slope, less than 5%, from east to west, surface runoff is minimal. The water table ranges from approximately 1.2 m throughout most of the property (about 70% of the property) to 0.5m feet below the surface of the ground along the far south-western portion of the property – low lying area).

Rainfall runoff flows towards some existing drainage along the south-eastern boundary of the property and drains towards the south southwest in the direction of some grassland and sparse mangrove areas (outside the terminal property) before reaching the Big Creek some 300 meters away (see Figure 44 below).

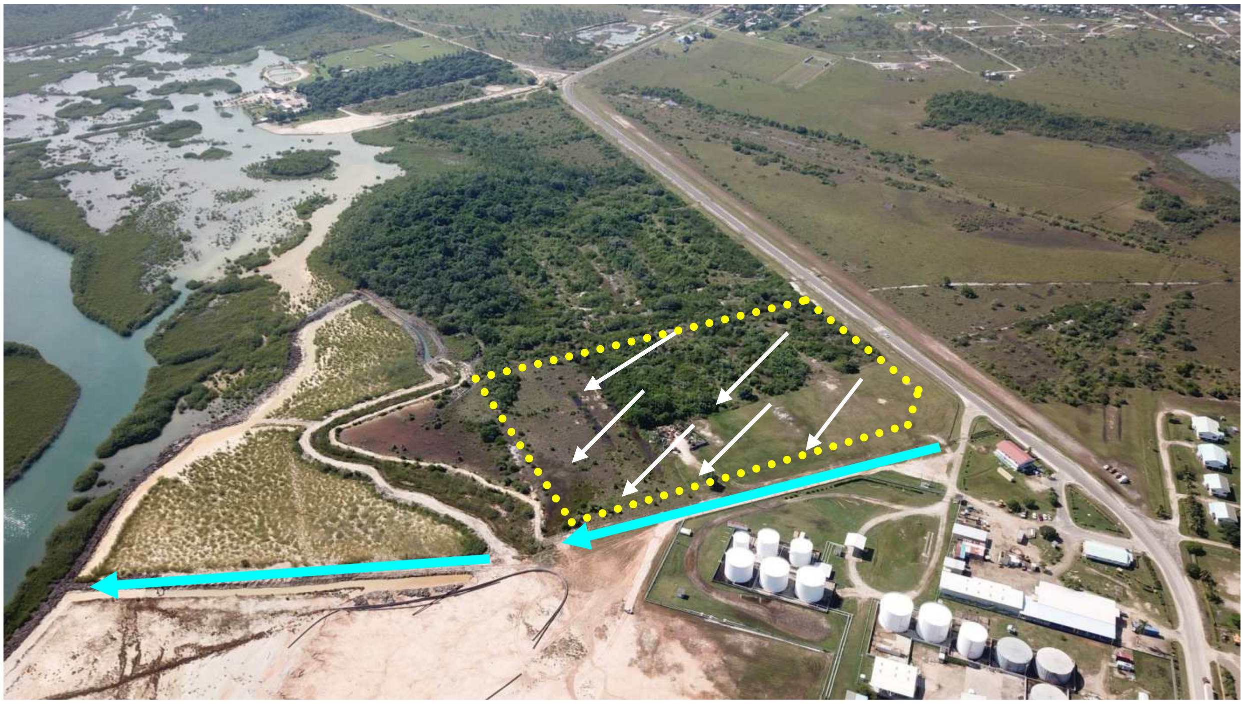
Figure 44: Diagram showing prevalent direction of water runoff.

Photograph 43 below (view to the west-north-west – yellow arrow pointing north/south) gives a more updated view of the location (August 2017) and it shows the Big Creek to the far left and the drain (blue arrows) leading from the north of the property to the Big Creek in the south (right to left in the photograph).

Also notable in the center of the photograph is a winding dyke-like structure constructed as part of the ongoing land filling and land reclamation project by the Port of Big Creek. The photograph also shows the sparse mangrove vegetation to the west of the proposed terminal site.

As can be noted, the area to the left of the dyke in photograph 28 below is a shallow and swampy area that normally remains under water for much of the year and only gets dry in the extreme of the dry months.

To the right of the dyke structure is another low lying area of which a portion falls within the BNGC terminal boundary. Much of this area remains dry but farther into the wet season, it tend to become soggy and flooded.



Photograph 28: General Topography and Layout of the Terminal site and surrounding areas.

The photograph below (#29) shows a more close-up aerial view of the proposed BNGC site property. As can be noted and explained above, the low lying area is the south-west portion of the property. This area does remain dry for a few months out of the year but does get soggy and inundated during the wet season.

Photograph 29: Aerial view of Topography of BNGC Terminal Site.

Although compared to other parts of the country or even the same area, this area may be considered low, a flood risk analysis conducted by King et al, classified the flood risk of this area (shown by white arrow) as being "Low" (see figure 45 below)

This low-lying area will be backfilled with material obtained from the water pond being excavated by BNGC for firefighting purposes.

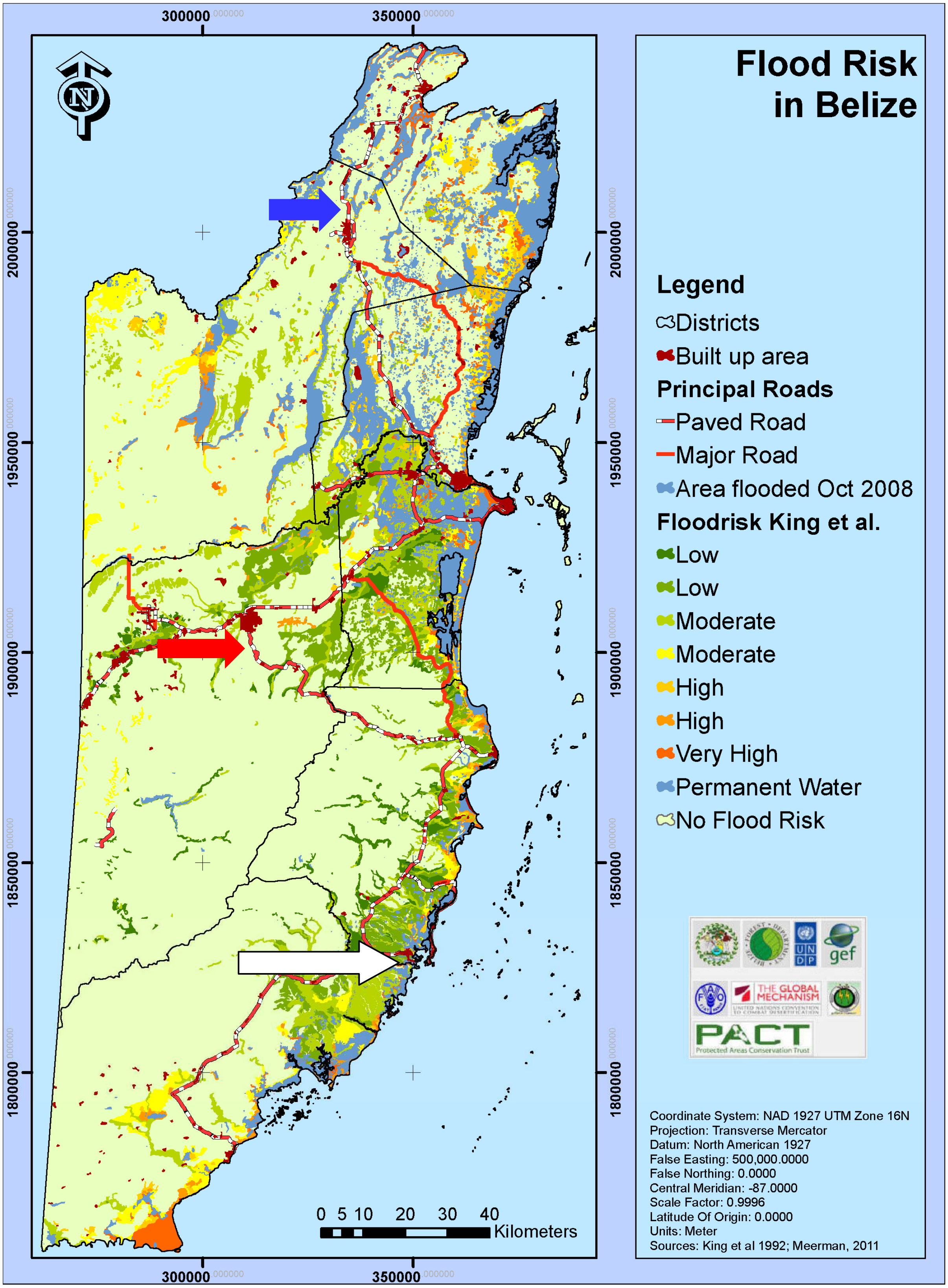


Figure 45: Flood Risk Map of Belize

2.2.2 Soil

The soil is semi permeable, containing a large percentage of sand. As a result, vertical water movement is very significant. According to the GeoTech Belize Report, the following layers of soil was discovered from the test pits.

Trial Pit 1

- Pit was excavated to a depth of 3.0m with two different layers of soil discovered. The first layer consisted of well-graded sand (SW) measuring 0.9m thick. The second layer was silty sand (SM) measuring 2.1m thick. Presence of ground water was discovered at 0.9m depth. Pit was then backfilled with excavated material.

Trial Pit 2

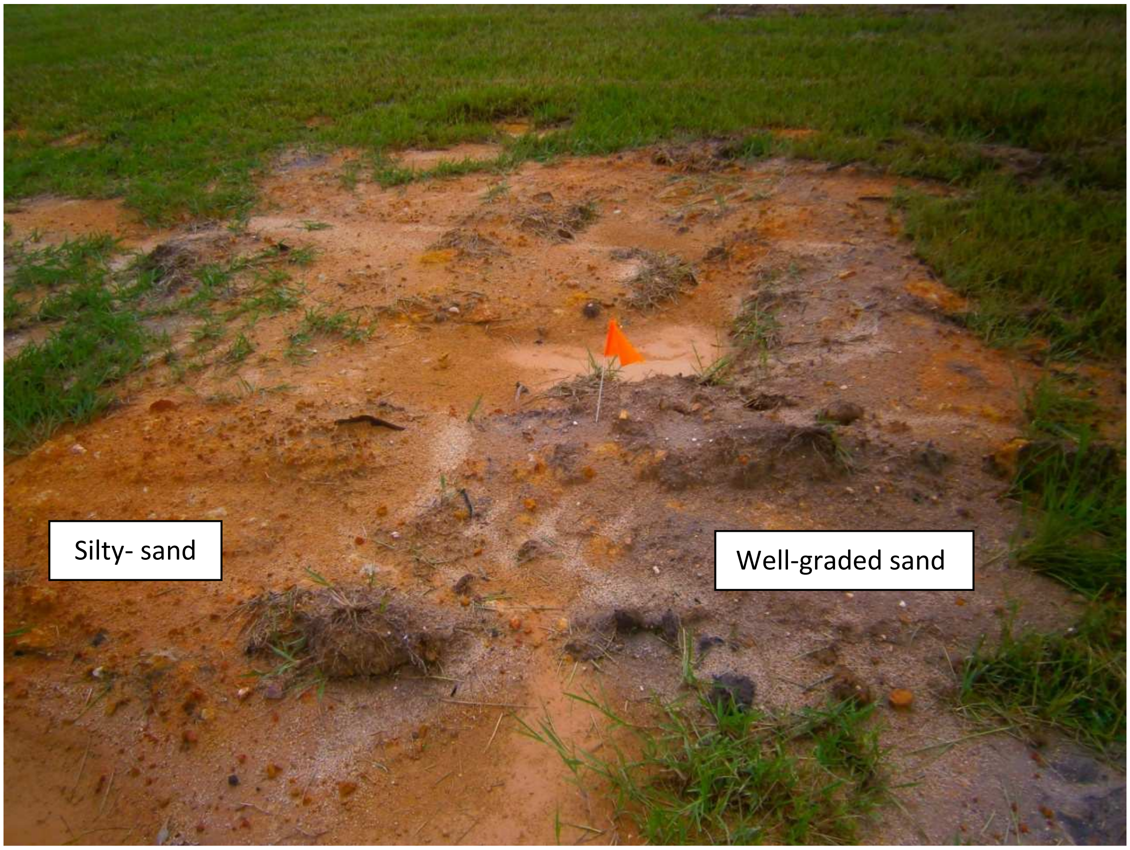
- Pit was excavated to a depth of 2.6 m with two different layers of soil discovered. The first layer consisted of well-graded sand (SW) measuring 1.0m thick. The second layer was silty sand (SM) measuring 1.6m thick. Presence of ground water was discovered at 1.0m depth. Pit was then backfilled with excavated material.

Trial Pit 3

- Pit was excavated to a depth of 2.7m with two different layers of soil discovered. The first layer consisted of well-graded sand (SW) measuring 0.8m thick. The second layer was silty sand (SM) measuring 1.9m thick. Presence of ground water was discovered at 1.0m depth. Pit was then backfilled with excavated material.

Photograph 30 below shows the two different types of soil discovered in the test pits. The well graded sand (SW) appears more grey in color, whilst the silty sand (SM) appears more orange in color.

Due to the make-up of the soil, surface water moves both laterally and vertically very quickly to reach the water table of the nearby port harbor (sea) and Big Creek. The rainy season and tidal fluctuations have very little effect on the water level of the port harbor (sea) but it is slightly impacted when the Big Creek receives large amounts of water from flooding upstream. This, along with effects of the tides, causes the water level in the port to temporarily increase in height. The effect is more visual as the Big Creek would dump tons of water filled with sediments from runoffs of upstream shrimp operations and banana farms.



Photograph 30: Backfilled test pit showing two grades of sand discovered

2.3 Zone of Influence

2.3.1 – Communities

As defined in the dictionary, a community is *a small or large social unit (a group of living things) who have something in common, such as norms, religion, values, or identity. Communities often share a sense of place that is situated in a given geographical area (e.g. a country, village, town, or neighbourhood) or in virtual space through communication platforms.*

When considering the above definition and applying it in terms of communities nearest the terminal, the Port of Big Creek would into the category of the nearest community. The port presently houses different offices and workplaces for several companies / industries; namely, Port of Big Creek Offices, residential area for some of the ports staff, Fyffes, Customs Department, Immigration Department, Belize Port Authority, BNE, Santander, among others *(see Figure 46 below)*. All in all, it is estimated that this community has an average daily population of about 100 people during the day and about 10 to fifteen personnel at night, depending if no major activities are ongoing.

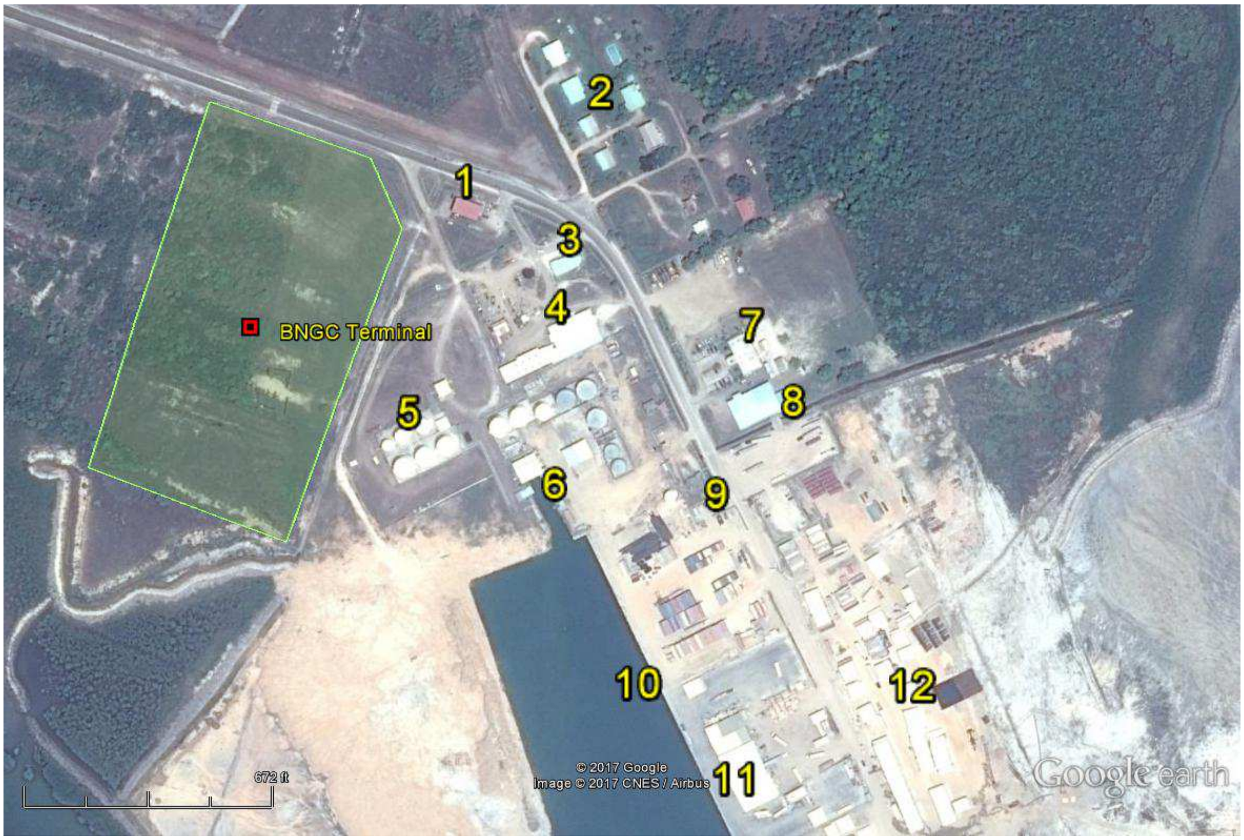


Figure #46: The Port of Big Creek "Community".

As can be seen from the figure above, the Port of Big Creek Community is a very diverse community, with many people and establishments in that one small area. The numbers in the figure signify the following:

1. Fyffes Offices
2. Port Of Big Creek Staff Residential Area
3. Port of Big Creek Warehouse & Maintenance Crew Office
4. Chemicals Warehouse / Store Room
5. "Petro-Fuel" Storage Tanks (now being used to store Molasses from Santander)
6. BNE Office and Tank Farm Storage Facility
7. Port of Big Creek Administrative Office (also houses Belize Port Authority)
8. Fertilizer Warehouse
9. Customs Department Office
10. Berthing/Docking area
11. Banana Storage / Packing Shed
12. Santander Storage / Operations

Should there be an accidental release at the BNGC Terminal, it is more than likely that all these offices and facilities will have to be evacuated; as they would all fall into the initial 800 m evacuation zone (which surely be extended should the situation worsen).

2.3.2 Villages

The nearest villages to the BNGC Terminal would then be those of Independence and Mango Creek. Although they are two communities, most people refer to the entire area as Independence Village. Mango Creek village is the most eastern part of the entire inhabited area.

In terms of where they are located with respect to the proposed terminal site, the Mango Creek area lies almost straight north of the site, whilst the Independence Village lies a little bit more to the northwest (see Figure 47 below).

As both villages are separated only by a shared street, the center of the villages is located about 2 km to the north northwest of the terminal. The outskirt of the villages, though, lies only about 1,100 meters from the site; just outside the one kilometer radius of evacuation, should there be a large release and or fire incident at the terminal.

Figure 47: Map showing Independence & Mango Creek Communities in relation to BNGC Terminal and Evacuation Zone.

The arrow in the figure above is indicating where the closest residence is located, outside of the port area. This residence is just at the one kilometer mark, but in the case of an accidental release incident, they would still be warned and evacuated as part of BNGC's Emergency Response Plan.

2.3.3 Protected Areas

In relation to environmentally sensitive areas near the terminal, specifically speaking protected areas, the closest protected area to the Terminal is the Mango Creek 4 Forest Reserve.

Forest reserves, are overseen by the Forest Department and are intended for the sustainable extraction of timber without destroying the biodiversity of the location. These are gazetted under the Forests Act of 1927, which allows the department to grant permits to logging companies after extensive review. There are currently 16 forest reserves with a combined acreage of 380,328 hectares (939,810 acres), making up 9.3% of total national territory.

The Mango Creek Reserve, which was established in 1989, is a Forest Reserve that is divided into two parcels, namely Mango Creek 1 and Mango Creek 4.   Between both parcels they have a combined area of 12,090 hectares or 29,900 acres The BNGC Terminal (red dot) lies approximately 20 km south-east of Mango Creek 1 Forest Reserve and about 4 Km east of Mango Creek 4 Forest Reserve (See Figure 48 & 48-A below).

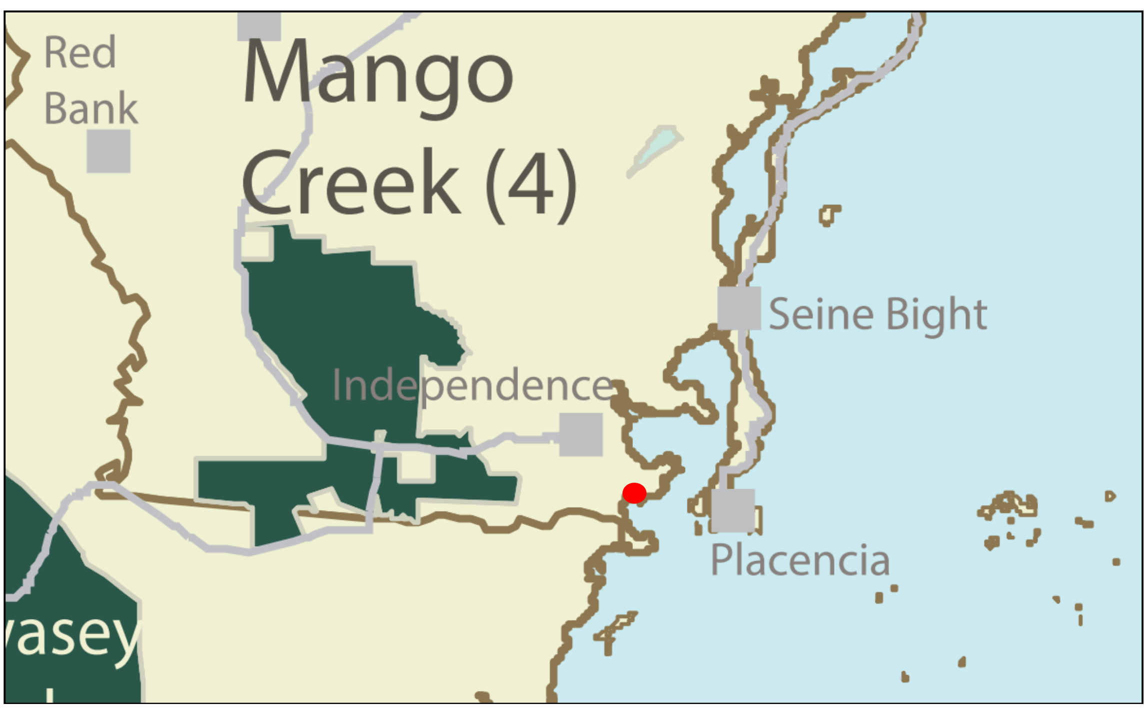


Figure 48: Map showing Mango Creek 4 Forest Reserve west of BNGC Terminal (red dot)

Figure 48-A: NPAS Map of Protected Areas in Belize (2015)

Impacts to Protected Areas:

Over the past decade, the Mango Creek 4 Forest reserve have been very much damaged by both legal and illegal logging, and it was devastated by Hurricane Iris in 2001. Since then, there have been continuous incursions into the reserve by residents of the nearby communities and by immigrants living in the Bella Vista Village and Trio Villages, whom mostly rely on wood and other forest products such as game meat. It is believed that the wildlife of the area/reserve has been almost completely wiped out. As can be seen in Figure 48-B below (the green line depicts eastern boundary of reserve), the area that is supposed to be the reserve is practically barren with very sparse vegetation. The only dense vegetation can be found along the banks of the Big Creek, an area that the BNGC Terminal will never impact.

Figure 48-B: Map showing southern and eastern Boundaries of Mango Creek Reserve 4

Overall, the nearest protected area, Mango Creek Forest Reserve, which has become an almost barren portion of land due to many reasons. The eastern portion of the said reserve though, falls well outside the Zone of Influence should there ever be an incident at the BNGC Terminal.

2.4 Climate, Hydrology and Meteorology:

2.4.1 Climate

As a Central American country, Belize has an overall subtropical to tropical environment with a defined wet and dry season. The seasons though do vary as one travels from north to south and so does the rainfall throughout the country. The average rainfall throughout the country range from less than 60 inches (1,534 millimeters) in the extreme north and northwest, to 160 inches (4,064 millimeters) in the extreme south and the lower Maya Mountain region.

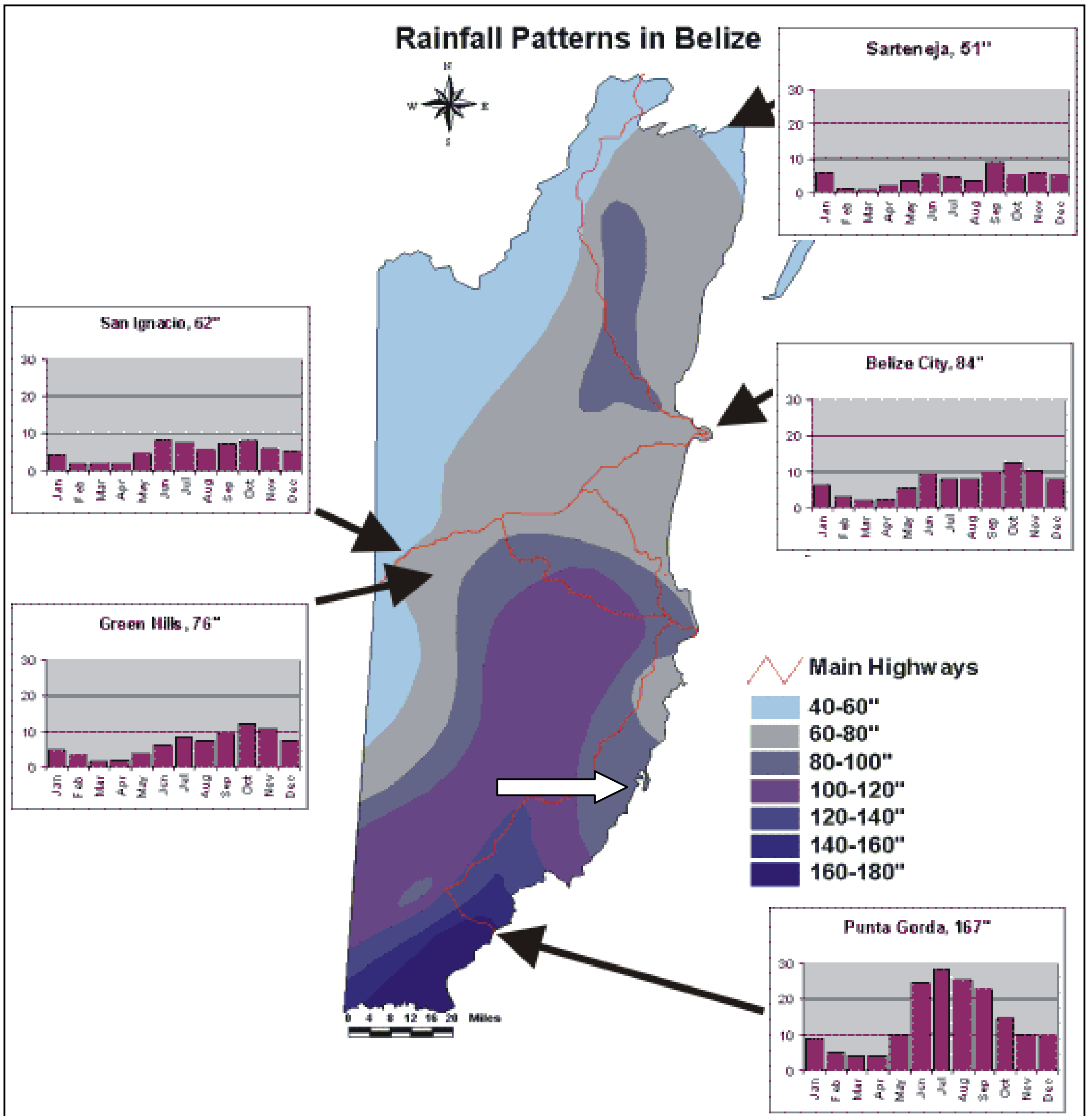


Figure 49: Average Rainfall Map of Belize

From the Rainfall Map above (Figure 49), it can bed educed that the BNGC Terminal area (white arrow) falls within the rainfall range of 80-100 inches of rain yearly. Seasonal differences in rainfall are greatest in the northern and central regions of the country where, between January and May, fewer than 100 millimeters of rain fall per month is recorded. The dry season is shorter in the south, normally only lasting from February to April. A break in the rainy period usually occurs in late July or early August, after the initial onset of the rainy season which commences in early May in Toledo, (where the annual rainfall is highest) progressing north to the Stann Creek, Belize, Cayo and Orange Walk District in late May, followed by Corozal District in early June.

From Figure 49-A below, one can see that BNGC terminal falls in the lighter blue area (white dot) that between 1951 and 2013, received on average between 2249.4 to 2571.5 mm of rainfall per year (295mm/month).

Mean Yearly Rainfall for Belize 1951-2013

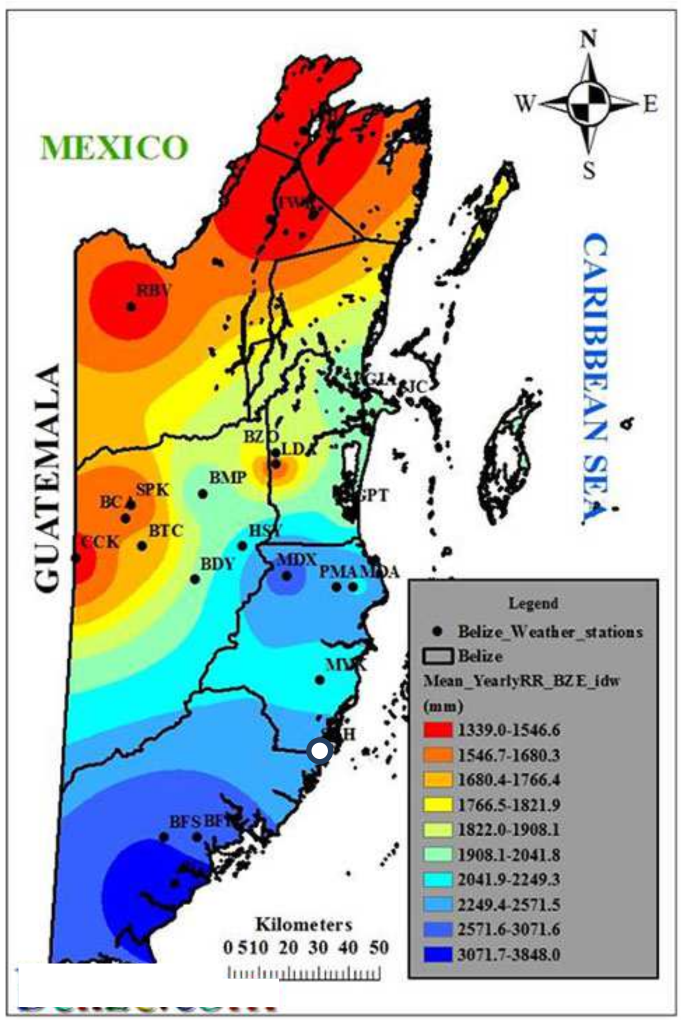


Figure 49-A: Rainfall Map of Belize 1951-2013

The Savannah Forest Station being only about 2 miles northwest of the BNGC Terminal will be used as a climatic representation of the climate around the Terminal area.

From Figure 50 below, we can see that over the last 10 years, the Savannah Meteorological Station recorded a gradual reduction in the monthly average rainfall since 2013 and which was more pronounced since 2015 with a gradual decrease in average monthly rainfall of 207.7 mm in 2015 to 184.3 mm in 2016. So far in 2017 (up to August) the trend seems to be holding, with a monthly rainfall average of about 150mm per month. Should this trend continue it will no doubt have an impact in the amount of runoffs from the BNGC Terminal site and also reduce the chance of the location becoming flooded from excessive rainfall.

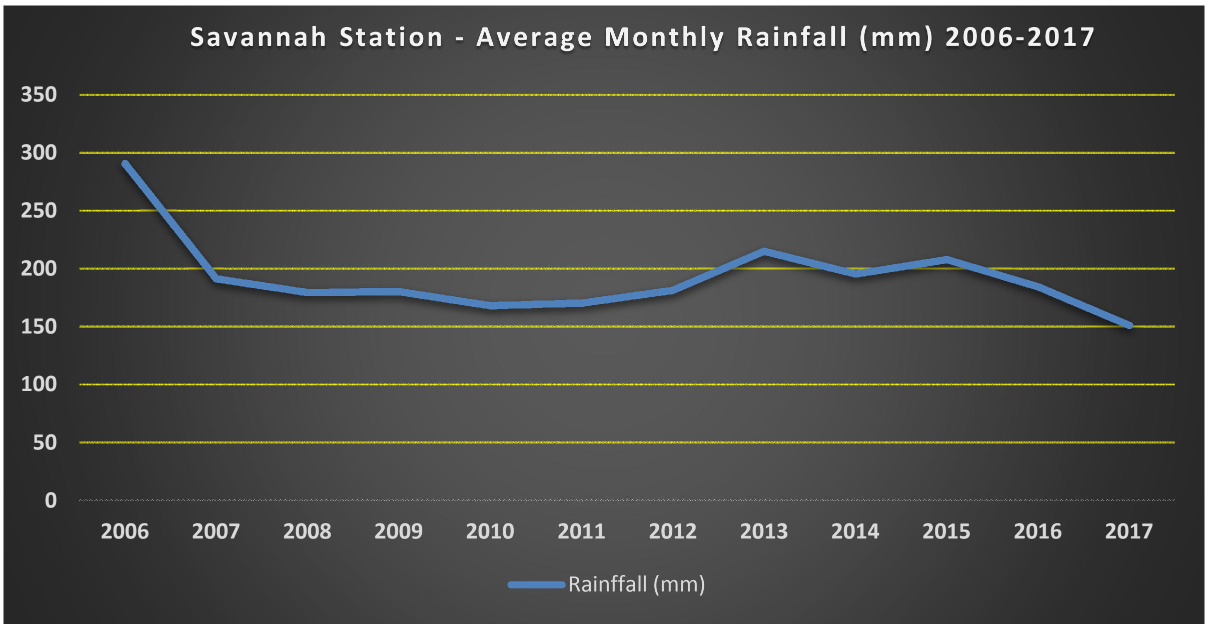


Figure 50: Savannah Station Average Monthly Rainfall (mm) 2006 -2017

Temperatures in Belize range from 50°F to 95°F with an annual mean of 79°F. November to January are traditionally the coolest months with a 75°F average and May to September are the warmest at about 81°F average (see Figure 51 below). In Belize, location is a big factor for temperature as the west can be several degrees colder than along the coast and during November at night, temperatures can fall to a low as 46°F. In the mountains, the coldest days and nights might seem relatively very cold, however, the mean annual temperature in the mountains is a comfortable 72°F.

The mean annual humidity is 83%, but many days the humidity is masked by the cooling sea breezes. The Belize coastal area is exposed to northeast trade winds averaging 10-13 knots and attain an uncanny consistency during the month of July. The coldest month is

January while the highest temperatures are experienced during the month of May. A cool transition period (November through February) separates the wet and dry season.

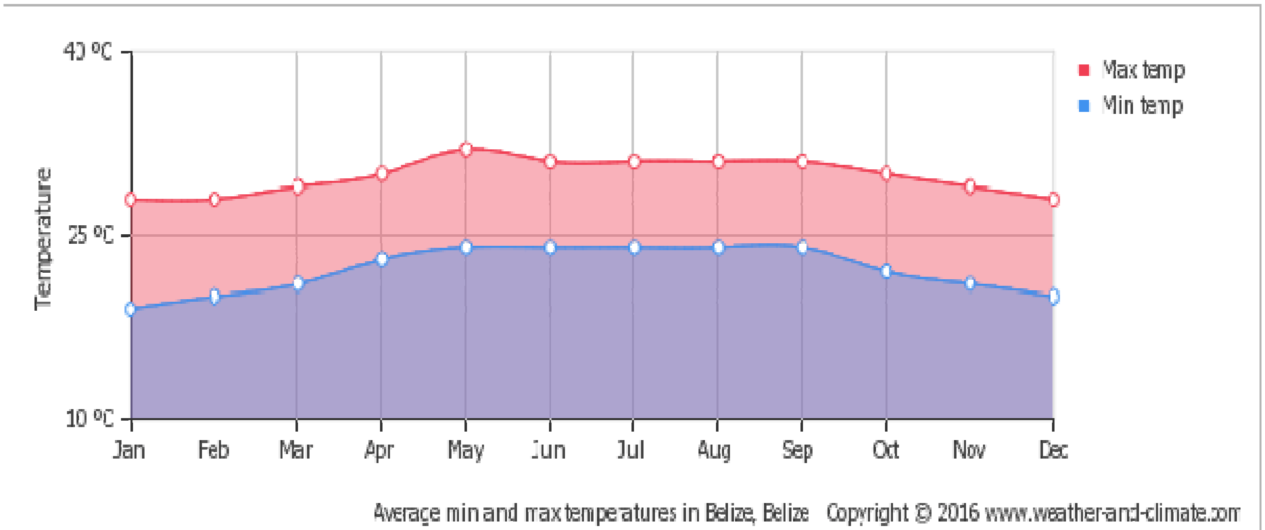


Figure 51: Graph Showing Monthly Maximum and Minimum Temperature Averages for Belize

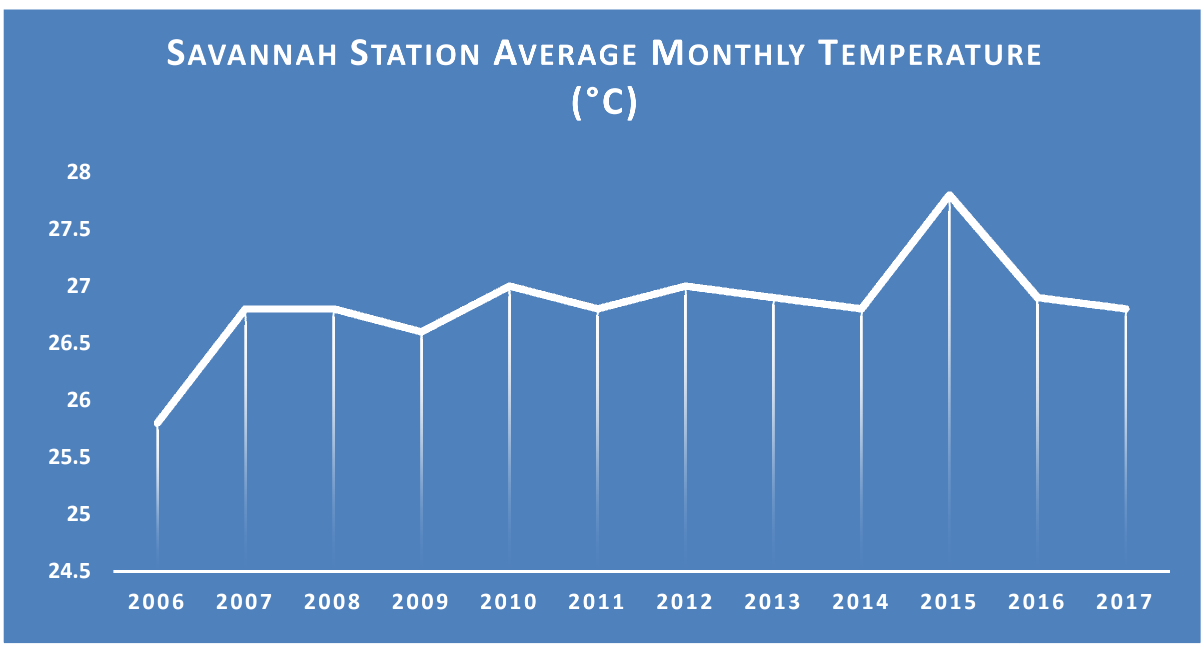


Figure 52: Savannah Station Average Monthly Temperature (°C) 2006-2017

Temperature wise, the Savannah or Big Creek area seems to have remained almost constant except in 2015 when the monthly average temperature was 27.8 °C, compared to 26.8 °C in 2014 and 26.9 °C in 2016. The average monthly temperature so far in 2017 is 26.8 °C (up to August) which could mean that it might be a normal year.

