SUMMARY ENVIRONMENTAL IMPACT ASSESSMENT

HOCHIMINH CITY METRO RAIL SYSTEM PROJECT LINE 2

CONTENTS

I. INTRODUCTION

As reported by Multi-sectoral Action Plan Group-2002, in 2001, about 2.2 million vehicles were on the roads of HoChiMinh City (HCMC), of which 90% were motorcycles. The city's public transport system is comprised of public buses running on set routes between specified hours of the day. Despite recent upgrades to the city bus system, public transport accounts for only around 3% of demand, compared to 50-60% of demand in other countries. HCMC's Master plan to the year 2020 aims for public transport to serve 30% of total vehicle passengers by 2010 and 50% of passengers by 2020.

At the present, the city's transportation infrastructure does not facilitate efficient flows of the traffic. Congestion is commonplace at intersections during the city's rush hours and average traffic speeds vary between 10-30km/h. Due to an increasing in prosperity and income leading to an increasing in owning vehicles, demand on road surfaces for motorbikes and cars in 2020 is estimated to be 4 times higher than now. It is realized that this problem will be very difficult for a high population density like HoChiMinh City, not to mention that life quality will be decrease because of pollution and traffic jam. To meet the increasing demand on transport in future, a development of railroad system in city is very essential.

Hochiminh City People's Committee (PC) has drew out a plan of Metro Rail System with 6 main lines to link the city centre to other areas of the city. The line No1 has been started the construction on February, 2008. The line No2 and No3 are studying by MVA Asia Limited by the fund of Asian Development Bank (ABD) in order to identify the scale and feasibility of the project.

Based on the Decree N°.80/CP of the Vietnamese Government which instructing on execution of the Environmental Law and the relevant technical guideline of environmental impact assessment from ADB, this Project is determined to be a Category A project. The Category A project with potential for significant adverse environmental impacts requires an environmental impact assessment (EIA) to address significant impacts (OM 20).

This summary EIA is based on the detailed EIA prepared by the HoChiMinh City's Environmental Protection Agency (HEPA), under the contract with the MVA Asia Limited.

II. DESCRIPTION OF THE PROJECT

The project has the name as Project Preparation Technical Assistance: "HOCHIMINH CITY METRO RAIL SYSTEM PROJECT, LINE 2 AND 3". The Government of Viet Nam has requested the Asian Development Bank (ADB) to provide a loan to implement two interconnected Mass Transit Lines, UMRT Lines 2 and 3. In order to clarify the scope and feasibility of the proposed lines, the ADB is financing this project preparation technical assistance (PPTA). The Consultant MVA Asia Limited was selected to carry out this PPTA. The PPTA will assist the Urban Metro Preparation Unit in HoChiMinh City's Department of Transport and Urban Public Works to develop plans to implement the two lines.

The scope of this summary report will focus on the metro line No 2. Two thirds of the route of this metro line No 2 (10,25 km) is underground and located in the center areas which have dense population and narrow roads. The elevated section is only designed for the new developing areas of HCMC where the roads are widened to more than 60 meters, much larger than the width of designed elevated line (10.5 meters) and stations (27.1 meters). Besides, the site planned for constructing Tham Luong depot is currently abandoned cultivated land.

Figure 1 Solution of line No2

Line 2 starts from the end of Ham Nghi street and pass underground to station at the end of Ben Thanh market to Cach Mang Thang Tam street, go along to Truong Chinh street and after passing underground Truong Chinh 1 Station, the line move above the street then go along Truong Chinh street until pass above An Suong Flyover to stop at An Suong Station. The depot is located near Tham Luong bridge before go to the last station.

There are 11 stations designed to be underground the street. The underground stations have the length of 180m, the width of 21-26m, and the depth of 15.5-25m. The designed underground metro line has the length of 10.25km, the depth of 17m, and the diameter of 6.8m.

Line No2 has 3 above stations having the height of 11-12m, the length of 140m, and the width of 27m. The bridge is designed in the width of 10.5m. Metro line which goes through the 3 above stations is 4,935km length. Depot where metro will be maintained and fixed occupies the area of 30ha.

III. DESCRIPTION OF THE ENVIRONMENT

1. Natural and Socio-economic Conditions

Natural Conditions:

HCM City is 1,730km from Hanoi by land and is at the crossroads of international maritime routes. It is also at the center of Southeast Asia. The city center is 50km from the East Sea in a straight line. It is a transport hub of the southern region and a gateway to the world, having the largest port system and airport in Vietnam.

HCM City has an area of approximately 2,094 square kilometers. It is located from 10° 10'-10° 38' North and 106^o2'-106^o54' East. The city has Binh Duong Province in the north, Tay Ninh Province in the northwest, Dong Nai Province in the east and northeast, Ba Ria-Vung Tau Province in the southeast, and Long An and Tien Giang provinces in the west and southwest.

HCMC's climate is subequatorial, characterized by a strong monsoon influence. Average daily temperatures are 27ºC ranging between 35-36ºduring the rainy season (May – end October) and 24-25ºC during the dry season (November – April). The average monthly solar radiation is about 140 kcal/cm^2/yr. About 80-85% of annual rainfall occurs during the rainy season when average volume is between 250-330 mm/month. Rainfall intensity is high at 0.8 – 1.5mm/minute. There are two main wind directions in HCM: east–southeast during the dry season and west-southwest in the rainy season, when it has an average speed of 3-4m/second. Annual average humidity is 79,5%; average humidity is about 80% in

rainy season (maximum value is 100%) and 74,5% in dry season (minimum value is 20%).

HCM City belongs to a transitional region between the southeastern and Mekong Delta regions. The general topography is that HCM City terrain gets lower from north to south and from east to west.

The soil of HCM City was formed upon two sediment classes: Pleistocene and Holocene.

- *The Pleistocene sediment:* This ancient alluvial sediment covers most of the northern, northwestern and northeastern parts of the city, encompassing Cu Chi, Hoc Mon, northern Binh Chanh and Thu Duc districts, north and northeastern District 9, and old inner-city areas.

  Main characteristics of the sediment class are hilly terrain, with a depth range of three to 25 meters, and oscillation in the southeastern direction. Due to the combined effects of natural factors, including creatures, climate, time and human activities, and erosion and decomposition, the sediment class has developed into grey soil. Grey soil makes up 45,000 hectares or 23.4% of the city's total soil area.

