Initial Environmental Examination

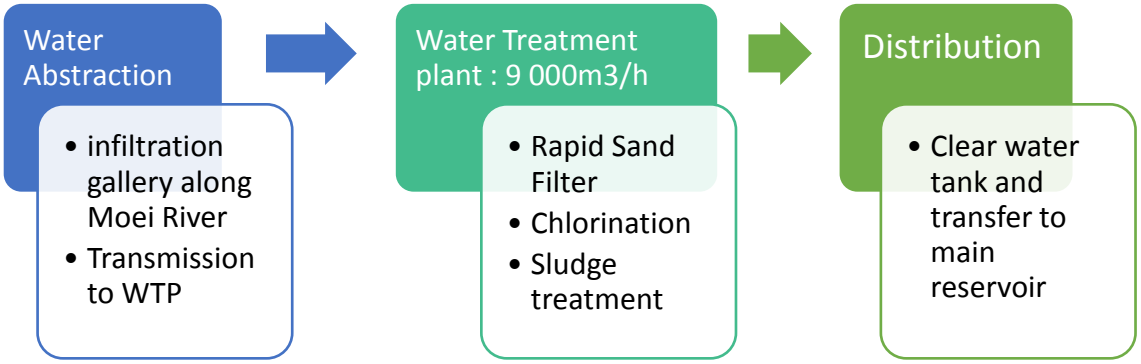
April 2017

Myanmar: Third GMS Corridor Town Development Project
“Kayin State” (Part 2 of 3)

the drains is taken to a collection well and then pumped to the water treatment plant through a transmission line equipped with flowmeter to control pumps and to display real-time information at the WTP site.

3.2.4.2 Treatment Plant

It is proposed the construction of a new water treatment plant with a nominal capacity of 9 000m^3/d (15h/day operation). Capacity has been set according to water demand for the project area (average daily need).



The proposed treatment process includes:

Clarification: Thanks to the natural filtration process at intake, it is assumed that clarification would not be necessary.

Filtration step consisting in a battery of 3 open type gravity sand filters, with the associated backwash, air scour and control facilities. Same design as for Hpa-An applies. An overall filtration surface of nearly 75m² is required (3 x 25m²).

Because of the expected very low turbidity of the raw water, it is considered that coagulation/flocculation step would not be required, hence limiting the use of chemicals.

Chlorination for disinfection will be performed into a clear water tank prior to distribution.

Treated water will be stored on site (1 000m^3 storage tank) and supplied through transmission pipe to the main water storage.

The new facility will also include operation building, electricity building, chlorination plant, air production. The amount of sludge produced is expected to be very limited due to the low turbidity of alluvial aquifer raw water. The proposed process is compact and able to treat a large quantity of water in a limited space. The process diagram below shows the global system proposed.