2.4.2 Hydrology

According to the World Meteorological Organization, Belize is the country with maximal average value of water availability per capita of about 58,500 m3 /year (CEPAL, 2003). Groundwater and surface-water systems are hydrologically interconnected and function together to provide water for public, industrial, agricultural, and recreational use. Knowledge of these complex systems gained through scientific research is paramount to the protection and sustainability of this irreplaceable resource.

As mentioned earlier, the BNGC Terminal is located within the Port of Big Creek compound which is along the Belizean coastline in the most south-eastern portion of the Stann Creek District. According to Figure 53 below, the BNGC Terminal would then fall within the Savannah Groundwater Province of Belize.

Belize hydrology network is divided into major river catchments and sub-catchments. Belize has 33 watersheds of which 17 are classified as major watersheds. The majority of the rivers originate on the eastern slopes of the Maya mountains. A notable exception is the Belize River, the country's largest watershed and longest river, whose headwaters originate on the western side of the Maya Mountains main divide and descends the slopes of the Maya Mountains skirting the northern lowlands before emptying into the Caribbean Sea. The Savannah Province is located in the Southeastern watershed region (Boles, 1999). **Table 6** below lists the 19 watersheds that are located within the Savannah Province area:

North Stann Creek
Bocatora Creek
Yemeri Creek
Northern and Southern Lagoon
Black Creek
Mullins River
Sennis River
Big Creek
Mango Creek
Freshwater Creek
Punta Ycacos Lagoon
Monkey River
Pine Ridge Creek
Sittee River
Santa Maria Creek
South Stann Creek
Golden Stream
Deep River
Cabbage Haul Creek

Table 8: Watersheds within the Savannah Province

Figure 53: Groundwater Provinces of Belize

The BNGC Terminal would therefore fall within the Big Creek Watershed as it is located some 700 meters north of where the Big Creek enters the Port of Big Creek marina area.

All streams drain the southeastern and eastern slopes of the Maya mountains. In the mountainous areas they have well developed branching patterns with relatively steep, straight courses. Below the slopes, though, on the coastal plain, streams become more sluggish and drainage of the area is less effective.

Rivers are generally discharged into the Caribbean Sea and their flow rate varies depending on the rain season. Being a part of a coastal plain, the Savannah Province is rich in lagoons, mangrove swamps, deep estuaries and river-mouth bars (Hartshorn et al., 1984). Water from rivers is commonly used as a reliable water source. Surface water is generally suitable for irrigation purposes but in some places is used as drinking water source as well.

The Savannah Groundwater province extends over an area approximately 1500 km2 (Williams, 2011) in southeastern part of Belize, in the Stann Creek district and partly in the Toledo district.

The aquifers in the northern portions of this Province are confined and overlain with karstic and fractured cretaceous limestones and quaternary alluvial deposits.

Multiple aquifers exist within this Groundwater Savannah Province with the alluvium deposits forming the uppermost or phreatic aquifers. These phreatic aquifers found 3 to 8 m below the surface are discontinuous and connected to rivers and streams extend westwards. Immediate aquifer response are expected to pumping, drought, and rainfall.

The Big Creek watershed on the other hand, is relatively small in comparison with other major rivers and streams, but none-the-less an important one. As can be seen in Figure 54 below, the Big Creek watershed, of which most lies within the Mango Creek 4 Forest Reserve, have been greatly impacted by the expansion of Independence Village; the deforestation of the upper reaches of the watershed due to legal and illegal logging; clearing of lands for farming (banana & shrimps as well as subsistence farming), hurricane and also due to developmental projects throughout the south eastern region of the Stann Creek District.

Despite this, BNGC will as much as possible keep the natural vegetation within its 15 acre plot, especially those bordering the west of the property near the Big Creek. Also, as BNGC will be constructing its own pond for water supply for fire-fighting purposes, it will direct most if not all of its storm water runoffs towards the said pond and will ensure that runoffs are treated prior to exiting the facility.

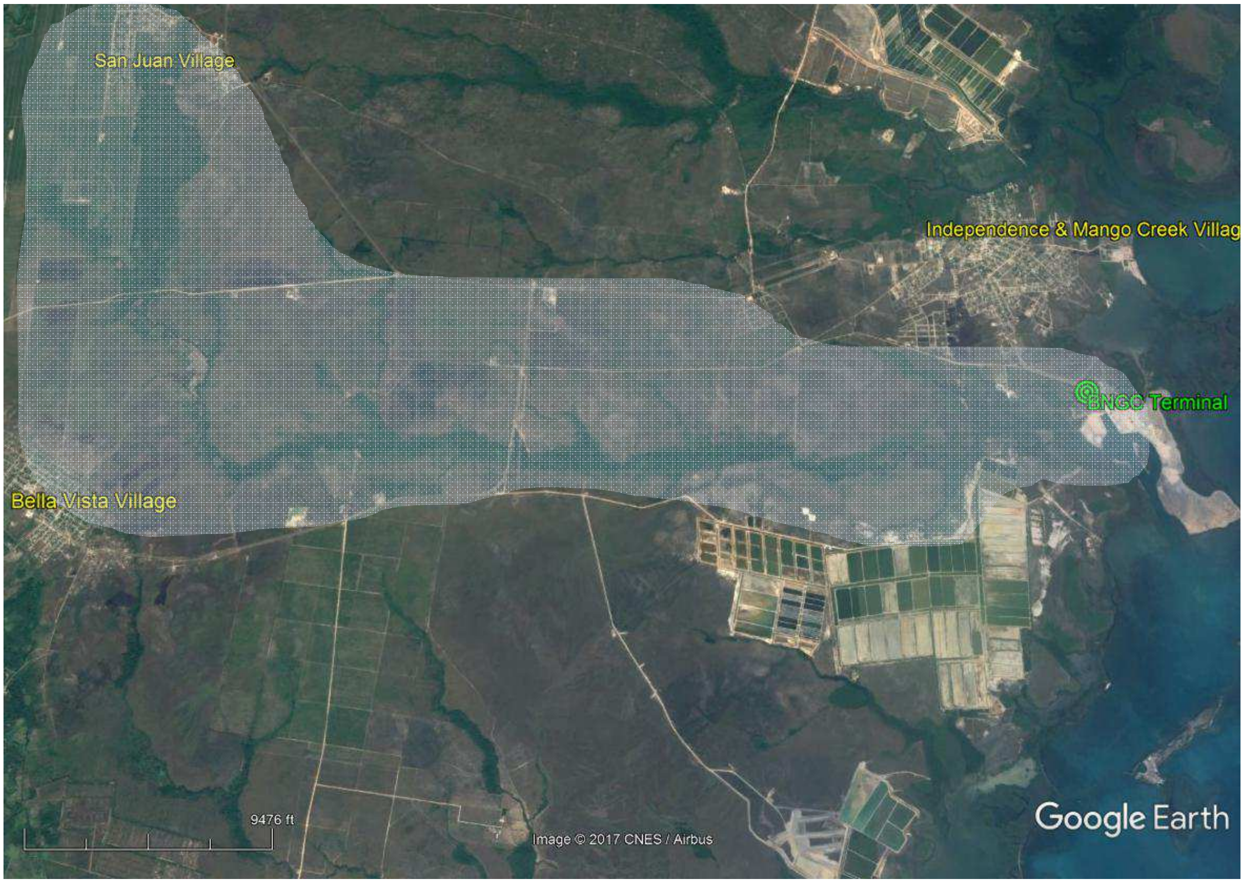


Figure 54: Big Creek Watershed Area

2.4.3 Meteorology

As cited earlier, Belize lies in the outer tropics or subtropical geographic area with mean monthly temperatures ranging from 61° F in the wet cooler months to >90° F in dry warmer summer.

Belize lies directly in the path of tropical storms and hurricanes and they are a consistent occurrence that bring heavy rainfall that challenge flood control management policies and infrastructure. Approximately 62% of the populated settlements in Belize lie within areas that are at high risk of flooding and many of these are located directly within flood plains that are inundated on an annual basis.

The on-shore breeze that is predominantly from the east to south-east, moderates the daily high temperature. These southeast trade-winds attain greatest constancy in July. The northern coastal plain of Belize receives about thirty percent of the rainfall of southern Toledo district. Annual rainfall ranges from 1347 mm at Libertad (Corozal district) to 4526 mm at Barranco (Toledo district). Seasonal effects are more significant in the central and northern regions. In the south-central region the dry season lasts from February till April. A minor, less-rainy period usually occurs in August.

From a review of reports and weather data for Belize from over the past 30 + years, it seems that the weather has more or less remained constant as it relates to temperature and rainfall (Figures 50 & 52 above). It's only been in the last five years or so that there has been some reduction in the average annual rainfall throughout the country.

As can be noted from Table 9 below, the data corroborates what has been stated about the wet and dry seasons of Belize; i.e., there's a dry season during the month of February to April and the wet season May to November, with the transitional period between December to February.

Savannah Forest Station | Temperature and Precipitation (1981-2010)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years
AVG TMP Daily (°C)	24.2	25	27.2	27.5	28.4	28.4	28	27.7	27	27.3	25.8	25	26.8	21
AVG PRECIP Monthly (mm)	132.8	86.8	51.9	54.8	122	318	329	361	317	298	210	151	207.2	20
NUM Rain Days > 1mm	10	8	5	4	7	14	18	19	18	17	13	12	12	20

Source of the above data: *Historical and current records at the Savannah Forest Station located in the South Stann Creek approximately 30 Miles from Dangriga Town in the Stann Creek District. Latitude 16° 31' N, Longitude 088° 26' W with an elevation of 13 meters.*

Table 9: 1981-2010 Temperature & Rainfall Monthly Average - Savannah Forest Station

Looking at the climatic and weather data above, and should the trend continue similar to that of the 30+ years period, the BNGC Terminal should not be severely impacted by the climate and climatic changes in the upcoming years. The greatest threat to the BNGC Terminal, weather wise, is that of a tropical cyclone which normally brings along winds and unusually higher storm surges and heavy rainfall causing localized flooding.

It must be recognized that there's no certainty in using trends to predict weather impacts on any one project, as from one year to the other, the weather can be completely different.

2.5 Land Use

The main land use of the area immediately surrounding the BNGC Terminal is presently for the establishment of businesses that require the use of a marine terminal, either for export, import or for both. This is especially apparent with the businesses presently located within the port facility and that is adjacent to the proposed BNGC Terminal site. These businesses are mainly concentrated to the east and south-east of the proposed site (see Photograph 31 below)(east is towards the lower right hand corner).

Photograph #31: Showing Boundary of Port of Big Creek & port facilities east of Terminal site.

As can be noted from the picture above, the land to the southeast, west, and north of the proposed site has no development as yet, especially within the confines of the Port of Big Creek property (blue dashed line).

The photographs below shows updated (August 2017) land use of the area surrounding the immediate proposed terminal site. Photograph 32 (below) was taken in a northerly direction and one can see that for 1 km north, there's basically no development until you reach the outskirts of the village which is about 500m past the property line of the port. As mentioned before, adjacent to the proposed site is the old Petro-fuel tank farm now being used to store molasses; there is a two-storey office building; a wooden office building; a residential area with about 10 homes; the BNE Crude Oil Storage Facility; and other offices and businesses further east inside the port complex (refer to Figure 44).

The rest of the immediate area is either bare ground (landfill) and or low-lying swampy mangrove vegetation with savannah grass interspersed between a few broadleaf trees. Further to the west, northwest and south, lies vast swampy mangroves and or open savannah areas with very few pine trees.

Photo 32: Open Spaces to the North of proposed BNGC Terminal

To the south of the proposed site lies a recently landfilled area, bordered by the Big Creek. Beyond the Big Creek lies mangroves and savannahs before you reach the Texmar Shrimp farm located some 3km to the south of the site (see photograph 33 – left).

Photograph 34 below shows the west and north-west view from the proposed terminal location. As can be seen only the residential house (in the center of the photograph) can be seen within a one kilometer range of the terminal, with the western portion of Independence Village in background

Photo 33: View to the south of Proposed Terminal Site

Photo 34: View to the West and North-west of the proposed Terminal.

Photo 35: View to the East of proposed Terminal Site

Photograph 35 (left) shows a view to the east of the proposed site and one can see the road infrastructure along with the various offices, warehouses and residential buildings of the Big Creek Port facility.

Apart from these establishments and the residential home just outside the property line for the port (900 m away), there are no other buildings within a 1 km radius of the terminal.

IMPACTS:

As the proposed BNGC Terminal site falls within the port area, the only possible major impacts to any adjacent facility would be in the case of an accidental release and or fire/explosion. Apart from that, the terminal should have very little direct impact on any adjacent property or business.

Topography – Central Region Depot

The proposed site for the Central Region Depot is located in an area classified as rolling terrain with instances of karst outcrops. The 5 acre plot of land is owned by Belize Natural Energy (BNE), and is adjacent to the Hummingbird Highway approximately 1 mile outside the City of Belmopan.

A Geotechnical study was conducted by excavating 3 trial Pits and 3 boreholes on the site to determine soil type (see Figure 55A below). The following results were obtained:

Figure 55A: Map of Bore Holes and Test Pits – Central Region Depot

Trial Pit 1

Pit was excavated to a depth of 1.9m with two different layers of soil discovered. The first layer being topsoil measuring 0.3m thick. The second layer was sandy fat clay (**CH**) with assumed limestone rocks measuring 1.6m thick. Excavation became difficult for excavator to continue at 1.9m depth due to the fact that rocks became larger so excavation was stopped. A sample taken from Bore Hole 1 (BH1) at a depth of 1.0m and contained 34.6% sand, 23.3% silt and 42.1% clay. This soil is classified as Sandy Fat Clay (**CH**).

Trial Pit 2

Pit was excavated to a depth of 2.0m with two different layers of soil discovered. The first layer being topsoil measuring 0.5m thick. The second layer was sandy lean clay (**CL**) with assumed limestone rocks measuring 1.5m thick. Excavation became difficult for excavator to continue at 2.0m depth due to the fact that rocks became larger so excavation was stopped. A sample taken at from Bore Hole 2 (BH2)a depth of 1.0m and contained 48.3% sand, 25.2% silt and 26.5% clay. This soil is classified as Sandy Lean Clay (**CL**).

Trial Pit 3

Pit was excavated to a depth of 1.7m with two different layers of soil discovered. The first layer being topsoil measuring 0.4m thick. The second layer was silty sand (**SM**) with limestone rocks measuring 1.3m thick. Excavation became difficult for excavator to continue at 1.7m depth due to the fact that rocks became larger so excavation was stopped. A sample was taken from Bore Hole 3 (BH3) at a depth of 1.0m and contained 60.6% sand, 31.5% silt and 7.9% clay. This soil is classified as Silty Sand (**SM**).

Slopes, Drainage and Flooding

Photograph 36A - Flow of drainage at Central Region Depot Site (top of picture is west)

The Central Region Depot is for the most part sloping towards the west and south west, which would then influence drainage to flow in those directions (see photograph 36A above). From the Flood Risk Map above (Figure 45) it can be seen that the location of the depot is within an area classified as "No Flood Risk" (Red Arrow). Storm water runoffs would flow west towards the highway and then south towards a small perennial creek that runs towards the east through the adjacent property (See Photograph below).

Impact on Protected Areas

The nearest protected area to the Central Region Depot is the Guanacaste National Park which is located 4.5 kilometers north of the proposed site. At this distance the Central Region Depot would have no impact on the said Guanacaste National Park.

Climate, Hydrology and Meteorology

The Central Region Depot located in Central Belize falls within the zone that receives between 80" to 100" of rain per annum (Figure 49 above). According to records obtained from the Meteorology Office, data from the Belmopan Weather Station located about 3 kilometers north of the proposed site for the depot, the climate is said to be mostly hot and humid with an average temperature ranging between 23° C to 28° C and rainfall averaging between (see Figures 55B & 55C below).

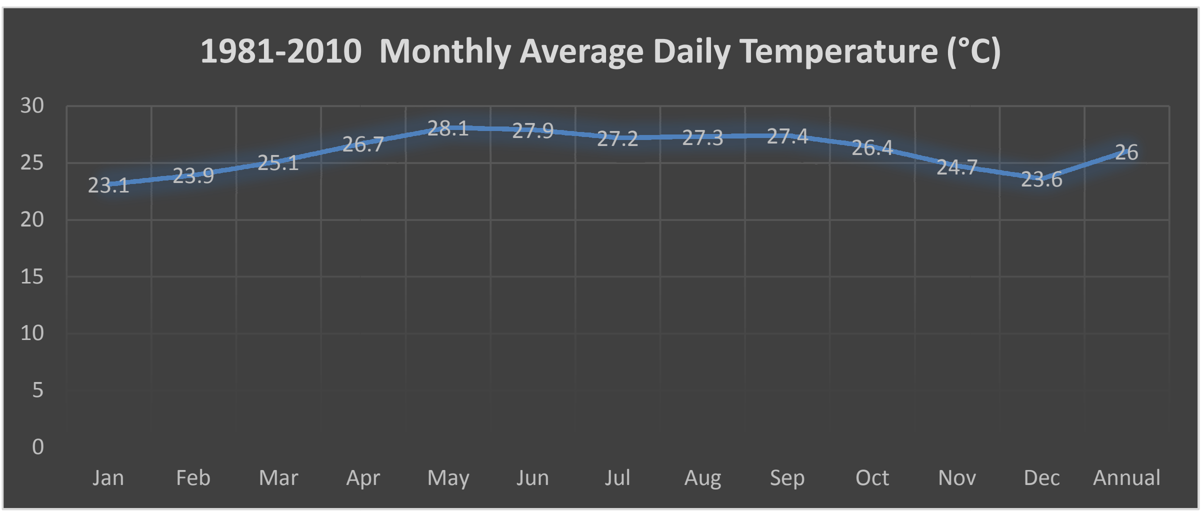


Figure 55B: Average Temperature by Month 1981-2010 – Belmopan Weather Station

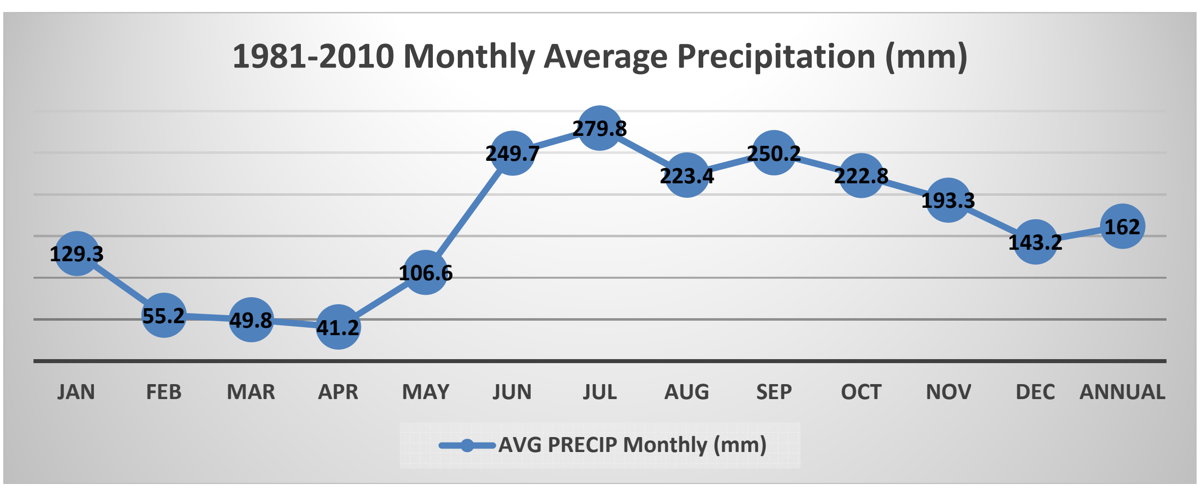


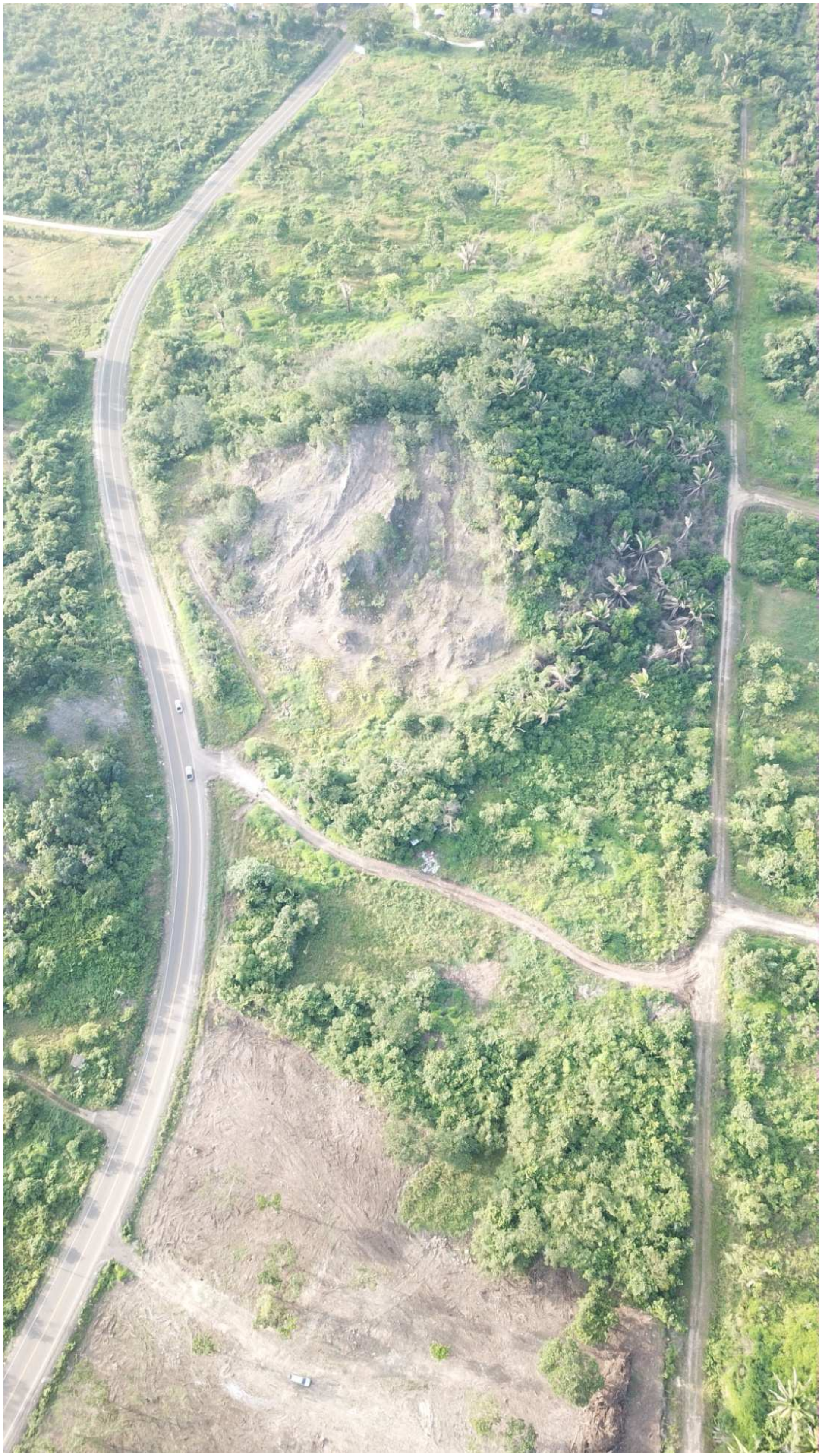
Figure 55C: Average Rainfall by Month 1981-2010 – Belmopan Weather Station

Land Use

The proposed site for the Central Region Depot is located in an areas with very few development, except for one or two residential homes within a half-kilometer radius. The site is bordered by several quarry sites to the north, south and west, where the property across the highway was once used as the garbage disposal site for the City of Belmopan. To the east of the proposed site looks like a proposed subdivision, but is yet without public utilities.

For the most part the immediate surrounding areas have had most of the original vegetation removed and are now overgrown with shrubs, some trees and mostly grass (See photographs 36B, B1, B2, B3, B4, B5 below).

Photograph 36B – Western View from proposed site of present Land Use



Photograph 36B-1: Northern View from proposed site of present Land Use

Photograph 36B-2: North-western View from proposed site of present Land Use

Photograph 36B-3 – North-Eastern View from proposed site of present land use

Photograph 36B -4: Eastern View from proposed site of Land use

Photograph 36B – 5: Southern View from proposed site of present land use.

Topography – Northern Region Depot

The proposed site for the Northern Region Depot is located in an area classified as flat to slightly rolling terrain   The 10 acre plot of land will be purchased by BNGC and is adjacent to the Phillip Goldson Highway (Mile 57) approximately 1.5 miles north of Orange Walk Town.

A Geotechnical study was conducted by excavating 2 boreholes on the site to determine soil type and three boreholes to assume bedrock (see Figure 55C-1 below). Dynamic penetration tests were performed at each location to determine load bearing capacity of the soil. The following results were obtained:

Figure 55C-1 – 5: Map showing locations of Boreholes.

Borehole

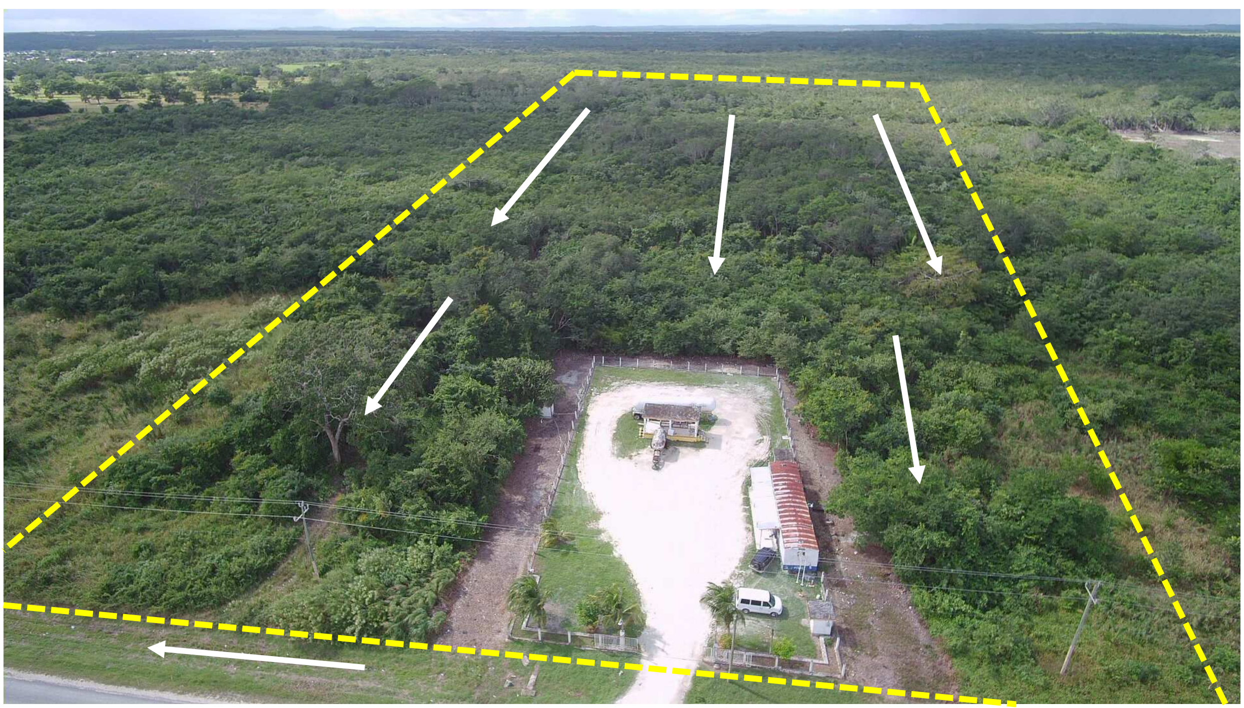
The bedrock depth was found to be between 2.5 meters to about 10.5 meters for Boreholes BH1, BH2 and BH3.

Borehole w/ Sampling (BHS1)
Pipe was driven to a maximum depth of 3.0m with three different layers of soil discovered. The first layer being topsoil measuring 0.2m thick. The second layer was classified as fat clay with sand (CH) (21.9% sand, 29.3% silt and 48.8% clay) measuring 0.7m thick. The third layer was classified as lean clay (CL) measuring 2.1m thick.

Borehole w/ Sampling (BHS2)
• Pipe was driven to a maximum depth of 2.2m with three different layers of soil discovered. The first layer being topsoil measuring 0.4m thick. The second layer was classified as elastic silt with sand (MH) (19.4% sand, 28.1% silt and 52.5% clay) measuring 1.5m thick. The third layer was classified as lean clay (CL) measuring 0.3m thick. Ground appeared to be very hard and hence sampling pipe became difficult to drive into ground this cause the operation to stop at the 2.2m depth.

Slopes, Drainage and Flooding

The Northern Region Depot is for the most part flat and although the water table was not reached during the soil testing phase, water would tend to percolate vertically and run less horizontally. In heavy rainfall, though, the water would tend to flow towards the highway and then south (see Photograph 36C below). From the Flood Risk Map above (Figure 45) it can be seen that the location of the depot is within an area classified as "No Flood Risk" (Blue Arrow). With respect to its hydrology, the proposed site falls in the "Coastal Shelf" Water Province.



Photograph 36C - Flow of drainage at Northern Region Depot Site (top of picture is west)

Impact on Protected Areas

The nearest protected area to the Northern Region Depot is the Honey Camp Lagoon Reserve which is located some 15 kilometers to the south-east of the proposed site. At such distance the Northern Region Depot would have no impact on the said Honey Camp Lagoon.

Climate, Hydrology and Meteorology

The Northern Region Depot located in northern Belize falls within the zone that receives the least amount of rainfall in Belize, ranging from 60" to 80" per annum (Figure 49 above). According to records obtained from the Meteorology Office, data from the BSI Towerhill Weather Station located about 10 kilometers south of the proposed site for the depot, the climate is drier in the first three months of the year but with heavier rainfalls during the latter months, with average temperatures ranging between 23° C to 28° C (see Figures be 55C & 55D below).

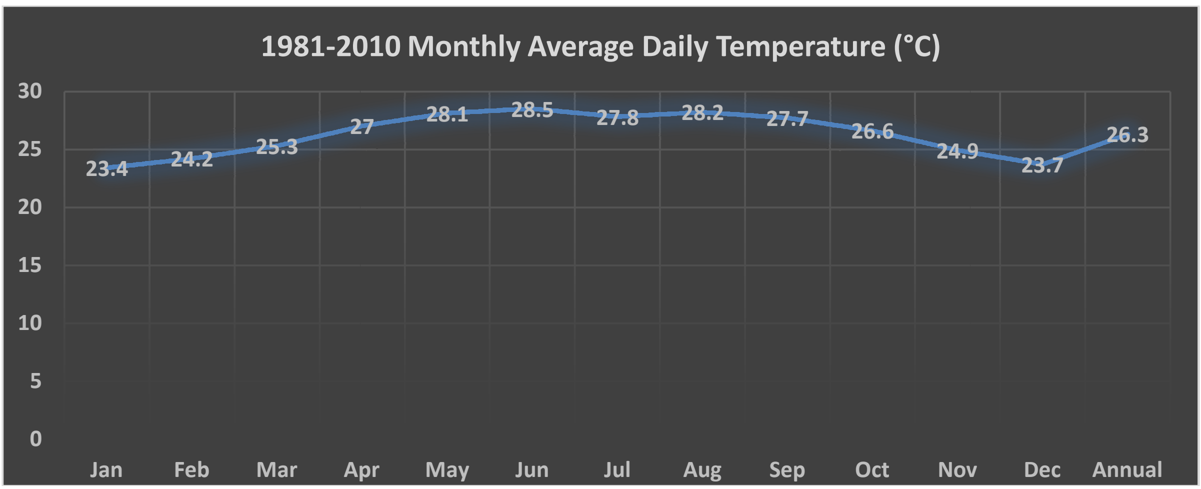


Figure 55C: Average Temperature by Month 1981-2010 – Towerhill Weather Station

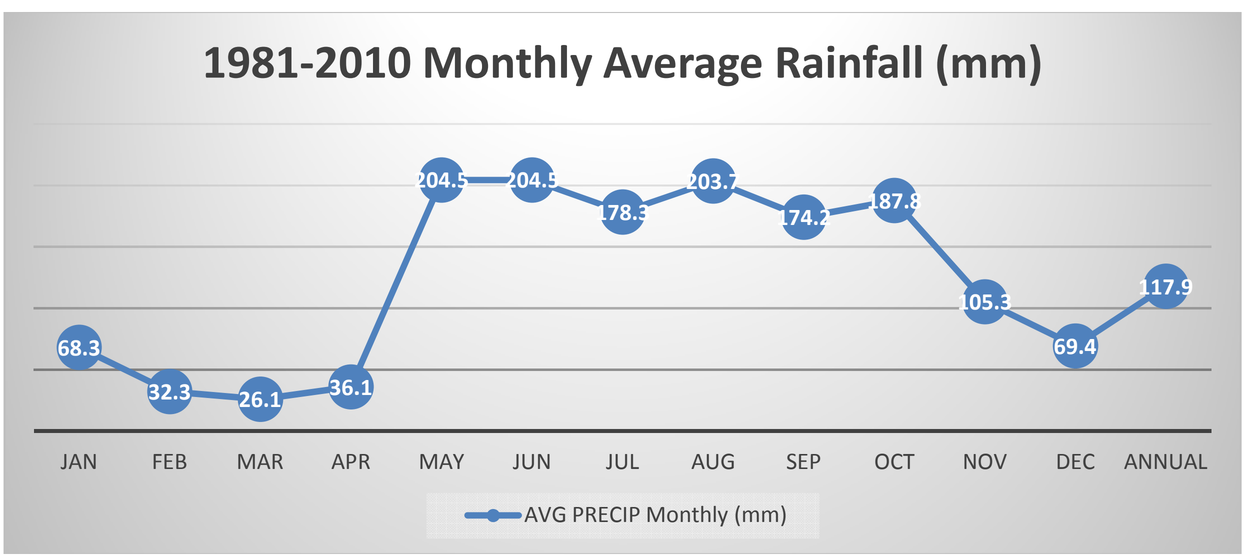


Figure 55D: Average Rainfall by Month 1981-2010 – Towerhill Weather Station

Land Use

As mentioned earlier, the area where the proposed depot will be situated is located at Mile 57 along the northern highway in very flat region. The lands surrounding the proposed site is either under secondary vegetation, cane fields, grass fields being used as pasture, used for some other form of business activities (scrap metal), slaughter house and the site itself is being used as a butane depot (BWEL) (See photographs 36C, C1, C2, C3 below). There are only a few residential homes within a 1 kilometer distance of the proposed site.

Photograph 36C –1 - Northern View from the proposed site of present land use.

Photograph 36C-2 – Eastern View from proposed site of present land use.

Photograph 36C-3 – Southern View from the proposed site of present land use.

Photograph 36C-4 – Western View from proposed site of present land use.

2.6 Waterbodies

Apart from the mangrove swamp, immediately to the south and southwest of the proposed BNGC Terminal site, the closest open body of water is the marina area of the port which is approximately 200m southeast of the site. The marina has been recently dredged and is about 10 meters deep and has a turning basin just over approximately 400 m wide at its widest point. The channel to the marina is about 1.8 km from where the berthing area is to the open sea.

The Big Creek, which drains the area west of the terminal all the way from the Bella Vista and San Juan Villages (20 km upstream), just east of the Maya Mountain Range; lies approximately 300m south west at its closest point to the site. The Big Creek winds itself along the coastal plains and at one point in time used to empty itself into the Caribbean Sea, but since the port has dredged and continues to dredge, it now empties into the marina (see Figure 56 below).

Figure 56: Water bodies nearest the BNGC Terminal

2.7 Air Quality

Since the project is still in its infant stage, the only air quality test done on site has been with the use of a BW Gas Alert MicroClip XL Meter #01 (Ser. #KA415-1087789) that was used to test for Hydrogen Sulphide (H2S), Oxygen Level (O2), Lower Explosive Limit (LEL) and Carbon Monoxide (CO). The results of the ten (10) chosen locations on the proposed site (see Figure 57 below), revealed that no carbon monoxide (ppm), H2S (ppm) and explosive gas levels (LEL%) were detected, i.e. they all recorded zero (0). The oxygen levels were recorded as being normal at 20.9% at all locations.

Figure 57: Map of Air Quality Sampling Points (AQTP) and Diff Tubes Location

Since BNE has its Crude Oil Storage Facility just over 100 m from the proposed terminal location and conducts quarterly air quality tests for Benzene, Toluene, Ethyl-Benzene, mp-Xylene and o-Xylene; the results could provide an idea of what could be expected from an LPG facility such as that of BNGC. BNE conducts its Air quality using passive diffusion tubes which are supplied and analyzed by Gradko International Ltd. Based in the UK. Since they require no battery supply, Diffusion Tubes are ideal for carrying out long term monitoring of gaseous pollutants where spatial coverage is required.

Their only restriction is that they provide monthly mean averages of pollutant concentration but do not provide more detailed temporal information. They do not, for instance, provide the information of a daily peak in pollutant concentration. A set of Diffusion Tubes were placed on the Terminal site to commence obtaining background data. However they do provide useful information for comparison against annual mean air quality standards.