- *The Holocene sediment:* This new alluvial sediment of HCM City had its origin in coastal areas, bays, riverbeds and alluvial plains and consequently formed different types of soil. Specifically, alluvial soil makes up 15,100 hectares or 7.8% of the total area; aluminum soil is 40,800 hectares or 21.2%; and alkaline soil is 45,500 hectares or 23.6%. The remaining area, 400 hectares or 0.2%, is made of sandy soil near the ocean and yellow-brown fealties soil on hills that have eroded.

HCM City is situated next to the Saigon river, which joins the Dong Nai river to make northern and eastern boundaries of the city. These waterways can act both as potential water supply resources and as a medium to carry away the wastewater. The Dong Nai river has a minimum flow of approximately 100m^3/sec. It is originated from the Central Highlands of Vietnam and flows through Dong Nai and HCM City with contributories from other provinces. The total catchment area is 42,665km^2 and total flow volume is 30.6 km^3/year. Further downstream of the river, it is joined at Nha Be area of HCM City by the Saigon River. Inside the city, a hydrological network of 5 canals acts as the natural water drainage: Nhieu Loc – Thi Nghe (9km), Tau Hu – Kinh Doi – Kinh Te (19.5km), Ben Nghe (5.9km), Tan Hoa – Ong Buong – Lo Gom (7.2km), and Tham Luong – Ben Cat – Vam Thuat (14km).

The groundwater table consists of:

- Holocene aquifer (Qiv): distributing over a small area (revealing at Le Minh Xuan- Binh Chanh and Can Gio areas), average width of 0-8m. Water extracted from this zone is seldom used for daily purposes.
- Pleistocen aquifer (Qi-iii): encompassing the entire area. Water table: changing depth from 3.2m (Linh Xuan, Thu Duc) to 63m (Tan Tao, Binh Chanh); at Hoc Mon and Cu Chi areas, this water table is less than 20m deep; at downtown area: 20-30m deep.
- Pliocen aquifer (N2):
    - Top Pliocen aquifer (N2b): depth from surface to the water containing zone: 40-80m, depth of the water containing zone changing from 36m (Cu Chi) to 82m (Hoc Mon).
    - Bottom Pliocen aquifer (N2a): depth from surface to the water containing zone: from 125m, depth of the water containing zone is above 50m.

Currently, groundwater is extracted mainly from the Pleistocen and Pliocen aquifers.

Natural Hazards:

Flooding frequently occurs in HCMC during the rainy season when the city's drainage system is unable to cope with the volume and intensity of rainfall. Streets can remain flooded for several hours or even days. Flooding is particularly severe in newly developed parts of district 6, 11, and Tan Binh.

Natural Resources in Project Areas:

The Metro line No2 is located entirely within residential areas, thus animal and vegetation resources are insignificant.

Socio-economic Conditions:

HCM City is divided into 14 urban districts and 10 suburban districts with population of over 6 millions. The metro line No2 passes residential areas including 5 urban districts and 1 suburban district, as described in Table 1.

Table 1 Population and population density in the project areas (in 2006)

District	Wards	Area (sq.km)	Population (person)	Population density (pers/sq.km)
Dist. 1	10	7,73	200.768	25.973
Dist. 3	14	4,92	199.172	40.482

Dist. 10	15	5,72	238.799	41.748
Dist. 12	11	52,78	306.922	5.815
Tan Binh	15	22,38	387.681	17.323
Tan Phu	11	16,06	376.855	23.465

Socio-economic Status:

HCMC is the economic and industrial hub of Vietnam. In 2005, HCMC's Gross Domestic Product (GDP) amounted to 33.3% of the GDP of the whole of Vietnam.

Employment in HCMC is comprised of services, construction/industry and agriculture. In 2001, the proportion of persons employed in these sectors was 49.6%, 37.9% and 12.5% respectively.

The city needs to provide for its growing population which has meant that between 1996 - 2000, the land area for housing in the city has increased by 3.1 km^2 each year. In 1999, the average area of dwelling house per resident was 10.3m^2.

2. Existing Situation of Environmental Quality

2.1 Existing Situation of Air Quality in the Project Areas

In order to better understand baseline air quality in project areas, the EIA team conducted air quality monitoring along the metro line No2 from 17 to 20 October 2007.

The air quality monitoring results are summaried as follows:

- Temperature varies from 24.4 to 30.8^{o}C. The highest temp. is at 10 – 11 pm, and the lowest temp. is at 7 – 8 am. Humidity is rather high over 50%.
- The most concentration of pollutants (NO_2, SO_2, CO and Total HC) in 5 monitoring locations are lower than permissible value according TCVN 5937-2005 and TCVN 5938-2005.
- The concentration of TSP in most monitoring locations are higher than Vietnamese standard, except two points in Ben Thanh station (17h-18h) and Dien Bien Phu. The concentration of TSP in most points is 1.2 - 2.2 times higher than permissible value (TCVN). The main reasons are due to transportation activities of vehicle in these areas.

2.2 Existing Situation of Water Environment in the Project Areas

Surface Water

In order to have data for preparation of EIA, monitoring activities on water quality in proposed project areas have been carried out by HEPA in October 2007. The surface water quality results are summmarised as follows:

- All the rivers and canals in Hochiminh city are influenced by flood – tide of the East Sea. Therefore, water monitoring points are sampled at two times: high – tide and low – tide.
- On the monitored data reported by HEPA from 2000 to 2007, it can be seen that water quality in Saigon River and canals in Hochiminh city is being polluted with DO, oil, coliform and heavy metals. The causes were from the fact that the river and canals receive domestic and industrial wastewater.
- At low water level, without dilution, content of pollutants is higher than at high water level from 1 to 2 times. The concentration of pollutants as a whole are rather high and many times exceeds the permissible value in TCVN 5942-1995, class B.
- Water quality at monitoring points at both high and low water level are below:
    - pH fluctuates from 6.63- 7.21, that meets Vietnamese standard TCVN 5942-1995;
    - Heavy metal is almost lower than TCVN, except the monitoring point at Tham Luong canal;
    - Total N and Total P meet TCVN 5942-1995;
    - Organic matters is 2 – 6 times higher compared with TCVN 5942-1995, column B;
    - Dissolved oxygen is rather low (DO<2);
    - The concentration of oil is higher than Vietnamese standard from 19 to 32 times;
    - Coliform is 2.4 - 2300 times higher than TCVN 5942-1995.
    - Only the water quality at Bach Dang wharf (Sai Gon river) is rather good, except coliform.