Figure [18] DESCRIPTION OF MYAWADDY WATER TREATMENT PLANT

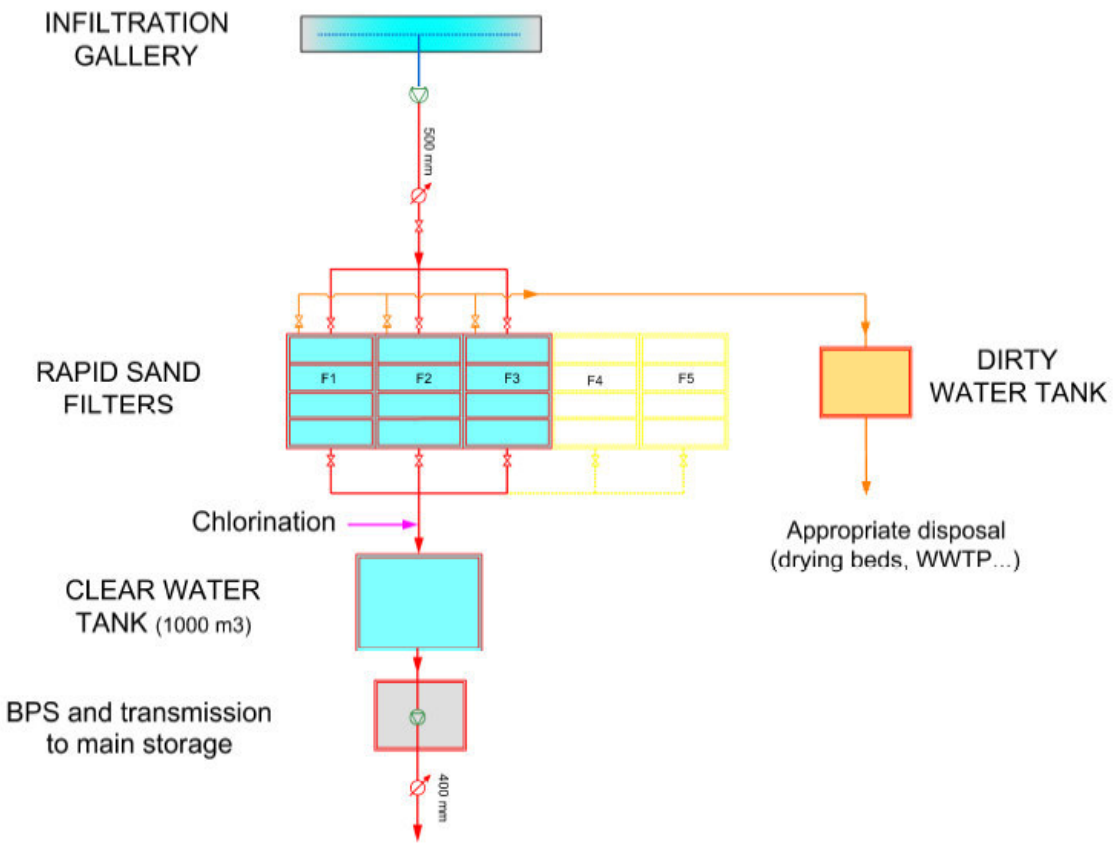


Figure [19] VIEW OF THE WATER TREATMENT PLANT SITE

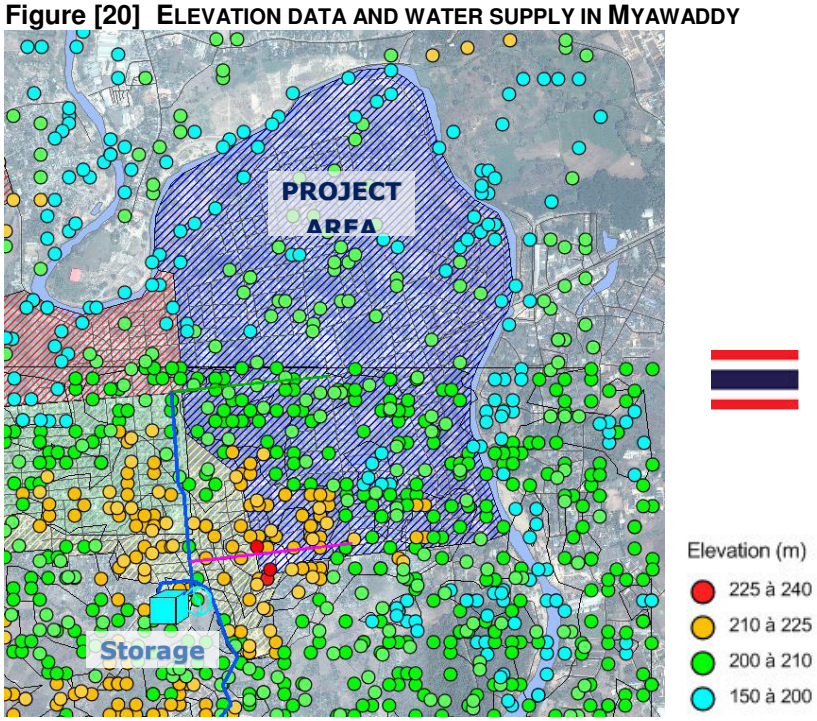
Design and area size include possibilities for extension on the long term from 9 000 m^3/d to 15 000 m^3/d (from 600 m^3/h to 1 000 m^3/h) by the addition of two more filters.

3.2.4.3 Storage

It is proposed the construction of a new above ground level reservoir within the city area with capacity of 4 500 m^3 (i.e. 1Mgal), which represents half of the daily production. According to available elevation data, most of the city can be supplied by gravity from the selected reservoir site. Only limited areas around the reservoir cannot be supplied with a suitable pressure and would require a booster pumping

station with pressure regulation. At this stage of the study, it is considered that a booster pumping station will be used and sized for the entire area to provide a sufficient pressure throughout the distribution system. The following figure details elevation data highlighting the problematic areas (yellow= insufficient pressure and red = no supply under gravity conditions).

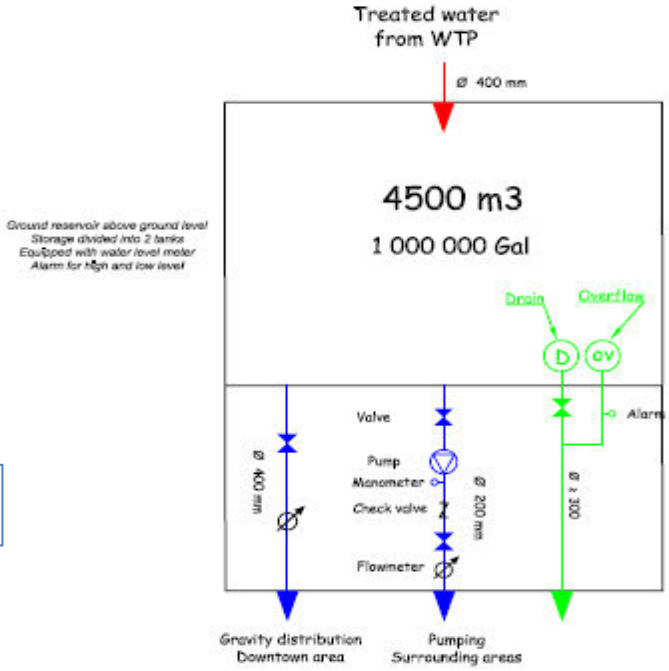
Figure [20] ELEVATION DATA AND WATER SUPPLY IN MYAWADDY



The reservoir will be equipped with overflow and drain system (for regular emptying and cleaning) as well as water level meter and sensors (low and high level). Measurements and data will be sent to the SCADA system and control room located at the treatment plant site.

Figure [21] SITE IDENTIFICATION AND GENERAL SCHEME OF MYAWADDY MAIN STORAGE

Location (0.5 acre) and view of existing site



3.2.4.4 DISTRIBUTION

Transmission and main distribution include the new transmission line between water intake and treatment plant, the transmission lines between treatment plant and storages of Bare Mae and Kyar Inn Mountain (400 mm), the main distribution lines (200-300 mm) from the two storages to the city wards.