BNE has several monitoring stations at its Big Creek Facility, at the office, near the tank farm and under the loading bay. The following parameters were monitored, nitrogen dioxide, sulphur dioxide (SO2) and the Volatile Organic Compounds (VOCs) known as BTEX (Benzene, Toluene, Ethyl Benzene, Xylene). As the goal of this process is to get the best possible scenario of the air quality of an LPG terminal, the results for the monitoring station under the Loading/Discharging Bay will be analyzed.

As none of the Environmental and Health Regulations of Belize actually has standards set for ambient NO_2, SO_2 and BTEX levels, BNGC will use the following ambient and Permissible Exposure Limits (PEL) listed in Table 10 below:

Chemical	Standard (TWA)	Regulation
Benzene	5ppb	NIOSH (Ambient)
Toluene	100 ppm / 200ppm	NIOSH / OSHA
Ethyl Benzene	100 ppm	NIOSH
Xylene	100 ppm	OSHA
NO_2	40 mg/m^3)	OSHA
SO_2	5 ppm (13mg/m^3)	OSHA/ NIOSH

Table 10: Permissible Exposure Limits for BTEX, NO_2 and SO_2

The Belizean and US legislations do not cover Benzene, despite the fact that it is a known carcinogen, and the World Health Organization (WHO) cannot recommend a safe level of exposure because of benzene's toxicity.

Figure 57A below shows the results that were obtained for BTEX Levels from 2007 to 2016 at the Loading Bay monitoring station in Big Creek (200m away from the proposed Terminal location):

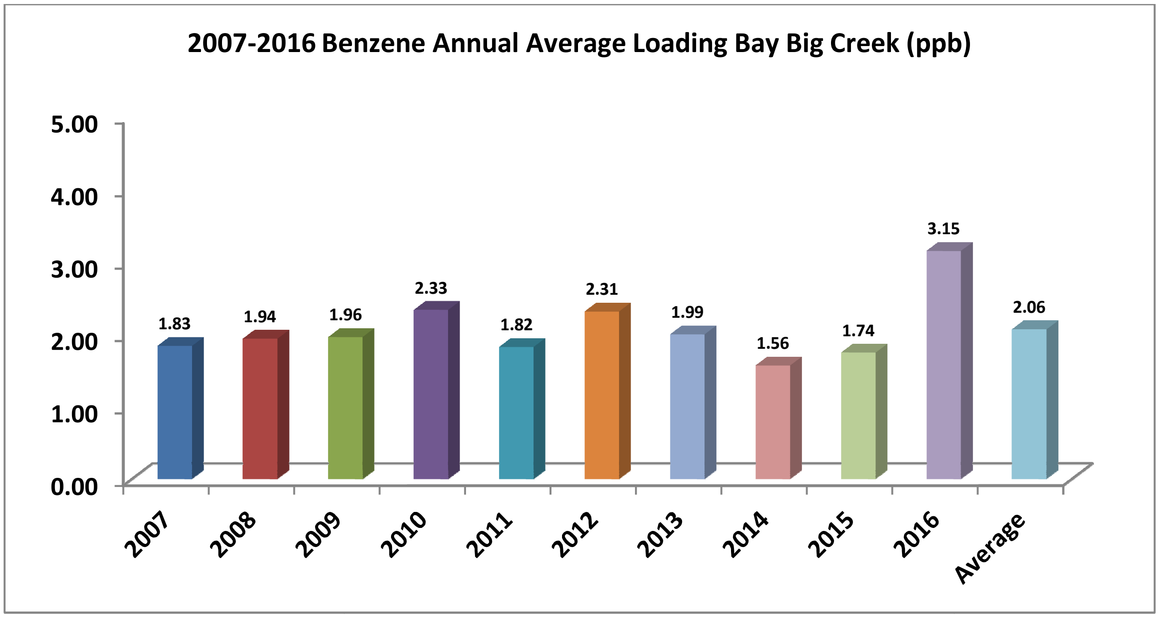


Figure 57A: Graph Showing Benzene Levels at Big Creek Loading Bay

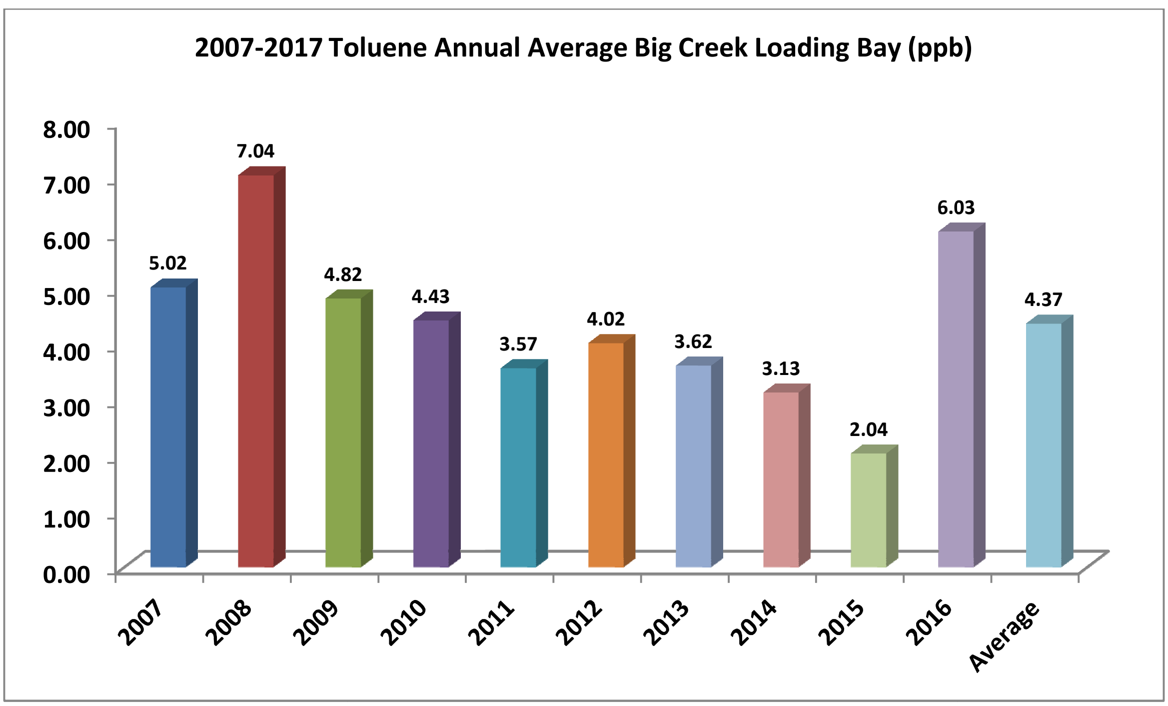


Figure 58: Graph Showing Toluene Levels at Big Creek Loading Bay

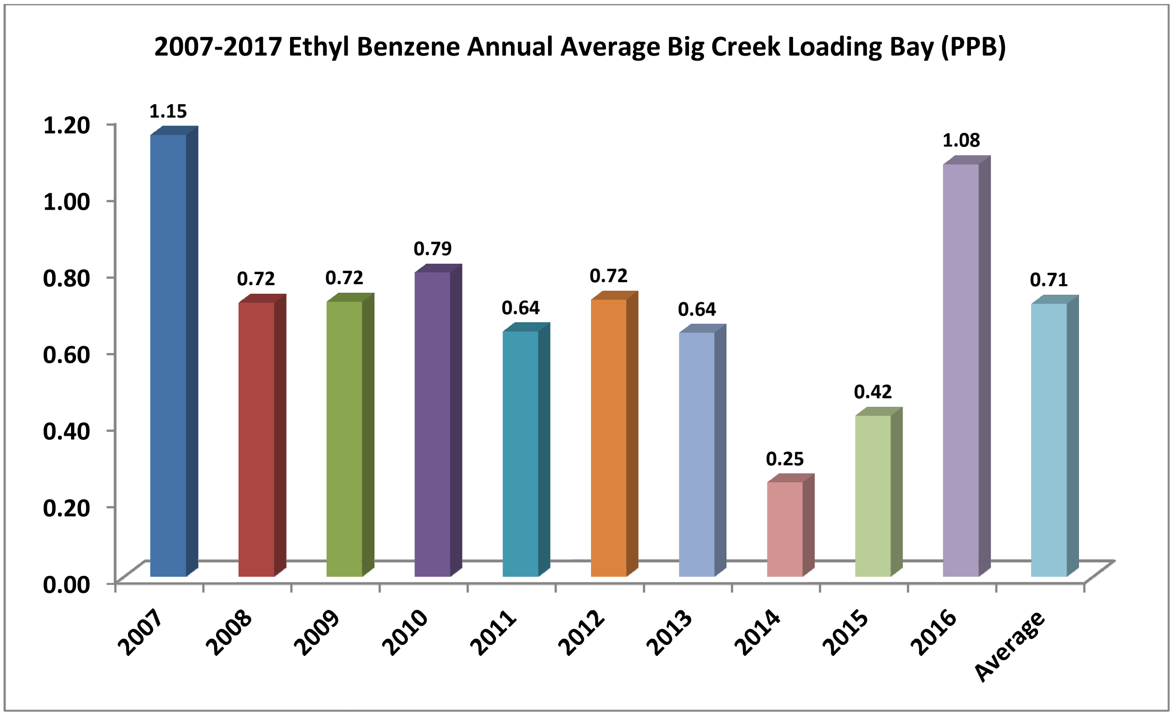


Figure 59: Graph Showing Ethyl Benzene Levels at Big Creek Loading Bay

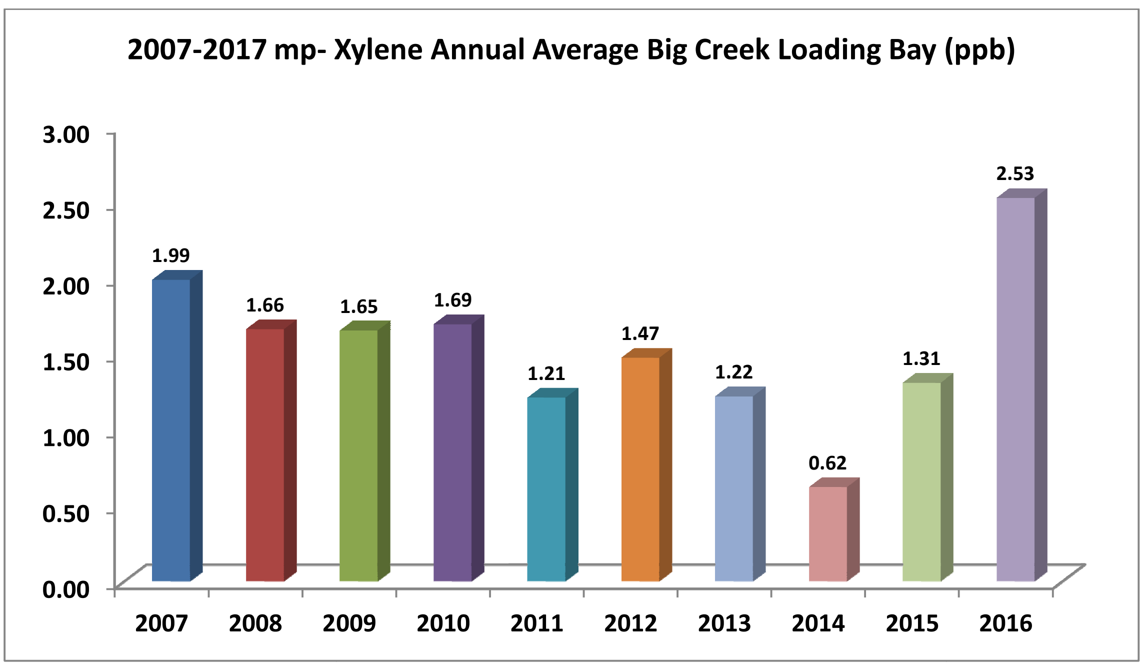


Figure 60: Graph Showing mp-xylene Levels at Big Creek Loading Bay

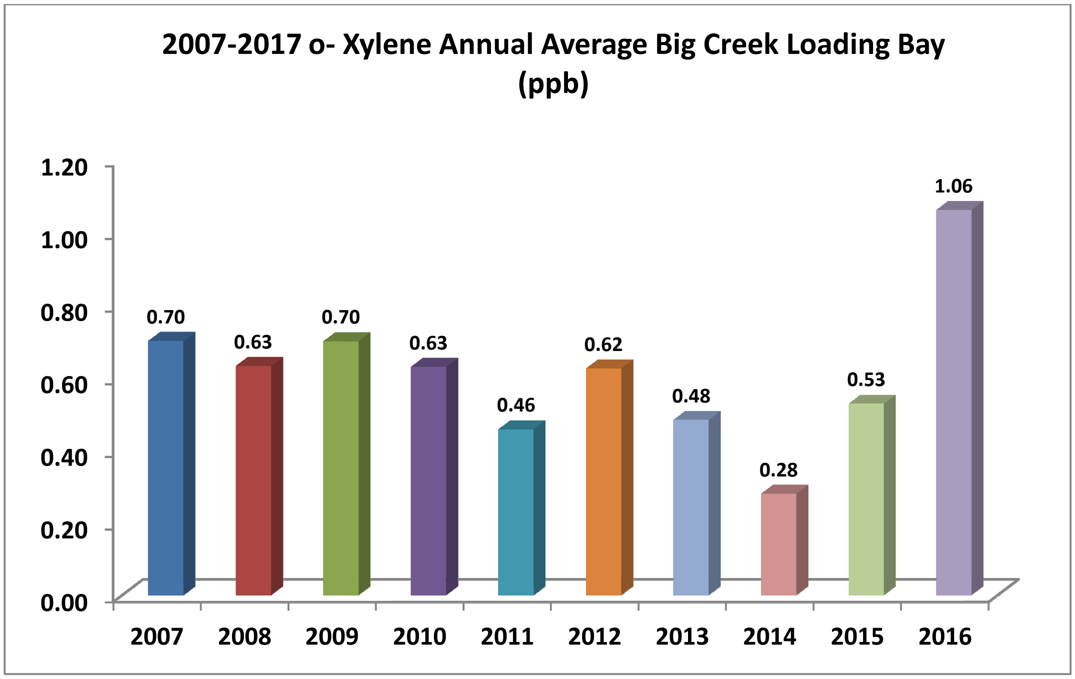


Figure 61: Graph Showing o-Xylene Levels at Big Creek Loading Bay

As can be noted in Figure 57A above, the highest annual average concentration of Benzene was recorded in 2016 at 3.15 ppb which is less than the ambient standard of 5ppb. At no point in time over the 10 year period did the annual average concentration level of Benzene exceed the NIOSH Standard; as a matter of fact the overall average over the said period was 2.06 ppb – less than half of the recommended permissible limit.

As for Toluene, Ethyl Benzene and the Xylenes (mp- and o-), the levels obtained over the 10 year period could be considered negligible, as they were far below the recommended standard. For example, Toluene had an overall annual average concentration of 4.37 ppb, which when converted to ppm is 0.00437 ppm. The standard for Toluene is 100 ppm or 100,000 ppb. All other parameters had similar averages to Toluene.

When compared to US National Ambient Air Quality Standards (NAAQS), the level of NO_2 and SO_2 concentrations can be considered negligible. Similar to the concentrations obtained for Toluene and the other VOCs, the NO_2 and SO_2 levels were far below the recommended TWA levels. In terms of NO_2, the standard is 40 mg/m^3, nearly 20 times and 15 times that of the average annual concentration of NO_2 and SO_2, respectively (see Figures 62 and 63 below).

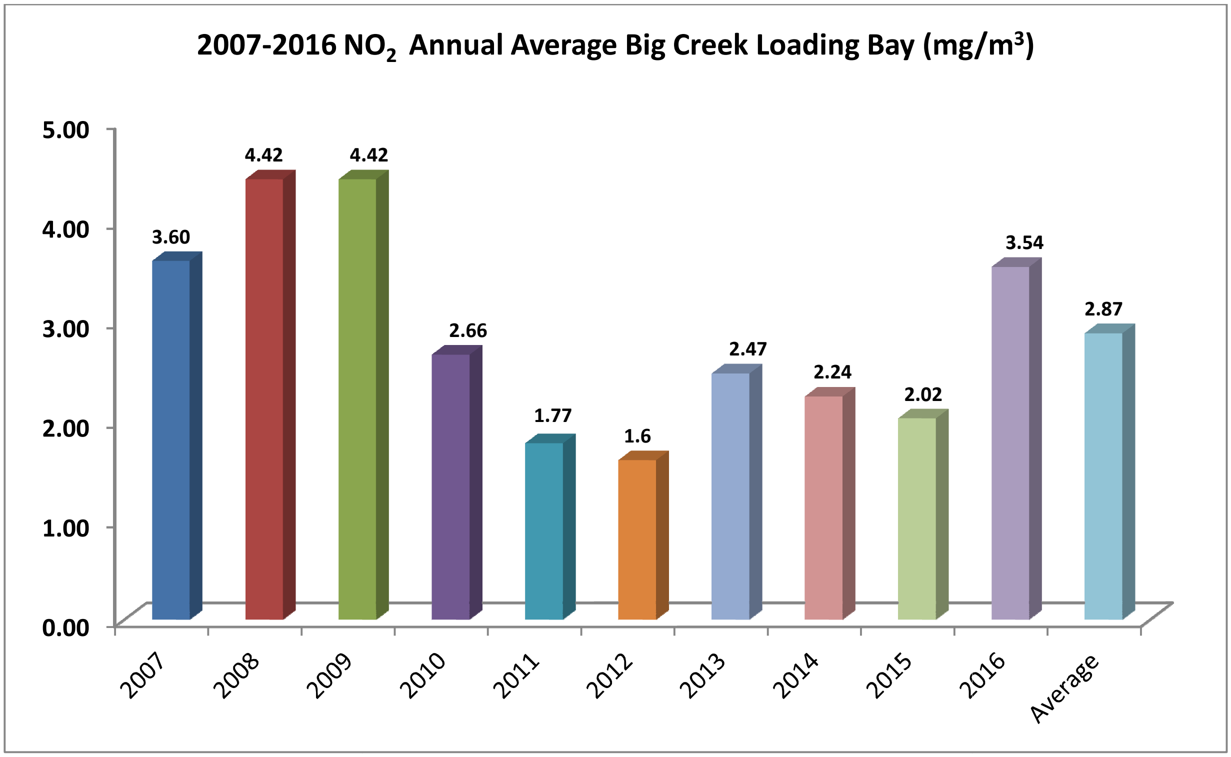


Figure 62: Average Annual Concentration of NO_2 2007-2016.

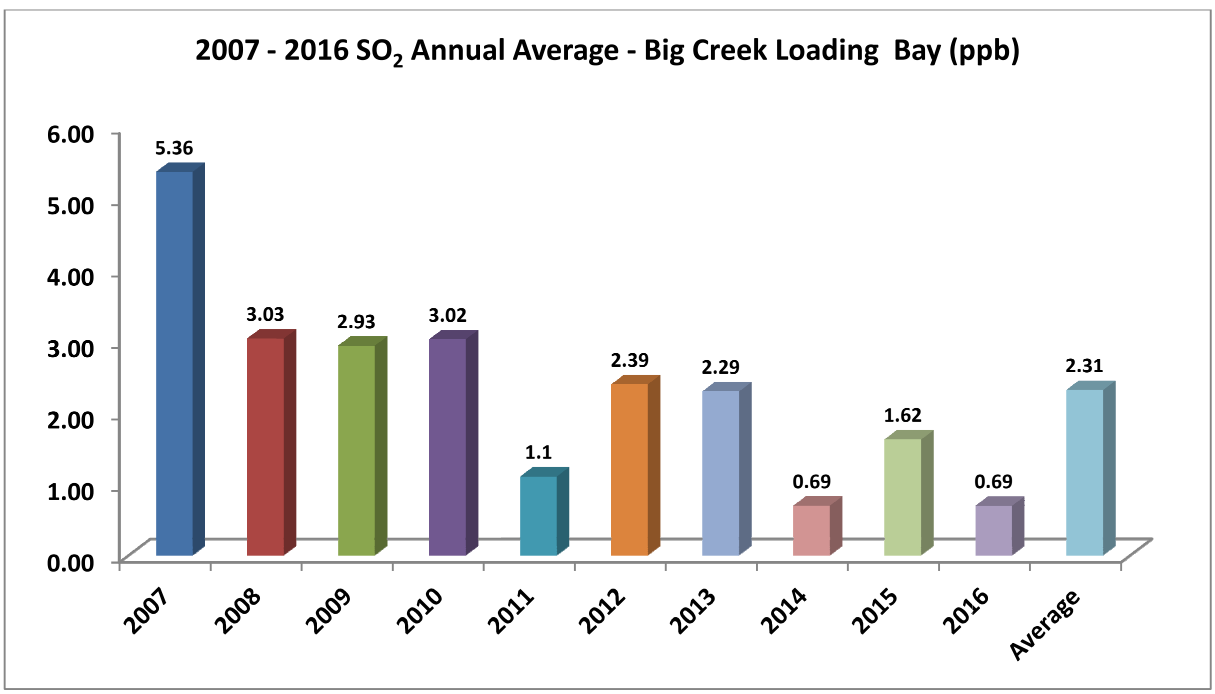


Figure 63: Average Annual Concentration of SO_2 2007-2016.

3.0 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

3.1. Introduction

Current national environmental policies are based on the need to take an integrated approach to environmental management and the need to work towards the goal of sustainable development. The Government of Belize through the Department of Environment, Coastal Zone Management Authority and Institute, the Fisheries Department, and the other government institutions such as the Land Utilization Authority (LUA), the Geology and Petroleum Department (GPD), the Forest Department, and the Public Health Department (PHD) are the regulatory bodies of the various instruments.

Of importance to the proposed developments is the need to identify those regulations and legislations which will need compliance for development activities in respect to the area and region of the proposed development. In light of the fact that although the area and region of the proposed developments are not within areas of significant importance in terms of their ecological and biological sensitivity, it is of great importance to BNGC that all its development activities strike a balance between development and the environment.

In view of this a review of the relevant environmental resource and planning legislations and regulations to ensure that BNGC's Terminal and Regional Depots meet policy and legislative criteria, and that relevant requirements are built into projects design and implementation. The policy review also outlines specific procedures and measures to be carried out before, during and after project development.

3.1.1 The EIA Process

The EIA Regulation was enacted in 1992. The EIA process of Belize is comprehensive and includes the following standard stages: (i) screening; (ii) scoping; (iii) baseline studies; (iv) public consultation; (v) review process; and (vi) preparation of an environmental compliance plan.

This project was required to conduct a Limited Level Environmental Study (LLES), in accordance with Schedule II of the EIA (Amendment) Regulations, 2007. This document is prepared following the DoE's Terms of Reference (ToR), the specifics of which have been agreed with them for the project proposed by BNGC, and a copy of which is provided in Appendix VII. The ToR follows the guidelines for the Preparation of an LLES and is based on the EIA Regulations, 1995, the EIA (Amendment) Regulations, 2007 and the Environmental Protection Act, 1992, revised 2003.

Since its inception as a Department, in 1989, the DoE, through the enactment of various legislations, has played an important role in Belize's development. One of the most important legislations implemented by the DoE that guides development is the EIA Regulations of 1995 and its Amendment of 007.

The EIA process in Belize is a well-structured process with the key components being typical of EIA processes of the region. It consists of an initial conceptual stage of project design, a screening phase (to determine if an EIA is needed), a scoping phase determine the scope of the EIA, if one is needed), and an EIA preparation stage, a vetting stage and follow-up activities (to ensure that any requirements identified by the EIA are satisfied).

The EIA process also calls for, if necessary, various levels of public consultation. This includes meetings with key stakeholders in order to get their views and inputs, local community consultations, the publishing of a notice in a local newspaper advertising the location and dates when the EIA document will be made available to the public for two weeks.

At the final stage of approval, the DoE requires the project owner ("developer") to sign an Environmental Compliance Plan (ECP), a legal document to which the developer needs to adhere. This document is legally binding and contains the mitigation measures, stages of development, and technology to be utilized during the various phases of the project. It also makes provisions for monitoring and enforcement of the conditions agreed to and provisions for failure to implement the agreement.

3.1.2 Legal Framework

The principal legislation having direct or indirect bearing on the project are therefore the Following:

3.1.2.1 The Environmental Protection Act SI 22/1992 and 328/2003 and 2009

This act established the Department of the Environment. Under section 3 (3) the Department has the responsibility to monitor the implementation of the Act and Regulations, and to take necessary actions to enforce the provisions of the Act and Regulations. This enabling legislation provides the Government and the Department with comprehensive environmental protection authority it needs in order to address modern environmental pollution problems. The Act also grants the Department of the Environment broad regulatory and enforcement authority for the prevention and control of environmental pollution, conservation and management of natural resources, and Environmental Impact Assessment (EIA).

The Environmental Protection Act entrusted the Department of the Environment with a broad range of functions relating but not limited to the assessment of water pollution, the coordination of activities relating to the discharge of wastes, the licensing of activities that may cause water pollution, the registration of sources of pollution and the carrying out of research and investigations as to the causes, nature and extent of water pollution, and the necessary prevention and control measures (section 4). The Department is also empowered to approve EIA's and LLES.

Under the revised edition 2000 Part III 7 (1) *(d) specifying the standards in excess of which pollutants discharged into the environment shall not be discharged or emitted; (e) formulating environmental codes of practices specifying procedures, practices or releases limits for environmental control relating to works, undertakings and activities during any phase of the development and operation, including the location, design, construction, start-up, closure, dismantling and clean-up phases and any subsequent monitoring activities and (f) environmental quality guidelines specifying recommendations in quantitative or qualitative terms to support and maintain particular uses of the environment and (j) the control of noise*.

Under the Act, no person, installation, factory or plant shall, unless specifically permitted by the Department, emit, deposit or discharge or cause emission of any pollutant or contaminant into the atmosphere or environment in contravention of the permitted levels:

Every person, installation, factory or plant emitting air pollutants is required to maintain and submit to the Department, records of the type, composition and quantity of pollutants emitted.

No person shall cause or permit the extracting, crushing, screening, handling or conveyance of materials or other operations likely to give rise to airborne dust without taking reasonable precautions, by means of spray bars or wetting agents, to prevent particulate matter form becoming airborne.

Furthermore any person or undertaking exploiting the land, water resources, seas or other natural resources shall ensure the protection of the environment against unnecessary damage or from pollution by harmful substances; and no person shall emit, import, discharge, deposit, dispose of or dump any waste that might directly or indirectly pollute water resources or damage or destroy marine life.

The amendment of January 2009 specifically addresses the Petroleum industry. It states: "to provide for greater environmental control and management of the petroleum industry". This includes any refining process, pollution and damage caused by spills, reporting requirements and defines deep well injection as hazardous waste disposal. The amendment establishes an Environmental Management Fund to assist the department in dealing with many aspects of their work (even if not petroleum related). This environmental fund will largely be funded by 0.01% of all Gross Revenue of all petroleum production in Belize.

3.1.2.2 Environmental Impact Assessment Regulations SI 107/1995

The Environmental Impact Assessment (1995) regulations describe in detail the processes involved in the preparation and evaluation of environmental impact assessments. The regulations divide projects or activities into three categories. The first category consists of those projects that automatically require an environmental assessment based on the sensitivity of the surroundings or the nature of the undertaking. The second category comprises those projects that may require an assessment to be carried out, but with some modifications based on the location and size of a project. The third category encompasses activities or programs that do not require an assessment to be conducted which may not have significant impacts on the environment.

3.1.2.3 Environmental Impact Assessment Regulations (amendment) SI 24/2007

These regulations refine and reclassify many of the regulations in the 1995 Act. Of particular importance for the current project is that while the storage of natural gas, coal, lignite on a large scale commercial basis" was already a schedule II activity (and could only require and EIA of not) under the 1995 regulations, the Amendment now gives the DOE the option to require a Limited Level Environmental Study (LLES). However, exploration works inside a protected area are still classified as a schedule 1 activity.

3.1.2.4 Pollution Regulations SI 56/1996 and Pollution (Amendment) Regulations, 2009

The Pollution Regulations of 1996 addresses issues of air, water and soil pollution, including noise pollution. Part III – 6 (1) deals generally with the emission of contaminants into the air where no person shall cause, allow or permit contaminants to be emitted or discharged either directly or indirectly into the air from any source.

Part X 31 (c & d) deals with pollution of land generally that could be harmful, or potentially harmful to animals, birds, wildlife, plants or vegetation. The Department of Environment is responsible for the enforcement of the Regulations made Act.

The Pollution Regulations were amended, via SI 101 of 2009 to include, among other things, issues related to the commitments made under the Montreal Protocol on Ozone

Depleting Substances. The major changes made were the prohibition on the imports of equipment using ozone depleting substances and the establishment of a licensing system for the importation of these substances. It basically allowed Belize to strengthen a licensing system for the importation of refrigerants into the country for data gathering purposes only. This amendment also complements the Act in addressing the petroleum industry, including refining.

3.1.2.5 The Mines and Minerals Act (Chap 226/ 2000)

The extraction of all non-renewable resources except petroleum is regulated by the Mines and Minerals Act (1988). The government owns all minerals under public and private lands, and, minerals are reserved from all future grants of state lands. The Act provides for licenses and royalties for the taking of minerals, and prohibits the pollution of any river, stream or watercourse.

3.1.2.6 Belize Public Health Act Revised Edition SI 40/2000

Under Part VIII of Offensive Trades 128 (1) b the Minister can make regulations relating to nuisances for the prevention, control or reduction of pollution or contamination of air, soil or water caused by any activity or condition resulting in the emission of a pollutant or contaminant into the environment. The Act also specifies restrictions and regulations for nuisances from factories or other industrial developments, and incidental provisions relating to offensive businesses.

3.1.2.7 National Lands Act (No. 6 of 1992) and SI 191 of 2000

The Act is designed to establish a framework for the management of national lands. The Act applies to all lands (other than Reserved Forest) not already "located" or granted, including any lands acquired by or ceded to the Crown. They are classified as town, suburban, rural, mineral lands and beach lands.

In section 28 where the sea, or any sound bay or creek is described as forming part of the boundary of any national land to be granted or disposed of, then the high water mark shall be considered to be the property boundary. Under the Act, the seabed is defined as the land extending seawards from the high water mark of ordinary tides and is considered National Land owned by the Government of Belize under the authority of the National Lands Act.

3.1.2.8 Petroleum Act (Chap 225 /2003)

Describes all aspects of oil exploration and exploitation including licenses, fees etc. The government owns all oil and gas under public and private lands, and these are reserved from all future grants of state lands.

3.1.2.9 The Forest Act SI 213/2000

This Act includes the establishment of Forest Reserves which may include mangroves, littoral forests and water bodies. The Forest Act has just recently been revised and fines and penalties have been amended.

3.1.2.10 The Land Utilization Act (Chapter 188 of revised edition 2007).

The Land Utilization Act, under which the Land Utilization Authority of the Ministry of Finance and Natural Resources (MFNR) is established, provides for measures to govern the use and development of land, and introduces measures for the conservation of land and watersheds. This Act governs the subdivision of private lands and the construction of jetties on coastal areas.

3.1.2.11 The Wildlife Protection Act (Chap 220/2000)

The Wildlife Protection Act controls the conservation, and use of protected species. It also empowers the Forest Department to pass regulations that govern the management of endangered flora and fauna. Under this Act "Endangered Species" may not be kept in captivity unless so approved by the Forest Department. All species listed as endangered by CITES are protected in Belize.

3.1.2.12 National Park System Act SI 215/2000

The National Parks Systems Act establishes four types or categories of protected areas: Natural Monuments, National Parks, Nature Reserves and Wildlife Sanctuaries. Several reports have suggested the usefulness of a revision of this Act to address the mandatory requirement of management plans for protected areas, assessment of the success of protected areas, and the periodic review of existing Management Plans for Protected Areas.

Under part II of the act the Minister may declare any specified area of land to be designated a national park, a nature reserve, a wildlife sanctuary or a natural monument.

A special permit can be obtained to carry out various activities in the protected area; however, specific rules are also enforced for various activities. Section III sets out the general rules and regulations pertaining to the Act.

3.1.2.13 Ancient Monuments and Antiquities Act SI 330/2000

Under section (4) of the Ancient Monuments and Antiquities Act, all ancient monuments and antiquities however situate, whether upon any land or in any river, stream or watercourse, or under territorial waters of the country, and whether or not before the date of the commencement of this Act in private ownership, possession, custody or control, shall absolutely vest in the Government. Under section (12), if any person finds any ancient monument or antiquity he shall within fourteen days of such findings report the details of the findings to the Minister.

3.1.2.14 Institute of Culture and History (Amendment) Act (No. 20 of 2003)

This act empowers the Institute of Archaeology to carry out research, interpretation and the protection of the Archaeological Heritage of Belize. The ownership of all ancient monuments and antiquities shall rest in the Institute of Archaeology, Government of Belize.

3.1.2.15 Solid Waste Management Authority Act SI 224 of 2000

Under the Act, the Authority shall devise ways and means for the efficient collection and disposal of solid waste employing modern methods and techniques and exploring the possibility of recycling waste materials. Under the Act "construction waste material" includes building materials from construction, alteration and remodeling building or structure of any kind, such as lumber, concrete, steel roofing, etc. SI 13/1991 established the Solid Waste Management Authority and gave it broad powers for the collection and disposal of solid waste.

3.1.2.16 Effluent Limitation Regulations SI 94/1995

These came into force in 1996, at which time the Department of the Environment commenced enforcing the Regulations. The Regulations are intended to control and monitor discharges of effluent unto land and into any inland waters or the marine environment of Belize.

3.1.2.17 Dangerous Goods Act Chapter 134

This Act is enforced by the Ministry of Home Affairs and sets out the stipulation for the licensing of businesses or establishments that will transport or store petroleum or any other dangerous goods such as LPG.

3.1.2.18 Forest Act

The Forest Act establishes the Forest Department and provides for the regulated cultivation of forest produce, including timber and non-timber products and includes both flora and fauna. It also provides for the issuance of Salvage Permits for the salvaging of wood material and other forest produce from areas destined to be cleared of vegetation. This allows the licensee to utilize natural resources that would otherwise be destroyed.

3.2 Administration

Some of the key agencies responsible for environmental protection and natural resources management are the Ministry of Finance and Natural Resources (MFNR), the Ministry of Agriculture, Fisheries, Forestry, the Environment and Sustainable Development and Immigration (MAFFESDI), the Ministry of Economic Development, Petroleum, Investment, Trade and Commerce, the Ministry of Health, and the Ministry of Tourism and Civil Aviation. These Ministries are empowered by legislation which govern the use of the natural resources and environment.

The MAFFESDI is one of the largest Ministries of the Government of Belize. It includes the DoE, the Agriculture Department (AD), Fisheries Department and the Forest Department (FD) among others. Among these departments are also various important sections such as the Conservation Division of the Forest Department. The MFNR includes the Lands and Surveys Department (Lands), Land Utilization Authority (LUA), and the Land Valuation Department.

The Environmental Protection Act 1992 legally established the Department of Environment (DoE), which is charged with a wide range of responsibilities. These include the guidance of development by industry, the encouragement of the adoption of environmentally friendly technology, the control of pollution, the requests for and administration of the EIA process, and the sustainable use of the natural resources and the environment.

The Geology and Petroleum Department is responsible for most aspects of oil and gas exploration and exploitation.

The Forest Department is responsible for implementation of the Wildlife Protection Act, 1981.

The Public Health Department of the Ministry of Health is responsible for overseeing a wide range of public health matters including the on-site sanitary working conditions of projects and developments, sewage systems, safety of and within buildings.

The National Institute of Culture and History (NICH) houses the Institute of Archaeology, which is responsible for the administration of the archaeology countrywide.

The Institute of Archaeology monitors all ongoing archaeological projects in Belize and issues permits for site work. The Institute is also responsible for all aspects involving any ancient Maya remains, artifacts and structures as well as any other item of historical significance. Any findings have to be reported to this department. Removal of artifacts or disturbance of sites is illegal without written permission of this Department.

3.3 International Conventions and Agreements

Belize is signatory or party to many international conventions and agreements, and is a member of many regional organizations involved in the management and protection of biological resources. Those that impact on biodiversity are listed below.

(a) World Heritage Convention (ratified in 1990).

(b) Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES) (ratified 1976).

(c) Convention on Biological Diversity (CBD) (ratified in December, 1993).

(d) Central American Biodiversity Convention.

(e) Convention for the Conservation of Biodiversity and the Protection of Priority Areas in Central America.

(f) Protocol on Specially Protected Wildlife (SPAW Protocol)

(g) Land-Based Sources of Pollution Protocol (LBSP).

(i) United Nations Framework Convention on Climate Change (ratified September, 1994).

(j) The Convention on Wetlands of International Importance Especially as Waterfowl Habitats (RAMSAR)(Signed 1971).

Belize’s compliance with its commitments under the above mentioned conventions has been minimal due to the lack of appropriate enforcement mechanisms, but some improvements have been seen in some areas over the recent years.

Permits, Licenses and Penalties

Although all of the above referenced regulations carry a penalty for various offences, the Table 9 below cites the most relevant permits, licenses that must be obtained by BNGC:

Regulation	Permit/License Required	Penalty
EIA	Environmental Clearance - ECP	$5,000 - $25,000 and or to prison term not exceeding 12 months
Effluent Limitations Regulations	Effluent License	$5,000 or 2yrs imprisonment
Forest Act	Salvage Permit	$500.00 & material confiscated
Dangerous Goods Act	Dangerous Goods License	$1,000
Trade License Act of Belize	Trade License	$500 plus $5/day the offence continues (2 yrs suspension)

Table 11: Permits, Licenses and Penalties pertaining to BNGC's Project

B. ENVIRONMENTAL ISSUES

ENVIRONMENTAL IMPACTS

As with all LPG bulk storage facility there's always the concern of the direct and cumulative impacts such facilities will have on the environment. In the case of the BNGC Terminal, because of the location of the site where the proposed terminal will be placed, it is anticipated that the proposed LPG storage facility will have no significant impacts on the environment. Despite this, the BNGC Terminal will be built and operated taking into consideration all EHS aspects and will implement mitigation measures to address such aspects.

It must be noted that the area being proposed for the terminal has been disturbed time and time again by the deposition of dredged and excavated material, the disposal of waste such as old machinery and also by bush fires that have constantly gutted the area, preventing larger vegetation from taking hold in the area. Most of the species of flora and fauna recorded were common and generalist, meaning fauna species of least conservation concern (wide spread and abundant). The high diversity of generalist species indicates the high degree of anthropogenic disturbances happening at the landscape level.

1.1 Flora

An onsite verification of the existing eco-system of the proposed site, occurred in mid-May, 2017. Transects were established and walked throughout the property going from east to west and north to south. During the assessment, it was noted that there was very few species of vegetation and that there was no major closed canopy due to the sparse vegetation *(see Photograph 37- left)*. As mentioned before the property consists of a considerable amount of grassland with some shrubs and few trees over 4m in height (berry & mango trees).