Underground Water

According the report of DONRE 2006: Total groundwater demand was 615.242,1 m^3/day with 56,61% for production purpose. The layer exploited as follow:

- Holocen: 116 m^3/day
- Pleistocen: 284.654,4 m^3/day
- Pliocen : 326.309,6 m^3/day

To make the basis for the assessment of the project to groundwater quality, sampling and analysis in the potential affected location has been conducted. Most of samples were taken from shallow wells with the average depth of 20-40 m.

The analyzed results fo groundwater show that:

- Most of the samples are lower than permissible values in TCVN 5944-1995.
- All the samples shows high concentration of coliform, fecal coliform, hardness of water, SO_4^{2-}
- In general, groundwater quality in study area polluted by many substances such as coliform (30 – 500 times higher than TCVN 5944-1995), ion sulphate and hardness of water.

2.3 Existing Situation of Noise Level in the Project Areas

There are 22 monitoring points along the metro line No2 are selected for monitoring of noise levels. The basis for assessment of noise levels was based on Vietnamese Standard TCVN 5949-1998.

The noise level monitored results show that:

- Average noise level fluctuated from 71.9 - 81.4 dBA.
- Most of average noise levels were higher than permissible value (TCVN 5949-1998). However, noise level at Ben Thanh station, Ben Thanh market and New World was equal to permissible values.

2.4 Existing Situation of Vibration in the Project Areas

The major sources which cause the vibration are from construction activities, from traffic vehicles and from the living activities. The basis for assessment of noise levels was based on Vietnamese Standard TCVN 6962-2001.

Compared with the permissible value $L_{Eq(Z)}$ (dB), $L_{Eq(Y)}$ (dB), and $L_{Eq(X)}$ (dB), the monitored results show that average vibration levels on road along the metro line No2 are 1.2 to 3.8 dB lower than the permissible values in residential areas.

IV. ALTERNATIVES

The analysis of alternatives for HCMC Metro Rail Project Line No is conducted in two aspects, included:

- Route Alignment
- Tunnel Construction.

1. Route alignment

There is only one alignment alternative of the Metro Line 2 which has been described clearly. This alignment design is rooted from HCMC Master Plan of Transportation. That means it has been already studied carefully and decided as the preferred alignment alternative for Line 2 by the Master Plan.

However, the issue needed to be considered here is whether the Line should overlap the residential areas along the preferred route or should locate right in the middle of the roads (e.g. Cach Mang Thang Tam, Truong Chinh). Thus there are two alternatives to compare:

- Alternative 1: Route lies under houses and buildings along the roads
- Alternative 2: Route lies right under the middle of the roads

The comparison between two alternatives shows that although Alternative 2 causes significant traffic congestion, this contemporary impact will disappear after the construction phase. In comparison to the Alternative 1, the Alternative 2 affects much less local residents' lives in terms of house and business lost. Correspondingly, the compensation cost for resettlement will be reduced considerably. In additions, the risk of damaging building due to vibration and pile collision in case of the Alternative 2 is also lower than that of the Alternative 1. Therefore, The Alternative 2: Locating the line in the middle of the roads is determined as the preferred alternative.

2. Tunnel Construction

2.1. Cut and cover method versus tunnel boring method

During the construction phase, two excavation methods are considered to be employed included *cut and cover* and *tunnel boring method* (using Tunnel Boring Machine-TBM). Accordingly, two tunnel construction alternatives needed to examine are:

- Alternative 1: using cut and cover method for constructing both sub-stations and rail tunnels
- Alternative 2: using cut and cover method for constructing sub-stations and tunnel boring method (TBM) for constructing rail tunnels.

Cut and cover method is an open excavation which can cause high risk to the environment in terms of air pollution (dust), noise and vibration and traffic congestion. In additions, the cut and cover method is unable to excavate at very long depth underground in the large area (e.g. all the length of underground section). Meanwhile, the tunnel boring method can solve all the above problems. Excavating the tunnel as the average depth of 17 meters, the tunnel boring method almost have no air pollution or noise as well as traffic congestion impacts on the

environment above the ground. The boring speed of TBM at the average 17 m depth is very slow about 10 m per day which can cause least vibration impact to adjacent structures. Although the cost of building tunnel using tunnel boring method is much higher, the cut and cover method may be resulted in high cost of prevention vibration and settlement impact as well as huge compensation cost for any damage to adjation structures.
Obviously, the alternative 2 "using cut and cover method for constructing sub-stations and tunnel boring method (TBM) for constructing rail tunnels" with many advantages is chosen as the preferred alternative.

2.2. Twin tunnels versus single tunnel

After the tunnel boring method was selected for constructing the rail tunnels, the project has to decide whether to build twin tunnels or single tunnel. Therefore, there are two alternatives to compare:

- Alternative 1: Twin tunnels (single track tunnel – bitube)
- Alternative 2: Single Tunnel (double track tunnel – monotube).

Technical parameters of the tunnel in each alternative are displayed in the table below.

Table 2: Technical parameters of twin tunnels alternative and single tunnel alternative

No.	*Parameters*	*Alternative 1: Twin Tunnels*	*Alternative 2: Single Tunnel*
1	Internal Diameter (m)	5.90	9.80
2	Linning thickness	0.30	0.45
3	External diameter of linning (m)	6.50	10.70
4	External diameter of excavation (m)	6.80	11.10

Many criteria were used to compare between the twin tunnels and single tunnel alternatives such as risks of costruction, impacts on station and ancilary works. According to the comparison, the Alternative 1: twin tunnels clearly have much more advantages than the Alternative 2: single tunnel. Therefore, the twin tunnels alternative is chosen.

The environmental problem related here is the impact of settlement of each alternative on the street and on of each alternative on the adjunction existing structures. The values of settlement in the middle of the street and under building located above the tunnels were calculated for the two alternatives. The calculation results show that they all have the same acceptable settlement impact on the street

but the single tunnel alternative causes much higher settlement impact on buildings.

V. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

1. Anticipated environmental impacts

1.1 Prospect benefit and positive impacts

The implementation of the Metro line No.2 will yield benefits from non-tangible parameters such as social-economic benefits resulting from the safe mass transport, less travel time, and better accessibility. The main positive impacts that have been identified as:

- *Employment opportunities*: during the period of construction and operation, a lot of labors will be required for many supporting construction and operation acitivities.
- *Traffic congestion reduction and city aesthetic enhancement*: It is estimated that once the Metro Lines are in operation, the two lines in the project will divert over 1.4 million person-times per day from the motor vehicle traffic, including 570,000 by the Metro Line No.1 alone. The diversion would significantly reduce the motor vehicle traffic which would be present on the city roads if without the project, particularly along the metro line directions, thus significantly reduce the traffic congestion.
- *Benefits to the economy*: With the easy accessibility, quick and safe transport, the Metro line No.2 will improve the dynamic working environment in the HoChiMinh City by saving a lot of unneccessary time for travelling. The Metro line No.2 also helps to develop the North-West of the city which is now under development.
- *Quick service and safety transport*: For the first period of metro operation, passengers just take around 22 minutes to travel from one end to the other of the metro line No2. In the next period of operation, the time to complete the entire Metro line is reduced to 11 minutes. The Metro line No.2 will play an important role for reducing as much as possible traffic accidents.
- *Fuel consumption reduction*: It is estimated that once the metro line No2 is existing, the total gasoline consumption reduction is a considerable amount: around **31.32 milion litres of gasoline per year**.
- *Carbon dioxide reduction and air quality improvement*: the air pollutants in HoChiMinh City will be significantly reduced because of the motorbike reduction causing by the existing of the Metro line.

1.2 Impacts of the resetlement

According to the Resettlement Plan for HCMC Metro Line 2 Project, the project will acquire 21,992 m^2 of land at 15 wards of 6 districts in HCMC. Consequently, many houses, buildings and public facilities will be affected either partly or fully in terms of structure displacement or business and in come lost. The census and inventory of losses found that:

- There are a total of 403 households who will have land/houses acquired. Of which there are 376 private owned households and 27 public owned households at 15 wards in 6 districts of HCMC.
- There are a total of 241 households affected on their business facilities (shops).
- 51 fully affected households whose remaining land areas after acquired are less than 15 m^2 will be relocated;
- There are also many affected underground facilities will be affected such as water supply system, drainage, electricity network, telecommunication etc.

1.3 Impacts during construction phase

Resettlement

Around 21,992 m^2 of land will be acquired. Consequently, many houses, buildings and public facilities will be affected in terms of structure displacement or business and income lost.

Air pollution

Significant in open construction sites such as sub-stations and grade and elevated sections due to excavation, construction and transportation activites (i.e. traffic congestion). Especially dust may exceed the standard from 3 to 4 times.

Noise, vibration and settlement

Noise may be significant impact at open construction sites such as sub-stations and grade and elevated sections due to construction equipment and transportation, especcially at night time.

Piling activity and open excavation method (cut and cover) can cause great vibration and settlement impact on structures.

Tunnel boring using Tunnel boring machine (TBM) with very slow boring speed (10m per day) at the average depth of 17m almost cause no noise. vibration and settlement impacts that can be perceived.

Community and traffic disturbance

During construction at open sites, part of roads need to be temporarily closed which may cause traffic congestion. Besides, the contribution of transport vehicles serving project will increase the traffic volume along the proposed route.

The construction sites (i.e. sub-stations) may block entrances of community's houses, shops and businesses.

The impacts are significant in the areas which have narrow street and busy community and business (CMT8 street from Hoa Hung to Nguyen Hong Dao).

Water pollution

- *Underground water:*
  - The Pleistocene underground water aquifer lies at 20 -50 meters underground why sub structure of the project have the depths ranging from 15 to 25 meters. Thus, the construction of substruture may pollute and block flow of the underground water.
  - The Public consultation showed that most households in the project area can access the water supply system. Thus, the impact may be not significant.

- *Surface water:*

  The surface water may be contaminated in terms of run off which contains solid waste and waste water from construction sites and labour camps. No sub –structure cross the river or canals so the direct impact on surface water is not great

Solid waste

The most significant solid waste is excavated soil (about 1.4 million m^3). With huge amount, it is likely to cause significant impact on the environment both air and water bodies.

Municipal waste generated from workers' activities in both construction sites and labour camps (approximately 0.3 ton per day) may cause insanitary and disease problems

Ecology

The number of tree along the proposed route is very few. Besides, The metro line is confined to the middle of the roads so least trees need to be clear out.

The project plans to use 23 September and Le Thi Rieng parks as two temporary sites for receiving materials and taking out excavated soil . Thus, the clearance of some trees in these sites is needed.

There is a need to consider the impact of dust from construction sites to ecology in 3 big parks along the metro line 2: Tao Dan, 23 September and Le Thi Rieng.

The tunnel sections are designed not to pass across any canals or rivers. Therefore, the impact of the project on aquatic ecology is negligible.

Emergency accidents

The metro project is a new type of project in HCMC in terms of underground construction. It is quite new experience for many workers while many potential risks may arise. For instance, toxic airs generate when drilling soil and rock but the ventilation underground is bad; fire, soil collapse and flood hazards occur when the sub-station and tunnel constructions are carried out.

Besides, HCMC is has a long history of human activities. Although there is no major direct impact to any known cultural relics by project construction, there could still be potential for chance finds of archaeological properties during construction

1.4 Impacts during operation phase

Air quality:

Air quality in HCM City will be improve once the metro line No2 is operating, as described in Section 1.1

Water quality:

Wastewater sources during operation period are domestic wastewater from train stations along the Metro line, and wastewater (mainly oils and dusts) from the Tham Luong depot as a result of maintenance and cleaning activities. If there are no suitable treatment solutions, the surrounding environment will be affected by these wastewaters.

Solid waste:

During the operation period of the Metro line, passengers could generate solid, non-hazardous, food wastes from food establishments, packaging materials from retail facilities, paper, newspaper, and variety of food containers.

Hazardous materials

Hazardous materials, including solvents, loolants, acids, and alkalis, may be used in locomotives and train cars maintenance activities. Polychlorinated biphenyls (PCB) could be found in some electrical equipments (for example: transformers and capacitors), and asbestos could be present in some parts such as wheel bearing and seals for steam engines.

Noise impact

During the operation phase of the Metro line, noises generated from the entire Metro system can be identified as air-borne noise and ground-borne noise.