Table [12] LENGTH OF TRANSMISSION AND MAIN DISTRIBUTION LINES FOR MYAWADDY

	200 mm	250 mm	300 mm	400 mm	500mm	TOTAL
Length (m)	800	750	780	6 550	100	**8 980**

In the absence of any existing internal distribution system, a fully new distribution network will be developed, sized on the population forecasts and future water demand, with the objective to cover 70% of the population by 2025 and 95% by 2040 (long term). Consequently, the length of internal network required by 2025 is estimated to be nearly 60km

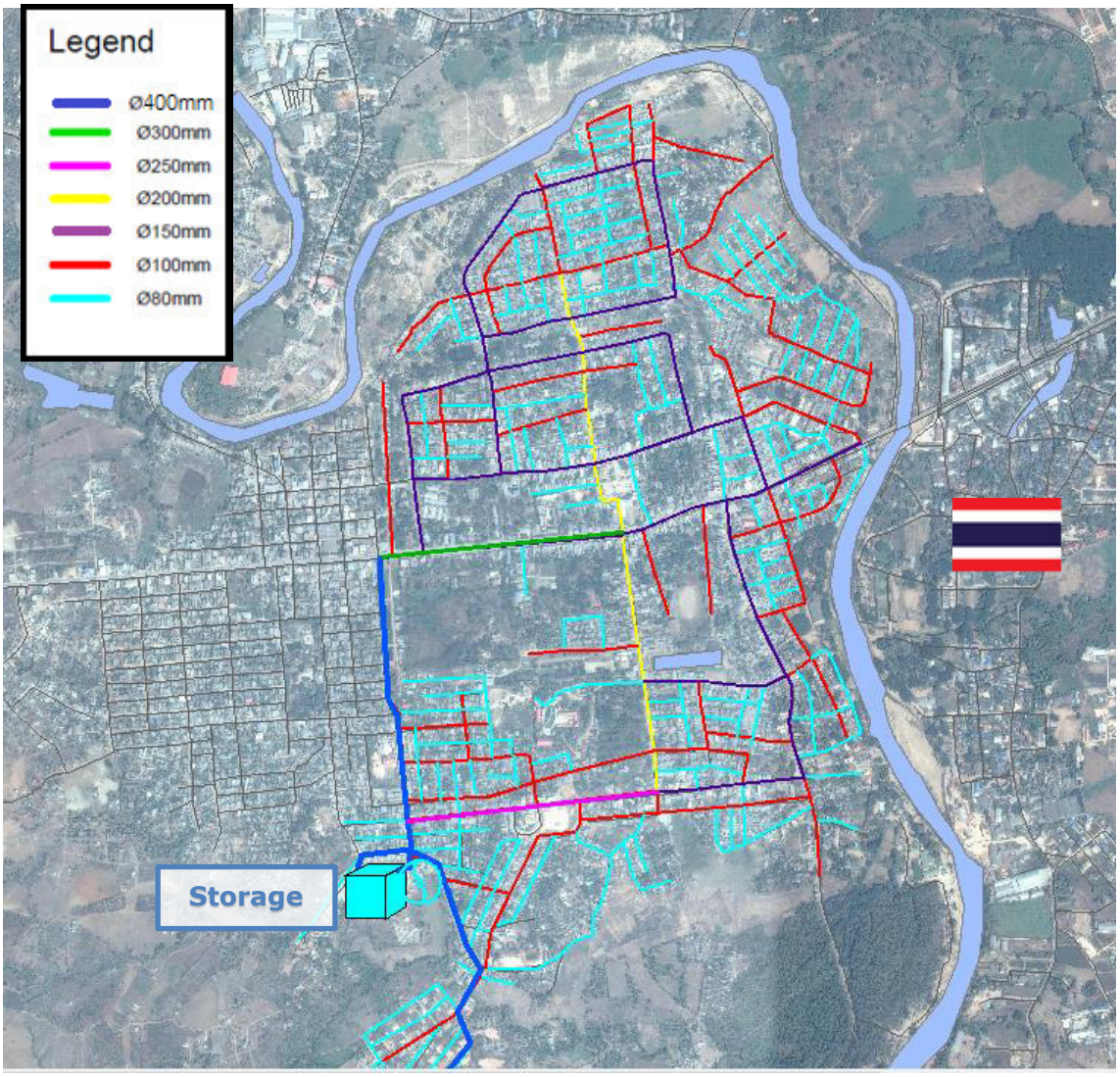
Table [13] LENGTH OF INTERNAL DISTRIBUTION LINES FOR MYAWADDY

Diameter (mm)	≤ 80mm	100 mm	150 mm	200 mm	TOTAL
Breakdown	40%	35%	20%	5%	**100%**
Length (km)	23.8	20.8	11.9	3.0	**59.5**

At this stage, for durability and economic considerations, it is proposed to install ductile iron pipeline; alternatively HDPE could be considered for internal network.

Following map is a draft design of tentative future internal distribution network which shall be further detailed during the next steps of the Project:

Figure [22] TENTATIVE DRAWING OF MYAWADDY FUTURE DISTRIBUTION NETWORK



The number of new connections is estimated to be nearly 14 900. New connections shall be implemented according to international standards with a defined procedure (material, maximal, length, registration…), and equipped with high quality water meters: certified class B or ideally class C.