Photo 37 – Sparse Vegetation on proposed site for BNGC Terminal

Almost 60% of the proposed site is covered in grass, whilst the remaining 40% of the area has sparse vegetation (Photographs 3 above). Since there's no significant or endangered species in this area, it is anticipated that some vegetation will be removed for both development and for fire protection/prevention safety of the facility.

A portion of the site being utilized for the terminal may fall into the **lowland savannah** category. This vegetation type is common in the area, especially when approaching San Juan and Savannah Forest Station areas in southern Belize. This area is primarily comprised of scattered trees occurring in "short grass" (mainly sedges). The savannah is maintained as open vegetation by a combination of wet-season flooding, dry-season drought and fire. Typical trees found in this area include: *Acoelorraphe wrightii (savanna palmetto)*, Coco Plum – *Chrysobalanus icaco* and Blackberry, *Eugenia sp., MYRTACEAE.*

Grassland / Sedge – As mentioned earlier the primary vegetation on the property is savannah grass (approx. 60%) with a few patches of palmetto *(see Photograph 37A below)* and a few taller shrubs and trees scattered within or around the area. This type of grassland, as noted on the property extends all the way to the rear of the plot of land and into a swampy area *(see photograph 38 below).* The swampy area can be classified as Tropical Lowland reed swamps (UNESCO) and occurs mostly over peat soils and are inundated through much of the year. Much of this swampy area will remain intact and used as buffer around the rear of the facility.

Photo 37A – Grassland and palmettos with few shrubs and trees

Photo 38 – Grassland on Proposed Site for BNGC Terminal

Coco Plum – Chrysobalanus icaco – is a very common tree found throughout the coastal region of Belize *(right)*. Coco plum as it is locally referred to, is a shrub 1–3 metres (3.3–9.8 ft), or bushy tree 2–6 metres (6.6–19.7 ft), rarely to 10 metres (33 ft). It has evergreen broad-oval to nearly round somewhat leathery leaves (3 to 10 cm long and 2.5 to 7 cm wide). Leaf colors range from green to light red. The bark is greyish or reddish brown, with white specks .

Palmetto – Acoelorraphe wrightii - is native to Central America, and the Caribbean, where it grows in lowland areas and swamps and periodically in flooded forests *(left)*. It is a small to moderately tall palm that grows in clusters to 5–7 metres (16–23 ft), rarely 9 m (30 ft) tall, with slender stems less than 15 centimetres (5.9 in) diameter. The leaves are palmate (fan-shaped), with segments joined to each other for about half of their length, and are 1–2 m (3.3–6.6 ft) wide, light-green above, and silver underneath.

Blackberry, Eugenia sp., MYRTACEAE –Eugenia is a genus of flowering plants in the myrtle family Myrtaceae. It has a worldwide, although highly uneven, distribution in tropical and subtropical regions. All species are woody evergreen trees and shrubs. Several are grown as ornamental plants for their attractive glossy foliage, and a few produce edible fruit that are eaten fresh or used in jams and jellies. It is very common throughout Belize and is well known for the berry fruit it bears *(right)*. The fruit of this tree is used primarily in making local wine. Normally it grows very abundantly, once one bush is planted, there are many.

Mangoes - are juicy stone fruit (drupe) from numerous species of tropical trees belonging to the flowering plant genus *Mangifera*, cultivated mostly for their edible fruit *(left)*. The majority of these species are found in nature as wild mangoes. Mangoes are native to South Asia, from where the "common mango" or "Indian mango", *Mangifera indica*, has been distributed worldwide to become one of the most widely cultivated fruits in the tropics.

Elephant Grass: *(right)* There are numerous patches of tall elephant grass (Pennisetum purpureum), also locally referred to as wild cane grass *(although wild cane grass is different)*, is a species of perennial tropical grass. It has low water and nutrient requirements, and therefore can make use of otherwise uncultivated or disturbed lands.

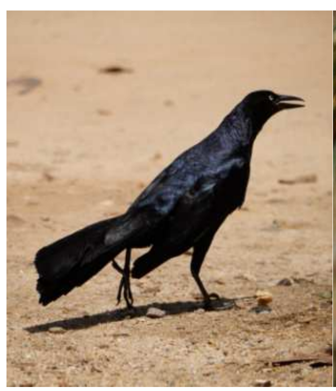
Sea Grapes (Cocoloba uvifera) is a species of flowering plant in the buckwheat family, Polygonaceae, that is native to coastal beaches throughout tropical America and the Caribbean. Common names include seagrape and baygrape. In late summer, it bears green fruit, about 2 cm (0.79 in) diameter, in large, grape-like clusters. The fruit gradually ripens to a purplish color. Each contains a large pit that constitutes most of the volume of the fruit.

C. uvifera is wind resistant, moderately tolerant of shade, and highly tolerant of salt, so it is often planted to stabilize beach edges; it is also planted as an ornamental shrub. The fruit is very tasty, and can be used for jam or eaten directly from the tree.

Apart from one or two red mangrove trees at the farthest corner of the plot, none of the above-mentioned vegetation are on the CITES list or under some form of protection; during the land clearing process and land filling operations, soil erosion and siltation will be the two major concerns.

1.2 Fauna

Birds



During the assessment and walking through the proposed terminal site, only a few common brown jays, locally known as the flycatcher or kiskadee; and some ravens were noted in the area. No other species of birds was noted during the assessment but it is highly assumed that other common coastal birds frequent the area *(see Photograph - right)*.

Mammals:

During the assessment no mammal species were sighted, but some tracks belonging to the hog-nosed skunk (*Conepatus mesoleucus*), was seen just outside the periphery of the proposed terminal site. Similar as with the case of the birds, it is believed that due to the presence of humans in the area and the disturbance to the area over the years, only few small mammal species would frequent the area, none of which would be considered as endangered.

Although the impact of the proposed project is considered to be very minimal to none, BNGC will implement proper developmental planning to avoid and reduce, as much as possible, any negative impacts on biodiversity and adjacent properties.

Regional Depots

Flora

Similar to the main Terminal in Big Creek, because of their locations of the sites for the proposed depots, it is likewise anticipated that the proposed depots will have no significant impacts on the environment. As mentioned earlier, regardless of the fact that the proposed sites are not considered ecologically sensitive, BNGC will put in place all the necessary features to ensure that the existing environment on and around the sites are not negatively impacted by the depots.

From the photographs in the land use section of this LLES, it can be seen that the sites for the depots have been constantly disturbed over the years and that each site have been entirely (Belmopan) or partially (Orange Walk) cleared in very recent times. The Belmopan site had a considerable amount of garbage and was being used as an illicit dump site, prior to it being cleaned out by BNE earlier in the year. The Orange Walk site had been partially cleared and backfilled with gravel chippings and portion is now being used for an LPG depot which can presently store up to 30,000 gallons of LPG in three storage tanks that are on site. Although most of the site is under secondary growth vegetation only a portion or what is necessary will be cleared for use by this project.

All of the species of flora and fauna recorded at both sites were common and generalist, meaning fauna species of least conservation concern (wide spread and abundant). The high diversity of generalist species indicates the high degree of anthropogenic disturbances happening at the landscape level.

Some of the vegetation found on both sites are listed in Table 12 below:

Central Region Depot	
Cohune Trees	*Attalea cohune*
Jacaranda	*Peltophorum Pterocarpum*
Northern Region Depot	
Madre de cacao	*Gliricidia sepium, Fabaceae*
Black Berry	*Eugenia sp., MYRTACEAE*
Jacaranda	*Peltophorum Pterocarpum*
Indian Jujube Plum tree	*Ziziphus mauritiana.*
Calabash Tree	*Cresedentia cujete,* BIGNONIACEAE
Trumpet Tree	*Cecropia peltata , CECROPIACEAE*
Guano palm	sabal mauritiiformis
Warree Cohune	*Astrocaryum mexicanum, PALMAE*
Bay Cedar or West Indian Elm Tree	Guazuma ulmifolia
Bulletwood (Bullet Tree)	*Manilkara bidentata*

Table 12 – List of Trees found on Depot Sites

Fauna

Similar to the flora, the fauna seen at the depot sites were very few very and of the generalists group. None of the fauna seen on sight are on any endangered species list. The following were the fauna found at both sites (see Table 13 below):

White-winged dove	*Zenaida asiatica*
Flycatcher	*Kiskadee*
Fly catcher	*Black phoebe*
Hummingbird	*Anthracothorax prevostii*
Turkey vulture	*Cathartes aura*
Common Raven	*Corvus corax*

Table 13: Fauna seen on Depot Sites during site Visits

1.2 Environmental Impacts & Mitigation Measures

As with any development project, the conversion of ecosystems, whether natural or pre-disturbed, into any anthropogenic land use has impacts on biodiversity, as it will cause loss of habitat, decrease food source availability (vegetation), interrupt wildlife movement and displace species. Many of the identified impacts are relatively small in scale and will either be permanent or have a long-term effect on the local environment. To mitigate against the known impacts relevant to this type of project, BNGC will implement good management practices during the various phases of the project.

Impacts to Vegetation and Mitigation

The vegetation cover of the terminal project site is dominated by characteristics of a typical coastal savannah mixed with marsh, mangrove and littoral forests. The littoral forest found along coastal areas is primarily dominated by palmetto plants, sea grapes (*Cocoloba uvifera*), coco plum *(Chrysobalanus icaco)*, some fruit trees (mangoes, black berries, etc.) and other littoral species. As previously mentioned there is very little mangrove on the proposed terminal site except for a couple small patches of red mangrove on the southwestern edge of the property.

At the regional depots, the vegetation types of the Central Region Depot, although much less, could also be found at the Northern Region Depot's site, except for the cohune palm. As mentioned earlier none of the species found on either site are of any economic importance.

The biggest impact to vegetation will be the removal of most trees for the placement of the storage tanks and infrastructure of the terminal and depots. As for the Central Region Depot, the impacts will be much less as the property has very little to no trees on it. The Northern Region Depot, although mostly covered in vegetation, has a habitat that is very common to the surrounding areas. To mitigate this impact, though, BNGC will as much as possible and as safely as can be done, leave vegetation in place that will not hamper, obstruct, or put in danger, the operations of the terminal and depots in any way. BNGC will leave as much vegetation in place to provide for a buffer and will also obtain a Salvage Permit to make best use of resources that would otherwise be destroyed.

Impacts to Fauna

Although only a couple species of birds were noted at all three sites during the transects, it is believed that there are several species of birds, which may inhabit the areas or at least visit the sites. As with most areas in Belize, the presence of crows (ravens), brown jays, kiskadees and several species of small birds; were noted. With the installation of the terminal and depots and the subsequent removal of the vegetation, the most ecological consequence resulting from the proposed development is the removal of habitats for the birds and other small animals (raccoons, rats, lizards, etc.) of the area. As the adjacent properties, although having had some level of disturbance, are somewhat undeveloped and have similar vegetation cover as the three sites, it is expected that these animals will more than likely migrate to the adjacent properties.

Although the number of fauna noted on the project sites were very limited in number, it is nonetheless either feeding grounds and or home to some of the native fauna seen. And as there is little that can be done with respect to the removal of habitat, BNGC will conduct its land clearing activities in such a unidirectional way that would allow for any small animals to migrate into the adjacent property.

During the land clearing process, should any fruit trees (saplings) be found, these will be transplanted along the perimeter of the sites and or planted in a suitable location.

2.0 CHEMICALS MANAGEMENT

2.1 Blending Process

The blending process will involve the use of Propane and Butane and during the loading of the tanker trucks, an odorant, namely mercaptan will be infused into the propane/butane mixture. Blending will only be conducted at the Terminal in Big Creek and not at the Regional Depots, which will simply be for distribution of the final blended product.

As mentioned earlier BNGC will conduct its blending operation using the batch blending or tank mixing method. This will entail the following processes:

1. The propane and butane storage tanks will be connected to the blending facility/skid via separate 4 inch schedule 80 black steel pipelines.
2. The blending facility/skid will in turn be connected to the designated blended product storage tank(s) via one of the same type of pipeline.
3. The blending facility will then be calibrated to pump propane and butane simultaneously into the blended product storage tank at a preset ratio of 70% propane and 30% butane. As Butane has lower vapor pressure than propane and LPG has in between vapor pressure; both will be mixed/blended in a proportion so that the mixture will meet the vapor pressure requirement for LPG. To accomplish this, BNGC will use several standards such as the ASTM D 2598 for blending.
4. When the LPG blending process is started the required flow rate and component ratio is set by the control system based on the ratio entered in the recipe. A density analyzer, installed on the system, generates a control signal, which is used to continually optimize the component ratio. This ensures that the blended product is always produced as specified.
5. The blending skid to be used by BNGC is designed to ensure maximum reliability and a minimal pressure drop to avoid any flashing of the propane and butane. These blending skids instantly respond to changes in process conditions or feedstock quality. The feedstock and blended product are continuously measured and adjusted during the batch to ensure optimum quality. Blended LPG products are volume corrected to local standard conditions using API 2540/ IP 200.
6. This blending process will continue until the designated blended storage tank reaches a storage capacity of about 70% to 80%, at which time the blending operation will stop and a sample taken for testing to ensure the blend complies with local standards.

7. Should the blend be in compliance, then the blending operation will continue until the tanks reaches a maximum storage capacity of 85%, after which blending is stopped and final testing done. If the initial testing (when the tank is at 70%-75% capacity) shows that the blend is not compliant with the local standard, then the necessary adjustments and additional testing will be done until the blended product is compliant and the tank reaches 85% storage capacity.

After the blending operation is completed the product will then be stored in the storage tank designated for blended product and subsequently loaded into the road tankers at the 3-lane loading bay via three skids with loading arms/hoses. During this loading process and before the LPG is pumped into the truck, mercaptan/methanethiol, an odorant, will be systematically injected into the line to ensure that the loaded product can be easily detected by smell should there be any release.

2.1 Safety during Blending Process

2.1.1 Administrative

Trained Staff

It is imperative that all employees of BNGC understand that LP Gas is potentially hazardous from the point of production until it has been safely used and the combustion products have been properly disposed of. They must understand that the term LP Gas describes a range of products which have much in common but also have their differences which affect the approach to safety. Safety comes from understanding the behavior of LP Gas and keeping it under control.

In light of this, BNGC will have a well-trained and competent staff on hand. As can be seen from the operations organizational structure, this facility will have a staff of approximately 13 personnel, all of whom will have to have some knowledge about LPG and its characteristics.

Standard Operating Procedures (SOP) and Checklists

To complement the above, BNGC will develop a Standard Operating Procedure (SOP) and Checklist for the "Blending of Propane/Butane." This SOP will be a dynamic one, in that any changes to the blending process will be documented, the SOP revised and all employees involved in this process will be re-trained using the revised SOP. As part of the SOP, a safety toolbox talk will be conducted prior to the commencement of any blending activity, among others. The checklist will ensure that no step(s), such as opening/closing a valve, is missed which can lead to an incident

Signage Program

BNCG will ensure that all storage tanks, pipelines, valves, etc. are labeled to avoid any confusion. Signs around the blending facility and the tank farm area, will warn/remind personnel of the dangers associated with propane and butane; and will also ban certain activities in the area, such as smoking and hot works.

As quite a bit of LPG related incidents have been caused due to the opening/closing of the wrong valves, all valves will be numbered and labeled so that reference to a specific valve cannot cause any confusion amongst personnel.

Pipelines will also be color-coded to ensure that personnel can distinguish which of the pipelines is for butane and propane fluid; as well as which is for vapor.

Drug Tests

To ensure that staff area always competent to perform their duties, especially, when blending and or loading or operating LPG tanker trucks, BNGC will put in place scheduled and surprise drug tests. This will as much as possible ensure that employees remain drug free and are in the best of mindset when working on the facility.

Emergency Plans

Regardless of all the safety devices and training, incidents are bound to occur whether due to human or equipment failure, or even a natural event; thus BNGC to reduce the loss of life, environmental pollution and damage to property, will develop an overall Emergency Response Plan (ERP) which will address, accidental releases, fire, natural disasters, sabotage, etc. BNGC will ensure that all personnel are trained in their roles and made aware of how all these plan works. During simulations, BNGC will involve personnel from adjacent businesses/offices within the port area, as well as residents who fall within the evacuation areas of the Terminal and depot locations.

2.1.2 Engineering

Safety Devices

During the planning and construction phase of the terminal, BNGC will look at installing the Best Available Technology (BAT) as much as reasonably possible. For the blending process, this include the installation of a state of the art blending skid, fully equipped with both analogue and digital pressure gauges so that the operating pressures can be closely monitored to prevent a rupture and or overfilling of the storage tanks.

From the very onset, the materials used to construct the facility will be compliant with international standards and certified. Storage tanks, pipelines, valves, fittings, plugs, unions, pressure relief valves, gauges, etc., will all be purchased from reputable companies.

Although all pieces of equipment are important, in the LPG industry, the pressure relief valves are considered one of the most important piece of safety device; as this can prevent pipelines and tanks from becoming over pressurized causing a large release due to a rupture. BNGC will ensure thus ensure that these pressure relief valves are installed on all tanks within the facility.

Monitoring

During blending operations, personnel will be on hand monitoring the gauges and will be backed up by personnel in the control room who will be monitoring the entire facility via cameras. During the blending process, personnel will be continuously conducting checks for leaks (with leak detectors and gas meters), listening for abnormal sounds and or ensuring that all pumps and equipment are operating in good order.

There will also be installed throughout the facility, hydrocarbon leak detectors that can detect any hydrocarbon (LPG) and immediately send a warning signal to the Control Room and/or activate an Emergency Shutdown Button or Valve.

Apart from this, passive monitoring of ambient air quality will continuously be done with the use of diffusion tubes that can measure the average monthly release of BTEX and NOSO.

Fire Suppression System

BNGC, in case of a release and or a fire, will have in place a fire suppression (kill) system with a network of hydrants and monitors (with foam) ready to suppress any release/fire should there be one. This system will be operated by a team of fire-fighters specifically trained in combating LPG/petroleum fires.

2.1.3 Personal Protective Equipment (PPE)

The last line of defense against any hazard is PPE's. All of BNGC personnel will be provided with the basic PPE's such as steel toed boots, gloves, hardhats, goggles, and coveralls. Those who will at any point in time be working near or within the LPG tank farm or processing area, especially when doing maintenance work, will be provided with either full-faced or half-faced masks with activated charcoal/chemical filters.

Personnel will also have access to Self-Contained Breathing Apparatus (SCBA's) and escape 5-minute packs should there be an incident and they need to either exit the facility or respond to the emergency.

BNGC is cognizant that PPE's are of no use if personnel don't use them or even more so, don them inappropriately, therefore all personnel will undergo training in the use of PPE.

2.2 Chemicals used in Blending Operations

LP Gas is produced in oil refining and the processing of natural gas liquids. Commercial, or fuel grade, LP Gas mainly consists of Butane and Propane with small amounts of lighter and heavier fractions, such as Ethane and Pentane. Apart from the propane and butane that are the main ingredients in the blending process, the only other chemical to be used by BNGC is Mercaptan (methanethiol), which is used as the ordorizing agent.

2.2.1 Propane

The table below provides an overview of some of the properties and hazards of Propane:

Names	
Preferred IUPAC name	**Propane**
Systematic IUPAC name	**Tricarbane**
Identifiers	
CAS Number	74-98-6
UN number	1978
Properties	
Chemical formula	C_3H_8
Appearance	Colorless gas
Odor	Odorless
Density	2.0098 kg/m^3 (at 0 °C, 101.3 kPa)
Melting point	−187.7 °C; −305.8 °F; 85.5 K
Boiling point	−42.25 to −42.04 °C; −44.05 to −43.67 °F; 230.90 to 231.11 K
Vapor pressure	853.16 kPa (at 21.1 °C (70.0 °F))
Hazards	
Safety data sheet	***See Appendix V***
GHS signal word	**DANGER**
Flash point	−104 °C (−155 °F; 169 K)
Auto-ignition temperature	470 °C (878 °F; 743 K)
Explosive limits	2.37–9.5%
US health exposure limits (NIOSH):	
PEL(Permissible)	TWA 1000 ppm (1800 mg/m^3)
REL(Recommended)	TWA 1000 ppm (1800 mg/m^3)

IDLH (Immediate danger)	2100 ppm

Properties and Health Hazards of Propane

Hazards of Propane

As can be seen from the table above, propane is a hazardous material and because of it being denser than air it is classified as a simple asphyxiant. When released in large quantities, although it readily dissipates into the open air, it may accumulate in low spaces and near the floor. When abused as an inhalant, it may cause hypoxia (lack of oxygen), pneumonia, cardiac failure or cardiac arrest.

Propane has low toxicity since it is not readily absorbed and is not biologically active. Commonly stored under pressure at room temperature, propane and its mixtures will flash evaporate at atmospheric pressure and cool well below the freezing point of water. The cold gas, which appears white due to moisture condensing from the air, may cause frostbite. Because of it low toxicity level NIOSH has set its Recommended Exposure Limit (REL) at 1000ppm (1800 mg/m^3) and the Immediate Danger to Life and Health (IDLH) level at 2,800 ppm.

Propane is denser than air. If a leak in a propane fuel system occurs, the gas will have a tendency to sink into any enclosed area and thus poses a risk of explosion and fire.

Another hazard associated with propane storage and transport is known as a BLEVE or boiling liquid expanding vapor explosion. This generally occurs when a tank with propane is heated by an external source and causes the container to rupture violently.

2.2.2 Butane

The second chemical to be utilized in the blending process is butane. The table below provides an overview of some of the properties and hazards of Butane:

Properties	
Preferred IUPAC name	Butane
Chemical formula	C_4H_{10}
Appearance	Colorless gas
Odor	Gasoline-like or natural gas-like[1]
Density	2.48 kg/m^3 (at 15 °C (59 °F))
Melting point	−140 to −134 °C; −220 to −209 °F; 133 to 139 K

Boiling point	−1 to 1 °C; 30 to 34 °F; 272 to 274 K
Solubility in water	61 mg L^{-1} (at 20 °C (68 °F))
Vapor pressure	~170 kPa at 283 K [4]
Hazards	
Safety data sheet	*See: Appendix IV*
GHS signal word	DANGER
Flash point	−60 °C (−76 °F; 213 K)
Auto-ignition temperature	405 °C (761 °F; 678 K)
Explosive limits	1.8–8.4%
US health exposure limits (NIOSH):	
PEL(Permissible)	none
REL(Recommended)	TWA 800 ppm (1900 mg/m^3)
IDLH (Immediate danger)	N.D.

Properties and Hazards of Butane

Hazards of Butane

Although similar to propane, butane is slightly heavier and can cause asphyxiation. Unlike propane, though, butane can enter the blood supply and within seconds produce intoxication. Being one of the most commonly misused volatile substance in the world, when inhaled it can cause euphoria, drowsiness, narcosis, cardiac arrhythmia, fluctuations in blood pressure and temporary memory loss.

When used as fuel it produces a small amount of nitrogen dioxide, a toxic gas, which is a human health hazard.

The differences in their physical properties mean that Butane and Propane behave differently under everyday conditions and more especially under extreme conditions. Such differences can be turned to advantages in certain applications. However, differences in boiling point, liquid density and vapor pressure between Butane and Propane are particularly important for safety and appliance performance. Table 14 below provides a clearer picture of their differences.

Property	Propane	n-Butane
Chemical Formula	C_3H_8	C_4H_{10}
Boiling point at 101.3 kPa (°C)	-42.1	-0.5
Liquid density at 15 °C (kg/m³)	506.0	583.0
Absolute vapour pressure at 40 °C (kPa)	1510	375
Flash Point (°C)	-104	-60
Upper flammable limit (% vol. in air)	9.5	8.5
Lower flammable limit (% vol. in air)	2.3	1.9
Vol. vapour per vol. liquid	269	235
Relative vapour density (air = 1)	1.55	2.07
Coefficient of expansion (liquid) per 1°C	0.0032	0.0023
Minimum air for combustion (m³/m³)	24	30
Kinematic Viscosity (centistokes) @ 20°C	0.20	0.30
Latent Heat of Vapourisation (kJ/kg) @ 20°C	352	368
Specific Heat (kJ/kg/°C) @ 20°C - liquid	2.554	2. 361
Specific Heat (kJ/kg/°C) @ 20°C - vapour	1.047	1. 495
Minimum ignition temperature (°C) in oxygen	470 - 575	380 – 550
Maximum Flame temperature (°C)	1980	1990
Octane number	>100	92
Specific Energy (gross) kJ/kg	49.83	49.40

Table14: Comparison of the Properties of Propane and Butane

2.2.3 Hazards of LPG

With the mixture of both Propane and Butane, the resulting LPG product will thus exhibit some characteristics of both products. Therefore as a combined LP Gas, the Inherent Hazards and Potential Risks of a Butane/Propane mixture, include but is not limited to the following:

- The principal potential hazard with LP Gas is fire and explosion. This derives from its inherent quality of high flammability and in extreme cases may combine with another condition, i.e. high pressure, and lead to the BLEVE (Boiling Liquid Expanding Vapor Explosion) phenomenon. This is a type of explosion that can occur when a vessel containing a pressurised liquid is ruptured due to high temperature and pressure. Such explosions can be extremely hazardous. There are also hazards incidental to the various modes of transport for distribution and use.

- An additional potential hazard may arise at the point of use if ventilation is inadequate and the products of combustion are not dispersed into the atmosphere. Carbon Monoxide may be produced and reach dangerous levels. LPGas 'sniffing' i.e. the intentional inhalation of LP Gas vapor seeking a narcotic effect can result in injury or in some cases, death. The risks associated with such hazrds can be controlled using available, proven technology, i.e. the safety equipment and procedures normally used by the LP Gas industry.

- Liquid LP Gas will cause cold burns if it comes into contact with the skin. Propane, with its low boiling point is more hazardous in this respect than Butane which, in cold conditions, is slower to vaporise and disperse. The eyes and body must be protected when handling all liquefied products.

- LP Gas vapor being heavier than air, may, in the event of a leak, accumulate in confined spaces and low-lying areas. The means of ventilation and meteorological conditions will influence the movement and dispersion of the LP Gas vapor.

- Any uncontrolled release of LP Gas is inherently hazardous. A liquid LP Gas leak is considered more hazardous in that it will expand to vapor form with volume in excess of 200 times that of the original liquid volume leak. Being heavier than air, vapor will tend to lie, or drift, close to the ground with a risk that it will find a source of ignition while it remains within its flammable limits. The physical properties are given in the table shown earlier in this section.

- Liquid LP Gas has a high co-efficient of volumetric expansion and therefore cylinders and tanks should never be completely filled. They should be filled with ullage (the unfilled space in a container of liquid) to allow for liquid expansion caused by an increase in temperature. The degree of ullage necessary will depend on the operating conditions, especially the maximum expected operating temperature. This potential risk is further controlled by a combination of safety devices and procedures and especially by control during product transfer operations. This potential risk explains why cylinders and tanks should only be filled under the supervision of competent persons and why illegal filling is dangerous because of the risk of overfilling.

- Because of its much higher vapor pressure, tanks and cylinders containing Propane need to be stronger than those for Butane, and both should be protected against excessive pressure. This potential risk is controlled by safety devices and by segregating the products or, where LP Gas mixture is handled, ensuring that the Propane content does not exceed a specified upper limit. In cold weather, a tank storing Butane may be subjected to negative pressure and must be capable of withstanding this.

- During the process of distribution, LP Gas will normally be transported in one or more modes. There will be hazards associated with the transport mode and with the consequences of traffic accidents and incidents. The risks will vary from country to country and with the transport mode.

2.2.4 Mercaptan

Butane & Propane blends are on their own, odorless and can go undetected if it leaks and can reach a source of ignition and cause an explosion. To solve such an issue, an odorant or odorant is added to the LPG (propane & Butane) blend to make it possible for humans to detect such leaks before an incident occur. Methyl Mercaptan (simply called Mercaptan), also known as methanethiol is the most common odorant used today.

The table below provides an overview of some of the properties and hazards of Mercaptan (Methanethiol):

Names	
Preferred IUPAC name Methanethiol	
Other names Methyl mercaptan Mercaptomethane Methiol Thiomethyl alcohol Methylthiol	
Identifiers	
CAS Number	74-93-1
UNII	2X8406WW9I
Properties	
Chemical formula	CH_4S
Appearance	colorless gas[1]
Odor	Rotten cabbage, flatulence
Density	0.9 g/mL (liquid at 0°C)[1]
Melting point	−123 °C, −189 °F, 150 K
Boiling point	5.95 °C, 42.71 °F, 279.10 K
Solubility in water	2%
Solubility	alcohol, ether

Vapor pressure	1.7 atm (20°C)[1]
Acidity (pK_a)	~10.4
Hazards	
R-phrases	R12, R23, R50/53
S-phrases	S16, S25, S33S60, S61
Flash point	−18 °C; 0 °F; 255 K [1]
Explosive limits	3.9%-21.8%[1]
Lethal dose or concentration (*LD*, *LC*):	
LD_{50} (median dose)	60.67 mg/kg (mammal)[2]
LC_{50} (median concentration)	3.3 ppm (mouse, 2 hr) 675 ppm (rat, 4 hr)[2]
US health exposure limits (NIOSH):	
PEL(Permissible)	C 10 ppm (20 mg/m^3)[1]
REL(Recommended)	C 0.5 ppm (1 mg/m^3) [15-minute][1]
IDLH (Immediate danger)	150 ppm[1]

Properties of Mercaptan

Hazards of Mercaptan

The safety data sheet (SDS) lists Methanethiol as a colorless, flammable gas with an extremely strong and repulsive smell. At very high concentrations it is highly toxic and affects the central nervous system. Its penetrating odor provides warning at dangerous concentrations. An odor threshold of 1 ppb has been reported. The United States OSHA Ceiling Limit for human exposure is listed as 10 ppm.

2.2.5 Environmental Impacts of LPG

As mentioned earlier, there aren't much major environmental hazards/impacts from LPG, unless there's a fire and or explosion, which can have some detrimental impacts on both facilities and the surrounding environment. Below are some of other environmental impacts of LPG:

- The products of complete LP Gas combustion - mainly water and carbon dioxide - are not inherently hazardous. Good installation practice specifies ventilation to supply the air required for combustion and to vent the products of combustion. This minimizes risk by preventing a build-up of carbon monoxide or a development of asphyxiating (i.e. oxygen-deficient) conditions.

- Accumulation of LP Gas vapor may result in the development of an oxygen-deficient atmosphere which carries a risk of asphyxiation. The visible cloud might be smaller or bigger than the actual gas cloud, depending on humidity in the air.

- Although it is non-toxic, when it is spilled in large quantities the only environmental damage it can cause is freezing to plants and small water bodies etc.

- LPG release less CO_2 per unit of energy than that of coal or oil. It emits 81% of the CO_2 per kWh produced by oil, 70% of that of coal, and less than 50% of that emitted by coal-generated electricity distributed via the grid. Being a mix of propane and butane, LPG emits less carbon per joule than butane but more carbon per joule than propane." *Source: http://en.wikipedia.org/wiki/Liquefied_petroleum_gas#Environmental_effects*

- Butane is used as a refrigerant and is used to replace freon as a refrigerant in freezers and refrigerators. Using butane as a refrigerant is more environment friendly compared to using halomethanes that are known to damage the earth's ozone layer.

- Although propane produces more heat than butane and is more efficient in combustion, butane has a characteristic that makes it a favorite: it liquefies easily, and therefore, makes containment easy.

2.3 Handling and Storage of LPG

Every uncontrolled release of LPG is a hazardous event and should receive urgent attention. As LP Gas is potentially hazardous from the point of production until it has been safely used and the combustion products have been properly disposed of; BNGC realizes that safety comes from understanding the behavior of LP Gas and keeping it under control. Therefore the handling and storage of Butane will be as follows:

2.3.1 Butane & Propane Storage – Terminal

Butane and propane will be imported into Belize by a certified and licensed Gas Carrier. When transported in large ships LP Gas is normally refrigerated or under pressure with Butane and Propane stored in different cargo. These will then be off-loaded using separate pipelines for the fluid and separate pipelines for the vapor. During off-loading from the Gas Carrier, BNGC personnel will be monitoring the entire transfer process by manning the connection points to the ship and the levels in the tanks. As the tanks are reaching their 80%-85% capacity, product flow will be diverted to the subsequent tank.

Storage tanks will be 123 feet 6 inches in length and 10 feet 10 inches in diameter. These tanks will be pressure tested and rated for propane, which has the higher pressure of the two gases. Tanks will be retro-fitted with pressure relief valves to ensure that the pressure in the vessels won't be exceeded. Tanks will be placed some 125 feet away from the fence perimeter and will have a space of 50 feet between rows, 25 feet between each tank battery and 5 feet 6 inches space between each tank in the tank-battery.

Butane will be stored in 1 six tank battery (example shown Photograph 3) whilst propane will be stored in 2 six-tank battery. The blended product will be stored in a single tank which if necessary could be complemented with another tank from either the propane and or butane tank batteries.

3.2 Mercaptan (Methanethiol)

Mercaptan (methanethiol) is normally transported in cylinders, similar to that used in household, only much larger (120 gals or 700 lbs). Mercaptan cylinders will be connected to an injection system, which will introduce the gas into the LPG blend at the prescribed rate.

As it is also flammable it has to be handled with care and stored accordingly. BNGC will construct a covered shed similar to that shown below in Photograph 39, where the mercaptan cylinders will be stored and at the same time be kept well ventilated.

Photograph 39: Covered shed with adequate ventilation for the storage of Mercaptan Cylinders.

Regional Depots – Handling and Storage

As mentioned earlier, the final blended product will be transported to the Regional Depots using BNGC's road tanker trucks. Once at the site, LPG product will be stored in two 30,000 gallons LPG Storage Tanks. Although the entire facility compounds will be fenced in, the storage tank area will either have a secondary fenced in area, or will have safety barriers put in place to protect the tanks from possible damage.

3.3 Mitigation Measures for Chemicals

As mentioned earlier, apart from butane and propane, the only other "chemical" to used in the formulation of an LPG blend, will be mercaptan, which is used to add an odour to the blend. Regardless of such, any incident involving any of the three materials, can quickly get out of hand and thus the need for proper mitigation measures to be put in place to prevent any such incident from occurring.

The table below provides the most serious risks/hazards associated with the handling, storage and movement of propane, butane and mercapatan, at all three locations (Mercaptan is not used at the Northern and Central regional depots); and also considers some of the mitigation measures to address such hazards:

Aspect	Cause	Impacts	Mitigation/Management Measures
Accidental release	Equipment and/or Human failure	• During the release of propane, butane or Mercaptan these gases create a freezing effect (frostbite) and at the same time creates oxygen deficient areas. • Formation of explosive atmospheres • Visual Impact (white cloud)	• Storage of chemical in original containers (mercapatan) • Storage of chemicals in well ventilated places. • Barriers to protect tanks and pipelines from becoming damaged • Put in place a preventative maintenance schedule to try and detect faulty or defective equipment before they fail. • Installation of BAT to ensure that facility and equipment used are as safe as can possibly be. • Have detection systems in place to quickly detect any release (pressure gauges, hydrocarbon detectors, etc.) • ONLY Trained staff will be allowed to handle chemicals • Develop and implement Chemicals Management Plan • Provide personnel with SDS for chemicals
Fire, Explosion	Operation of the facility, spills, accidents, leaks, etc.	• Ignition of vapour cloud can cause an explosion, which could spread into neighbouring properties. • Possible injury and death • Damage to equipment • Air pollution	• Utilize only explosion proof electrical equipment/material. • Proper grounding of tanks and ancillary equipment. • Have Permit to work System in place. • Train personnel in handling material • Installation of a pressure & leak detection system for piping and tanks • Trained Fire fighters / Drills • Installation of adequate fire hydrants & monitors to quickly suppress any fire at main Terminal. • Installation of ABC extinguishers and Purple K fire fighting cart at regional depots. • Installation of safety signs • Adhere to national and international guidelines (SANS 1087-3:2010). • Adhere to separation distances between tanks

Air quality and odours	Operation of the facility	• LPG Leakages can lead to toxic gas releases • Pressure valve release	• Minimize vapour leaks and losses through vigorous maintenance schedule. • Storage tanks to be filled to a maximum capacity of 85%. • Ensure a high standard of housekeeping.

2.4 IMPACTS OF TERMINAL OPERATIONS ON NEARBY WATER BODIES

Water quality deterioration from development activities especially those near coastal areas can result from sedimentation during the construction period, from land movement activities and road maintenance during the operational period. Change in the hydrological flow regime of the area has the potential for flooding elsewhere if proper mitigation measures are not implemented. Water quality deterioration is also possible from the production of nutrients coming largely from waste water discharge (sewage) if appropriate mitigation measures are not implemented.

As mentioned earlier, LPG, unless there's a fire and or explosion when released, LPG has very minimal impacts on the environment and such impacts are much less on water. The larger the water body the less the impact (cooling/freezing effect). As for the terminal facility itself, the biggest impact it is anticipated to have will be that of surface runoff, which in itself will be minimal.

Photograph 40: Drainage of BNGC Terminal Site

As can be seen from the photograph #40 above, because of the present layout and topography of the property (which is mainly flat) and the present drainage system around the proposed property (blue arrows); the prevalent drainage of water is primarily towards the south and south-east.

Big Creek

With the terminal in place the external drainage system will not the impacted as proper drainage and culverts will be put in place along the main Port of Big Creek Road at the entrance of the facility. The external drains will still take some storm water runoffs towards the Big Creek to the south, but within the facility itself, as BNGC will be constructing its water retention pond for fire-fighting purposes (100 ft W x 200 ft L x 15 ft D), drainage for surface runoff will be primarily directed towards the said pond. Thus this should have a positive impact as it will reduce the amount of storm water runoff reaching the Big Creek.

The only other impact is that the excavated material from the pond will be used to fill the lower south-western portion of the 15 acre plot. This again will temporarily cause some silt to runoff the property into the bordering drainage system, which flows through a mangrove area before reaching the Big Creek some 300m to the south-west.

Although most of the vegetation on the property will be removed and some land preparation done, there will be some silt entering the external drainage system, but as mentioned before, BNGC will try and direct all runoff towards the pond. The pond, therefore, will double as a pre-treatment pond before overflowing into the nearby external drainage system.

Overall the impacts of the terminal on the water bodies in the area will be minimal to negligible. This is especially so, as can be seen in the photograph, because there's continuous dredging and land filling operations between the terminal site and the Big Creek.

Marina/Docking Area

As for the sea (marina area) which lies some 150m to the east of the terminal facility, the impacts of the operations from the terminal itself on the water body (sea) should be none-existent. Apart from the offloading operations within the marina area itself, the LPG offloading operations should be no different from that of any other shipping operations within the marina area; and to some extent should be less impacting than other operations conducted at the same berthing area.