- Air-borne noise: Direct noise in the medium air from the noise source to the receiver is defined as air-borne noise. Generally, railway air-borne noises are generated from:
  - Wheels rolling over the rails (rolling noise)
  - Sharp curves (squeal noise)
  - Braking
  - Traction motors, ventilators, air-conditioning units,…

  Noise estimation is conducted to evaluate how the air-borne noise could impact to the inhabitant areas, locating at 100 feet from the main track, along the elevated rail way section in the Truong Chinh street. The estimation of noise exposure levels at 100 feet from the main track are:

  - $L_{eq(day)}$= 67.86 – 4 = **63.86 dB**
  - $L_{eq(night)}$= 63.1 – 4 = **59.1 dB**

  According to TCVN 5949:1998 *Acoustics- Noise in public and residental areas- Maximum permitted noise level*, the noise exposure level is acceptable when the Metro operates at day (the permissible noise level is 75dB). However, from 10pm to 6am, the noise exposure level from the Metro line is around 9 dB higher than the Vietnamese standard level (the permissible noise level is 50dB).

- Ground-borne noise: The resulting vibrations of the walls and floors of buildings cause secondary radiation of noise called ground-borne noise. Together with vibration impact, ground-borne noise could have unpleasant impact to inhabitant areas along the underground metro sections if there are no appropriate solutions to tackle the vibration problem.

Vibration impact

In general, vibration impact of the railway system is generated from the pass-by of vehicle on rail, propagated through the ground or structure into a receiving building. To evaluate how the railway vibration could impact to the inhabitant areas along the underground railway section, some calculations and predictions are conducted. The estimated vibration level causing by the Metro line No2 operation at a distance of 15m from the center line is around **66.92 VdB.**

As described in Section III Description of the environment, the existing base vibration levels from 22h to 6h at mix residential areas along the underground line alter widely: *31.4 to 60.2 dB*. According to TCVN 6962:2001 *Vibration and shock - Vibration emitted by construction works and factories - Maximum permitted levels in the environment of public and residential areas*, the vibration level at day should be below 75 dB, and at night (from 22h-6h) the vibration level should be equal to the existing base vibration level (without any working machine). Therefore, the vibration level generated from the passing Metro train will have around 7dB over the standard from 22h to 6h.

Risks on safety and health

During the operation period, there are many risks on safety and health that should be taken into account as below:

- Train/worker accidents: railway workers, and even passengers could be damaged by the moving trains.
- Fatigue: Locomotive engineers and other railway workers are often required to work irregular work hours which may result in fatigue. Fatigue, particularly of drivers, signalers, maintenance workers, and others whose work is critical to safe operation, can pose a serious safety risk for railway workers and the general public.
- Electric and magnetic fields: railway workers on electric railway system may have a higher exposure to electric and magnetic fields than the general public due to working in proximity to electric power lines.

2. Mitigations measures

2.1 Mitigation of impacts during land take and preparation phase

Compensation for those households relocated should be fair and quickly administered. Information on new housing project for the affected people should be distributed. The government could provide soft loans for new housing for affected people.

2.2 Mitigation of impacts during construction phase

Air pollution mitigations

- Install barriers around the open construction sites.
- Only receive building materials and take out excavated soils at 2 sites (23 Sep and Le Thi Rieng parks).
- Cover carefully the construction materials and excavated soils during transport and storage.
- Water spraying inside and around the construction sites as well as for transport vehicle wheels.
- Good transport regulation.

Noise, vibration and settlement mitigations

- Install noise barriers.
- Re-route and regulate the traffic, a main source of noise
- Combine noisy operations to occur in the same time period.
- Avoid nighttime activities if possible.
- Use low noise and vibration machines machines; equip silencer for engines.
- Using press –in piling method.
- Install supporting wall piles to reduce vibration and settlement impact at sub-stations.

Community and traffic disturbance mitigations

- Communicate construction plan and schedule, traffic diversion plan on media (newspapers, TV).
- Have the mechanism for receive and response to complaints e.g. hot line number must be available at the construction sites.
- Cooperate with function bodies such as Traffic Police, Department of transport and social works to regulate the traffic.
- Strictly comply with the regulations in construction urban transport project.

Water pollution mitigations

- Provide adequate washing and toilet facilities with septic tanks and appropriate refuse collection and disposal system in labour camp.
- Clean construction sites and labour camps daily to avoid run off from sites to spoil water bodies.
- Good management of construction, chemicals and machine maintenance.
- Function contractors such as HCMC Urban Environmental Company will be hired to treat and dispose solid and toilet waste generated during project construction.

Solid waste mitigation

- Excavated soils will be taken out only at two sites (23 September and LeThi

Rieng parks), then transported by a contractor to a well managed temporary dumping site Cu Chi, a suburban ward of Ho Chi Minh City which has low density of population. From the dumping site in Cu Chi ward, excavated soil can be reused for the project or used for other construction works inside and around HCMC.

- Municipal and hazardous waste will be treated by function contractors such as HCMC Urban Environmental Company

Ecology mitigations

- After the project finish, re-vegetation should be done in order to compensate tree loss due to site clearance for sub-station, elevated section construction and at 23 September and Le Thi Rieng parks.
- The effect of air pollution to ecology in 3 big parks can be mitigate by air pollution mitigation measures mentioned above

Emergency accidents mitigations

- Training workers on special skills, environment, emergency and safety regulation especially for those that work underground.
- Safety equipment have to be available on site (helmets, masks, fire extinguishers, flash lights, medicines, etc).
- Good management, supervison and monitoring at sites especially The underground section in order to be able to detect the early sign of earth collapse.
- The construction of underground section should be carried out in dry season to avoid flooding risk from heavy rains.
- To minimize adverse impacts or damages to the chance finds of archaeological properties,
    - All construction activities will be immediately put hold when chance finds uncovered.
    - Contractors will notice the PMU, project owner and cultural relic authority immediately.
    - Site investigation by professional archaeologists
    - If the site is of high value and site preservation is recommended the project owner will need to make necessary design changes.

2.3 Mitigation of impacts during operation phase

Noise impact mitigations

As described above, at night time, the noise exposure level generated from the elevated rail structure is about 9dB higher than the Vietnamese standard level. Therefore, appropriate solutions should be applied to mitigate this high noise level as below:

- Reduce noise generation by smooth wheels on smooth tracks
    - Composite block brakes, disc or drum brakes
    - Good maintenance of running surfaces
    - Fewer wheels
- Reduce ground-borne noise transmission by compact, massive design, vibration isolation and high damping
    - Smaller wheels and/or wheel dampers, optimised geometry
    - Wheel-mounted disc brakes
    - Optimized track design, or rail damping devices in combination with railpad selection
- Reduce sound radiation by shielding
    - Wheel-mounted, bogie-mounted or vehicle-mounted shrouds
    - Low noise barriers close to the rail

With the low cost and easy to install, the glass sound barrier (noise reduction is around 5 to 10 dB) could be the suitable choice for air-borne noise mitigation.