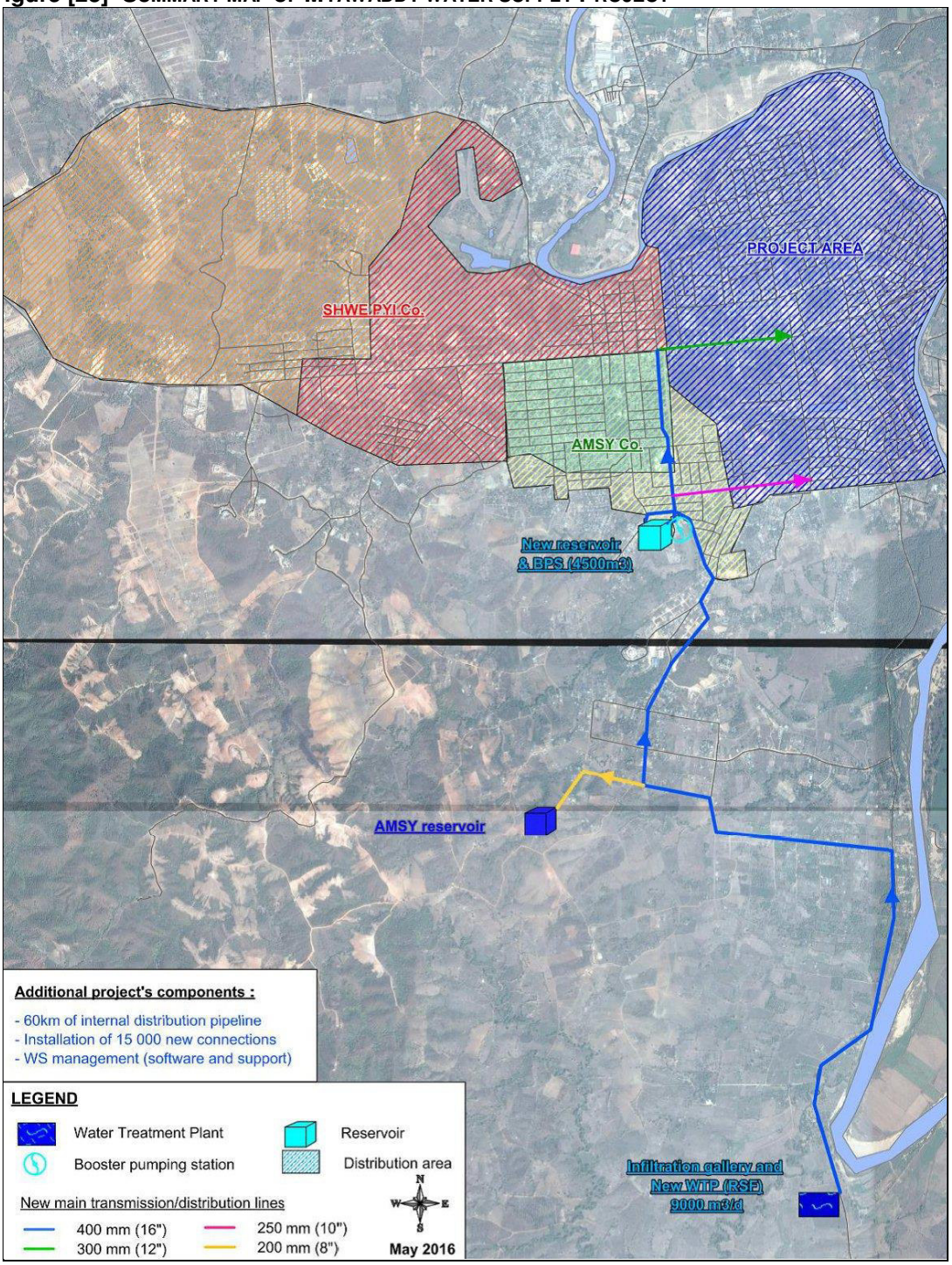
3.2.4.5 NRW Strategy

Same approach as Hpa-An is proposed in Myawaddy for NRW strategy to control and reduce losses, from a macro scale to a household level

3.2.4.6 Project Summary

The proposed water supply project and its components is summarized in the following summary map.

Figure [23] SUMMARY MAP OF MYAWADDY WATER SUPPLY PROJECT



3.3 Associated Facilities

Two water supply projects are currently under consideration in Hpa-An:

- JICA financed project: this project is part of an overall JICA grant to the Union of Myanmar covering several secondary towns.
- Water Supply Project for the Hpa An Industrial Zone (IZ) financed by the Union Government.

Regarding the Industrial Zone WS project, Kayin State Government confirmed during Interim Meeting his will to keep this project totally independent from the city water supply.

The other JICA project considers the construction of a new water intake in the Thanlwin River and a WTP slow sand filter type to supply water to the existing Bar Mae reservoirs.

The PPTA Consultant decided, given the relative small size of the JICA project, to ensure that the project proposed as part of the PPTA is a stand-alone project and not linked to the former. Nevertheless, a brief technical review of these 2 projects is provided in the FSR report. In both cases, the PPTA Consultant considers that the use of slow sand filters (SSFs), even with upstream pre-treatment facilities, is unsuited to the high levels of turbidity measured on the Thanlwin River and will most probably not be in position to provide high water quality to domestic and commercial or industrial customers.

No associated facilities or projects exist in Myawaddy.

4 BASELINE SITUATION

4.1 Topography, Regional Geology, Soils and Natural Hazards

4.1.1 REGIONAL GEOLOGY, SOILS AND SEISMICITY

Kayin State is a mountainous region with the Dawna Range running along the state in a NNW-SSE direction and the southern end of the Karen Hills in the northwest as shown in Figure [24] .