The biggest impact will be during the trenching operations for the burying of the pipeline leading from the marina to the terminal. During this period there should be expected some runoff with a bit more silt (most of the terminal is earthen and there is existing silt runoff when it rains). To prevent excess silt runoff, BNGC will ensure that trenches are properly constructed and compacted when completed.

Any release of LPG in the area should be minimal and should only occur after the transfer lines have been depressurized and disconnected. During disconnection of the pipeline, as with all LPG pipelines, very little product is released into the atmosphere. To further reduce this, BNGC will look at utilizing low emission transfer hoses and associated equipment.

Regional Depots – Impacts on Water

The Central Region Depot site is located approximately 2 kilometers east of the Roaring River, a tributary of the Belize River which lies some 5 kilometers to the north of the site. As for the Northern Region Depot site, it is located, at its closest point, some 1.5 kilometers to the west of the New River. There is no known tributary in the area that leads to the New River, although it is anticipated that storm water runoffs from the area would eventually reach the river through a network of natural and manmade drainage system.

As both Depots are far away from any major river or stream, and with the physical and chemical characteristics of LPG, it is expected that there should be no impacts to any water body, including ground water, which was still not encountered at 10 meters below the surface of the proposed site.

3.0 DISASTER MANAGEMENT & SOCIAL ENVIRONMENT

3.1 Safety Infrastructure

Cognizant of the various risks, hazards and impacts that LPG can have on the environment and surrounding facilities, BNCG will develop and implement a safety management plan for all aspects of it facilities, from off-loading, to storage, to blending, to in-land transportation and finally to customer distribution. The following are some basic safety management actions/activities that will be implemented by BNGC to ensure a very comprehensive safety management system and culture is implemented at its Terminal and Regional Depot facilities to protect the environment from any possible adverse impacts.

- ✓ As it pertains to LPG, the first rule of safety is to avoid any uncontrolled leakage of LP Gas. All systems will be designed by a certified engineering company (Polaris Ltd.) with the prime objective of prevention in mind. The Terminal facility will be built with all the relevant safety features including but not limited to; use of material and pressure rated piping, pressure relief gauges, automated and manual valves; digital and analogue pressure gauges; hydrocarbon leak detection sensors; a physical pipeline inspection program; an internal pipeline inspection program; a Control/Monitoring Room and the development of a comprehensive Emergency Management Plan; among other safety features. As for the Regional Depots, these will be fitted with pressure gauges, pressure relief valve and overfill valve, complemented with regular inspections/testing for leaks and a physical pipeline inspection program that will be put in place.

- ✓ The traditional approach to safety is based on generous use of space. BNGC's Terminal, is located on the outskirts of the present developed area of the Port of Big Creek and is downwind of the said offices and buildings. The terminal, as has been stated, is approximately 500m to 800m inside the boundary of the port's property and to complement this, the storage tanks will have a setback distance of approximately 125 feet from the BNGC property boundary line. The nearest residential home outside the port facility in any direction is almost 1 km away and only very few homes are located within a 1.5 km radius of the facility.

- ✓ As both Depots are on 5-acre plots, this in-itself provides for an adequate buffer as required by the DOE Guidelines, but both sites are also presently a minimum of 250 meters away from any nearby residential building (some of which are further protected by a vegetation barrier or hill). These distances provide an adequate buffer between the facilities and these homes; in case of an emergency, there should be ample time to evacuate anyone within the ***"Zone of Influence".***

- ✓ BNGC, at the Terminal, will have in place a water deluge or fire-fighting system for emergency response. This system will have its own water pond capable of storing some 2 million gallons of water which can provide over 6 hours of cooling capability in case of an emergency. This fire-fighting system will at some point be connected to the existing fire-fighting system at BNE's Crude Oil Storage Facility and will thus have an indefinite supply of water from the sea. At the Depots, apart from having some extinguishers and a 300 lb Purple K wheeled unit, an Emergency Response Plan will be developed along with the local National Fire Service (NFS) to efficiently and effectively combat any fire emergency, should the need arise.

- ✓ At the Terminal, BNGC will install a modern valve control system that will be capable of automatic and/or remote operation. It will ensure that main valves are closed unless they are required to be open and only while that requirement lasts and that they close in case of emergency or alarm being activated.

- ✓ At the three locations (Terminal and Depots) all storage tanks will be fitted with high level gauges and alarms to prevent overfilling; but these will only be back-up to continuous supervision of loading/transferring of product. Sections of pipe work and storage systems will be designed and equipped with safety valves so that they can be isolated should the need arise, especially during an emergency.

- ✓ As history has proven, many plant incidents take place outside normal working hours, and often during maintenance operations. BNGC as part of its safety management program, at all three locations, will have adequate after-hours security and strict supervision when maintenance works are being conducted. All critical works or works done in critical areas will be subject to a risk assessment and a permit to work program.

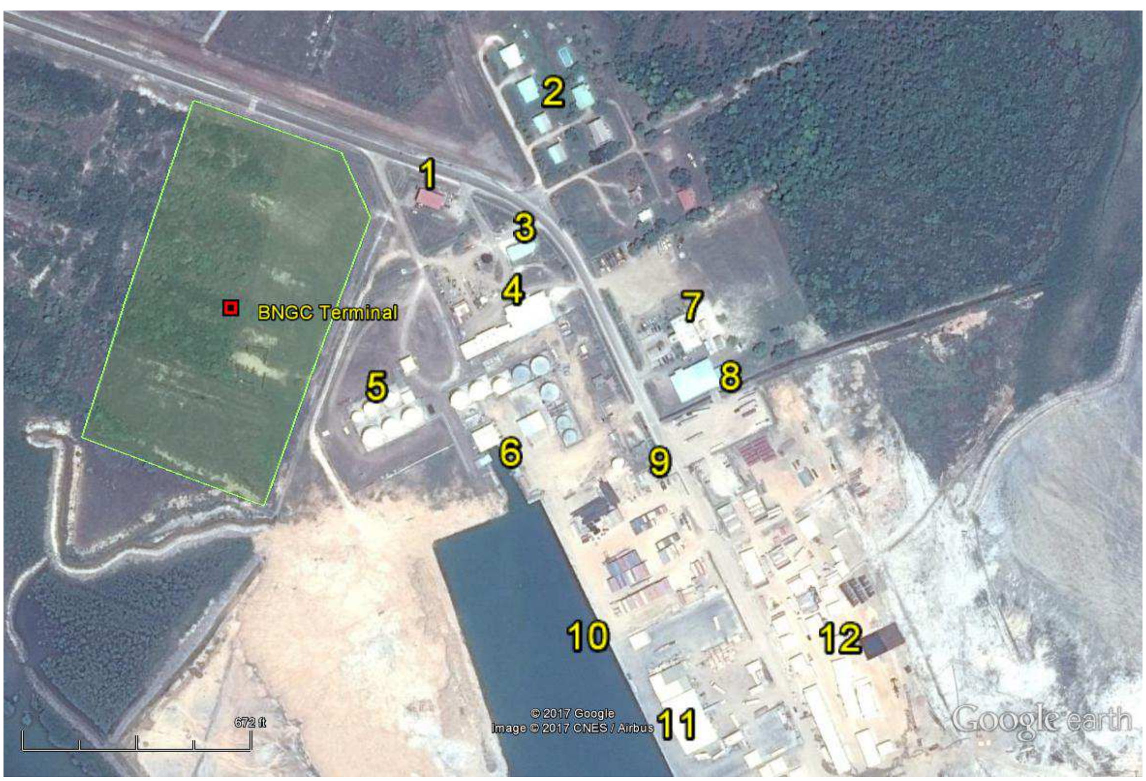
- ✓ Static electricity discharge is a cause for concern and so steel structures and pipe work will be securely earthed at all three locations. Road tankers will be bonded to earth before LP Gas transfers commence and remain so until the operation is complete and the hose is disconnected.

- ✓ As part of its safety program, BNGC will ensure that road tankers allowed to enter the terminal facility, will be properly equipped and comply with both national and international standards. Tankers will be immobilized during transfer/loading operations and equipped to prevent untimely movement. Loading/unloading bays will be protected against impact by the placement of physical barriers. Both company-owned and contractors' vehicles will be made to comply with safety standards.

The above measures can only do so much as it pertains to safety and thus it is imperative that personnel working at the facilities are well-trained and are aware of the potential hazards associated with the storage and handling of LPG. BNGC will ensure that personnel at all three locations are well versed in the overall operations of their respective facility and especially so in the safety programs/emergency plans for the said facility.

3.2 Risks to Adjacent Infrastructure

The proposed BNGC Terminal, as mentioned before, will be located in the north or northwest vector of all the other existing operations within the Port of Big Creek Facility; but all operations fall within an 800m distance from the proposed site. As presently planned, the nearest building which houses offices for the Port of Big Creek (labeled #1in the figure below), would be approximately 150 feet away from the perimeter fence of the facility. The old Petro-Fuel tanks (now used for molasses) are about the same distance away from the fence line.



As can be noted above, most offices within the port area would be within a 400m radius of the Terminal. Thus the following steps would be incorporated into BNGC's Emergency Plan:

Accidental Release without Fire (Small)

The quantification of the size of a release can be very daunting, but an operator at the facility should be able to quickly determine the extent of a release and the potential for the incident to escalate. For example, a pipe that is in use to transfer products and ruptures would continue to release gas until pertinent valves are closed leading to the pipeline. Likewise, a pipeline not in use and somehow springs a leak or ruptures, would only release the gas or vapor present within that pipeline (assuming that all valves to storage tanks are closed, as they should be).

In either case, a ruptured pipeline can quickly be isolated and the release stopped. BNGC would in such a case sound the alarm to evacuate to the area within the first 300m of the facility, i.e., buildings/premises #1 - #9.

After quickly verifying the wind direction, anyone within any of the said structures would be directed upwind to the nearest muster point. BNGC will have already had a plan in place with the Port of Big Creek to account for all personnel within the port facility.

Action: Alarm activated and Upwind Evacuation of all premises within a 300m radius.

Accidental Release without Fire (large)

Should an incident occur where there is an uncontrollable or large accidental release (eg. An entire tank), the BNGC Emergency Plan, in accordance with international LPG emergency guidelines, will call for an immediate evacuation of a minimum of 800m. BNGC in taking every possible action to save lives would extend that evacuation area to 1 km. This would thus include all facilities/offices presently within the port area.

At the same time and as a precaution, any residential homes within a one kilometer radius outside of the terminal would be informed and asked to evacuate as well.

Action: Evacuation of Entire Port Facility to upwind Muster Point (800m).

Accidental release with Fire

An accidental release that catches fire would be considered as the highest threat to lives and property; and thus BNGC's Emergency Plan would be to sound the alarm and effect an immediate evacuation to at least 1 km upwind from the facility. This again would mean a complete evacuation of the port facility and any residential homes within the 1km radius.

Action: Evacuation of ALL Port facilities (minimum1km radius)

Regional Depots – Impact to Adjacent Properties

With the distances and barriers between the depots and their nearest building(s) outside the facility; it is anticipated that there should be no permanent impacts to anyone or any building should there be an accidental release and or fire at any of the depots. In the case of the Northern Region Depot, the residents of the residential homes some 250 meters away may need to be evacuated temporarily until the situation is brought under control. In both cases, though, the highways adjacent to the locations may also need to be temporarily blocked until it is safe to allow vehicles to pass.

3.2.1 Potential Social and Economic Impacts

3.2.1.1 Social Impacts

Any incident at the terminal that requires an evacuation, even if for just a few hours, will disrupt the lives and work of most, if not everyone present and or employed within the Port of Big Creek facility. Even if no physical harm is caused by the incident itself, the psychological impact can be great and will need to be taken into consideration. This impact would be even more so, if the incident results in damage to adjacent properties/offices and even fatalities.

Emergency situations can be an incredibly stressful, disruptive and traumatic time for anyone affected. Entire communities can be uprooted, friends and family divided, homes, livelihoods and, of course, lives can be lost. In the aftermath of such an experience, people may experience a range of physical, psychological, emotional or behavioral reactions that, while perfectly natural, can significantly impact their ability to cope with the situation.

People may experience shock and disbelief, fear and apprehension, and anger over the longer term. Trauma and grief will put personal, family and community relationships under pressure. The mental health impacts of a traumatic incident can lead to an increase in problematic alcohol and drug use, self-harm, violence and abuse – which may well act as early warning signs. Whether or not they have experienced direct losses, the disaster may trigger post-traumatic stress for people who have experienced previous trauma, including previous fires and family loss.

A study done on the psychological impacts of a fire incident in Australia stated that the estimated social costs ($3.9B) associated with the incident were larger than the actual financial costs ($3.1B) (DHS, *Psychosocial support: a framework for emergencies*, Victorian Government, 2014).

It is thus imperative that BNGC take all the necessary steps and invest as much as possible into preventing any such incidents from occurring.

Regional Depots – Social Impacts

Apart from the temporary evacuation and disruption of the flow of traffic and the supply of LPG, due to an incident at any of the depots, there should be no other negative social impacts. On the contrary, though, the constant and reliable provision of a stable and higher quality of LPG and the potential for employment opportunities (especially if there's the need for expansion), there should be numerous positive impacts on both communities and the country of Belize as a whole.

3.2.1.2 Economic Costs:

Similar to that mentioned above, an accidental release resulting in the Port of Big Creek being shut down and evacuated would result in substantial economic impact to the area. As on an average day, there are approximately 150 employees within the Port of Big Creek Compound, a quick analysis of the salaries lost for one day can provide an approximation of how much such an incident would cost the livelihood of employees from the port.

Also the Port of Big Creek moves (exports & imports) hundreds of millions of dollars of products annually and any incident that would stop operations for at least one day would be even more costly to the Belizean economy.

On the other hand, there are several positive economic reasons of having the terminal. One of the biggest impacts will be in the nearby communities when the terminal is being constructed; the jobs that will be created will be both temporary and permanent. During construction, which is anticipated to be about 12-14 months, there will be a need for the employment of contractors and laborers from the area and all over Belize.

The materials needed for the construction of the facility will also have a positive economic impact on other businesses that employ residents from the communities. The purchasing of material will result in the Government of Belize to collect additional revenues from local taxes. Whenever there are large construction activities such as this one would be, other smaller entrepreneurship businesses are established, such as food vendors and snack shops, even if only for the construction period.

Should the need be to import workers into the area, then housing and food will be necessary and it is anticipated that regardless of that, the local hotel industry should see some benefits from this project as well.

The greatest economic impact will be the country of Belize that will now have a reliable source of LPG and will not have to depend on trucks from Mexico, Guatemala and El Salvador delivering our supply of LPG. Also, because of the LPG now being delivered by a much larger bulk, it is anticipated that the overall cost of LPG should be less than the present costs (of course this is dependent of purchase and transportation costs).

3.3 Safety Measures to Reduce Risk of Fires/Explosions

As mentioned earlier BNGC will put in place a state of the art Terminal facility and two Regional Depots that will all comply with local standards and more so with international standards. BNGC will implement **Prevention Through Design (PtD)** program and put in place the following safety features at the onset during construction of the facility to reduce the risks of fires/explosion:

1. ***Compatible Material/Equipment***
   Use of pressure rated material and equipment compatible with Propane and Butane Gases and the blended mixture LPG. (eg. piping – Schedule 80 black steel, automated ESV's).

2. ***Leak Detection Systems:***
   BNGC will install pressure gauges and hydrocarbon leak detection sensors systems throughout the entire facility and along the pipelines. The pressure gauges will be both digital and analogue and they will be able to detect any drop in pipeline and or tank pressure that could signify a leak (release) or equipment malfunction. These gauges will be made to trigger an automatic Emergency Shutdown Button (ESB) that would shut down the process until the cause of the drop in pressure can be determined.

   During the transfer of product from the ship to shore storage tanks, the Gas Carrier will also be utilizing its own monitoring system to measure the pressure in the transfer pipelines. The hydrocarbon leak detector sensors will be placed at strategic locations throughout the entire operation area at the Terminal. This system can either be wired and or wireless and can be connected to audible and visual alarms that will be activated once the alarm is triggered.

3. *Monitoring Cameras*

Similar to the present monitoring system in place at BNE's facilities, and as a back-up to the above mentioned safety devices, BNGC will also have in place numerous cameras that will be monitored by trained personnel. Cameras will be constantly reviewed to see if any visible leaks can be detected on screen.

4. *Control Room – Remote Monitoring*

BNGC will install a Control Room (similar to that of BNE) within the same onsite administrative building that will be manned by at least one Operator on site. All digital pressure gauges, Hydrocarbon Leak Detection System and cameras will be connected to the Control Room, where should any alarm be activated, the Control Room personnel can either request for actions to be taken, and or immediately shutdown pumps, close valves, etc. to prevent a major incident from occurring

5. *Physical Inspections*

BNGC will also have on the ground personnel throughout its operations and especially when transfers, blending or loading operations are being conducted. The technicians at each facility, but especially at the Terminal, will conduct routine inspections of the pipelines and tanks and the monitoring systems (gauges, cameras, Detectors, etc.). Personnel will be equipped with both personal gas meters and gas leak detectors meters whilst doing routine inspection of the facilities.

6. *Pipeline Leak Detection System*

Firstly, and in accordance with the DOE's Environmental Guidelines for LPG Depots and the U.S. Department of Transportation (DOT) Pipeline and Hazardous Materials Safety Administration (PHMSA), the pipelines will be designed per 49 CFR Part 195 for hazardous liquid pipelines and Part 192 for gas pipelines. The design requirements of these codes address such issues as:

i. the required strength of the pipe;
ii. the design of components that are attached to the pipe;
iii. the special requirements that specifically address construction issues such as how the welding is performed and the qualifications of the welder;
iv. the limitations on pipe bending;
v. the installation of pipelines in trenches; and
vi. the required depth of burial.

As most of the pipeline leading from the ship docking area to the storage tank farm area will be underground, and cognizant of the environment that the pipelines will be installed;

BNGC will from the very onset procure the best quality and most durable pipelines that will work best in such environment. BNGC will utilize the Schedule 80 Black Steele Pipeline and will install the said pipelines according to both local and International standards. Some of the steps to be taken by BNGC are as follows:

Physical Protection - Below Ground Pipeline

BNGC will follow the above mentioned standards and prior to the below-ground pipelines being installed and covered, they will have at least four layers of physical protection as follows:

a. Firstly the pipelines will be sanded and immediately painted using an anti-corrosion paint specifically designed for coastal marine environment (photograph 41 below).
b. After receiving the coat of paint, the pipeline will then be coated with a bitumen (tar-like) material, adding another protective coat around the pipeline (Photograph #42).
c. The pipeline will then be wrapped in a layer of “grease-cloth” which adds another water-proof layer over the previous two protective barriers; (photograph 43 below) and then finally
d. Then the pipeline will be finally wrapped in a PVC-like tape which yet has an inner tar-like lining (photograph 43A below).

Photo# 41: Painting of Underground pipeline

Photo#42: Wrapping Pipeline with Bitumen Tape

Photo # 43: Wrapping Pipeline with Grease cloth **Photo #43A: Wrapping Pipeline with PVC-like Tape**

Physical Protection – Aboveground Pipelines

All above-ground pipelines will be exposed to all the natural weather elements including sea water and air; which can cause corrosion of the exposed pipelines. To combat this issue, BNCG will have all aboveground pipelines including those interconnecting the tanks with the other facilities (blending facility, loading, etc.) or wherever the underground pipelines comes to the surface and becomes exposed; to be coated with three (3) layers of anti-corrosion paint. Again all pipelines will be sanded down and the first coat of paint applied immediately. After going through the treatment process, three times, the pipelines will be put into service (see Photograph 26 below).

Photograph #44: Photograph showing Painted exposed and PVC Tape Wrapped Underground Pipeline

Additional Protection - Depth of Pipeline

The pipelines, then, will be buried to a depth of 5 feet 6 inches, giving it a safe covering above from potential accidental ground perforations. At approximately one foot above the pipeline (or at about 4.5 ft of depth), a warning tape will be placed to warn anyone excavating in the area that LPG gas lines are present below (see Photograph 45 left).

Photograph 45: Warning tape being installed one foot above underground pipeline

Additional Protection – Traffic

Where the pipeline will pass under trafficked area, or where other heavy loads pass over the pipe, BNGC will put in place additional pipeline protection measures, such as load-bearing slabs and or covers (conduits) (Photograph 46 below).

Photograph 46: Example of a Pipeline Protection Conduit

Additional Protection – Pipeline Route Markers

Another mechanism to protect the pipeline along its buried route, will be the placement of aboveground pipeline markers. BNCG will ensure that these markers are placed at distances where they are in view of other markers, in order that anyone working in the area will be able to see the pipeline route (see photograph 29 below).

Photo #47: ***Examples of Gas Pipeline markers*.**

Pipeline Inspections

Because most of the pipelines, especially those leading from the berthing area to the storage tank terminal, will be below-ground, BNGC will comply with the US Department of Transport International Standards and have the underground pipelines regularly inspected for corrosion and or damage, with the use of a pigging system .

Pigging, as it pertains to pipelines, refers to the practice of using devices known as "pigs" to perform various maintenance operations such as cleaning and inspecting the pipeline for corrosion and or damages from the inside (see Figure 33 & 34 below). These devices contain electronic and magnetic sensors to check the interior condition of pipe walls. If they detect any cracks, or other problems, that section of the pipeline can be easily identified, dug up and either repaired or replaced.

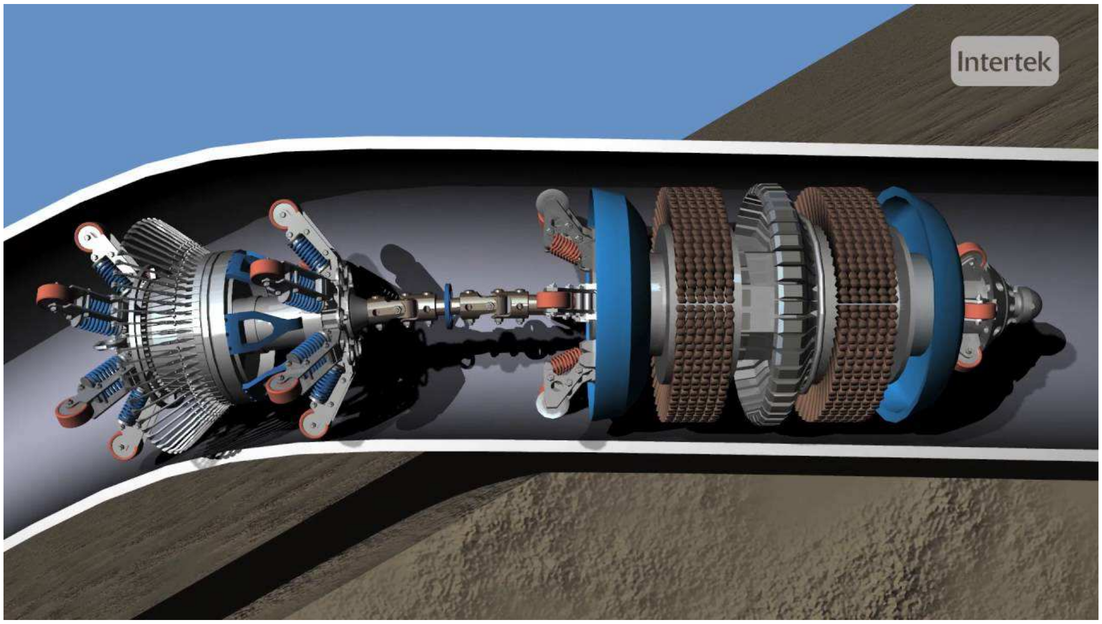


Figure33: Example of a Pigging Device used to inspect underground pipelines

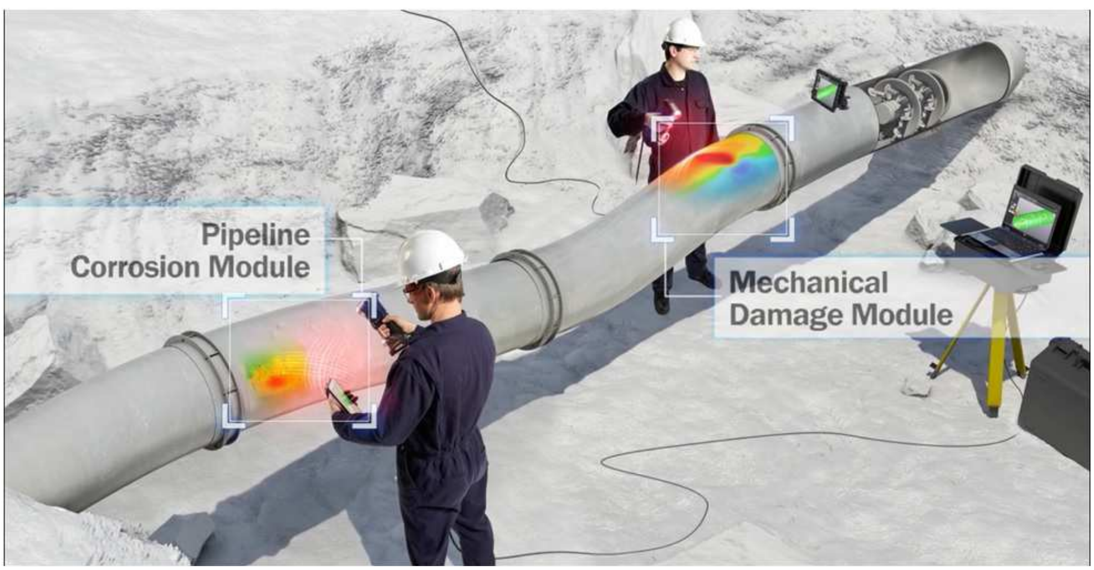


Figure 34: Pigging Device are capable of showing corrosion or mechanical damage to pipelines

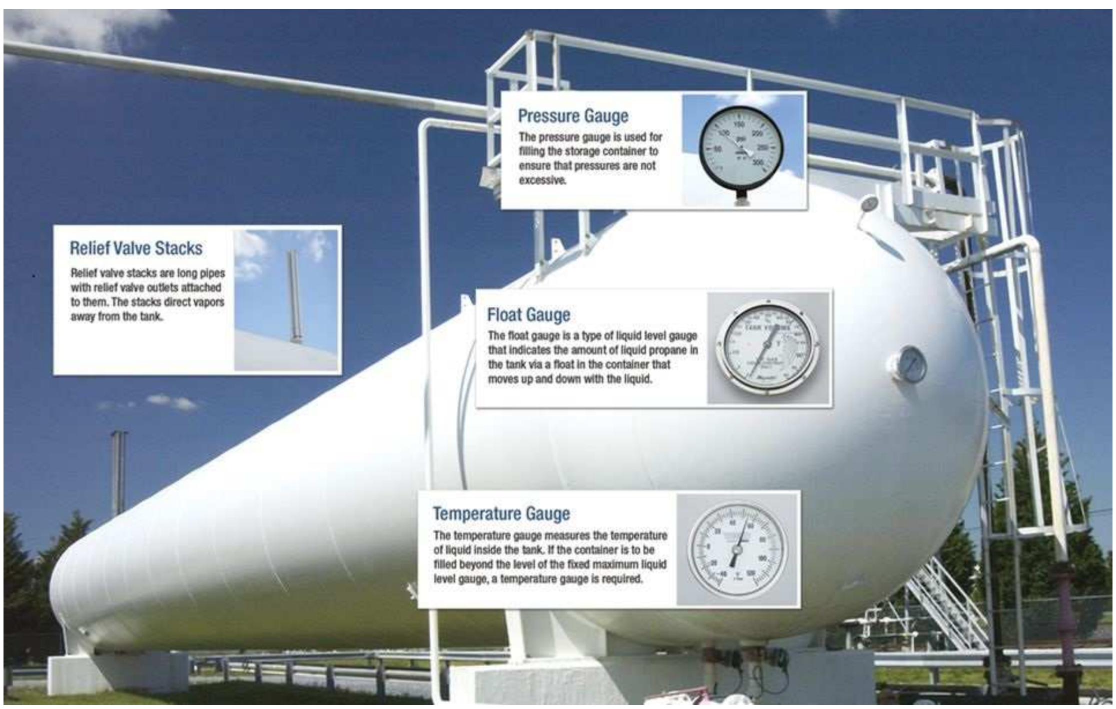
In case of a pipeline or valve becoming damaged and or about to leak, such integrity failure should be caught either by the pressure monitoring system, the Hydrocarbon Leak Detection system and or by physical inspection (pigging or otherwise).

7. Tank Safety

As there will be at least nineteen 90,000 gallons storage tank on site, BNGC will ensure the following:

a. Tanks will be obtained from a reputable supplier and BNGC will ensure that all tanks and fittings are compliant with safety standards (national & international) and that they are pressure rated for the storage of propane (propane has a higher pressure than butane).
b. All tanks will be placed on concrete footings, built to standard, and will be placed in two rows; one for butane battery and the other row for the two propane batteries and the blended product storage tank. The tanks will, as per the LPG guidelines, have spacing of 5.5 feet in between each tank; 25 feet between each tank battery; and 50 feet between the two rows. All tanks will have a setback distance of about 125 feet from the property boundary.

c. All tanks will be fitted with rated pressure relief valves, pressure gauges, float gauge (over-filling monitoring device) and temperature gauges to prevent the tank from being over-pressurized, overheated and or overfilled (see Photograph 48 below).



Photograph 48: LPG Storage tank with safety devices

d. Even though only authorized personnel will be made to enter the tank farm area, physical barriers will be put in place to prevent vehicles/heavy equipment from hitting the tanks and or piping that could result in a release incident.

8. Fire Suppression System

To complement the above safety devices, BNGC will, in the case of an emergency, have in place nine fire hydrants with monitors, placed strategically throughout the facility to ensure that all tanks and pipelines can be reached. These hydrants with monitors will also be connected to totes containing AAA (environmentally friendly) foam used in fighting petroleum fires. The fire suppression system will be managed, maintained and operated by a well-trained and well equipped fire-fighting team.

A water retention pond measuring 100 ft x 200 ft x 15 ft will be constructed onsite to supply water for any incendiary incident for up to more than 6 hrs.

9. Loading Safety Devices:

Road Tankers, apart from being operated by experienced and well trained drivers, these tankers will themselves be subjected to all safety standards; both local and international. The tanker truck will be fitted with the following safety devices (see Figure

Emergency Shut-off Valve	Pressure Gauge
Manual Cut-off Valve	Level gauge
Liquid and Gas Pipelines	Manhole;
Temperature Gauge	Safety Valve (pressure relief)

Figure 64: LPG Tanker Trailer with Safety Devices

Loading Arms/Hoses

Another safety device BNGC will put in place at all three locations is the "breakaway coupling" on the hoses or loading arms. If at any point a tanker moves or is moved whilst still attached to the loading bay, as pressure is exerted on the arms/hoses, the couplings will cause the line to break and a shutoff valve will instantly be activated closing the line preventing a continuous escape of LPG.

3.4 Natural Disaster Management Plan

As Belize is not immune to natural disasters, BNGC will develop as part of its Emergency Response Plan (EMP) that will include both the Terminal and the Regional Depots. These management plans will be implemented during different specific emergencies caused by nature.

Hurricane & Flood

Belize National Gas Company (BNGC) will develop a Hurricane Preparedness Plan (HPP) to provide planning information and procedures to follow prior to, during and after a storm/hurricane or flood.

The purpose of this plan will be to establish a guide and procedures to protect the lives of personnel and minimize storm related damage to BNCG's property. The plan will identify actions and those individuals responsible for fulfilling actions listed in this plan.

The overall objective of the plan will be:

a) To have a plan in place for immediate implementation to protect BNGC assets and property should the threat of a storm/hurricane become a reality.

b) To respond to the threat of a hurricane in an organized, well thought out manner where everyone is aware of the policies, procedures and responsibilities of their individual departments.

c) To restart operations, resume production and reopen the facilities as soon as possible once the hurricane has passed.

d) To have a plan that will achieve a & b and at the same time not endanger the lives of staff allowing them enough time to attend to the emergency needs of their own families.

Some of the basic emergency procedures to be included in the plan are as follows:

1. Control Room to track the storm as long as it poses a threat to Belize, especially the south of the country.
2. Control Room to continuously update and inform the supervisor/personnel on developments regarding the storm.
3. Have and activate shut-in procedures for the Terminal, where all operations are halted and tanks and pipelines isolated (all valves are closed). Inspection of and reinforcement/securing of tanks, pipelines, equipment, etc. prior to arrival of storm.
4. All mobile/loose items are secured.

5. Personnel are kept safe.
6. Inspection of facility (tanks, pipelines, pumps, etc.) and conduct repairs if necessary, prior to restarting operations.

Earthquakes

Although Belize is not directly within an earthquake zone, the north-western portion of the Caribbean Plate, known as the Cayman Trough, passes just about 50 miles south of Belize's southern border with Guatemala. As recently as in 2009, a 7.1 magnitude earthquake centered about 140 miles southeast of Belize City, rocked the country causing some damages to infrastructure and buildings in Independence Village, Stann Creek District.

As Belize has no warning capability, with respect to earthquakes, one can only react as it's occurring and thereafter make the necessary adjustments, where necessary. BNGC, depending on the magnitude and how much is felt here in Belize, especially at the terminal area, will in the wake of an earthquake ensure that operations are stopped and all pipelines and tanks are shut-in.

If it is believed that the earthquake was of a magnitude that could cause some damages, a thorough inspection of the aboveground facilities will be done. The following are some of the inspections to be conducted:

1. Inspection of the tanks and tank-bases: as was experienced during the earthquake of 2009, some liquefaction occurred and the base of some houses and infrastructure shifted or sank. The bases of tanks will need to be checked for visible cracks and whether any shifting/subsidence or tilting occurred.
2. Inspection of pipelines (piping): as these could be bent, cracked or welding/bolts come loose at joints (flanges/valves),
3. Inspection for possible shifting of equipment – as the geology of the area has sand in it, the bases for pumps, blending facility, etc. could shift a bit, causing pipelines to become unaligned resulting in leaks.
4. To determine whether underground pipelines were impacted, any un-alignment that resulted in damage to the pipeline, could be detected by pressure loss in the pipeline and or by physically walking the line daily for a period of time with a leak detector meter.

Bush Fire

As all three locations have either quite a bit of vegetation on site or adjacent to them, primarily open savannahs and some trees and brushes surrounding the facilities; brush fires can and do occur from time to time in the adjacent areas. Although most of the bushfires in the area have an anthropogenic source, some fires can start naturally (lightening, or magnification of sunlight through a bottle).

In the case of bushfire, BNGC personnel (fire-fighters) would monitor the prevalent wind direction. Once the fire reaches within the 800 m radius of any of its facility and is moving towards the facility, the fire team will be dispatched and a proactive approach will be taken to prevent the fire from reaching close to the terminal. At the Depots, the National Fire Service Department will be informed of the pending threat. A joint fire-fighting plan will be developed with the local National Fire Service Department to fight any fires within or near any of the facilities.

3.5 Shipping Route & Cargo Transfer

3.5.1 Shipping Route

The shipping route to be used by the BNGC's contracted Gas Carrier, will be the same route that is used by the crude oil tanker and other bulk cargo ships that docks at the Port of Big Creek.

The Gas Carrier will leave the US Coast in the Gulf of Mexico and proceed towards the southeast through the channel between Mexico and Cuba just off the northeastern end of the Yucatan Peninsula and passing through Mexican territorial waters.

Upon entering Belizean waters and after notifying the relevant authorities of their presence, the Gas Carrier will proceed south towards the coast of Honduras but will remain outside the Lighthouse Reef Atoll. As it passes the Belize City latitude, it will commence a slight turn towards the south west bringing it a few miles east of the outer continental shelf of Belize or just alongside the reef.

For safety reasons and because of the reef coming closer to land the farther south you travel and having no channels to pass through directly to the Port of Big Creek, the Gas Carrier will go pass the ports latitude by about 30 miles, make a U-turn and then head back up north towards the port on the western side of the reef (see Figure 65 below).

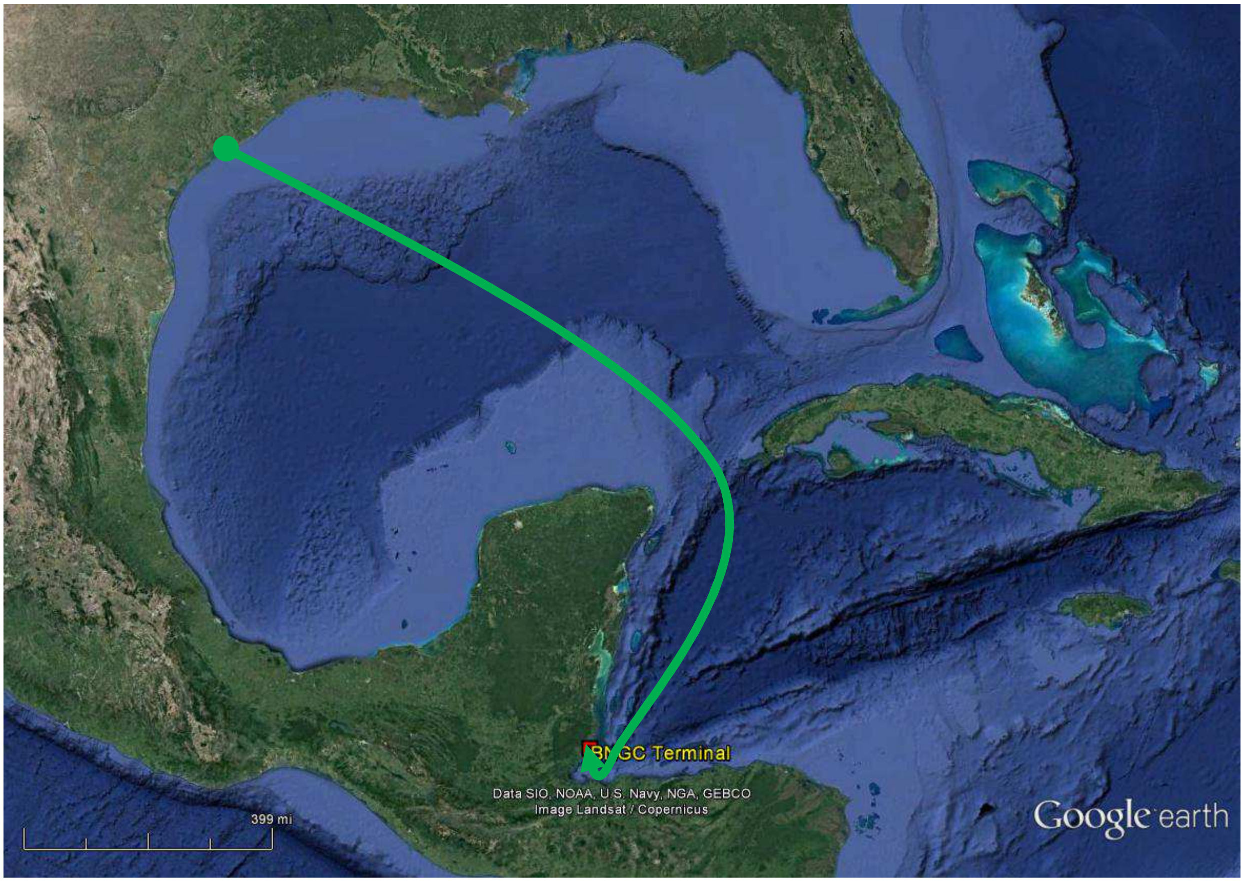


Figure 65: Gas Carrier Route from US Gulf Coast to Port of Big Creek, Belize.