Vibration mitigations

There are many solutions could be applied to reduce the vibration effects as follow:

- Mitigation at source:
    - Track design: vibration could be reduced significantly by applying resilient fasteners, ballast mats, resilient supported ties, or floating slabs.
    - Maintenance procedures: effective maintenance programs are essential for controlling ground-borne vibration. When the wheel and rail surfaces are allowed to degrade the vibration levels can increase by as much as 20 dB compared to a new or well-maintained system.
- Limiting the propagation: concrete walls between a source and receiver could be applied to mitigate vibration.
- Mitigation at receivers: For new buildings, this is generally via base isolation or by isolating spaces within buildings (box-in-box structure), which are more effective at dealing with ground-borne noise.

Among the vibration mitigations mentioned above, application of ballast mat, with the effective vibration reduction capacity (from 10 to 15 dB reduction), and low cost (around 180$ per track foot) could be a appropriate sollution.

Water impact mitigation

There will be a huge amount of domestic wastewater generated from staffs and passengers using the sanitary systems. Therefore, septic tank and collecting

systems should be constructed at the stations to effectively deal with these wastewater.

Besides, wastewater generated from the Tham Luong depot is also a problem. The oil content of this wastewater tends to be 3.5 times higher than that of Vietnamese standard. Therefore, the wastewater treatment system focusing on dealing with oil contents should be constructed.

Solid waste impact mitigation

Non hazardous solid waste will be collected at each train station. If possible, place the labeleb waste containers in passenger terminals for metals, glass, paper, plastics and food wastes. Regulaly, the constracted solid waste collector will take the distinguished solid wastes to the city's solid waste treatment area.

Hazardous materials impact mitigation

For hazardous materials management, some strategies are recommended:

- Use of aqueous detergent cleaning solutions or steam cleaning, or use and recycling of aliphatic cleaning solvents, for example when removing axle protective coatings or for cleaning of large equipment
- Use of water-based paints
- Use of track mats to retain wayside grease and other contaminants
- Avoiding use of new or replacement parts with asbestos containing materials.

Risk for safety and health mitigations

With the risks for safety and health described above, there are many management strategies that should be taken into account:

- Train/worker accidents:
    - Training workers in personal track safety procedures
    - Blocking train traffic on lines where maintenance is occuring
    - Design and construction of rail lines with adequate clearance for workers
- Fatigue, particularly of drivers, signalers, maintenance workers, and others whose work is critical to safe operation. Therefore railway operators should scheldule rest period at regular intervals and during night hours, to the extent feasible, to maximize the effectiveness of rest breaks.
- Electric and magnetic fields: occupational electric and magnetic fields (EMF) exposure should be prevented or minimized through establishment and identification of safety zones to differentiate between work areas with

expected elevated EMF levels compared to those acceptable for public exposure, and limiting access to properly trained workers.

VI. ECONOMIC ASSESSMENT

1. Estimated cost for mitigation measures during construction phase

The costs of resettlement measures are estimated in the resettlement plan of the project (e.g. land, houses, business and trees lost).

The major measures employed to prevent or reduce environmental impacts during construction phase are good practice, management and supervison such as:

- Good management and supervison of costruction activities and construction sites
- Good coordinating of transportation.
- Good cooporating with authorities (e.g. traffic coodinating , applying for night working permit, etc.)
- Training for workers on safety, environment and sanitary requirements.

Therefore, the cost of this type of measures is included in the project construction management cost.

There are also other technical measures of which the cost are estimated in the logistic and construction costs of the project such as:

- Installing barriers around construction sites to reduce impact of noise and air pollution.
- Installing supporting wall piles when constructing sub –stations using cut and cover excavation method to reduce vibration and settlement impacts on adjacent structures.
- Installing inclined micro –piles to reduce vibration and settlement impacts from tunnels construction on adjacent structures.
- Installing camps with necessary sanitary facilities (e.g. solid waste bins, toilets,etc.)
- Buying safety equipments such as safety clothes, gloves, helmets, fire extinguishers and so on.

2. Estimated cost for mitigation measures during operation phase

- **Estimated cost for noise impacts mitigation:**

As described above, at night time, the noise exposure level generated from the elevated rail structure is about 9 dB higher than the Vietnamese standard level.

Therefore, appropriate solutions should be applied to mitigate this high noise level.

With the low cost and easy to install, the glass sound barrier could be the suitable choice for air-borne noise mitigation. This solution is also applied widely in many elevated railway system in the world.

The estimated cost is calculated for installing sound barrier along the elevated Metro line on the Truong Chinh street. In pratice, there are just some sensitive places such as schools, churches, pagodas,… that need strictly sound protection. At the other places along the elevated Metro line depending on the desires and requirements of the local inhabitants and authorities, sound proof windows at buildings or sound barrier will be considered for installation.

According to Nelson (1997), the cost of the typical sound barrier walls could be around 15$ - 20$ per square foot. That means a typical 8-ft high sound barrier wall could cost about 120$ -160$ per lineal foot of track.

The elevated Metro line No.2 is about 4km (approximately 13,333.3 ft). Estimate that the requirement for sound barrier walls at sensitive zones is 10% of the total elevated line. Therefore, the cost invesment for installing sound barrier along this line is about **160,000$ to 213,000$.**

- **Estimated cost for vibration impacts mitigation**

As described above, the estimated vibration level generated from the passing Metro train will have around 7dB over the standard from 22h to 6h.

To deal with the vibration impact, regular maintenance program will be strictly followed. Besides, at some sensitive zones where require strict limitation of vibration, such as unviversity research centers, theaters.., effective vibration mitigation should be applied. Among the vibration mitigations mentioned above, application of ballast mat, with the effective vibration reduction capacity (from 10 to 15 dB reduction), and low cost (around 180$ per track foot) could be a appropriate sollution.

The under-ground Metro line No.2 is about 10km (approximately 33,333.3 ft). Estimate that the requirement for strict limitation of vibration at sensitive zones is 6% of the total underground line. Therefore, the cost invesment for installing ballast mats along this line is about **360,000 $.**

- **Estimated cost for wastewater impact mitigation**

Domestic wastewater:

There will be a huge amount of domestic wastewater generated from staffs and passengers using the sanitary systems. Therefore, septic tank and collecting systems should be constructed at the stations to effectively deal with these wastewater.