Hpa-An is the capital city of Kayin State located on the eastern bank of the Thanlwin river. The city is expected to grow as a logistics centre along the EWEC to support cross-border trade. The city also attracts tourists by its beautiful scenery of limestone hills and Buddhist heritages including pagodas and monasteries. Myawaddy is a border city located at the border with Thailand. It is separated from the Thai border town of Mae Sot by the Thaungyin (Moei) River, and the town is a major trading point between Myanmar and Thailand. The main rock types found in Kayin state are Soft Rocks, and Hpa-An area has soft rocks such as sandstone, shale, limestone and conglomerate. The rock types which found around the area of Myawaddy are hard rocks composed with limestone and dolomite, schist and granitic rock.

Regarding the soil type, red-brown forest soils, together with mountain red brown forest soils, primitive crushed stone soils are found in Kayin State. Lateritic soils and laterites are found at altitude below 100m above sea-level.

According to the seismic zone map of Myanmar shown in Figure [25] , the areas of the proposed projects in Hpa-An and Myawaddy are located in the low zone with less than 0.11 pga (peak ground acceleration).

Figure [24] GEOLOGY OF MYANMAR

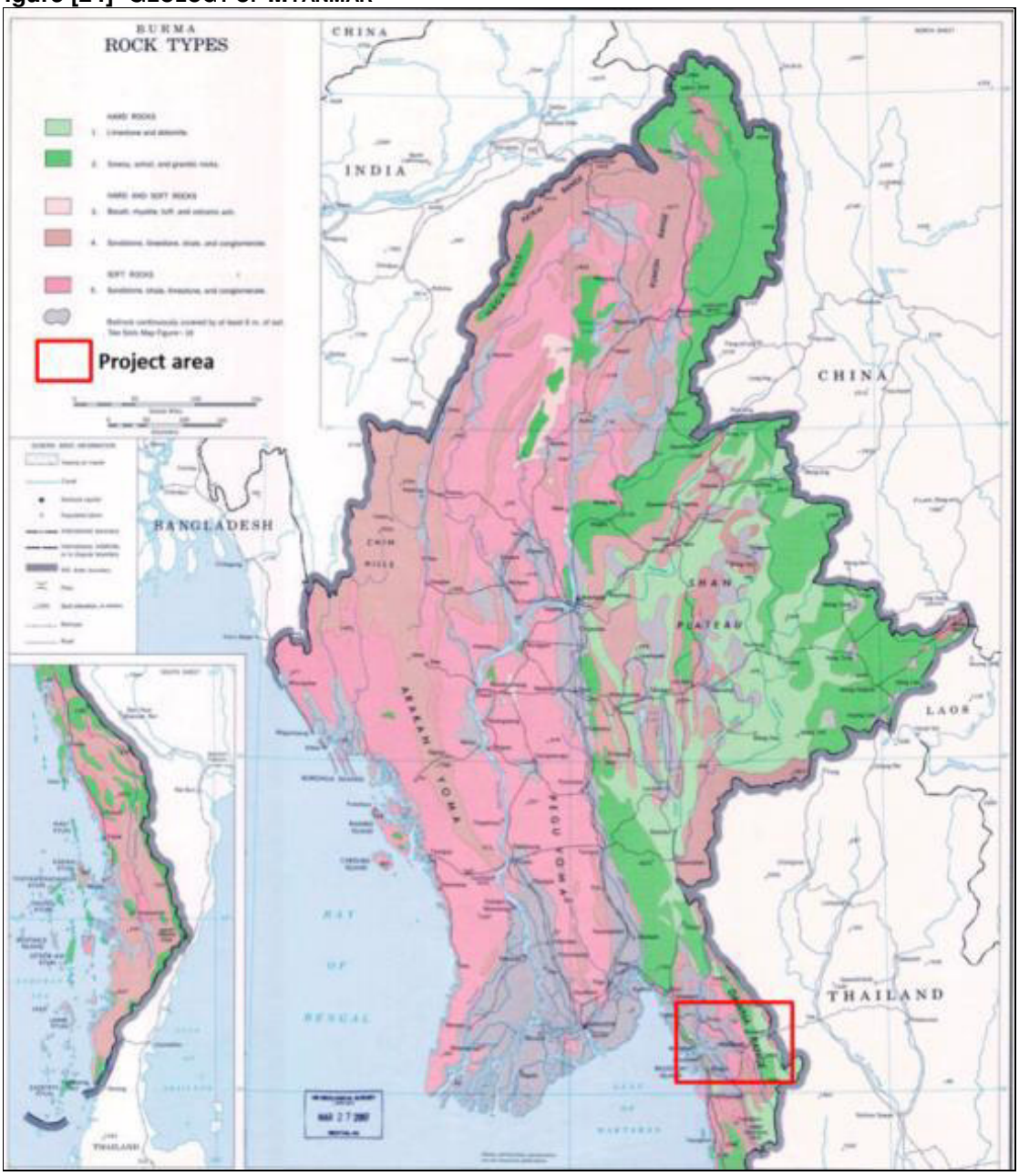
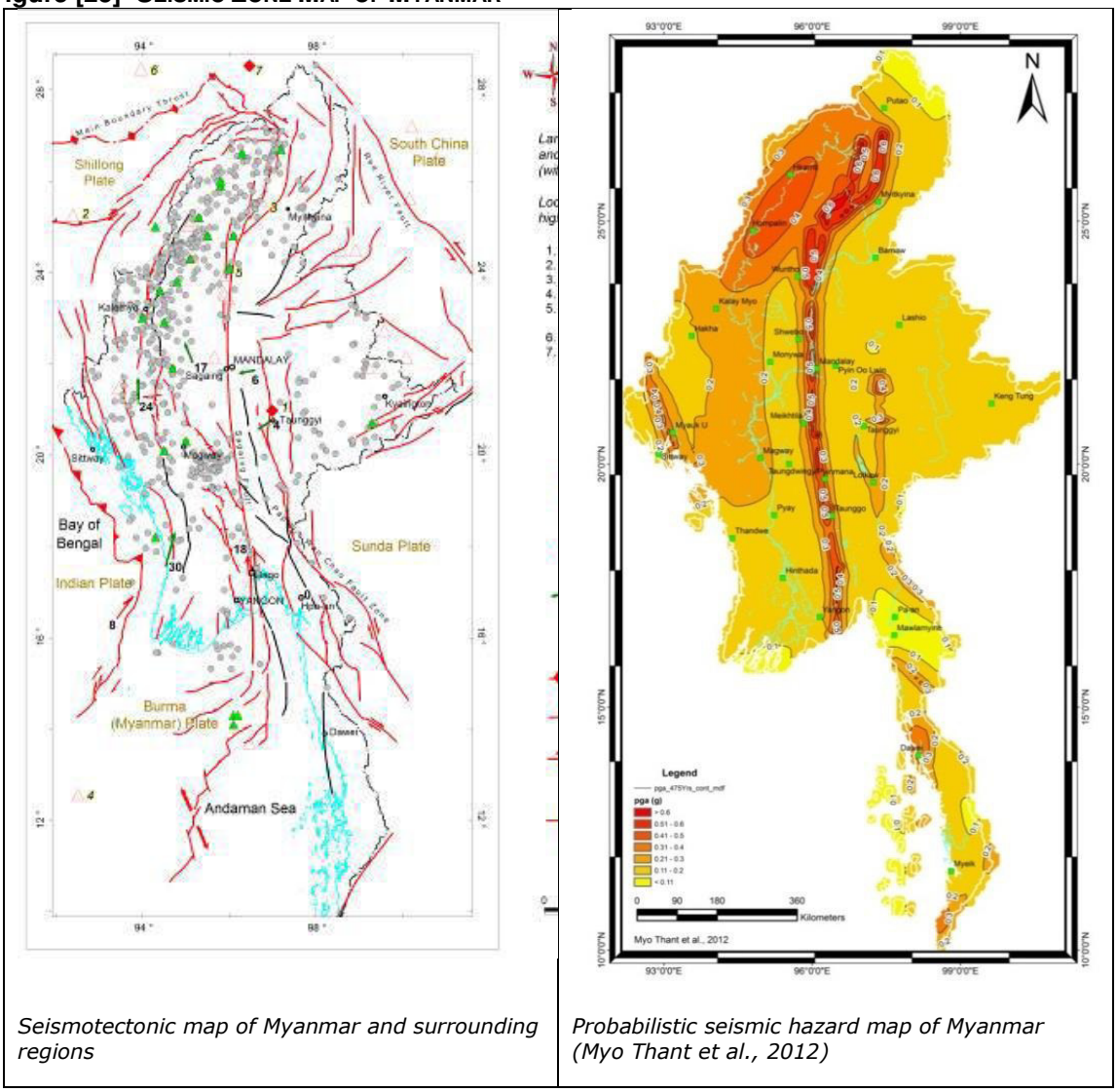