3.5.2 Cargo Transfer – Ship To Shore

When cargo is to be transferred from the ship to shore tanks, the following precautions should be observed. In addition, the relevant precautions in the ICS/OCIFM publication "Ship to Shore Transfer Guide (Liquefied Gases)" should be closely observed.

Before starting transfer operations the ship master and Terminal Supervisor must agree on every aspect of the transfer procedure and appoint a person in overall charge. Transfer operations between gas carriers and terminals should be carried out in accordance with the requirements of the receiving entity. In all cases, however, the ship master remains fully responsible for the safety of his own ship, its crew and cargo, and must not permit safety to be prejudiced by the actions of the other entity concerned.

Transfer operations will only be carried out in favorable weather conditions and should not begin until the master and responsible person on both sides are satisfied that the situation is safe.

A safety checklist will be used prior to commencing transfer operations and, in the event of subsequent stoppages, a further check should be made before resuming operations.

Discharging:

During operations the maximum transfer rate must be consistent with the receiving tanks' re-liquefaction capacity. Alternatively, a vapor return hose connection should be made to the discharging vessel.

In addition, the following additional precaution should be taken during transfers:

(1) Before transfer begins the person in overall charge should be satisfied that the ship and terminal personnel are fully conversant with the nature of the hazards presented by the cargo being transferred and with the necessary safety precautions;

(2) Moorings should be of such a nature that the ship can be quickly released in an emergency;

(3) The rate of transfer should be controlled according to the nature and size of the storage tanks;

(4) Operations should be stopped immediately if either the ship and or terminal fails to comply with the safety requirements in any respect;

(5) The ship should be requested to move from alongside the dock as soon as possible after completion of discharge.

Discharge of Product from Gas Carrier

For the actual discharge of the Propane and Butane from the ship, the following procedures will be followed:

Personnel will confirm that the liquid manual/automatic manifold valves are open. The liquid manifold cool down valves will be manually closed prior to commencing the transfer.

Prior to cargo pump start, confirm that all liquid branch valves are closed and all filling valves are opened. Also notify the engine room to verify that sufficient generator capacity is available. Start the cargo pumps as per established guidelines. It is important that the shore is made aware of when pumps will be coming on line and the consequent changes in their tank pressures then can expect.

The usual procedure is to start two pumps on re-circulation on one tank, then commence discharge from the tank. This usually takes a few minutes. A similar procedure is then applied to the other tanks with a few minutes period between each tank. Once all pumps are running on 60% load the speed is slowly increased until it reaches the maximum specified load.

As the tank pressure falls, a request to the receiving terminal is made to start to send vapors back to the ship and to maintain the agreed tank pressure level. The following items are always being monitored during discharge.

1. Cargo tank level
2. Cargo tank pressure
3. Cargo pump motor load and discharge pressure
4. Draft, trim and heel
5. Ship condition

If stripping is planned for several tanks, it is recommended to keep the tank levels slightly different in each tank in accordance to the established "ramp down" procedures.

A request is then made to the receiving terminal to stop the return gas blower in order to keep an adequate tank pressure. After discharging, at least one filling valve is kept open to avoid pressurization of the liquid line. Liquid draining and vapor purging of the arms/hoses is performed after completion of cargo discharging. After completing the draining and purging, the following operations are carried out.

- Final gauging after discharging
- Arm/hose disconnection and de-icing (if necessary)

NB. The ship specific cargo manual should be referred to regarding maximum and minimum allowable liquid levels for sea passage.

3.6 Ground Transportation Safety

As briefly mentioned before, BNGC will also put in place two additional Regional Depots – one each in Orange Walk District and near the City of Belmopan. Each location will be equipped with two 30,000 gallons tank for the supply of butane to the northern and central region of the country. Each site will have a Terminal Supervisor and a technician present at all times, especially when receiving and or loading the truck of local distributors.

The transportation of LPG across land via the highways will be another area where BNGC will become exposed to additional hazards. As with all risks and hazards, these can be addressed and reduced to "As Low As Reasonably Possible" (ALARP) with the implementation of procedures and use of safety devices.

At the BNGC Terminal, as part of the terminal personnel, there will be four road tanker truck drivers who will be responsible for delivering the LPG to the two regional depots. To ensure that these road tankers are safe and operate safely, BNGC will take the following steps.

1. As previously stated, these tanker trucks will be fully equipped with safety pressure relief valves, liquid level gauges, pressure gauges, manual cut-off valves, emergency shut-off valves, temperature gauges, fire extinguishers, etc.

2. Loading of trucks will be scheduled to avoid too many trucks at the facility at the same time. This will also aid in having a reasonable time gaps between the tankers on the road.

3. Tankers supplying the regional depots in Belmopan will utilize the Southern and Hummingbird Highway; whilst those continuing farther north will continue unto the George Price Highway and the Phillip Goldson Highway via the Hattieville Burrell Boom Road.

4. Upon arriving at the gate, there will be adequate space for the tanker(s) to pull off the main Big Creek Road whilst being processed prior to entering the terminal. Processing will also include, apart from weighing, an inspection of the truck itself to ensure that all traffic lights/signals, tires, brakes, horn, etc. are in good working condition. A walk around the truck will also be done to conduct an inspection of the fire extinguisher, valves and gauges.

5. Traffic within the terminal will be controlled by personnel at the gate, who will regulate the number of tanker trucks entering/exiting the facility. Tanker trucks will either be directed to an empty loading lane or to the tanker truck parking area, until a loading lane becomes available. Whilst being loaded, a second round of inspections will be done on the tanker truck.

6. Whilst BNGC cannot control the traffic on the Highways, it can to some extent control the tanker truck operators and thus will require that the operators undertake a "Defensive Driving" course one every two years. This course will greatly assist the tanker truck operators in avoiding unwanted situations and if one does occur, in making better decisions on the road when they are faced with unexpected situations.

7. Tanker trucks will also be fitted with tracking devices, so that the control room can always be aware of their location and track their speed as well. This will aid should

there be an incident on the road, as the response teams will know exactly where to locate the tanker.

8. Tanker truck operators will also be trained in responding to an incident (if they're capable to do so in the case of an accident). As the trucks will be equipped with traffic cones and extinguishers, the operators will be trained as to safety distances and emergency response procedures.

9. As the BNGC Terminal will be managed by BNE personnel, when the LPG tanker trucks are on the road, the emergency response personnel from both the Big Creek and Iguana Creek facilities will be on standby and ready to respond to any incident involving any one of the tanker trucks.

4.0 NOISE AND AIR QUALITY

4.1 Noise

Occupational hearing loss is one of the most common work-related illnesses around the globe. Each year, for example, about 22 million U.S. workers are exposed to hazardous noise levels at work. Over 30 million U.S. workers are exposed to chemicals, some of which are harmful to the ear (ototoxic) and hazardous to hearing. In addition to damaging workers' quality of life, occupational hearing loss carries a high economic price to society.

NIOSH Recommendations:

- The NIOSH Recommended Exposure Limit (REL) for occupational noise exposure is 85 decibels, A-weighted, as an 8-hour time-weighted average (85 dBA as an 8-hr TWA) using a 3-dB exchange rate. Exposures at or above this level are considered hazardous.
- Use the NIOSH Hierarchy of Controls to reduce workplace noise to below the NIOSH REL whenever possible. Use hearing protection when hazardous noise levels cannot be adequately reduced.

With respect to the BNGC Terminal itself, there will be approximately 11 pumps and compressors being used throughout the operations (see Table below).

Name	Type	Service	Specs
C-101	Compressor	Propane	Capacity: 28.7 SCFM 100F @ 30PSID Power: 25 HP
P-101	Pump	Liquid Propane	Capacity: 200 GPM @ 100PSID TDP
P-102	Pump	Liquid Propane	Capacity: 200 GPM @ 100PSID TDP
C-104	Compressor	Instrument Air	Capacity 10 SCFM @ 90PSI
SP-101	Air Dryer	Instrument Air	Capacity 10 SCFM @ 100PSI
C-102	Compressor	Butane	Capacity: 28.7 SCFM 100F @ 30PSID Power: 25 HP

P-103	Pump	Liquid Butane	Capacity: 100 GPM @ 150PSI TDP
P-104	Pump	Liquid Butane	Capacity: 100 GPM @ 150PSI TDP
P-105	Pump	LPG Blend	Capacity: 400 GPM @ 100PSID TDP
P-106	Pump	LPG Blend	Capacity: 400 GPM @ 100PSID TDP
Fire Kill Pump	Pump	Fire Water	Capacity: 4,000 GPM @ 150 PSI Driver: Patterson MAA12 x 8

It is anticipated that most of these pumps will be of the Blackmer brand/type, similar to those presently being used by BNE in its crude oil and LPG production/blending operations. The following noise level were recorded whilst pumps of various sizes were in operation at BNE, and should provide an idea of the expected noise levels at the BNGC Terminal. As the operations at the Depots will be of a much smaller scale, noise pollution from the Regional Depots are anticipated to be negligent.

Loading of LPG Bob Tail Truck

At the BNE LPG plant located at the Iguana Creek Bulk Storage Facility compound, a 15 horsepower Blackmer pump is used to load the bobtail trucks. This pump is also used in BNE's blending and recirculation processes as well as during the loading operations. Table 15 below shows the noise levels were obtained using a calibrated Sper Scientific Digital Sound Meter 840028:

Distance from Pump (feet)	Noise Level (dBA)
5	84
10	71
25	62
50	55
100	50-51

Table 15: Noise Levels – Loading of Bob Tail Truck

Discharging of LPG Tanker:

Part of BNE's present operation at its LPG production facility is the blending of BNE's LPG gas produced on site with that of the imported gas from Guatemala. During the discharging of the tanker truck, a compressor is used to pump vapor back into the tanker as it is discharging the LP Gas. During the discharge operations, the average decibel levels (A scale) were taken and shown below in Table 16:

Distance from Compressor (feet)	Noise Level (dBA)
5	74
10	70
25	69
50	60
100	58

Table 16: Noise Levels – Discharging of LPG Tanker Truck

Loading of Crude Oil Tanker Truck

Should the BNGC Terminal decide to use larger pumps for its operations, they might be similar to the 25 horsepower Blackmer pumps used by BNE to load their crude oil tanker trucks. Table 17 below shows the decibel level (A scale) readings that were obtained during the tanker loading process at BNE's Iguana Creek facility:

Distance from Pump (feet)	Noise Level (dBA)
5	94
10	89
25	81
50	77
100	63

Table 17: Noise Levels – Loading Crude Oil Tanker Trucks

From the above noise levels recorded during the various operations at BNE Iguana creek Facility, it can be noted that the pumps utilized generate noise levels that mostly falls within normal hearing range. The reason for this is because Blackmer had designed pump with sliding vanes that produce less noise and causes less vibration, resulting in longer pump life and reduced maintenance costs. These pumps were engineered specifically for LPG flow applications, and more specifically for cylinder filling, motor fueling, bulk transfer, vaporizers, and for use on bobtails and transports.

With the nearest adjacent office building outside the terminal facility being at least some 200 feet away from the tanker truck loading bay, it is anticipated that even if BNGC utilizes slightly larger pumps, there should be very little to no negative impact on adjacent operations; even if all three loading pumps are in use at the same time. Should at any point in time noise does become an issue, BNGC can take some noise reduction actions such as planting a hedge along the perimeter of its fence line. Other noise-reduction engineering methods will be looked at as well.

As it relates to the operations' noise impact on wildlife, this again should be very little to none. As previously mentioned, the wildlife in the area is very scarce and only a couple species of birds and lizards account for the majority of wildlife seen/found on site. The noise from the pumps should keep birds at bay, which for maintenance of the facility purposes, is a positive impact.

4.2 Air Quality

4.2.1 BTEX

The air quality results for Benzene, Toluene, Ethyl Benzene and Xylene, obtained by BNE at its loading/discharging bay at its Big Creek Port facility, from 2007 to 2016; are shown below in Figure 66:

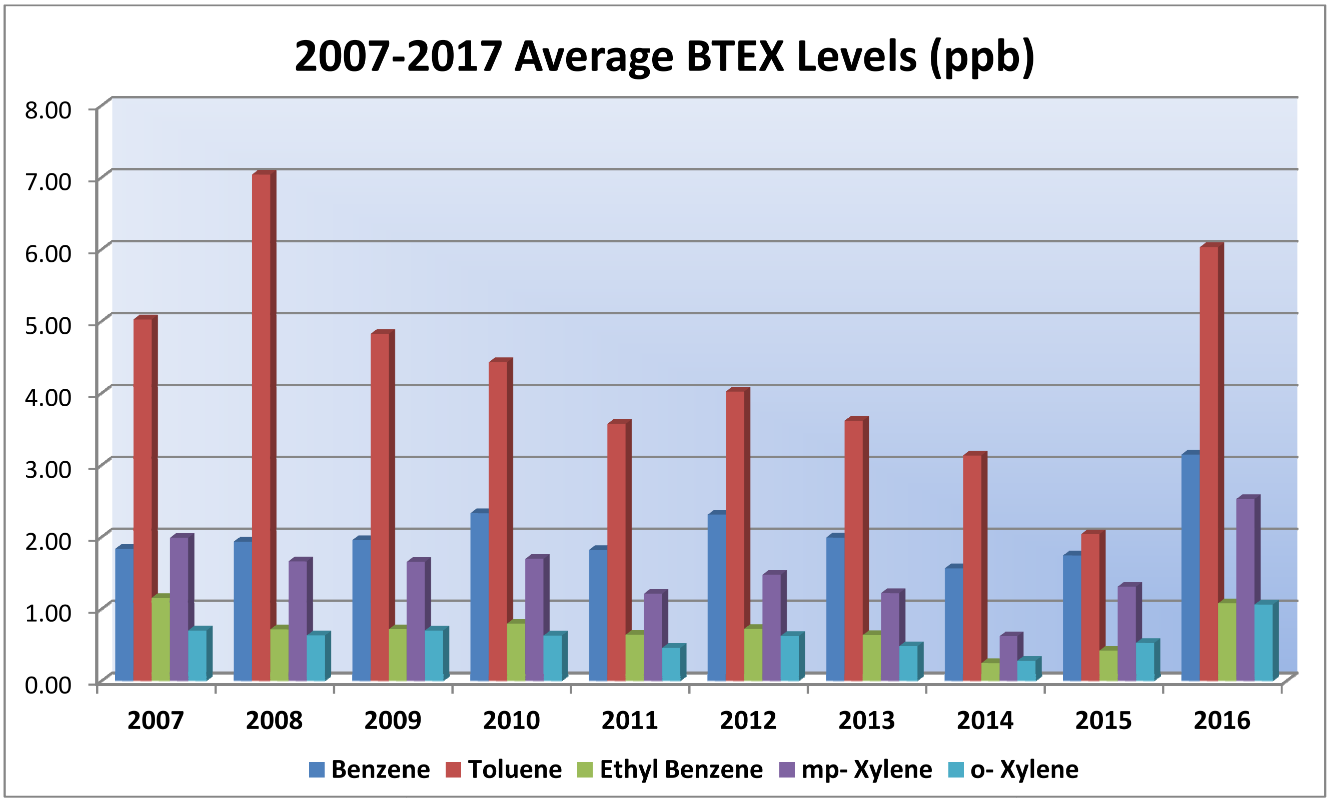


Figure 66: BTEX Averages from 2007-2016

The Permissible Limits (ambient and or personal) for the above mentioned parameters, along with the highest average obtained over the 10 year period, are listed below in Table 18:

Parameter	Limit	Regulatory Agency	Highest Yearly Average Obtained	Year
Benzene	5 ppb	NIOSH (ambient)	3.15 ppb	2016
Toluene	100ppm / 200ppm	NIOSH / OSHA	0.0070 ppm	2008
Ethyl Benzene	100 ppm	NIOSH	0.0012 ppm	2007
mp-Xylene	100 ppm	OSHA	0.0025 ppm	2016
o-Xylene	100 ppm	OSHA	0.0011 ppm	2016

Table 18: BTEX Results and Recommended Levels

BTEX Analysis

Looking at the results above, over the 10 years of data gathering, none of the yearly average exceeded the limits set out by National Institute for Occupational Safety & Health (NIOSH) or Occupational Safety & Health Authority (OSHA). It must be noted that, with respect to benzene, one or two months of the year, primarily during the summer time, when the ambient temperature is warmer, there's an increase in fugitive volatile organic compounds (VOCs) and the level of benzene climbs a little, but rarely exceeding the 5ppb limit. During the remainder of the year, the benzene and other VOC levels all remain well below the recommended limits.

It should also be taken into account, that the Loading Bay monitoring station is where there is the most fugitive VOC produced, as this is where the truck hatches are opened releases the gases. Therefore this should provide an idea or comparison of what the environmental levels would be within and around the BNGC Terminal.

With the above data, it can safely be said that the BNGC Terminal should have very little or no noticeable impacts on the environment and or on the health of BNGC's personnel. Since the predominant wind also blows towards the west and northwest, it is anticipated that any fugitive VOC's will be taken away from the populated port area, and thus there should be no health impacts on workers of the adjacent properties.

4.2.2 NOSO

With respect to Nitrogen Dioxide (NO_2) and Sulphur Dioxide (SO_2) also referred to as NOSO, the results obtained at the BNE Loading Bay monitoring station are shown below in Figure 67:

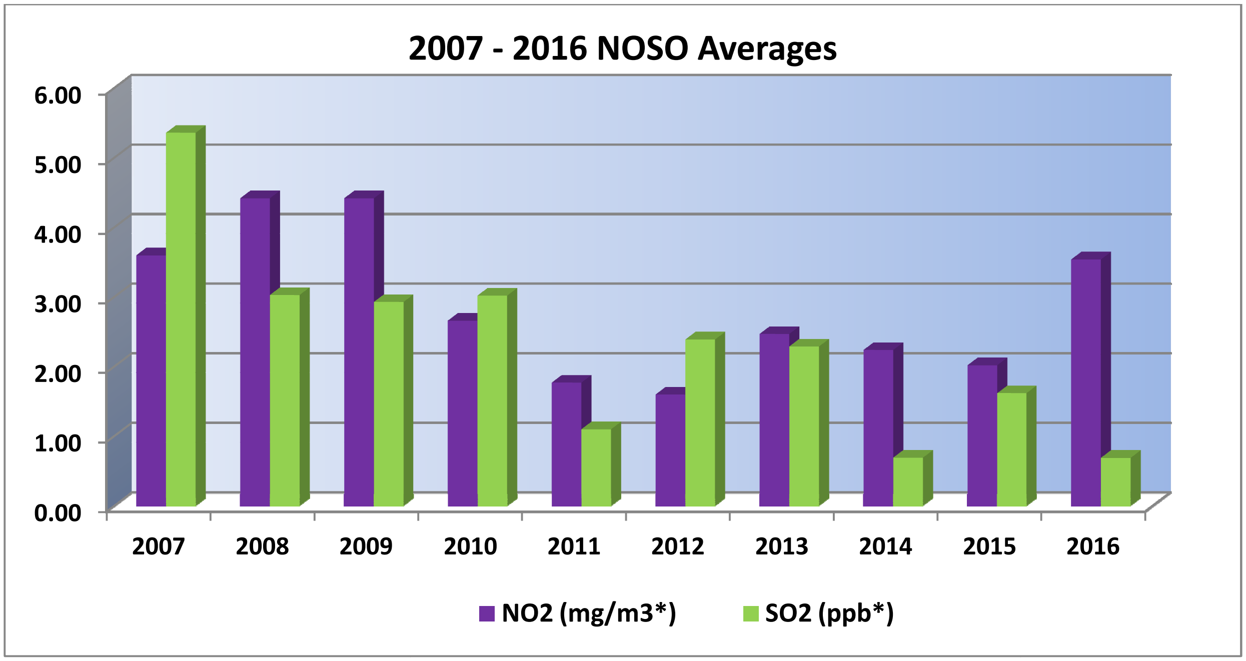


Figure 67: NOSO Yearly Average 2007 - 2016

The Permissible Limits (ambient and or personal) for the above mentioned parameters, along with the highest average obtained over the 10 year period, are listed below in Table 19:

Parameter	Limit	Regulatory Agency	Highest Yearly Average Obtained	Year
Nitrogen Dioxide NO_2	40 mg/m^3	OSHA	4.42 mg/m^3	2008/09
Sulfur Dioxide SO_2	5 ppm	NIOSH / OSHA	5.36 ppm	2007

Table 19: NOSO Levels and Recommended Levels

As can be noted from the table above, nitrogen dioxide (NO_2) remained well within the recommended exposure limit with the highest yearly average limit of 4.42 mg/m3 being reached in 2008 and 2009. Since then, it has dropped even farther. As for sulpur dioxide, in 2007, the yearly average was recorded at 5.36 ppm, which was slightly above the recommended limit of 5 ppm. Since 2008, though, the yearly average has drastically reduced until it reached an annual average of 0.5 ppm in 2016.

NOSO Analysis

Similar to the BTEX results, the overall average of nitrogen dioxide and sulphur dioxide are well below and within the NIOSH and OSHA Guidelines/Standards. It is thus very unlikely that there will be any impacts to the environment and to the health of humans from the operation of the BNGC Terminal at the said location.

4.3 Air Pollution Risk

From the data collected and analyzed on BTEX and NOSO as well as the insitu tests for CO, H2S, LEL and O2, it can be deduced that there exists no major risks to the environment from the normal operations of the facility. This of course is dependent that no major incident, whether an accidental release or fire occurs. To ensure that the risks of an incident occurring is reduced and or eliminated, BNGC will take the following steps:

1. The Terminal will be designed by an accredited engineering company that have experience in the designing and construction of LPG Terminals.
2. BNGC will construct the facility as per design and utilize the best material and contractors available. Construction will be closely monitored by BNGC (BNE) engineers.
3. The use of rated and product compatible material for the construction of the facility, eg. Schedule 80 Black Steel for pipelines.
4. BNGC will utilize various safety devices, such as, but not limited to:
    i. Hydrocarbon Leak Detector Sensors/System
    ii. Pressure Relief Valves (PRV)
    iii. Automated Emergency Shut-off Valve(s) (ESV)
    iv. Emergency Shutdown Button (ESB)
    v. Digital and Analogue Pressure Gauges
    vi. Meters
    vii. Tank Fluid Level Gauges
    viii. The use of anti-corrosion paint and bitumen wrapping for the protection of underground pipelines.
    ix. Cameras to monitor all operations on site.
    x. Break-away Coupling at the discharging / loading points

5. BNGC will establish a fully functional Control Room with the capability to remotely shut down operations and or close valves shut an emergency occur.

6. BNGC will develop a monitoring and inspection plan for the terminal and depots and will include the inspection of all pipelines which may require the use of the “pigging” method.
7. BNGC will have a fire-suppression system (hydrants, monitors connected to foam) in place which will be manned by a very competent fire team.
8. Apart from the necessary PPE’s, personnel will be equipped with personal multi-gas monitors and hand-held hydrocarbon leak detectors.
9. All personnel working at the Terminal will be experienced and well trained in their duties and in the Emergency Response Procedures for the terminal.

In the event a leak does occurs, the following will be some of the initial Emergency Response Procedures to be taken:

1. Personnel who discover the leak Must activate the alarm and immediately report it to Control Room, providing as much information as possible.
2. Control Room to remotely shut down operations (if the case requires it to do so) or isolate the area with the leak.
3. Control Room in turn would inform the Terminal Supervisor (if he has not yet been informed).
4. Supervisor to assess situation and determine whether the evacuation plan needs to be activated.
5. If an evacuation order is given, the Control Room will inform the adjacent premises and recommend which of the muster points they should gather.
6. Control Room will also be responsible for informing the residences west of the facility of the situation at hand.
7. The Supervisor and the Fire Team will then address the situation at hand and try to bring operations back to normal as soon as possible.
8. Subsequent to any incident, a thorough investigation will be done to determine the root cause of the incident and put measures in place to mitigate a reoccurrence of an incident of the same nature.

Regional Depots – Air Pollution

There was no data on air quality available for the Regional Depots, but it is very much believed that these facilities will have little to no impacts on the air quality of their respective areas.

C. CONCLUSION / RECOMMENDATIONS

1.0 ALTERNATIVE FOR DEVELOPMENT

In considering pursuing the present proposed Terminal, Belize National Gas Company had to give careful consideration to developmental alternatives. The requirement for the assessment of alternatives is also a requirement of the Terms of Reference for the Limited Level Environmental Study (LLES). As part of this process of the evaluation of alternatives, consideration should also be given to the "no action alternative." The evaluation of the alternatives almost always encompass the economic, social, and environmental considerations associated with the available options.

The evaluation of the two alternatives for implementation of the project inclusive of the 'no action alternative‟ focuses on the options that were more practical for the proposed project. And thus, the most important factors taken into consideration with the proposed terminal site included the following:

- The site suitability for the development;
- Cost of alternative sites and their development potential;
- The existing conditions including the existing infrastructure;
- The socioeconomic conditions of Belize and in particular the current situation of the LPG Sector in Belize;

Site Selection and Cost

The process of site selection for the implementation of the project started as far back as 2014, when Polaris Engineering Inc. was contracted by BNE to conduct an evaluation of the LPG sector in Belize and develop a sound plan with the best option going forward.

During this evaluation phase, four sites were evaluated for suitability to accommodate LPG imports into Belize by sea: Belize City Existing Dock, Belize City New Dock, Commerce Bight and Big Creek.

Each site was initially evaluated based on the fact that the level of LPG consumption in Belize today limits the import requirement to a relatively small parcel size. Each site must have truck access, available power, storage space capacity, capability for expansion, and be able to accommodate an LPG ship requiring no less than 6 meters of depth at any berth or channel required for LPG delivery. Based on this criteria alone, Big Creek, apart from meeting all the above requirements, also required the least capital investment, even though it is the furthest location from the current centers for LPG consumption.

Based on Belize's current LPG import rates and monthly deliveries of LPG, the following specifications were applied to all four sites. Note that the parcel size and restrictions to ship size will require the LPG to be imported blended at the 70/30 ratio. In this scenario, a more pure LPG such industrial propane (greater than 90% propane) will not be imported separately from butane to be blended later on land. Out of 100 3,000 CBM LPG Vessels, only 2 have the capacity to bring both mixed and HD5 propane. Even in the 5,000 to 6,500 CBM parcel sizes, the availability of ships is limited. Therefore, it was assumed that at minimum an 18,000 CBM ship would be required.

Site Specifications:

1. 6 meters of draft, minimum, for the LPG ship
2. Piping from ship to storage
3. At minimum nine 90,000 gallon LPG bullets for storage
4. At minimum dual truck loading rack
5. Fire suppression system
6. Security
7. Guard/Operator Shack
8. Truck access (roadways)
9. EPA and NFPA compliance

The two Belize City options were the least feasible due to the fact that the current utilization of the dock for container cargo could not accommodate LPG imports. The Belize City New Dock was not feasible based on cost and the Commerce Bight port requires 30% more capital investment.

The Big Creek site is a protected harbor inside a mangrove stand, has easy truck access, available power, storage space capacity, 400 acres of land available for expansion, and has three berths with 6.5 meters of depth. It was decided that the path forward was to develop the engineering and design of the terminal at the Port of Big Creek.

As for the Regional Depots, both sites were selected after reviewing and visiting several locations in each district. It was envisioned that a site in Belmopan and Orange Walk would best serve the Belizean public as they could each supply two districts each; with the Central Region Depot supplying both the Cayo and Belize Districts, whilst the Northern Region Depot would supply the Orange Walk and Corozal Districts.

Socio-economic Situation – LPG Sector

Today, Belize imports LPG by truck from Guatemala (70%) and Mexico (23%). All LPG imports from Guatemala do not conform to the existing Belizean regulation; Mexican imports and locally produced LPG are in conformance with the regulation. Trucking costs and dependence on neighboring countries for LPG supply is expensive and an impediment to industrial growth. Although most LPG currently imported is destined to be used residentially and in light commercial applications, there is a small amount of heavier, agricultural use.

The cost of LPG in Belize is primarily dictated by the cost of transport which is in turn highly dependent on the cost of fuel (diesel). As all of Belize's supply comes via road tanker trucks, the cost of LPG is much higher than the cost of importing LPG using Gas Carrier Tanker Ships. When compared, the cost of transporting LPG using a Gas Carrier could be as much as 50% less than utilizing road tanker truck. Despite this, LPG is by far the cheapest form of fuel in Belize. The additional savings that could be passed on to the public with importation via sea would definitely have a positive impact on the country.

The use of LPG in the transport sector is rapidly on the rise in Belize as presently it is the cheapest fuel on the Belizean Market. The transport sector could then also bring about an additional increase in the demand of LPG in Belize. Currently, there is no public power generation or heavy industrial use of LPG. This is viewed as an area of high potential for development. With the installation of a power generation plant to supply some 60MW of electricity in Belize, would greatly reduce the overall cost of production in the country, creating greater opportunities for foreign investments and a lower cost of living.

"No Action Alternative" Option

The "no action alternative‟ is almost always not economically viable for the business community. Although this option would result in the least negative environmental impacts, it also has the potential to be the most economically expensive option due to the tremendous potential loss associated with opportunity cost. The no action alternative would also negate the opportunity to fully maximize the LPG market in Belize and provide the potential positive socio-economic benefits to not only the nearby communities and residents but eventually to the entire country of Belize.

Therefore, this alternative is primarily used as a baseline mark for the comparison of the other remaining development options. A choice is then made between this option and the one that makes the most economic sense and would generate greater benefits while at the same time resulting in the acceptable negative environmental impacts. At the end, the success of any project development depends on the implementation of adequate mitigation measures, which are derived by identifying a combination of a lesser environmentally damaging alternatives, and those that are the most technically and economically viable to implement.

A "No Action Alternative" for Belize would mean that Belize would have to continue relying on Mexico and Guatemala for its supply of LPG. This has been and still is, a high risk option for the country, as any instability or a massive natural disaster cutting off the roads in either country, can result in Belize's LPG supply being reduced and or completely cut off without any warning/notice. This could result in sudden price increases in LPG costs and would be felt primarily by the Belizean public. The cost of living would increase drastically overnight and could destabilize the entire community/economy of Belize. A perfect example of this was experienced some years ago with the electricity supply from Mexico to Belize, during that time Mexico was unable to completely supply the additional energy Belize required, especially during the peak hours. During its peak demand hours, Mexico would divert Belize's supply back to its own populace causing many parts of Belize to suffer regular outages as the energy needs couldn't be met locally.

Table 20 below gives a comparative picture of the two alternatives:

Environmental Issues	No Action Alternative	Implementation Alternative
Land Use	Land remains undeveloped.	Land use suitable for proposed activities; has adequate buffer and Terminal area has adequate space for future expansion
Mangrove clearance	No - impacts	Minimal due to limited mangrove in area
Impacts on Vegetation cover	No- impacts	Minimal as project site already has approximately 60% of vegetation cover removed. Duration = long term.
Impact to General Ecology	No impacts	Moderate impact to on site terrestrial ecosystem but not to the overall ecology of the area. Hydrology in area will remain the same
Socio- economic	Loss of socio economic benefits.	Positive impacts, foreign exchange, jobs, training opportunities, lower cost of living.
Air Quality	No- impacts. Although if the vegetation remains in place it is expected that the air quality in the area will improve, the long term use of fossil fuel will eventually have an impact on the air quality of Belize.	Unless for accidental releases/fires, there will be little to no impacts from the intermittent small releases. Having one main terminal actually reduces the amount released during the numerous discharging operations of road tanker trucks presently importing LPG. Also utilizing LPG reduces greenhouse gases when compared to traditional fossil fuel.

Solid waste	Presently the current waste disposal site is a major source of contamination from leaching and surface water run-off.	Impacts to existing waste disposal site are predicted as minimal as only office waste will be disposed of at the local dump site. Any petroleum based and or contaminated waste considered hazardous will be disposed of by incineration.

Table 20: Project Alternatives

Therefore the "No Action Alternative" is not a valid option for Belize, especially in these times when Belize is facing significant development challenges. There's declining agricultural outputs, growing external debt, very low economic growth, and although we haven't had a serious natural disaster for a few years, we remain very susceptible to them. All these have contributed to uncontrollable challenges in Belize achieving its development goals. These events both financial and natural are just a few of the issues facing policymakers and are reminders of how vulnerable the economy of Belize is.

Having a sea Terminal and two additional regional depots would make Belize more self-reliant and sustainable as well as putting Belize a step closure to having complete control of its own energy supply needs. As mentioned before, the use of LPG for power generation could result in major positive socio-economic impacts for the country.

2.0 MITIGATION AND MONITORING PLAN

The assessments of the potential positive or negative socio-economic and environmental impacts are presented in the form of a matrix to allow for a readily visible comparison of these three major alternatives (Tables 21, 22 & 23). This comparison was used to assist in the determination and selection of the preferred option. The Port of Big Creek along with the two regional depots was the option with the highest economic opportunity, most technically feasible and with the least negative environmental impact.

2.1 Construction Phase

Aspect	Cause	Impacts	Mitigation/Management Measures
Soil Erosion	Removal of vegetation for land filling and/or construction.	• Natural Habitat Loss • Reduced soil quality • Visual Impact • Soil compaction	• Remove only necessary vegetation. • As much as possible use only high land that will require little or no filling. • Ensure that proper drainage is incorporated for storm-water management.
Fire, Explosion	Leaks, Accidents, spills	• Possible injury and death • Damage to equipment • Soil contamination • Air pollution	• Store all flammable material according to specifications. • Keep/store only necessary flammable material (do not over stock) • Train personnel in handling flammable material
Soil & water contamination	Construction of facility	• There could be localized soil pollution due to product spillages and from construction equipment and vehicles	• Implement a spill and leak detection and monitoring system • Ensure corrective actions are taken after possible leaks/spills • Develop Emergency Response Procedures for facility and have spill kits available. • No maintenance of vehicles permitted on site • Proper storage of chemicals and hazardous substances in sealed, covered and bunded areas.
Air quality impacts (dust)	Construction/ Development	• During the Construction phase there will be fugitive dust due to excavations & hauling and trucking of materials around the site.	• Use appropriate dust suppression should be undertaken to prevent nuisance to neighbouring properties.

Air quality impacts (exhaust emissions)	Construction / Development	• During the Construction phase there will be localised exhaust emissions generated from heavy equipment and machinery.	• Ensure vehicles are kept in good operating condition and serviced accordingly. • Vehicles must be left running when not in use.
Noise	Construction equipment Machinery	• Public Annoyance • Human health impact	• Use sound reduction mechanisms where possible • Maintenance of equipment • Use of equipment/ machinery only during daylight hours
• **Socio Economic Impacts**	Construction and operation of facility	• Increased commercial activity • Population growth • Increased demand for public services • Community disturbance • Revenue generation Increased tax collection • Jobs Demand for goods and services • Provision of employment • Creation of business opportunities • Training	• Utilize qualified and/or trained Belizeans employees and contractors • Utilize only registered businesses • Develop & implement positive social programs
Traffic impact	Construction & Operation of facility	• During construction phase heavy delivery vehicles could affect and/or disrupt the background traffic flows. • Increased traffic congestion, temporary road blockages	• Construction vehicles to conduct construction deliveries during non-peak hours. • If possible designate roads to be used • Procedure for the flow of traffic, in and out of the premises to be developed and implemented. • Extra large loads to comply with local authorities guidelines and permitting requirements.

Table 21: Construction Phase Impacts & Mitigation

2.2 Operational Phase

Aspect	Cause	Impacts	Mitigation/Management Measures
Storm water and soil contamination	Rain, fire fighting water, water leaks	• During rainfall events there will be an increase in storm water flows across and from the site, due to the change of surface from soil cover to hard surfaces • Reduced soil quality • Visual Impact	• Only clean storm water generated on site (excludes effluent from fuel & chemical storage areas) must be discharged into the environment. • Contaminated water will be captured and treated or kept in the hazardous waste stream. • Ensure that proper drainage is incorporated for storm-water management.

Fire, Explosion	Operation of the facility, spills, accidents, leaks, etc.	• Operation of the LPG facility is a potential source of ignition of fires and vapor cloud explosion, which could spread into neighbouring properties.
		• Possible injury and death
		• Damage to equipment
		• Soil contamination
		• Air pollution
			• Utilize only explosion proof electrical equipment/material.
			• Control static electricity by:
			  • Use of electrical wrist bands for operators
			  • Prohibiting overburdened electrical plugs in operation areas.
			• Train personnel in handling material
			• Installation of a pressure & leak detection system for piping and tanks
			• Trained Fire fighters / Drills
			• Installation of adequate fire hydrants & monitors to quickly suppress any fire.
			• Installation of safety signs (Prohibition of smoking, open flames and sparks).
			• Prevent activities that could cause spark and friction such as the use of metal wheeled equipment, etc.
			• Adhere to safety distance for LPG Bulk storage facilities (SANS 1087-3:2010).

Air quality and odours	Operation of the facility	• LPG Leakages can lead to toxic gas releases	• Minimize vapor leaks and losses will reduce air pollution and odours through ongoing tank maintenance. • Ensure tank seals are kept in god condition and caps are appropriately sealed. • Ensure a high standard of housekeeping. • Develop and implement a leak and spill monitoring system.