There will be 14 stations (11 underground stations and 3 elevated stations). The estimated cost for installing septic tank and collecting systems at these stations is: 14 x 100,000,000 VND = 1,4 billion VND = **87,500 $.**

The estimated cost for operation and maintenance the septic tank and collecting systems at these stations is around: 14 x 6,000,000VND/month = 84 milliion VND/month (approximate **5,250$/month**)

Wastewater from the Tham Luong depot:

To deal with wastewater generated from the Tham Luong depot, the wastewater treatment system is suggested to be installed. The estimated cost for installing this treatment system is around 500,000,000 VND (approximate **31,250$).**

The estimated cost for operation and maintenance of the wastewater treatment system is 20,000,000 VND/month (approximate **1,250$/month**).

- **Estimated cost for solid waste impact mitigation**

Non hazardous solid waste will be collected at each train station. The estimated cost for installing solid waste containers is around: 14 x 10,000,000 VND = 140 miliion VND (approximate **8,750$).**

The estimated cost for collecting and treating of solid waste is around: 14 x 5,000,000 VND/month = 70 milliion VND/month (approximate **4,375$/month**).

VII. ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

1. Environmental Management Plan

The pollution impacts during the construction and operation periods of the project are described in Table 3, together with mitigation measures and applicable standards. The table shows that project impacts can be mitigated through the use of appropriate technologies and good engineering practices.

Table 3 Environmenal Management Plan

Types of impact		Source of impact	Location	Parameters	Mitigation measures	Applicable standard
Air pollution	Construction phase	Dust from earthwork, mission from construction vehicle	Open construction sites and roads	TSP, NO_x, SO_2	- Install barriers around the open construction sites. - Only receive building materials and take out excavated soils at 2 sites (23 Sep and Le Thi Rieng parks). - Cover carefully the construction materials and excavated soils during transport and storage. - Water spraying inside and around the construction sites as well as for transport vehicle wheels. - Good transport regulation.	TCVN 5937:2005
Noise	Construction phase	Powered mechanical equipment and vehicle	Open construction sites and roads	50 - 75 dB	- Install noise barriers. - Re-route and regulate the traffic, a main source of noise - Combine noisy operations to occur in the same time period. - Avoid nighttime activities if possible. - Use low noise and vibration machines machines; equip silencer for engines.	TCVN 5949:1998
	Operation phase	Train and track noise	Along the line	50 - 75 dB	• Reduce noise generation by smooth wheels on smooth tracks • Reduce ground-borne noise transmission by compact, massive design, vibration isolation and high damping • Reduce sound radiation by shielding	TCVN 5949:1998
Vibration	Construction phase	Powered mechanical equipment and vehicle	Open construction sites and roads	75 VdB	- Use low noise and vibration machines machines; equip silencer for engines. - Using press –in piling method. - Install supporting wall piles to reduce vibration and settlement impact at sub-stations.	TCVN 6962:2001

	Operation phase	Train and track contact	Along the line	75 VdB	➢ Mitigation at source: • Track design: vibration could be reduced significantly by applying resilient fasteners, ballast mats, resilient supported ties, or floating slabs. • Maintenance procedures: effective maintenance programs are essential for controlling ground-borne vibration. When the wheel and rail surfaces are allowed to degrade the vibration levels can increase by as much as 20 dB compared to a new or well-maintained system. ➢ Limiting the propagation: concrete walls between a source and receiver could be applied to mitigate vibration. ➢ Mitigation at receivers: for new buildings, this is generally via base isolation or by isolating spaces within buildings (box-in-box structure), which are more effective at dealing with ground-borne noise.	TCVN 6962:2001
Wastewater	Construction phase	Washing construction equipment and vehicles; from workers	Working sites	COD, BOD, Oil, SS, etc.	- Provide adequate washing and toilet facilities with septic tanks and appropriate refuse collection and disposal system in labour camp. - Clean construction sites and labour camps daily to avoid run off from sites to spoil water bodies. - Good management of construction, chemicals and machine maintenance. - Function contractors such as HCMC Urban Environmental Company will be hired to treat and dispose solid and toilet waste generated during project construction.	
	Operation	From train	Stations	COD, BOD,	- Install septic tanks at	TCVN

	phase	maintenance and from passengers	and Tham Luong depot	Oil, SS, etc.	stations. - Install wastewater treatment plant in Tham Luong depot	5945:2005
Solid waste	Construction phase	From earthwork and worker activities	Working sites camps		- Excavated soils will be taken out only at two sites (23 September and LeThi Rieng parks), then transported by a contractor to a well managed temporary dumping site Cu Chi, a suburban ward of Ho Chi Minh City which has low density of population. - Municipal and hazardous waste will be treated by function contractors such as HCMC Urban Environmental Company.	
	Operation phase	From train maintenance and passengers	Stations and Tham Luong depot		- Non hazardous solid waste will be collected at each train station. If possible, place the labeleb waste containers in passenger terminals for metals, glass, paper, plastics and food wastes. - For hazardous materials management: + Use of aqueous detergent cleaning solutions or steam cleaning, or use and recycling of aliphatic cleaning solvents. + Use of water-based paints. +Use of track mats to retain wayside grease and other contaminants. + Avoiding use of new or replacement parts with asbestos containing materials.	
Ecology loss	Construction phase	Prepare temporary sites for receiving materials and taking out excavated soil	23 September and Le Thi Rieng parks		- After the project finish, re-vegetation should be done in order to compensate tree loss.	

2. Environmental Monitoring Program

Environmental monitoring will be carried out in both the construction and operation phases. In the construction phase, the monitoring will be done in two levels: daily and regular monitoring, to be carried out by contractors and construction supervision companies. Environmental staff will be trained prior to the start of construction for the monitoring which will include mostly visual monitoring of air borne dust, surface issues. Hand-hold noise meters will be used to monitor the noise level at sensitive receptors during construction. The objective of this daily monitoring program is to identify environmental issues at the same time as the construction activities on these sites to that appropriate mitigation actions, if needed, can be initiated and implemented timely to minimize the impacts.

At the same time, in addition to the daily monitoring by contractors, a formal environmental monitoring program will also be carried out during the construction, as well as operation phase. This program will be conducted by professional environmental monitoring program with main objective to provide official records on environmental and regulatory compliance status.