Figure [25] SEISMIC ZONE MAP OF MYANMAR



Seismotectonic map of Myanmar and surrounding regions

Probabilistic seismic hazard map of Myanmar (Myo Thant et al., 2012)

This means that the risk related to earthquake is considered as moderate and has been or will be fully integrated into the design standards applicable to the proposed facilities.

4.2 Climate

In the Andaman Sea, four seasons are distinguished:

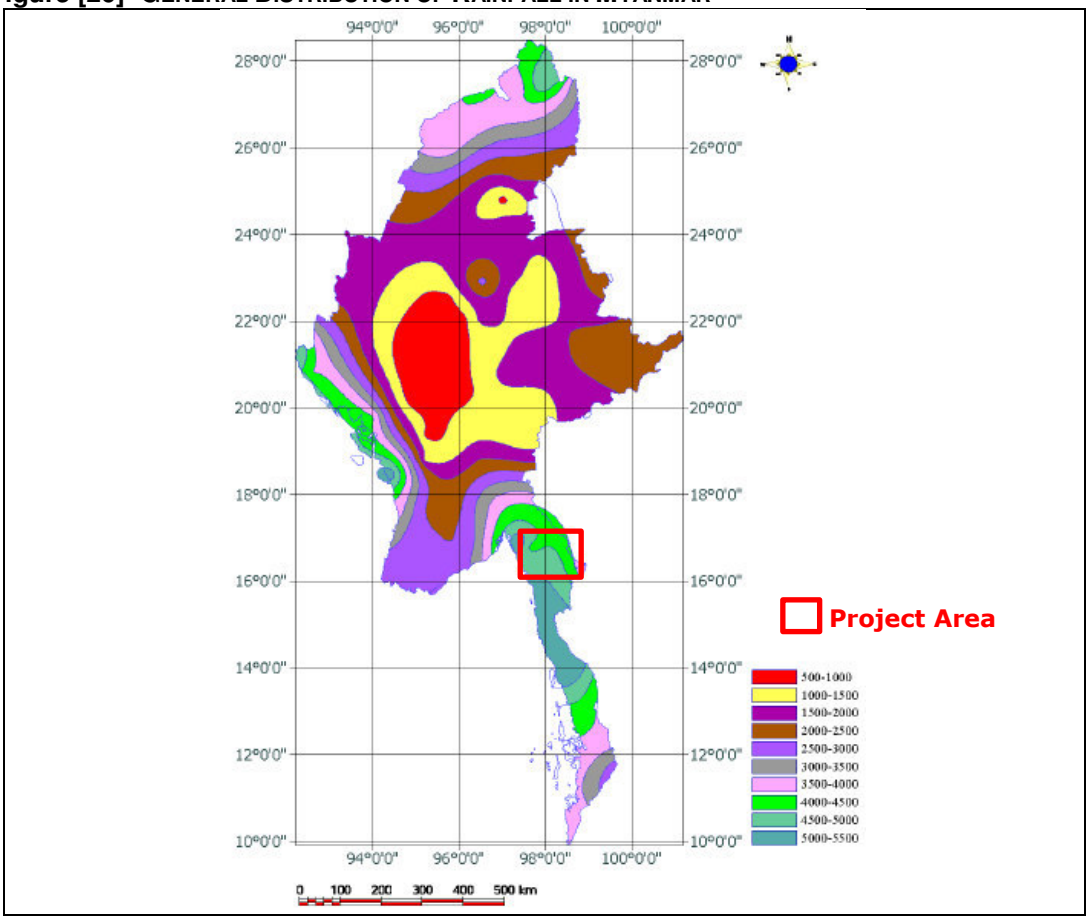
- The North-east Monsoon, from December to March, which brings fine cool weather and very little rainfall to the area.
- The Pre-monsoon transition period, from April to May, characterised by relatively weak and variable winds (prevailing land and sea breezes) and hot temperatures (37°C on the coast).
- The South-west Monsoon, from June to September, characterised by dense nebulosity, nearly daily drizzle interspersed with squalls, thunderstorms and heavy torrential rains along the East coast of the Andaman Sea.
- The Post-Monsoon Transition, from October to November, which is relatively similar to the Pre-monsoon transition with cooler temperatures.