Waste Management	Construction / Operation of facility	• The improper storage of waste and LPG products could potentially result in the contamination of storm water flows from the site during operation.	• All hazardous waste generated by the facility must be stored in appropriate containers, or in bunded areas. • Collection and disposal of Hazardous waste must be collected and /or treated by a DOE/SWMA approved waste contractor or disposed of according to the DOE/SWMA.
Socio Economic Impacts	Operation of facility	• The Operation phase will provide job opportunities and maintenance personnel and general • Creation of indirect business opportunities	• Ensure that any new job opportunities are extended to local community members where possible. • Utilize qualified and/or trained Belizeans employees and contractors • Utilize only registered businesses • Develop & implement positive social programs

Table 22: Operational Phase Impacts & Mitigation

2.3 Decommissioning Phase

Aspect	Cause	Impacts	Mitigation/Management Measures
Tanks and Gas Piping (Air and Soil contamination)	Construction and Operation of the facility	If not done properly, the decommissioning of the tanks and gas pipelines can lead to major leaks that could pollute air and soil. •	• A soil and ground water contamination investigation must be conducted to determine the presence, nature and extent of any contamination. Depending on the results, this will determine the extent of remediation that needs to be undertaken, if any. • Residue inside tanks and pipelines must be carefully removed prior to the tanks and associated piping being decommissioned.
Traffic	Decommissioning operations	• Increase of vehicles on the road	• Ensure vehicles conduct decommissioning activities only during non-peak times to minimize traffic disruption. • If possible designate roads to be used • Extra large loads to comply with local authorities guidelines and permitting requirements. •
Air quality and odours	Decommissioning of the facility	• During the decommissioning phase of the facility, there will be localized fugitive dust due to excavations and the hauling and trucking of materials around the site. •	• Ensure appropriate dust suppression is taken on site to avoid nuisance impacts to neighbours. • Removal of gas from tanks and pipelines before disconnecting. • Ensure a high standard of housekeeping. • Ensure vehicles are kept in good operating condition and serviced accordingly. • Vehicles must be turned off when not in use.
Waste Management	Decommissioning of facility	• Inert waste, hazardous and general waste will cause environmental and visual pollution.	• All solid waste generated from the removal of the tanks and associated piping, must be handled according to the precautionary principle, i.e., all waste should be considered as hazardous unless proven otherwise. • Only clean soil must be used for cleaning and backfilling purposes

			• Collection and disposal of Hazardous waste must be collected and /or treated by a DOE/SWMA approved waste contractor. • All waste taken from the site should be collected/disposed of according to the DOE/SWMA or at an approved waste site.
Noise	Decommissioning of the facility will require the used of heavy equipment and other machinery.	• Decommissioning activities will result in short-term noise impacts • Public Annoyance • Human health impact	• Decommissioning should be done only during daylight hours
Social	Decommissioning of facility	• During decommissioning and post closure of the facility, there will be loss of jobs that the local labourers are anticipated to benefit from the facility.	• Local unskilled labourers should be trained in different trades with the gas operations so that they get other related jobs should this operation cease to operate.

Table 23: Decommissioning Phase Impacts & Mitigation

Summary of Aspects, Impacts and Mitigation/Management for BNGC Project

Quantification of most likely environmental impacts caused by the proposed terminal and depots could be summarized in Table 24 below, using the below scale:

Table 24: Environmental Aspects Summary

Aspect	Construction Phase	Operation Phase	Decommission Phase
Air quality	II	I	I
Noise	II	I	II
Solid waste disposal	II	I	II
Flora	I	I	I
Fauna	I	I	I
Effluents	II	I	I
Geology	II	II	I
Visual & aesthetic	II	I	II
Excavation	II	I	II
Hydrocarbon by-products	II	I	I
Ground Water	I	I	I
Surface Water	II	I	I
Physical Chemical wastes	I	I	I
Traffic	II	II	II
Machinery	II	I	II
Economic	III	III	III
Job Creation	III	III	III
Environmental Impact Human Housing	II	II	II

I – Impact of minimal significance

II - Impact of standard significance

III – Impact of large significance

As can be noted from the above tables, the impact on biodiversity, although minimal due to the present state of the area, will be somewhat permanent; as even after the decommissioning phase, the site might remain barren for a few more years. As with respect to the adjacent properties, there will be some temporary impacts during the construction, operation and decommissioning phases but they will mainly be minor and temporary nuisances (dust, noise from engine, etc.).

During the operational phase, the impacts from nuisances will have reduced but the potential impacts from an accidental release or fire/explosion can be really devastating to nearby properties. Hence BNGC is cognizant of the importance of ensuring that the mitigation measures are adequate, appropriate and implemented to reduce the hazards/risks to "**As Low As Reasonably Possible**" (ALARP).

Environmental Monitoring and Reporting

Environmental monitoring requirements for the proposed development (Terminal and Depots) is intended to provide the environmental information necessary to ensure that the recommended mitigation measures set out in the project's design are implemented in accordance with the requirements of existing legislations and recommended mitigation plan to determine the effectiveness of the recommended measures in ameliorating the impacts associated with the proposed activities. These findings are also used to determine the need for additional measures at an early stage. Compliance monitoring is also supported by a series of other environmental monitoring requirements using predetermined key indicators to ensure that pollution or related problems are discovered in time to prevent or repair adverse effects.

The information obtained from the project's monitoring program will be used by BNGC and permitting agencies to observe for any changes over time that may be associated with the Terminal and depots. These changes would in principle vary over time in both magnitude and direction. In the case of the latter, it is important to understand that changes to the environment may also be positive and not only negative. Therefore, the environmental monitoring plan is expected to detect and record the positive and beneficial impacts that may be associated with the Terminal's activities and not only the perceived or anticipated negative impacts

The proposed monitoring program has been developed not only in relation to satisfying the statutory requirements of the Environmental Clearance Process, but also as a consequence of the proper implementation of the proposed Terminal.

BNGC is cognizant that the success of this project depends significantly on the proper design and installation of the Terminal and depot facilities coupled with the integration of the safety and monitoring devices. BNGC is committed to ensure that the quality of the surrounding environment is not compromised as it is critical for the sustainability of the entire project.

Since the proposed Terminal greatest threat is to the air, the air quality parameters to be monitored will be those previously reported upon; namely, benzene, toluene, ethyl-benzene, xylene, nitrogen dioxide and sulfur dioxide (BTEX and NOSO). The monitoring sites will be chosen in order to show whether there are any changes in the air quality that could potentially become a health risks to port personnel and or the nearby communities.

BNGC will develop a more detailed air quality monitoring program, and will continue to utilize the Diffusion Tubes for its long term air quality monitoring program. These tubes will be set out and collected and shipped to the UK for analysis, and copies of the analytical reports will be submitted to the Department of the Environment.

Other air quality tests will be done daily or as necessary and will primarily be for VOC's. Personnel will be taking these readings from time to time and logging these down in a chart. These charts will also be available for the DOE to review.

As there should be no impact to the nearby water bodies (Big Creek and marina area), BNGC sees no real need in establishing a water-quality monitoring program.

CONCLUSION:

The design, construction and operation of the Terminal and Depots will be done to comply with all national and international Environment, Health and Safety Standards/Guidelines (OSHA, NFPA, NIOSH, EPA, DOE Guidelines, etc.). As the Terminal facility will be the first of its kind in Belize, only the services of qualified contractors will be obtained for the construction of the necessary loading and off-loading facilities, as well as the tank farm storage facility. The tanks, its associated pipelines and safety systems that will be put in place, will be purchased from permitted companies and all tanks will be certified.

It is anticipated that such an LPG Terminal will provide and encourage the use of a more safe and environmentally friendly fuel in Belize; as the use of LPG has the following benefits:

a) LPG produces about 45% less carbon dioxide when compared to diesel. It also produces 33% less carbon dioxide when compared to petrol.

b) Use of LPG results in lesser hydrocarbon emissions. It is known to be lesser by almost 70% in comparison with diesel and 40% in comparison with petrol.

c) Sealed LPG tanks are also known to eliminate spillage.

d) When LPG is used in vehicles, they are known to produce less Nitrogen Oxide. When compared to petrol, it is lesser by almost 82%. The best comparison is said to come from diesel. LPG is considered to be 99% better in terms of emitting nitrogen dioxide.

e) LPG results in 63% lesser carbon monoxide and this is also a great advantage.

f) Again, as it relates to vehicular emission, LPG is considered favorable since it has a lower proportion of benzene as well as butadiene, when compared to those vehicles which run on gasoline.

In recent months, LPG has gone from being a traditional fossil fuel to a new form of renewable energy. Scientists have created a genetically engineered version of the common E. coli bacteria that produces propane (LPG). Therefore, LPG is now a renewable energy. The bacteria are made to consume sugar and are tricked, through genetic modification and with the help of a couple of enzymes, into making propane instead of their normal cellular material. The propane produced is chemically identical to regular propane.

REFERENCES

Polaris Engineering Inc., 2014. BNE LPG Import Facility Evaluation

Statistical Institute of Belize, 2016. External Trade Bulletin http://sib.org.bz/wp-content/uploads/2017/05/ExternalTrade_2016-12.pdf

Statistical Institute of Belize, 2016. Main results of the 2010 Population and Housing Census. Prepared by the Statistical Institute of Belize, 2010.

National Meteorological Services of Belize, 2016 http://www.hydromet.gov.bz/climatology/climate-summary

GeoTech Belize, 2017. Geotechnical Report BNGC Terminal Big Creek

Geomedia, 2013. Assessment of Groundwater Resources in the Southern Coastal Water Province of Belize Referred to as Savannah Groundwater Province

Golder Associates, 2014. Final EIA Sasol Petroleum Mozambique Non-Technical Summary

Belize National Meteorological Service, 2008. "Vulnerability Assessment of the Belize Coastal Zone: Enabling Activities for the Preparation of Belize‟s Second National Communication (SNC) to the United Nations Framework Convention on Climate Change (UNFCCC) Project."

BET, 2016. Environmental Impact Assessment for Ara Macao, Placencia, Belize.

Health and Safety (HSE), 2014. Safe Use of LPG

ANSInet, Science Alert, 2010. Assessment on the Consequences of Liquified Petroleum Gas Release Accident in the Road Transportation via GIS Approaches

BET, 2015. Marine Conservation and Climate Adaptation Project (MCCAP) KAP Survey: KAP Survey among Fisher folks and Households in Twelve Coastal Communities in Belize. Fisheries
Department, MAFFESD, Belize City, Belize.

CCCCC-MFFSD, 2015: A National Climate Change Policy, Strategy and Action Plan to Address Climate Change in Belize. EU-GCCA, UNDP/GEF – Third National Communication Project. Belmopan, Belize. http://www.caribbeanclimate.bz.

Coastal Zone Management Authority and Institute, 2013. "Belize Integrated Coastal Zone Management Plan." Accessed May 25, 2014. http://www.coastalzonebelize.org/wp-.

Dixon, C.G., 1956. Geology of Southern British Honduras with notes on adjacent areas. Printed by authority of his Excellency the Governor.

Environmental Water Quality Program, Water Quality Monitoring Protocol, Department of the Environment, June 1995.

Laws of Belize Revised Editions 2000 and 2003. Retrieved October 3, 2016 from http://belizelaw.org.

NEMO Belize. 2016. http://site.nemo.org.bz . Retrieved September, 2017.

Department of the Environment, 2017. http://www.doe.gov.bz/

Wikipedia, 2017,

List of Figures

Figure 1	*Butane Imports into Belize*
Figure 2	*Map showing location of Belize*
Figure 3	*Figure 3: Map of Belize showing location of BNGC Terminal*
Figure 4	*Proposed location of BNGC Terminal Storage Tank Farm (area highlighted in green)*
Figure 5	*Proposed location of BNGC Terminal Storage Tank Farm (area highlighted in green)*
Figure 5A	*Proposed Location of Central Region Depot*
Figure 5B	*Central Region Depot opposite the old Belmopan Dump Site.*
Figure 5C	*Northern Regional Depot north of Orange Walk Town*
Figure 5D	*Northern Regional Depot Located at Miles 55 on the Phillip Goldson Highway*
Figure 6	*Proposed Layout Plan for BNGC Terminal in Big Creek (macro)*
Figure 7	*Layout of BNGC Terminal Facility (micro)*
Figure 8	*BNGC Pipeline Route*
Figure 9	*Location of the Administrative Building for the BNGC Terminal*
Figure 10	*Upper & Lower Explosive Limits*
Figure 11	*Layout of Fire Hydrants and Water supply Pipeline*
Figure 12	*Location of Patterson MAA12 x 8 Fire Suppression Pump (red)*
Figure 13	*Entrance/Exits, Parking Lots, Roads and Pathways at BNGC Terminal*
Figure1 4	*Example of Muster/Assembly Point Sign*
Figure 15	*Muster Points for BNGC Terminal: Initial and Secondary*
Figure 15A	*Layout of BNGC Central Regional Depot, Hummingbird Highway*
Figure 15B	*Layout of BNGC Northern Regional Depot, Hummingbird Highway*
Figure 16	*Color Coded Diagram showing Butane (blue), Propane (brown) & Blended Product (yellow) Storage Tanks*
Figure 17	*BNGC Terminal Operations Flowchart*
Figure1 8	*BNGC Process/Services Flow Chart*
Figure 19	*Color Coded Diagram showing Butane (blue), Propane (brown) & Blended Product (yellow) Storage Tanks*
Figure 20	*BNGC Blending Operations Flowchart*

Figure 21	*Flowchart of Tanker Truck Loading*
Figure 22	*Map showing General location of BNLP Terminal and Depots*
Figure 23	*NGC Administrative Process/Services Flow Chart*
Figure 24	*NGC Operations Organizational Structure*
Figure 25	*Diagram of Hierarchy of Hazard Controls*
Figure 26 & 27	*Examples of Different Types of Digital and Analogue Gauges*
Figure 28	*Example of a Schematic of a Gas Leak Detection System*
Figure 29	*Example of Monitoring Camera*
Figure 30	*Example of a Control Room with Monitoring Displays*
Figure 31	*Physical inspection of LPG Tanks and Aboveground Piping*
Figure 32	*Example of a Gas Leak Detector*
Figure 33	*Example of a Pigging Device used to inspect underground pipelines*
Figure 34	*Pigging Device are capable of showing corrosion or mechanical damage to pipelines*
Figure 35	*Diagram of Predominant Trade Winds over Belize*
Figure 36	*BNGC Terminal in relation to prevailing wind direction & residential areas to the west and south west.*
Figure 37	*Map showing Residences in relation to BNGC Terminal*
Figure 37A	*Area predominant winds would carry released LPG - Central Region Depot.*
Figure 37B	*Area predominant winds would carry released LPG – Northern Region Depot.*
Figure 38	*Map showing very little to no development near proposed BNGC Terminal*
Figure 39	*Diagram showing Causes of Major LPG Accidents*
Figure 40	*800m Area of Influence that would be evacuated in case of a large accidental release.*
Figure 40A	*Area to be evacuated in case of large release of LPG - Central Region Depot.*
Figure 40B	*Area to be evacuated in case of large release of LPG – Northern Region Depot.*
Figure 40C	*Diagram of a BLEVE*
Figure 41	*One Kilometer Zone of Influence to be evacuated in a large release with fire scenario.*
Figure 42	*Estimated 300 meter Zone of Influence with greatest impacts in a*

	BLEVE incident.
Figure 42A	*Nearest Residential Home sheltered by Hilly Terrain – Central Region Depot*
Figure 42B	*Area to be evacuated in case of a major release – Central Region Depot*
Figure 42C	*Scrap metal yard and abattoir near Northern Region Depot*
Figure 42D	*1 Km Area to be evacuated in case of release - Northern Region Depot*
Figure 43	*Map showing Elevated area (blue) and Low Lying area (olive green) of BNGC Terminal Property*
Figure 44	*Diagram showing prevalent direction of water runoff.*
Figure 45	*Flood Risk Map of Belize*
Figure 46	*The Port of Big Creek "Community".*
Figure 47	*Map showing Independence & Mango Creek Communities in relation to BNGC Terminal and Evacuation Zone.*
Figure 48	*Map showing Mango Creek 4 Reserve west of BNGC Terminal (red dot)*
Figure 48A	*NPAS Map of Protected Areas in Belize (2015)*
Figure 48B	*Map showing southern and eastern Boundaries of Mango Creek Forest Reserve 4*
Figure 49	*Average Rainfall Map of Belize*
Figure 49A	*Rainfall Map of Belize 1951-2013*
Figure 50	*Savannah Station Average Monthly Rainfall (mm) 2006 -2017*
Figure 51	*Graph Showing Monthly Maximum and Minimum Temperature Averages for Belize*
Figure 52	*Savannah Station Average Monthly Temperature (°C) 2006-2017*
Figure 53	*Groundwater Provinces of Belize*
Figure 54	*Big Creek Watershed Area*
Figure 55A	*Map of Bore Holes and Test Pits – Central Region Depot*
Figure 55B	*Average Temperature by Month 1981-2010 – Belmopan Weather Station*
Figure 55C	*Average Temperature by Month 1981-2010 – Towerhill Weather Station*
Figure 55C-1	*Map of Boreholes on Northern Region Depot Proposed Site*
Figure 55D	*Average Rainfall by Month 1981-2010 – Towerhill Weather Station*

Figure 56	*Water bodies nearest the BNGC Terminal*
Figure 57	*Map of Air Quality Sampling Points (AQTP) and Diff Tubes Location*
Figure 57	*Graph Showing Benzene Levels at Big Creek Loading Bay*
Figure 58	*Graph Showing Toluene Levels at Big Creek Loading Bay*
Figure 59	*Graph Showing Ethyl Benzene Levels at Big Creek Loading Bay*
Figure 60	*Graph Showing mp-xylene Levels at Big Creek Loading Bay*
Figure 61	*Graph Showing o-Xylene Levels at Big Creek Loading Bay*
Figure 62	*Average Annual Concentration of NO_2 2007-2016.*
Figure 63	*Average Annual Concentration of SO_2 2007-2016.*
Figure 64	*LPG Tanker Trailer with Safety Devices*
Figure 65	*Gas Carrier Route from US Gulf Coast to Port of Big Creek, Belize.*
Figure 66	*BTEX Averages from 2007-2016*
Figure 67	*NOSO Yearly Average 2007 - 2016*

LIST OF PHOTOGRAPHS	
Photograph 1	*Example of a LPG Gas Carrier Tanker Ship*
Photograph 2	*Berthing Facility at Port of Big Creek*
Photograph 3	*Example of 6-tank batteries*
Photograph 4	*Example of elevated LPG Pipelines crossing waterway*
Photograph 5	*Showing Pipeline Route from the Berthing facility over the water channel and through Petro-fuel facility.*
Photograph 6:	*Proposed route of underground Pipelines traversing Petro-fuel Facility (in yellow)*
Photograph 7	*Proposed Pipeline route along outer perimeter of Petro Fuel Facility leading to BNGC tank farm*
Photograph 8:	*Proposed Pipeline route along outer perimeter of Petro Fuel Facility leading to BNGC tank farm*
Photograph 9	*Pipeline route from Berthing area to BBNGC Storage Facility*
Photograph 10:	*Examples of Gas Pipeline markers.*
Photograph 11:	*LPG Tanks Interconnected with several pipelines*
Photograph 12	*Example of Ferro-concrete structure with cement roof*
Photograph 13	*Example of Butane/Propane Blending Facility*
Photograph 14	*Gas Chromatographer used in Laboratory Analysis of LPG Blends*
Photograph 15 & 16	*Fire Hydrant with Monitor and Fire Suppression Foam Supply System*
Photograph 17	*Example of a Coriolis Mass Flow Meter*
Photograph 18	*Example of Skid Mounted LPG Loading Facility.*
Photograph 19	*Patterson Horizontal Split Case MAAA 12 x 8 Pump*
Photograph 20	*Example of a Multi-Lanes Tanker Truck Loading Facility*

Photograph 20A	*Example of LPG Tanker Truck Loading Arm*
Photograph 20B	*Security fence around LPG Tanks*
Photograph 20C	*Protection Barrier/Pillars around LPG Tanks*
Photograph 21	*Example of a manifold system*
Photograph 22	*Mango, black berry and coco-plum trees on portion of proposed BNGCT site*
Photograph 23	*Sparse vegetation covering about40% of the proposed site*
Photograph 24	*Grassland area on proposed BNGCT Terminal area*
Photograph 25	*Approximately 60% of proposed BNGC Terminal site is grass/open land.*
Photograph 26	*Scrap metal being stored on small portionof proposed BNGC Terminal site*
Photograph 27	*BNGC Terminal with Surrounding Open Areas*
Photograph 27A	*Cleared site for Central Region Depot*
Photograph 27B	*Orange Walk LPG Depot Site*
Photograph 27C	*Orange Walk LPG Depot Site - Aerial*
Photograph 28	*General Topography and Layout of the Terminal site and surrounding areas.*
Photograph 29	*Aerial view of Topography of BNGC Terminal Site.*
Photograph 30	*Backfilled test pit showing two grades of sand discovered*
Photograph 31	*Showing Boundary of Port of Big Creek & port facilities east of Terminal site.*
Photograph 32	*Open Spaces to the North of proposed BNGC Terminal*
Photograph 33	*View to the south of Proposed Terminal Site*
Photograph 34	*View to the West and North-west of the proposed Terminal.*
Photograph 35	*View to the East of proposed Terminal Site*

Photograph 36A	*Flow of drainage at Central Region Depot Site*
Photograph 36B	*Western View from proposed site of present Land Use*
Photograph 36B1	*Northern View from proposed site of present Land Use*
Photograph 36B2	*North-western View from proposed site of present Land Use*
Photograph 36B3	*North-Eastern View from proposed site of present land use*
Photograph 36B4	*Eastern View from proposed site of Land use*
Photograph 36B5	*Southern View from proposed site of present land use.*
Photograph 36C	*Flow of drainage at Northern Region Depot Site (top of picture is west)*
Photograph 36C1	*Northern View from the proposed site of present land use.*
Photograph 36C2	*Eastern View from proposed site of present land use.*
Photograph 36C3	*Southern View from the proposed site of present land use.*
Photograph 36C4	*Western View from proposed site of present land use.*
Photograph 37	*Sparse Vegetation on proposed site for BNGC Terminal*
Photograph 37A	*Grassland and palmettos with few shrubs and trees*
Photograph 38:	*Grassland on Proposed Site for BNGC Terminal*
Photograph 39	*Covered shed with adequate ventilation for the storage of Mercaptan Cylinders.*
Photograph 40:	*Drainage of BNGC Terminal Site*
Photograph 41:	*Painting of Underground pipeline*
Photograph 42	*Wrapping Pipeline with Bitumen Tape*
Photograph 43	*Wrapping Pipeline with Grease cloth*
Photograph 43A	*Wrapping Pipeline with PVC-like Tape*

Photograph 44	*Photograph showing Painted exposed and PVC Tape Wrapped Underground Pipeline*
Photograph 45:	*Warning tape being installed one foot above underground pipeline*
Photograph 46:	*Example of a Pipeline Protection Conduit*
Photograph 47	*Examples of Gas Pipeline markers.*
Photograph 48	*LPG Storage tank with safety devices*

LIST OF TABLES

Table1	*Showing List of Pumps to be used throughout BNGC Terminal*
Table 1A	*NFPA Chart on Permitted Liquid Volumes*
Table2	*Properties of Butane*
Table3	*Properties of Propane*
Table4	*Properties of Mercaptan*
Table 5	*Monthly Wind Speed/Direction for the last 30 years (PGIA)*
Table 6	*Predominant Causes of BLEVEs*
Table 7	*Safety Distances as per NFPA*
Table 8	*Watersheds within Savannah Province*
Table 9	*1981-2010 Temperature & Rainfall Monthly Average - Savannah Forest Station*
Table 10	*Permissible Exposure Limits for BTEX, NO_2 and SO_2*
Table 11	*Permits, Licenses and Penalties pertaining to BNGC's Project*
Table 12	*List of Trees found on Depot Sites*
Table 13	*Fauna seen on Depot Sites during site Visits*
Table 14	*Comparison of the Properties of Propane and Butane*
Table 15	*Noise Levels – Loading of Bob Tail Truck*
Table 16	*Noise Levels – Discharging of LPG Tanker Truck*
Table 17	*Noise Levels – Loading Crude Oil Tanker Truck*
Table 18	*BTEX Results and Recommended Levels*
Table 19	*NOSO Levels and Recommended Levels*
Table 20	*Project Alternatives*

Table 21	*Construction Phase Impacts & Mitigation*
Table 22	*Operational Phase Impacts & Mitigation*
Table 23	*Decommissioning Phase Impacts & Mitigation*
Table 24	*Environmental Aspects Summary*

APPENDICES

APPENDIX I

Survey Plan of 15 acre Plot – Port of Big Creek

APPENDIX II

Survey Plan of 5 Acre Plot – Belmopan

Belize

Report Date: 21-Feb-2012

Run Time: 3:57:48 PM

Land Register Report for Parcel ID: 20-17-7724

PROPERTY SECTION:

Parcel ID	**20-17-7724**		
Registration Section	Belmopan	Legal Description	20-17-7724
Original Registration Date	03-Jul-2006	Metes & Bounds Description	Mutation No. 165/2006 Ref. see parcel 7044 Entry No. 9746
Approximate Area	5.00 Acres	Appurtenances	
Strata / Timeshare Details		Status Indicators	Absolute Title, Private Land, Active Parcel, Freehold

PROPRIETORSHIP SECTION:

Entry #	Entry Date	Instrument	Description	Termination
1	17-Jul-2006		BELIZE NATURAL ENERGY LTD. - 3401 Mountain View Boulevard, City of Belmopan, CAYO DISTRICT, Belize (Inst. No. 7806/2006)	
2	17-Jul-2006		Land Cert. No. 7807/2006 isued	

INCUMBRANCES SECTION:

Entry #	Entry Date	Instrument	Description	Termination

Report Name: Land Register Report

Page **1** of 1

landfolio® registry

APPENDIX III

Survey Plan of 10 Acre Plot – Orange Walk District

APPENDIX IV- SDS BUTANE

Material Safety Data Sheet

Printing date 10/20/2008 Version 2 Reviewed on 10/20/2008

1 Identification of substance

· **Product details**

· **Trade name: Butane**

· **Article number:** 009-01-0003

· **Creation date:** 08/14/2006

· **Manufacturer/Supplier:**

Linde Canada Limited
5860 Chedworth Way
Mississauga, Ontario L5R 0A2
Telephone (905) 501-1700
24-HOUR EMERGENCY TELEPHONE NUMBER:
(905) 501-0802

Linde
575 Mountain Avenue
Murray Hill, NJ 07974
Telephone (908) 464-8100
24-HOUR EMERGENCY TELEPHONE NUMBER:
CHEMTREC (800) 424-9300

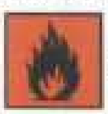
· **Information department:** Customer Service Centre: 1-866-385-5349

2 Composition/Data on components

· **Chemical characterization:**
· **CAS No. Description**
106-97-8 Butane
· **Identification number(s)**
· **EINECS Number:** 203-448-7
601-004-00-0

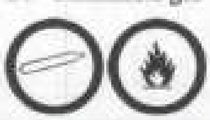
3 Hazards identification

· **Hazard description:**



Extremely flammable

· **WHMIS-symbols:**
A - Compressed gas
B1 - Flammable gas



· **HMIS-ratings (scale 0 - 4)**

HEALTH 0 Health = 0
FIRE 4 Fire = 4
REACTIVITY 0 Reactivity = 0

(Contd. on page 2)

CDN

Material Safety Data Sheet

Printing date 10/20/2008 | Version 2 | Reviewed on 10/20/2008

Trade name: Butane

(Contd. of page 1)

· **NFPA ratings (scale 0 - 4)**

Health = 0
Fire = 4
Reactivity = 0

· **Information pertaining to particular dangers for man and environment:**
Extremely flammable.

· **Classification system:**
The classification is in line with internationally approved calculation standards. It is expanded, however, by information from technical literature and by information furnished by supplier companies.

· **GHS label elements**

Danger

2.2/1 - Extremely flammable gas.

· **Prevention:**
Keep away from heat/sparks/open flames/hot surfaces. - No smoking.

· **Response:**
Leaking gas fire: Do not extinguish, unless leak can be stopped safely.
Eliminate all ignition sources if safe to do so.

· **Storage:**
Store in a well-ventilated place.

*

4 First aid measures

· **After inhalation:** Supply fresh air; consult doctor in case of complaints.
· **After skin contact:** Generally the product does not irritate the skin.
· **After eye contact:** Rinse opened eye for at least 15 minutes under running water. Then consult a doctor.
· **After swallowing:** Not applicable

*

5 Fire fighting measures

· **Suitable extinguishing agents:**
CO_2, powder or water spray. Fight larger fires with water spray or alcohol resistant foam.
· **Protective equipment:** Wear self-contained respiratory protective device.

*

6 Accidental release measures

· **Person-related safety precautions:**
Wear protective equipment. Keep unprotected persons away.
Ensure adequate ventillation.
Eliminate ignition sources
Stop leak - ONLY if possible to do so without risk.

· **Measures for environmental protection:** Prevent seepage into sewage system, workpits and/or cellars.

(Contd. on page 3)

Material Safety Data Sheet

Printing date 10/20/2008 Version 2 Reviewed on 10/20/2008

Trade name: Butane

(Contd. of page 2)

· **Measures for cleaning/collecting:** Ensure adequate ventillation.

*

7 Handling and storage

· **Handling:** Do not mix with air or oxygen above atmospheric pressure.
· **Information for safe handling:**
Open and handle cylinder with care.
Handle with care. Avoid jolting, friction, and impact.
Use only in well ventilated areas.
Store cylinders upright with valve protection cap in place and firmly secured to prevent falling or being knocked over.
· **Information about protection against explosions and fires:**
Keep ignition sources away - Do not smoke.
Protect against electrostatic charges.
Pressurized container: protect from sunlight and do not expose to temperatures exceeding 50°C. Do not pierce or burn, even after use.

· **Storage:**
· **Requirements to be met by storerooms and receptacles:**
Store in a cool location.
Do not expose cylinder to temperatures higher than 50°C (122 °F)
· **Information about storage in one common storage facility:**
Store away from oxidizing agents.
Store separately from cylinders containing oxygen or oxidants by a minimum distance of 20' or by a barrier of non-combustible material at least 5' high having a fire resistant rating of at least 30minutes.
Sources of ignition should be removed from storage area.
· **Further information about storage conditions:**
Keep cylinder valve tightly closed.
Store in cool, dry conditions in well sealed receptacles.
Protect from heat and direct sunlight.
Store cylinder in a well ventilated area.
Store in accordance with local fire code and/or building code or any pertaining regulations.

*

8 Exposure controls and personal protection

· **Additional information about design of technical systems:**
Adequate local ventillation.
Safety showers and eyewash stations should be nearby.

· **Components with limit values that require monitoring at the workplace:**	
106-97-8 Butane (23 - 100%)	
EL	Short-term value: 750 ppm Long-term value: 600 ppm

· **Additional information:** The lists that were valid during the creation were used as basis.

· **Personal protective equipment:**
· **General protective and hygienic measures:**
Wash hands before breaks and at the end of work.
Protective clothing should be kept free of oil and grease.

(Contd. on page 4)

CDN

Material Safety Data Sheet

Printing date 10/20/2008 Version 2 Reviewed on 10/20/2008

Trade name: Butane

(Contd. of page 3)

PPE should be inspected and maintained regularly to retain it's effectiveness.

· **Breathing equipment:**
Use atmosphere-supplying respirators (e.g. supplied-air: demand, pressure-demand, or continuous-flow or self-contained breathing apparatus: demand or pressure-demand or combination supplied-air with auxiliary self-contained air supply atmosphere-supplying respirator) in case of insufficient ventilation.

· **Protection of hands:**

Protective gloves.

· **Material of gloves**
The selection of the suitable gloves does not only depend on the material, but also on further marks of quality and varies from manufacturer to manufacturer.

· **Eye protection:** Safety glasses

*

9 Physical and chemical properties

· **General Information**	
Form:	Gaseous.
Color:	Colorless
Odor:	Nearly odorless
· **Change in condition**	
Melting point/Melting range:	-138°C
Boiling point/Boiling range:	0°C
· **Ignition temperature:**	365°C
· **Danger of explosion:**	In use, may form flammable/explosive vapour-air mixture.
· **Explosion limits:**	
Lower:	1.5 Vol %
Upper:	8.5 Vol %
· **Solubility in / Miscibility with Water at 20°C:**	0.061 g/l

*

10 Stability and reactivity

· **Thermal decomposition / conditions to be avoided:** No decomposition if used according to specifications.

· **Dangerous reactions**
May form explosive gas mixture with air.
May react with oxidizing agents.

· **Dangerous products of decomposition:** No dangerous decomposition products known.

CDN

(Contd. on page 5)

Material Safety Data Sheet

Printing date 10/20/2008 Version 2 Reviewed on 10/20/2008

Trade name: Butane

(Contd. of page 4)

*

11 Toxicological information

· **Acute toxicity:** -

· LD/LC50 values that are relevant for classification:		
106-97-8 Butane		
Inhalative	LC50/4hr	658 ppm (rat)

· **Primary irritant effect:**
· **on the skin:** No irritating effect.
· **on the eye:** No irritating effect.
· **Sensitization:** No sensitizing effects known.

12 Ecological information

· **General notes:** Generally not hazardous for water.

*

13 Disposal considerations

· **Product:**
· **Recommendation:** Unused product should be returned to vendor.

· **Uncleaned packagings:**
· **Recommendation:**
Cylinder and unused product should be returned to vendor. Disposable cylinder must be disposed of in accordance with local regulations.
· **Recommended cleansing agent:** None applicable.

*

14 Transport information

· **TDG and DOT regulations:**

· **Hazard class:**	2.1
· **Identification number:**	UN1011
· **Packing group:**	-
· **Proper shipping name (technical name):**	BUTANE
· **Label**	2.1
· **Packaging group:**	-

(Contd. on page 6)

CDN

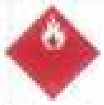
Material Safety Data Sheet

Printing date 10/20/2008 Version 2 Reviewed on 10/20/2008

Trade name: Butane

(Contd. of page 5)

· **Maritime transport IMDG:**



· **IMDG Class:**	2.1
· **UN Number:**	1011
· **Label**	2.1
· **Packaging group:**	-
· **EMS Number:**	F-D,S-U
· **Marine pollutant:**	No
· **Proper shipping name:**	BUTANE

· **Air transport ICAO-TI and IATA-DGR:**

· **ICAO/IATA Class:**	2.1
· **UN/ID Number:**	1011
· **Label**	2.1
· **Packaging group:**	-
· **Propper shipping name:**	BUTANE

· **UN "Model Regulation":** UN1011, BUTANE, 2.1

15 Regulations

· **Sara**

· **Section 355 (extremely hazardous substances):**

Substance is not listed.

· **Section 313 (Specific toxic chemical listings):**

Substance is not listed.

· **TSCA (Toxic Substances Control Act):**

Substance is listed.

· **Proposition 65**

· **Chemicals known to cause cancer:**

Substance is not listed.

· **Chemicals known to cause reproductive toxicity for females:**

Substance is not listed.

· **Chemicals known to cause reproductive toxicity for males:**

Substance is not listed.

· **Chemicals known to cause developmental toxicity:**

Substance is not listed.

(Contd. on page 7)

CDN

Material Safety Data Sheet

Printing date 10/20/2008 Version 2 Reviewed on 10/20/2008

Trade name: Butane

(Contd. of page 6)

· **Cancerogenity categories**

· **EPA (Environmental Protection Agency)**
Substance is not listed.
· **NTP (National Toxicology Program)**
Substance is not listed.
· **TLV (Threshold Limit Value established by ACGIH)**
Substance is not listed.
· **NIOSH-Ca (National Institute for Occupational Safety and Health)**
Substance is not listed.
· **OSHA-Ca (Occupational Safety & Health Administration)**
Substance is not listed.

· **Canadian substance listings:**

· **Canadian Domestic Substances List (DSL)**
Substance is listed.
· **Canadian Ingredient Disclosure list (limit 0.1%)**
Substance is not listed.
· **Canadian Ingredient Disclosure list (limit 1%)**
Substance is listed.

· **Product related hazard informations:**
The product was classified in accordance with the hazard criteria of the Canadian Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR.

· **Hazard symbols:**
Extremely flammable

· **Risk phrases:**
Extremely flammable.

· **Safety phrases:**
Keep out of the reach of children.
Keep container in a well-ventilated place.
Keep away from sources of ignition - No smoking.

*

16 Other information

This information is based on our present knowledge. However, this shall not constitute a guarantee for any specific product features and shall not establish a legally valid contractual relationship.

Please refer to the section 3 for NFPA and HMIS Hazard Codes.

DISCLAIMER OF EXPRESSED AND IMPLIED WARRANTIES
Although reasonable care has been taken in the preparation of this document, we extend no warranties and make no representations as to the accuracy or completeness of the information contained herein, and assume no responsibility regarding the suitability of this information for the user's intended purposes or for the consequences of its use. Each individual should make a determination as to the suitability of the information for their particular purpose(s).

(Contd. on page 8)

Material Safety Data Sheet

Printing date 10/20/2008 | Version 2 | Reviewed on 10/20/2008

Trade name: Butane

(Contd. of page 7)

GENERAL DISCLAIMER

For terms and conditions, including limitation of liability, please refer to the purchase agreement in effect between Linde Inc. (or any of its affiliates and subsidiaries) and the purchaser.

· **Department issuing MSDS:** Customer Service Centre: 1-866-385-5349

· **Abbreviations and Acronyms:**

ACGIH: American Conference of Governmental Industrial Hygienists
CAS: Chemical Abstract Service (Division of the American Chemical Society)
DOT: US Department of Transportation
EINECS: European Inventory of Existing Commercial Chemical Substances
GHS: Globally Harmonized System of Classification and Labelling of Chemicals
HMIS: Hazardous Material Identification System
IATA: International Air Transportation Association
IATA-DGR: Dangerous Goods Regulations by the "International Air Transportation Association"
ICAO: International Civil Aviation Association
ICAO-TI: Technical Instructions by the "International Civil Aviation Organization (ICAO)
IMDG: International Marine Code for Dangerous Goods
WHIMS: Workplace Hazardous Material Information System
LC50: Lethal Concentration, 50 Percent
LD50: Lethal Dose, 50 Percent
N/A: Not Applicable

CDN

APPENDIX VI – SDS PROPANE

SAFETY DATA SHEET

Propane

Airgas
an Air Liquide company

Section 1. Identification

GHS product identifier	:	Propane
Chemical name	:	propane
Other means of identification	:	Propyl hydride; n-Propane; Dimethyl methane; Bottled gas; propane in gaseous state; propane liquefied, n-Propane; Dimethylmethane; Freon 290; Liquefied petroleum gas; Lpg; Propyl hydride; R 290; C3H8; UN 1075; UN 1978; A-108; Hydrocarbon propellant.
Product use	:	Synthetic/Analytical chemistry.
Synonym	:	Propyl hydride; n-Propane; Dimethyl methane; Bottled gas; propane in gaseous state; propane liquefied, n-Propane; Dimethylmethane; Freon 290; Liquefied petroleum gas; Lpg; Propyl hydride; R 290; C3H8; UN 1075; UN 1978; A-108; Hydrocarbon propellant.
SDS #	:	001045
Supplier's details	:	Airgas USA, LLC and its affiliates 259 North Radnor-Chester Road Suite 100 Radnor, PA 19087-5283 1-610-687-5253
24-hour telephone	:	1-866-734-3438

Section 2. Hazards identification

OSHA/HCS status	:	This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).
Classification of the substance or mixture	:	FLAMMABLE GASES - Category 1 GASES UNDER PRESSURE - Liquefied gas

GHS label elements

Hazard pictograms :

Signal word	:	Danger
Hazard statements	:	Extremely flammable gas. Contains gas under pressure; may explode if heated. May cause frostbite. May form explosive mixtures in Air. May displace oxygen and cause rapid suffocation.