Table 4 Environmental Monitoring Plan

Environment	Item	Contents
Air	Parameter	Temp, Wind speed, Wind direction, Humidity, Pressure, TSP, NO_2, CO, SO_2, THC
	Length	2 years for construction and first 2 years in operation
	Frequency	Once a quarter and 1 day each time
	Time	7:00, 10:00, 17:00, 21:00
	Location	Stations of line 2: Ben Thanh, Dien Bien Phu, Hoang Van Thu, Tham Luong, An Suong
Noise and Vibration	Parameter	Noise level equivalent (Leq) Vibration Level Meter
	Length	2 years for construction and first 2 years in operation
	Frequency	Once a quarter and 1 day each time
	Time	One during the day and one at night
	Location	13 stations of line 2 and Vo Thanh Trang market, Lac Quang church, Van Hanh pagoda
Water	Parameter	Surface water: Temp pH, COD, BOD, SS, Total N, Total P, Hg, Pb, Oil, DO, Coliform
	Length	2 years for construction and first 2 years in operation
	Frequency	3 months/time for construction phase; 6 months/time for operation phase
	Time	Day time
	Location	Bach Dang wharf (Saigon River), Khanh Hoi bridge (Saigon River), Tran Quang Dieu bridge (Nhieu Loc canal), Tham Luong bridge (Tham Luong canal), Tham Luong canal (near National road 1A)

Table 5 Annual cost for mornitoring works

No	Parameter	Number of monitoring points	Number of samples/per day	Number of day/period	Number of times/year	Unit price (1000VND)	Cost price (1000VND)
1	**Air monitoring**						44,640
	Temp	5	4	1	4	32	2,560
	Wind speed	5	4	1	4	32	2,560
	Wind direction	5	4	1	4	32	2,560
	Humidity	5	4	1	4	32	2,560
	TSP	5	4	1	4	70	5,600
	NO2	5	4	1	4	70	5,600
	CO	5	4	1	4	70	5,600
	SO2	5	4	1	4	70	5,600
	THC	5	4	1	4	150	12,000
2	**Noise and Vibration**						10,400
	Noise	13	2	1	4	50	5,200
	Vibration	13	2	1	4	50	5,200
3	**Surface Water**						19,440
	Temp	5	1	1	4	32	640
	pH	5	1	1	4	30	600
	COD	5	1	1	4	80	1,600
	BOD	5	1	1	4	80	1,600
	SS	5	1	1	4	50	1,000
	Total N	5	1	1	4	80	1,600
	Total P	5	1	1	4	60	1,200
	Hg	5	1	1	4	80	1,600
	Pb	5	1	1	4	60	1,200
	Oil	5	1	1	4	300	6,000
	DO	5	1	1	4	60	1,200
	Coliform	5	1	1	4	60	1,200
4	**Labour cost**						6,034
	Take specimens of surface water: 2 people/days			1	4	200	800
	Take specimens of air quality: 4 people/days			1	4	872	3,489
	Take specimens of vibration and noise: 4			1	2	872	1,745

No	Parameter	Number of monitoring points	Number of samples/per day	Number of day/period	Number of times/year	Unit price (1000VND)	Cost price (1000VND)
	people/days						
5	**Car for taking speciments**			3	4	1000	12,000
	Total (1+2+3+4+5)						92,514
	VAT 5%						4,626
	Total cost						97,140

VIII. PUBLIC CONSULTATION AND INFORMATION DISCLOSURE

Public consultation is mandatory as part of the EA process for Metro line No2 ollowing the Environmental Protection Law as well as the regulation of WB. The adequacy of the public consultation and information disclosure is one of the criteria used to determine the project compliance with the safeguard policies.

Summary of the comments and suggestion of participants in Phase 1 of PC meeting, organized on 21-22 February 2008 with the attendance of People's committee, party committee, district's Fatherland front, district's Woman union, district youth union, ward's leader, ward's Fatherland front, local people living along metro line No2 :

(1) 79.8 percentage of participant understand the introduction of the scale and legal base of the project**.**
(2) 69 percentage of participant understand the introduction of technical design the project**.**
(3) 62.8 percentage of participant understand the introduction of the predicted environmental impacts of the project during construction and operation phases.
(4) Majority of participants assessing the current environmental status of your living area is polluted: 47.4% (no polluted 24.7%).
(5) The infrastructure status of your living area is neutral.
(6) Majority of impacts during instruction phase affect understand water, noise and vibration, soil environment (soil subsidence or pollution) and traffic congestion.
(7) 94.6 percentage of comment agrees with the mitigating solutions.

(8) The impacts of the project to the following aspects during the operation phase: not impact: 53.2%, Good impact: 19.7%, Bad impact: 16.7%, no answer: 10.4%.
(9) 92.6 percentage of participant agrees with the mitigating solutions.
(10) After being presented all information about the technical design, impacts and mitigating solutions of the project, 89.1 percentage of participant agrees to develop this project in the living area.

In virtual all PC meetings, participants were supportive the project but they required that:

- The project must implement fit rate of progress, avoid interrupting living and daily activities of local community.
- Providing information off project for community.
- Having specific solutions to mitigate environmental impacts affecting quality life, specially air, underground water environment, noise and vibration.
- Reviewing the effective solutions, supplementing more mitigated solutions, rapidly solving extra problems during operation.
- Finally, the participants hoped that the proposed mitigation measures in EA report must be implemented seriously following pledging.

Summary of the comments and suggestion of participants in Phase 2 of PC meeting, organized on 25th May 2008, with the attendance of People's Committee, district's Fatherland Front, ward's leader, ward's Fatherland Front. Comments from the People's Committee: 50% are agreed, and 50% have no comment with the project. Comments from the Fatherland Front: 38.2% are agreed, and 61.8% have no comment with the project.

In general, the people from districts and wards would like the potential impacts of the project to be mitigated by the suitable measure. The community expects that the mitigation measures in the report must be strictly applied and implemented during working time.

IX. CONCLUSION

The proposed Metro line No2 is proved to have significant positive effects to the development of HoChiMinh City. Benefits to the economy, traffic congestion reduction, quick and safety transport, employment oppportunities, fuel

consumption reduction, and air quality improvement are the obvious positive effects from this Metro line.

Besides, the potential adverse environmental impacts on air quality (during construction phase), water environment, noise and vibration, solid waste, ecology, population resetlement are also taken into consideration. Basing on these detail potential adverse environmental impacts, appropriate mitigation measures have been developed for consideration.

The EIA concluded that project impacts from both construction and operation will be minimal, and can be mitigated through the use of best practices and appropriate technologies. With the implemention of the EMP and the monitoring plan, the Project is not expected to have significant environmental impacts. Internal and external mornitoring and audits will be conducted to ensure that standards and regulations are being followed.