Hpa-An and Myawaddy climatic conditions reflect these general characteristics. Regarding Myawaddy meteorological data, only rainfall data is available from 2006 to 2015.

4.2.1 RAINFALL

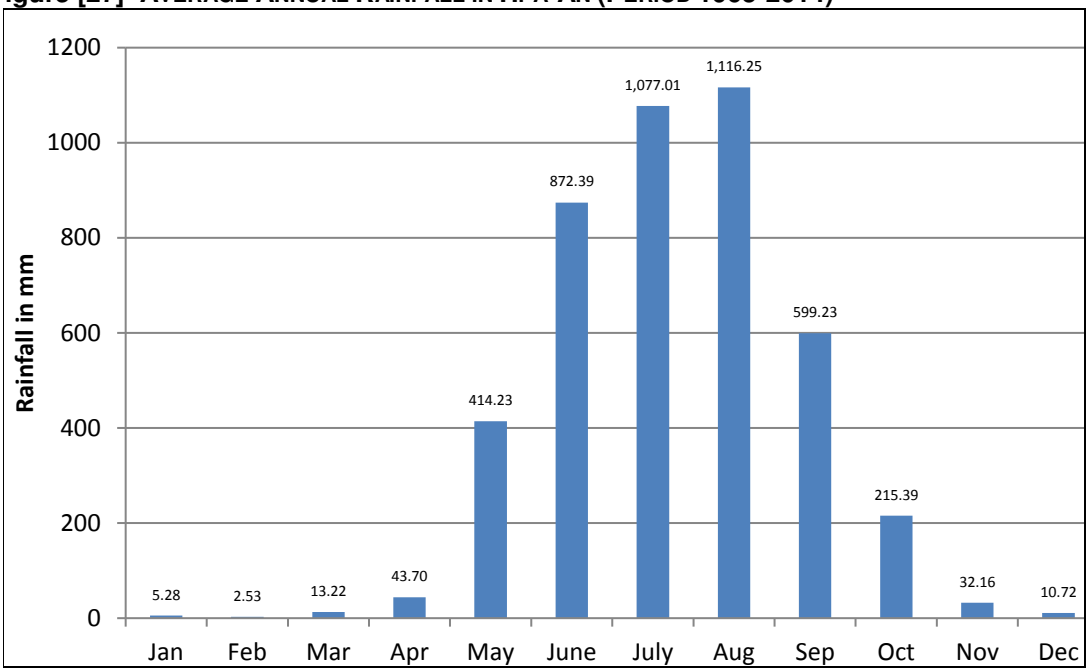
As presented on following figure, Hpa-An is located within the wettest part of Myanmar, receiving in average between 4500-5000 mm of rain every year.