Precautionary statements

General	:	Read and follow all Safety Data Sheets (SDS'S) before use. Read label before use. Keep out of reach of children. If medical advice is needed, have product container or label at hand. Close valve after each use and when empty. Use equipment rated for cylinder pressure. Do not open valve until connected to equipment prepared for use. Use a back flow preventative device in the piping. Use only equipment of compatible materials of construction. Always keep container in upright position. Approach suspected leak area with caution.
Prevention	:	Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.
Response	:	Leaking gas fire: Do not extinguish, unless leak can be stopped safely. Eliminate all ignition sources if safe to do so.
Storage	:	Protect from sunlight when ambient temperature exceeds 52°C/125°F. Store in a well-ventilated place.

Section 2. Hazards identification

Disposal : Not applicable.

Hazards not otherwise classified : In addition to any other important health or physical hazards, this product may displace oxygen and cause rapid suffocation.

Section 3. Composition/information on ingredients

Substance/mixture : Substance

Chemical name : propane

Other means of identification : Propyl hydride; n-Propane; Dimethyl methane; Bottled gas; propane in gaseous state; propane liquefied, n-Propane; Dimethylmethane; Freon 290; Liquefied petroleum gas; Lpg; Propyl
hydride; R 290; C3H8; UN 1075; UN 1978; A-108; Hydrocarbon propellant.

CAS number/other identifiers

CAS number : 74-98-6

Product code : 001045

Ingredient name	%	CAS number
Propane	100	74-98-6

Any concentration shown as a range is to protect confidentiality or is due to batch variation.

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

Occupational exposure limits, if available, are listed in Section 8.

Section 4. First aid measures

Description of necessary first aid measures

Eye contact : Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Check for and remove any contact lenses. Continue to rinse for at least 10 minutes. Get medical attention if irritation occurs.

Inhalation : Remove victim to fresh air and keep at rest in a position comfortable for breathing. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Get medical attention if adverse health effects persist or are severe. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

Skin contact : Wash contaminated skin with soap and water. Remove contaminated clothing and shoes. To avoid the risk of static discharges and gas ignition, soak contaminated clothing thoroughly with water before removing it. Get medical attention if symptoms occur. Wash clothing before reuse. Clean shoes thoroughly before reuse.

Ingestion : As this product is a gas, refer to the inhalation section.

Most important symptoms/effects, acute and delayed

Potential acute health effects

Eye contact : No known significant effects or critical hazards.

Inhalation : No known significant effects or critical hazards.

Skin contact : No known significant effects or critical hazards.

Frostbite : Try to warm up the frozen tissues and seek medical attention.

Ingestion : As this product is a gas, refer to the inhalation section.

Over-exposure signs/symptoms

Eye contact : No specific data.

Inhalation : No specific data.

Skin contact : No specific data.

Section 4. First aid measures

Ingestion : No specific data.

Indication of immediate medical attention and special treatment needed, if necessary

Notes to physician : Treat symptomatically. Contact poison treatment specialist immediately if large quantities have been ingested or inhaled.

Specific treatments : No specific treatment.

Protection of first-aiders : No action shall be taken involving any personal risk or without suitable training. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation.

See toxicological information (Section 11)

Section 5. Fire-fighting measures

Extinguishing media

Suitable extinguishing media : Use an extinguishing agent suitable for the surrounding fire.

Unsuitable extinguishing media : None known.

Specific hazards arising from the chemical : Contains gas under pressure. Extremely flammable gas. In a fire or if heated, a pressure increase will occur and the container may burst, with the risk of a subsequent explosion.

Hazardous thermal decomposition products : Decomposition products may include the following materials:
carbon dioxide
carbon monoxide

Special protective actions for fire-fighters : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training. Contact supplier immediately for specialist advice. Move containers from fire area if this can be done without risk. Use water spray to keep fire-exposed containers cool. If involved in fire, shut off flow immediately if it can be done without risk. If this is impossible, withdraw from area and allow fire to burn. Fight fire from protected location or maximum possible distance. Eliminate all ignition sources if safe to do so.

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

Section 6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel : Accidental releases pose a serious fire or explosion hazard. No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Shut off all ignition sources. No flares, smoking or flames in hazard area. Avoid breathing gas. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.

For emergency responders : If specialised clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".

Environmental precautions : Ensure emergency procedures to deal with accidental gas releases are in place to avoid contamination of the environment. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).

Methods and materials for containment and cleaning up

Small spill : Immediately contact emergency personnel. Stop leak if without risk. Use spark-proof tools and explosion-proof equipment.

Section 6. Accidental release measures

Large spill : Immediately contact emergency personnel. Stop leak if without risk. Use spark-proof tools and explosion-proof equipment. Note: see Section 1 for emergency contact information and Section 13 for waste disposal.

Section 7. Handling and storage

Precautions for safe handling

Protective measures : Put on appropriate personal protective equipment (see Section 8). Contains gas under pressure. Avoid contact with eyes, skin and clothing. Avoid breathing gas. Use only with adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Do not enter storage areas and confined spaces unless adequately ventilated. Store and use away from heat, sparks, open flame or any other ignition source. Use explosion-proof electrical (ventilating, lighting and material handling) equipment. Use only non-sparking tools. Empty containers retain product residue and can be hazardous. Do not puncture or incinerate container. Use equipment rated for cylinder pressure. Close valve after each use and when empty. Protect cylinders from physical damage; do not drag, roll, slide, or drop. Use a suitable hand truck for cylinder movement.

Advice on general occupational hygiene : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

Conditions for safe storage, including any incompatibilities : Store in accordance with local regulations. Store in a segregated and approved area. Store away from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10). Eliminate all ignition sources. Keep container tightly closed and sealed until ready for use. Cylinders should be stored upright, with valve protection cap in place, and firmly secured to prevent falling or being knocked over. Cylinder temperatures should not exceed 52 °C (125 °F).

Section 8. Exposure controls/personal protection

Control parameters

Occupational exposure limits

Ingredient name	Exposure limits
Propane	**NIOSH REL (United States, 10/2013).** TWA: 1800 mg/m³ 10 hours. TWA: 1000 ppm 10 hours. **OSHA PEL (United States, 2/2013).** TWA: 1800 mg/m³ 8 hours. TWA: 1000 ppm 8 hours. **OSHA PEL 1989 (United States, 3/1989).** TWA: 1800 mg/m³ 8 hours. TWA: 1000 ppm 8 hours.

Appropriate engineering controls : Use only with adequate ventilation. Use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits. The engineering controls also need to keep gas, vapor or dust concentrations below any lower explosive limits. Use explosion-proof ventilation equipment.

Environmental exposure controls : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

Individual protection measures

Section 8. Exposure controls/personal protection

Hygiene measures : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

Eye/face protection : Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists, gases or dusts. If contact is possible, the following protection should be worn, unless the assessment indicates a higher degree of protection: safety glasses with side-shields.

Skin protection

Hand protection : Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. It should be noted that the time to breakthrough for any glove material may be different for different glove manufacturers. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Body protection : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product. When there is a risk of ignition from static electricity, wear anti-static protective clothing. For the greatest protection from static discharges, clothing should include anti-static overalls, boots and gloves.

Other skin protection : Appropriate footwear and any additional skin protection measures should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Respiratory protection : Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

Section 9. Physical and chemical properties

Appearance

Physical state : Gas. [Liquefied compressed gas.]

Color : Colorless.

Molecular weight : 44.11 g/mole

Molecular formula : C3-H8

Boiling/condensation point : -161.48°C (-258.7°F)

Melting/freezing point : -187.6°C (-305.7°F)

Critical temperature : 96.55°C (205.8°F)

Odor : Odorless.BUT MAY HAVE SKUNK ODOR ADDED.

Odor threshold : Not available.

pH : Not available.

Flash point : Closed cup: -104°C (-155.2°F)
Open cup: -104°C (-155.2°F)

Burning time : Not applicable.

Burning rate : Not applicable.

Evaporation rate : Not available.

Flammability (solid, gas) : Extremely flammable in the presence of the following materials or conditions: open flames, sparks and static discharge and oxidizing materials.

Lower and upper explosive (flammable) limits : Lower: 1.8%
Upper: 8.4%

Vapor pressure : 109 (psig)

Vapor density : 1.6 (Air = 1)

Section 9. Physical and chemical properties

Specific Volume (ft ^{3}/lb)	: 8.6206
Gas Density (lb/ft ^{3})	: 0.116 (25°C / 77 to °F)
Relative density	: Not applicable.
Solubility	: Not available.
Solubility in water	: 0.0244 g/l
Partition coefficient: n-octanol/water	: 1.09
Auto-ignition temperature	: 287°C (548.6°F)
Decomposition temperature	: Not available.
SADT	: Not available.
Viscosity	: Not applicable.

Section 10. Stability and reactivity

Reactivity	: No specific test data related to reactivity available for this product or its ingredients.
Chemical stability	: The product is stable.
Possibility of hazardous reactions	: Under normal conditions of storage and use, hazardous reactions will not occur.
Conditions to avoid	: Avoid all possible sources of ignition (spark or flame). Do not pressurize, cut, weld, braze, solder, drill, grind or expose containers to heat or sources of ignition.
Incompatible materials	: Oxidizers
Hazardous decomposition products	: Under normal conditions of storage and use, hazardous decomposition products should not be produced.
Hazardous polymerization	: Under normal conditions of storage and use, hazardous polymerization will not occur.

Section 11. Toxicological information

Information on toxicological effects

Acute toxicity

Not available.

IDLH : 2100 ppm

Irritation/Corrosion

Not available.

Sensitization

Not available.

Mutagenicity

Not available.

Carcinogenicity

Not available.

Reproductive toxicity

Not available.

Teratogenicity

Not available.

Section 11. Toxicological information

Specific target organ toxicity (single exposure)

Not available.

Specific target organ toxicity (repeated exposure)

Not available.

Aspiration hazard

Not available.

Information on the likely routes of exposure : Not available.

Potential acute health effects

Eye contact	: No known significant effects or critical hazards.
Inhalation	: No known significant effects or critical hazards.
Skin contact	: No known significant effects or critical hazards.
Ingestion	: As this product is a gas, refer to the inhalation section.

Symptoms related to the physical, chemical and toxicological characteristics

Eye contact	: No specific data.
Inhalation	: No specific data.
Skin contact	: No specific data.
Ingestion	: No specific data.

Delayed and immediate effects and also chronic effects from short and long term exposure

Short term exposure

Potential immediate effects	: Not available.
Potential delayed effects	: Not available.

Long term exposure

Potential immediate effects	: Not available.
Potential delayed effects	: Not available.

Potential chronic health effects

Not available.

General	: No known significant effects or critical hazards.
Carcinogenicity	: No known significant effects or critical hazards.
Mutagenicity	: No known significant effects or critical hazards.
Teratogenicity	: No known significant effects or critical hazards.
Developmental effects	: No known significant effects or critical hazards.
Fertility effects	: No known significant effects or critical hazards.

Numerical measures of toxicity

Acute toxicity estimates

Not available.

Section 12. Ecological information

Toxicity

Not available.

Persistence and degradability

Not available.

Bioaccumulative potential

Product/ingredient name	$LogP_{ow}$	BCF	Potential
Propane	1.09	-	low

Mobility in soil

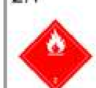
Soil/water partition coefficient (K_{OC}) : Not available.

Other adverse effects : No known significant effects or critical hazards.

Section 13. Disposal considerations

Disposal methods : The generation of waste should be avoided or minimized wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction. Empty Airgas-owned pressure vessels should be returned to Airgas. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Empty containers or liners may retain some product residues. Do not puncture or incinerate container.

Section 14. Transport information

	DOT	TDG	Mexico	IMDG	IATA
UN number	UN1978	UN1978	UN1978	UN1978	UN1978
UN proper shipping name	PROPANE	PROPANE	PROPANE	PROPANE	PROPANE
Transport hazard class(es)	2.1 	2.1 	2.1 	2.1 	2.1 
Packing group	-	-	-	-	-
Environment	No.	No.	No.	No.	No.
Additional information	**Limited quantity** Yes. **Packaging instruction** **Passenger aircraft** Quantity limitation: Forbidden. **Cargo aircraft** Quantity limitation: 150 kg **Special provisions** 19, T50	Product classified as per the following sections of the Transportation of Dangerous Goods Regulations: 2.13-2.17 (Class 2). **Explosive Limit and Limited Quantity Index** 0.125 **ERAP Index** 3000	-	-	**Passenger and Cargo Aircraft**Quantity limitation: 0 Forbidden **Cargo Aircraft Only** Quantity limitation: 150 kg

Section 14. Transport information

	For domestic transportation only, UN1075 may be substituted for the UN number shown as long as the substitution is consistent on package markings, shipping papers, and emergency response information. See 49 CFR 172.102 Special Provision 19. Containers of NON-ODORIZED liquefied petroleum gas must be marked either NON-ODORIZED or NOT ODORIZED as of September 30, 2006. [49 CFR 172.301(f), 326(d), 330(c) and 338 (e)]	**Passenger Carrying Ship Index** 65 **Passenger Carrying Road or Rail Index** Forbidden **Special provisions** 29, 42			

"Refer to CFR 49 (or authority having jurisdiction) to determine the information required for shipment of the product."

Special precautions for user : **Transport within user's premises:** always transport in closed containers that are upright and secure. Ensure that persons transporting the product know what to do in the event of an accident or spillage.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code : Not available.

Section 15. Regulatory information

U.S. Federal regulations : **TSCA 8(a) CDR Exempt/Partial exemption**: Not determined

United States inventory (TSCA 8b): This material is listed or exempted.

Clean Air Act (CAA) 112 regulated flammable substances: propane

Clean Air Act Section 112 (b) Hazardous Air Pollutants (HAPs) : Not listed

Clean Air Act Section 602 Class I Substances : Not listed

Clean Air Act Section 602 Class II Substances : Not listed

DEA List I Chemicals (Precursor Chemicals) : Not listed

DEA List II Chemicals (Essential Chemicals) : Not listed

SARA 302/304

Composition/information on ingredients

No products were found.

SARA 304 RQ : Not applicable.

SARA 311/312

Classification : Refer to Section 2: Hazards Identification of this SDS for classification of substance.

State regulations

Section 15. Regulatory information

Massachusetts : This material is listed.
New York : This material is not listed.
New Jersey : This material is listed.
Pennsylvania : This material is listed.

International regulations

International lists

National inventory

Australia : This material is listed or exempted.
Canada : This material is listed or exempted.
China : This material is listed or exempted.
Europe : This material is listed or exempted.
Japan : This material is listed or exempted.
Malaysia : This material is listed or exempted.
New Zealand : This material is listed or exempted.
Philippines : This material is listed or exempted.
Republic of Korea : This material is listed or exempted.
Taiwan : This material is listed or exempted.

Canada

WHMIS (Canada) : Class A: Compressed gas.
Class B-1: Flammable gas.

CEPA Toxic substances: This material is not listed.
Canadian ARET: This material is not listed.
Canadian NPRI: This material is listed.
Alberta Designated Substances: This material is not listed.
Ontario Designated Substances: This material is not listed.
Quebec Designated Substances: This material is not listed.

Section 16. Other information

Canada Label requirements : Class A: Compressed gas.
Class B-1: Flammable gas.

Hazardous Material Information System (U.S.A.)

Health	*	1
Flammability		4
Physical hazards		2

Caution: HMIS® ratings are based on a 0-4 rating scale, with 0 representing minimal hazards or risks, and 4 representing significant hazards or risks Although HMIS® ratings are not required on SDSs under 29 CFR 1910. 1200, the preparer may choose to provide them. HMIS® ratings are to be used with a fully implemented HMIS® program. HMIS® is a registered mark of the National Paint & Coatings Association (NPCA). HMIS® materials may be purchased exclusively from J. J. Keller (800) 327-6868.

The customer is responsible for determining the PPE code for this material.

National Fire Protection Association (U.S.A.)

Reprinted with permission from NFPA 704-2001, Identification of the Hazards of Materials for Emergency Response Copyright ©1997, National Fire Protection Association, Quincy, MA 02269. This reprinted material is not the complete and official position of the National Fire Protection Association, on the referenced subject which is represented only by the standard in its entirety.

Section 16. Other information

Procedure used to derive the classification

Classification	Justification
Flam. Gas 1, H220 Press. Gas Liq. Gas, H280	Expert judgment Expert judgment

History

Date of printing : 6/28/2017

Date of issue/Date of revision : 6/28/2017

Date of previous issue : 10/20/2015

Version : 0.02

Key to abbreviations : ATE = Acute Toxicity Estimate
BCF = Bioconcentration Factor
GHS = Globally Harmonized System of Classification and Labelling of Chemicals
IATA = International Air Transport Association
IBC = Intermediate Bulk Container
IMDG = International Maritime Dangerous Goods
LogPow = logarithm of the octanol/water partition coefficient
MARPOL 73/78 = International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978. ("Marpol" = marine pollution)
UN = United Nations

References : Not available.

Indicates information that has changed from previously issued version.

Other special considerations : The information below is given to call attention to the issue of "Naturally occurring radioactive materials". Although Radon-222 levels in the product represented by this MSDS do not present any direct Radon exposure hazard, customers should be aware of the potential for Radon daughter build up within their processing systems, whatever the source of their product streams. Radon-222 is a naturally occurring radioactive gas which can be a contaminant in natural gas. During subsequent processing , Radon tends to be concentrated in Liquefied Petroleum Gas streams and in product streams having a similar boiling point range. Industry experience has shown that this product may contain small amounts of Radon-222 and its radioactive decay products, called Radon "daughters". The actual concentration of Radon-222 and radioactive daughters in the delivered product is dependent on the geographical source of the natural gas and storage time prior to delivery. Process equipment (i.e. lines, filters, pumps and reaction units) may accumulate significant levels of radioactive daughters and show a gamma radiation reading during operation. A potential external radiation hazard exists at or near any pipe valve or vessel containing a Radon enriched stream, or containing internal deposits of radioactive material due to the transmission of gamma radiation through its wall. Field studies reported in the literature have not shown any conditions that subject workers to cumulative exposures in excess of general population limits. Equipment emitting gamma radiation should be presumed to be internally contaminated with alpha emitting decay products which may be a hazard if inhaled or ingested. Protective equipment such as coveralls, gloves, and respirator (NIOSH/MHSA approved for high efficiency particulates and radionuclides, or supplied air) should be worn by personnel entering a vessel or working on contaminated process equipment to prevent skin contamination, ingestion, or inhalation of any residues containing alpha radiation. Airborne contamination may be minimized by handling scale and/or contaminated materials in a wet state.

Notice to reader

Section 16. Other information

To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein.
Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

APPENDIX VI – SDS EHTYL MERCAPTAN

MEGS

Tel: 514-956-7503
Fax: 514-956-7504
Internet: www.megs.ca
Email : support@megs.ca

Montreal	St-Laurent	Tel : 514-956-7503	Fax : 514-956-7504
Ottawa	Nepean	Tel : 613-226-4228	Fax : 613-226-4229
Quebec	Quebec	Tel : 418-834-7447	Fax : 418-834-3774

ETHYL MERCAPTAN- MATERIAL SAFETY DATA SHEET

TABLE OF CONTENTS:

1. Chemical Product and Company Identification
2. Composition, Information on Ingredients
3. Hazards Identification
4. First Aid Measures
5. Fire Fighting Measures
6. Accidental Release Measures
7. Handling and Storage
8. Exposure Controls, Personal Protection
9. Physical and Chemical Properties
10. Stability and Reactivity
11. Toxicological Information
12. Ecological Information
13. Disposal Considerations
14. Transport Information
15. Regulatory Information
16. Other Information

24 Hour EMERGENCY CONTACT

U.S- CHEMTREC 1-800-424-9300

CANADA- CANUTEC 613-996-6666

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Up to Table of Contents

Matheson Tri-Gas, Inc.

The telephone numbers listed below are emergency numbers, please contact your local branch for routine inquiries.

USA	CANADA
959 Route 46 East Parsippany, New Jersey 07054-0624 USA **Phone:** 973-257-1100	530 Watson Street Whitby, Ontario L1N 5R9 Canada **Phone:** 905-668-3570

SUBSTANCE: ETHYL MERCAPTAN

SYMBOL: C_2H_6S

TRADE NAMES/SYNONYMS:
ETHANETHIOL; ETHYL SULFHYDRATE; MERCAPTOETHANE; ETHYL HYDROSULFIDE; ETHYL THIOALCOHOL; THIOETHANOL; THIOETHYL ALCOHOL; LPG ETHYL MERCAPTAN 1010; UN 2363; O-2712; 958-T; 7171-T; MAT09070; RTECS KI9625000

CHEMICAL FAMILY: mercaptans

CREATION DATE: Jan 24 1989
REVISION DATE: Mar 16 1999

2. COMPOSITION, INFORMATION ON INGREDIENTS

Up to Table of Contents

COMPONENT: ETHYL MERCAPTAN

CAS NUMBER: 75-08-1

EC NUMBER (EINECS): 200-837-3

EC INDEX NUMBER: 016-022-00-9

PERCENTAGE: 100.0

3. HAZARDS IDENTIFICATION

Up to Table of Contents

NFPA RATINGS (SCALE 0-4): HEALTH=1 FIRE=4 REACTIVITY=0

WHMIS CLASSIFICATION: BD2

EC CLASSIFICATION (ASSIGNED):
F Highly Flammable
Xn Harmful

R 11-20

EC Classification may be inconsistent with independently-researched data.

EMERGENCY OVERVIEW:

Color: colorless

Physical Form: liquid

Odor: garlic odor

Major Health Hazards: central nervous system depression

Physical Hazards: Flammable liquid and vapor. Vapor may cause flash fire.

POTENTIAL HEALTH EFFECTS:

INHALATION:
Short Term Exposure:irritation, nausea, difficulty breathing, headache, symptoms of drunkenness, bluish skin color, convulsions, coma
Long Term Exposure: no information on significant adverse effects

SKIN CONTACT:
Short Term Exposure: irritation
Long Term Exposure: no information on significant adverse effects

EYE CONTACT:
Short Term Exposure: irritation
Long Term Exposure: no information on significant adverse effects

INGESTION:
Short Term Exposure: sore throat, nausea, stomach pain
Long Term Exposure: no information on significant adverse effects

CARCINOGEN STATUS:
OSHA: N
NTP: N
IARC: N

4. FIRST AID MEASURES

Up to Table of Contents

INHALATION:
Remove from exposure immediately. Use a bag valve mask or similar devi ce to perform artificial respiration (rescue breathing) if needed. Get medical attention.

SKIN CONTACT:
Remove contaminated clothing, jewelry, and shoes immediately. Wash with soap or mild detergent and large amounts of water until no evidence of chemical remains (at least 15-20 minutes). Get medical attention, if needed.

EYE CONTACT:
Wash eyes immediately with large amounts of water or normal saline, occasionally lifting upper and lower lids, until no evidence of chemical remains. Get medical attention immediately.

INGESTION:
Never make an unconscious person vomit or drink fluids. Give sodium bicarbonate solution. When vomiting occurs, keep head lower than hips to help prevent aspiration. If person is unconscious, turn head to side. Get medical attention immediately.

ANTIDOTE:
amyl nitrite, inhalation; sodium nitrite, intravenous; pyridoxine, intravenous; urea, intravenous. CAUTION! Get medical attention immediately.

NOTE TO PHYSICIAN:
For ingestion, consider gastric lavage.

5. FIRE FIGHTING MEASURES

Up to Table of Contents

FIRE AND EXPLOSION HAZARDS:
Severe fire hazard. Moderate explosion hazard. Vapor/air mixtures are explosive. The vapor is heavier than air. Vapors or gases may ignite at distant ignition sources and flash back.

EXTINGUISHING MEDIA:
alcohol resistant foam, carbon dioxide, regular dry chemical, water

Large fires: Use alcohol-resistant foam or flood with fine water spray.

FIRE FIGHTING:
Move container from fire area if it can be done without risk. Cool containers with water spray until well after the fire is out. Stay away from the ends of tanks. For fires in cargo or storage area: Cool containers with water from unmanned hose holder or monitor nozzles until well after fire is out. If this is impossible then take the following precautions: Keep unnecessary people away, isolate hazard area and deny entry. Let the fire burn. Withdraw immediately in case of rising sound from venting safety device or any discoloration of tanks due to fire. For tank, rail car or tank truck: Evacuation radius: 800 meters (1/2 mile). Water may be ineffective.

FLASH POINT:
-54.9 F (-48.3 C) (CC)

LOWER FLAMMABLE LIMIT:
2.8%

UPPER FLAMMABLE LIMIT:
18%

AUTOIGNITION:
572 F (300 C)

FLAMMABILITY CLASS (OSHA):
IA

6. ACCIDENTAL RELEASE MEASURES

Up to Table of Contents

OCCUPATIONAL RELEASE:
Avoid heat, flames, sparks and other sources of ignition. Stop leak if possible without personal risk. Reduce vapors with water spray. Small spills: Absorb with sand or other non-combustible material. Collect spilled material in appropriate container for disposal. Large spills: Dike for later disposal. Remove sources of ignition. Keep unnecessary people away, isolate hazard area and deny entry.

7. HANDLING AND STORAGE

Up to Table of Contents

Store and handle in accordance with all current regulations and standards. Subject to storage regulations: U.S. OSHA 29 CFR 1910.106. Grounding and bonding required. Keep separated from incompatible substances.

8. EXPOSURE CONTROLS, PERSONAL PROTECTION

Up to Table of Contents

EXPOSURE LIMITS:

ETHYL MERCAPTAN:
10 ppm (25 mg/m3) OSHA ceiling
0.5 ppm (1.3 mg/m3) OSHA TWA (vacated by 58 FR 35338, June 30, 1993)
0.5 ppm (1.3 mg/m3) ACGIH TWA
0.5 ppm (1.3 mg/m3) NIOSH recommended ceiling 15 minute(s)

VENTILATION: Provide local exhaust ventilation system. Ventilation equipment should be explosion-resistant if explosive concentrations of material are present. Ensure compliance with applicable exposure limits.

EYE PROTECTION: Wear splash resistant safety goggles. Provide an emergency eye wash fountain and quick drench shower in the immediate work area.

CLOTHING: Wear appropriate chemical resistant clothing.

GLOVES: Wear appropriate chemical resistant gloves.

RESPIRATOR: The following respirators and maximum use concentrations are drawn from NIOSH and/or OSHA.
5 ppm
Any chemical cartridge respirator with organic vapor cartridge(s).
Any supplied-air respirator.
12.5 ppm
Any supplied-air respirator.
Any powered, air-purifying respirator with organic vapor cartridge(s).
25 ppm
Any chemical cartridge respirator with a full facepiece and organic vapor cartridge(s).
Any air-purifying respirator with a full facepiece and an organic vapor canister.
Any supplied-air respirator with a full facepiece.
Any powered, air-purifying respirator with a full facepiece and organic vapor cartridge(s).
Any self-contained breathing apparatus with a full facepiece.
Any supplied-air respirator with a full facepiece.
500 ppm
Any supplied-air respirator operated in a pressure-demand or other positive-pressure mode.
Escape -
Any air-purifying respirator with a full facepiece and an organic vapor canister.
Any appropriate escape-type, self-contained breathing apparatus.
For Unknown Concentrations or Immediately Dangerous to Life or Health -
Any supplied-air respirator with full facepiece and operated in a pressure-demand or other positive-pressure mode in combination with a separate escape supply.
Any self-contained breathing apparatus with a full facepiece.

9. PHYSICAL AND CHEMICAL PROPERTIES

Up to Table of Contents

PHYSICAL STATE: liquid

COLOR: colorless

ODOR: garlic odor

MOLECULAR WEIGHT: 62.14

MOLECULAR FORMULA: C2-H6-S

BOILING POINT: 95 F (35 C)

FREEZING POINT: -227 F (-144 C)

VAPOR PRESSURE: 442 mmHg @ 20 C

VAPOR DENSITY (air=1): 2.14

SPECIFIC GRAVITY (water=1): 0.8453 @ 25 C

WATER SOLUBILITY: 6.7% @ 20 C

PH: Not available

VOLATILITY: Not available

ODOR THRESHOLD: 0.001 ppm

EVAPORATION RATE: Not available

VISCOSITY: 0.3155 cP @ 20 C

COEFFICIENT OF WATER/OIL DISTRIBUTION: Not available

SOLVENT SOLUBILITY:
Soluble: alcohol, ether, naphtha

10. STABILITY AND REACTIVITY

Up to Table of Contents

REACTIVITY:
Contact with water or moist air may form flammable and/or toxic gases or vapors.

CONDITIONS TO AVOID:
Avoid heat, flames, sparks and other sources of ignition. Containers may rupture or explode if exposed to heat. Keep out of water supplies and sewers.

INCOMPATIBILITIES:
acids, oxidizing materials, combustible materials

HAZARDOUS DECOMPOSITION:
Thermal decomposition products: oxides of sulfur

POLYMERIZATION:
Will not polymerize.

11. TOXICOLOGICAL INFORMATION

Up to Table of Contents

ETHYL MERCAPTAN:

IRRITATION DATA:
500 mg/24 hour(s) skin-rabbit mild; 84 mg eyes-rabbit; 100 mg/24 hour(s) eyes-rabbit moderate

TOXICITY DATA:
4420 ppm/4 hour(s) inhalation-rat LC50; 682 mg/kg oral-rat LD50

ACUTE TOXICITY LEVEL:
Moderately Toxic: inhalation, ingestion

TARGET ORGANS:
central nervous system

12. ECOLOGICAL INFORMATION

Up to Table of Contents

ECOTOXICITY DATA:

FISH TOXICITY:
20000 ug/L 0.033 hour(s) (Behavior) Aholehole (Kuhlia sandvicensis)

INVERTEBRATE TOXICITY:
170 ug/L 48 hour(s) LC50 (Mortality) Water flea (Daphnia magna)

13. DISPOSAL CONSIDERATIONS

Up to Table of Contents

Subject to disposal regulations: U.S. EPA 40 CFR 262. Hazardous Waste Number(s): D001.
Dispose in accordance with all applicable regulations.

14. TRANSPORT INFORMATION

Up to Table of Contents

U.S. DOT 49 CFR 172.101. SHIPPING NAME-UN NUMBER; HAZARD CLASS; PACKING GROUP; LABEL:
Ethyl mercaptan-UN2363; 3; I; Flammable liquid

15. REGULATORY INFORMATION

Up to Table of Contents

U.S. REGULATIONS:
TSCA INVENTORY STATUS: Y

TSCA 12(b) EXPORT NOTIFICATION: Not listed.

CERCLA SECTION 103 (40CFR302.4): N

SARA SECTION 302 (40CFR355.30): N

SARA SECTION 304 (40CFR355.40): N

SARA SECTION 313 (40CFR372.65): N

SARA HAZARD CATEGORIES, SARA SECTIONS 311/312 (40CFR370.21):
ACUTE: Y
CHRONIC: N
FIRE: Y
REACTIVE: N

SUDDEN RELEASE: N

OSHA PROCESS SAFETY (29CFR1910.119): N

STATE REGULATIONS:
California Proposition 65: N

EUROPEAN REGULATIONS:

EC NUMBER (EINECS): 200-837-3

EC RISK AND SAFETY PHRASES:

R 11	Highly flammable.
R 20	Harmful by inhalation.
S 2	Keep out of reach of children.
S 16	Keep away from sources of ignition - No smoking.
S 25	Avoid contact with eyes.

16. OTHER INFORMATION

Up to Table of Contents

Matheson Tri-Gas makes no express or implied warranties, guarantees or representations regarding the product or the information herein, including but not limited to any implied warranty of merchantability or fitness for use. Matheson Tri-Gas shall not be liable for any personal injury, property or other damages of any nature, whether compensatory, consequential, exemplary, or otherwise, resulting from any publication, use or reliance upon the information herein.

APPENDIX VII – BNGC TERMS OF REFERENCE

TERMS OF REFERENCE AND FORMAT FOR AN LLES TO BE PREPARED FOR "BELIZE NATIONAL GAS COMPANY LIMITED's" LPG STORAGE DEPOT PROJECT IN THE TOLEDO DISTRICT

This Terms of Reference (TOR) has been prepared following the scoping for the most critical issues that will need to be addressed for the proposed development which consists of establishing an LPG Storage Depot at the Big Creek Port Facility in the Stann Creek District, Belize C. A.

In the preparation of the Limited Level Environmental Study (LLES), the following main areas of concern will need to be addressed:

i. Potential environmental impacts as a result of installation of the storage facility;
ii. Fire/Safety Hazards to nearby facilities
iii. Potential impacts as a result of transportation;
iv. Human, socio-economic and cultural impacts
v. Environmental Management Issues;

This Term of Reference is divided into three (3) sections:

A. PROJECT DESCRIPTION AND PHYSICAL, BIOLOGICAL AND SOCIAL ENVIRONMENT
B. ENVIRONMENTAL ISSUES.
C. CONCLUSIONS / RECOMMENDATIONS (MITIGATIONS/MONITORING)

A. PROJECT DESCRIPTION AND PHYSICAL AND SOCIAL ENVIRONMENT

This section of the document deals primarily with information pertaining to the background of the project, and the physical environment within which it is proposed.

The LLES will need to address:

:

1.0 THE PROJECT DESCRIPTION AND PLAN

Maps at appropriate scales must be provided, these should be properly labeled inclusive of legends to illustrate the general settings of project related development sites as well as surrounding areas likely to be environmentally affected. These maps shall include topographic contours, where available, as well as location of major surface waters, roads, parks or reserves, political boundaries, protected areas and existing adjacent land uses (tourism, agricultural, aquaculture, industrial and residential). Additionally the following should be provided.

1.1 Give the exact location of the project and provide proof of ownership of the parcel of land comprising the project site. Include a copy of a lease document or land title.

1.2 Provide the layout and describe the following characteristics of the proposed development:

- Tank farm;
- Pipelines;
- Administration facilities;
- Fire Fighting Equipment;
- Pumping Facilities;
- Loading areas;
- Pathways and roads.
- Muster Points

1.3 In regards to the tank farm, provide number of tanks, their respective volumes and storage use, along with pertinent certification for their intended use.

1.4 Describe, using a process flow diagram, the processes involved in the movement of LPG from the tanker to the storage tanks, to the blending tanks and finally to the loading the tanker trucks.

1.5 Describe chemicals utilized in the facility operations.

1.6 Discuss as detailed as possible the storage of LPG, the blending process, and the storage of blend-stocks and the distribution to market of the finished product.

1.7 Provide outline of the overall management structure anticipated for the proposed activities.

1.8 Safety mechanisms in place for detection of leaks and compromised pipelines and/or valves.

1.9 Prevailing winds and projection of gas in the event of major escape.

2.0 THE PHYSICAL AND SOCIAL ENVIRONMENT

2.1 Provide details of the basic physical environment of the project site and zone of influence. This should include:

2.2 Topography: including degree of slopes, drainage patterns around project site, and flood hazard;

2.3 Include a map outlining the boundaries of zone of influence in relation to protected areas, surrounding villages and communities etc.

2.4 Climate, hydrology and meteorology: including rainfall average per year, prevailing wind patterns;

2.5 With use of a map identify current land use of project site and adjacent properties including existing road infrastructure and highlight possible impacts of this project on existing properties.

2.6 Physical description of surrounding receiving water bodies including creeks and rivers.

2.7 Provide existing base line data for air quality parameters for sites near the project area. These should include**:**

- Nitrogen Dioxide,
- Sulphur Dioxide,
- Benzene,
- Toluene,
- Ethyl Benzene and
- Xylene.

3.0 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

Describe the pertinent legislation and policies that may impact the proposed development. Highlight the various permits, licenses which will be required and highlight the fines associated with not obtaining the permits and licenses.

B. ENVIRONMENTAL ISSUES

This section of the document primarily targets the environmental issues of critical concerns based on information provided in section A.

The following are the issues the LLES will need to address for the proposed development:

1.0 FLORA AND FAUNA

1.1 Describe the vegetation of the surrounding properties, and provide land use history of the project site and the possible impacts/hazards that this development may have on current land use and adjacent properties.

1.2 Identify the measures that will be put in place to maintain and enhance the terrestrial habitat within the project site, and indicate measures that will be put in place to reduce impacts to nearby properties and infrastructure

2.0 CHEMICALS MANAGEMENT

2.1 Describe the blending process to be undertaken on site, outline the safety mechanisms and procedures which will be used to safeguard human health and the environment.

2.2 Provide a list of chemicals, including management safety data sheet, to be used in the blending operations. Provide a description of these chemical in regards to toxicity, degradation and environmental impacts.

2.3 Based on the above, provide a management plan for the handling and storage of these substances and describe measures to be used to mitigate for any possible impacts to the environment.

2.4 Assess the effects, if any, of the storage and blending activities on waterbodies near the project site and indicate whether the laying of necessary infrastructure will impact surface run-off and identify mitigation measures.

3.0 DISASTER MANAGEMENT & SOCIAL ENVIRONMENT

3.1 Considering that the principal potential hazard associated with LP Gas storage facilities is fire and explosions, describe the designs and type of infrastructure that will be installed to reduce or prevent such hazards:

3.2 Describe the associated risks of such a project on the adjacent infrastructure (Big Creek Port, Big Creek/Independence communities, nearby shrimp farms), and determine the potential social, economic impacts (positive and negative) with the development of this project.

3.3 Identify the safety measures and safeguards that will be utilized to minimize/reduce the risk of fire, explosion, pipeline ruptures, gas escapes etc.

3.4 Outline the disaster management plan in the event of natural disasters such as hurricanes, floods etc, and determine the risks and mitigating measures that will be deployed during these types of events.

3.5 Provide a management plan that will consider the transportation routes which will be utilized for the shipping of LPG to the proposed project and recommend measures to be utilized during the unloading of the product to the terminal.

3.6 Outline measures that will be put in place to manage any possible incident that may arise during the ground transportation of LPG via the national road networks, and recommend measures for the proper management of all types of traffic close to and within the project area. These mitigation measures must include recommendations for protection features against potential pollution to the environment as well as social and human impacts.

4.0 NOISE AND AIR QUALITY

4.1 Quantify noise levels to be expected from operations (pumping, blending and loading activities) and specify any potential impacts of these on the surrounding environment, including wildlife and human habitation.

4.2 Conduct an analysis of the air quality in the area utilizing pre-existing sites located within a half mile radius of the proposed location. Parameters to be reported on shall include, but not limited to the following: Particulate Matter, SO_2, NO_2, and BTEX (benzene, toluene, ethylbenzene and xylene)

4.3 Evaluate the risk of air pollution by the said operation and measures that will be utilized to detect leaks during operations of the facility, and the measures that will be taken in the event a leak is detected.

C. CONCLUSIONS / RECOMMENDATIONS

This section proposes alternatives to the execution of the project based on the information generated by Section B.

1 ALTERNATIVES FOR DEVELOPMENT

Present all reasonable alternatives for development in comparative form, exploring the alternative. Include the no-action alternative, and the reason why certain alternatives were recommended or eliminated.

2 MITIGATION AND MONITORING PLAN

Provide a monitoring plan to be implemented for the entire operation.