Figure [26] GENERAL DISTRIBUTION OF RAINFALL IN MYANMAR



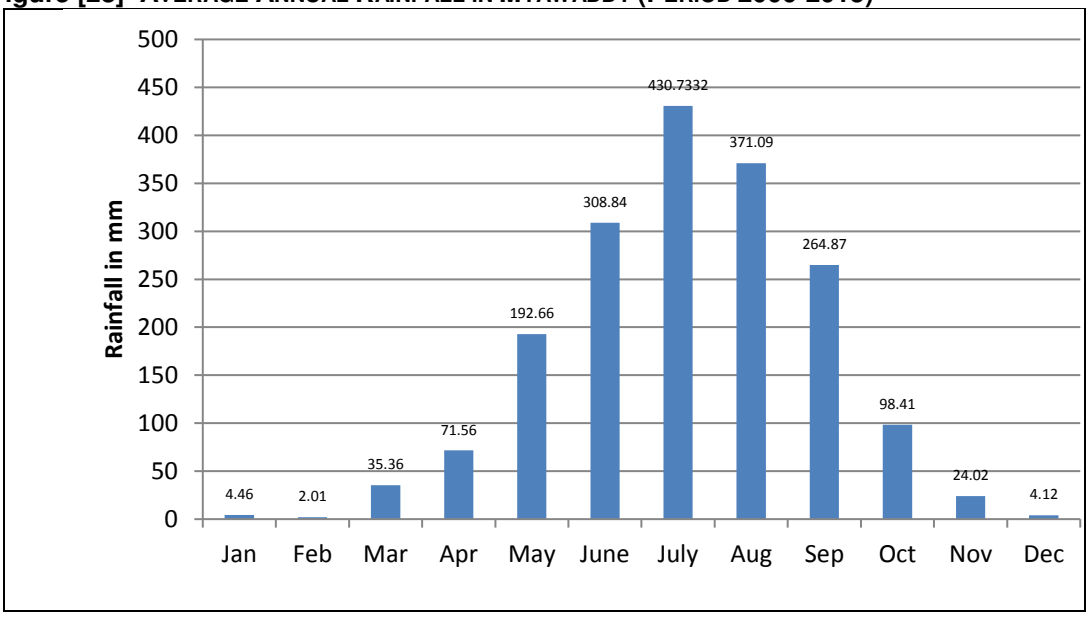
Annual rainfall average over the period 1965-2014 (50 years) in Hpa-An is provided in Figure [27] and the annual rainfall average over the period 2006-2015 (10 years) in Myawaddy is provided in Figure [28] . Average annual rainfall over the 50 years period in Hpa-An is 4 402 mm while the average annual rainfall over the 10 years period in Myawaddy is 1808 mm. About 83% (in Hpa-An) and 76% (in Myawaddy) of the annual rainfall falls from June to September, the 4 wettest months of the South-west monsoon.

Figure [27] AVERAGE ANNUAL RAINFALL IN HPA-AN (PERIOD 1965-2014)



Source: PPTA Consultant, 2015, data from Hpa-An hydro-meteorological station

Figure [28] AVERAGE ANNUAL RAINFALL IN MYAWADDY (PERIOD 2006-2015)

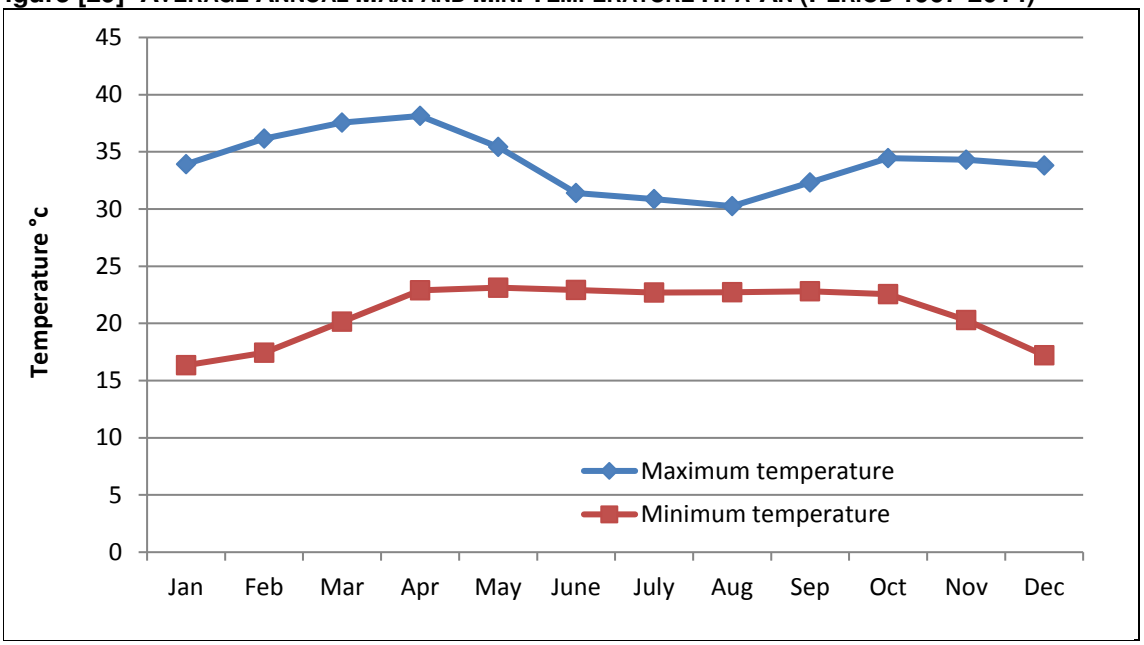


Source: PPTA Consultant, 2015, data from Myawaddy hydro-meteorological station

4.2.2 TEMPERATURE

Temperature in Hpa-An remains high all along the year as presented in following figure. February is the most contrasted month with about 19°C amplitude between maximum and minimum temperature while August presents the lowest difference with about 7.5°C. Average minimum monthly temperature never drops below 16°C.

Figure [29] AVERAGE ANNUAL MAX. AND MIN. TEMPERATURE HPA-AN (PERIOD 1967-2014)



Source: PPTA Consultant, 2015, data from Hpa-An hydro-meteorological station

4.2.3 WIND

In Hpa-An, the wind is predominantly from SE during the wet season as shown on Table [14]. In late afternoon, the wind speed is higher except January, September and December. The average maximum wind speed occurred in afternoon of April with 3.58 m/s.

Table [14] AVERAGE WIND SPEED AND DIRECTION IN HPA-AN (2011-2015)

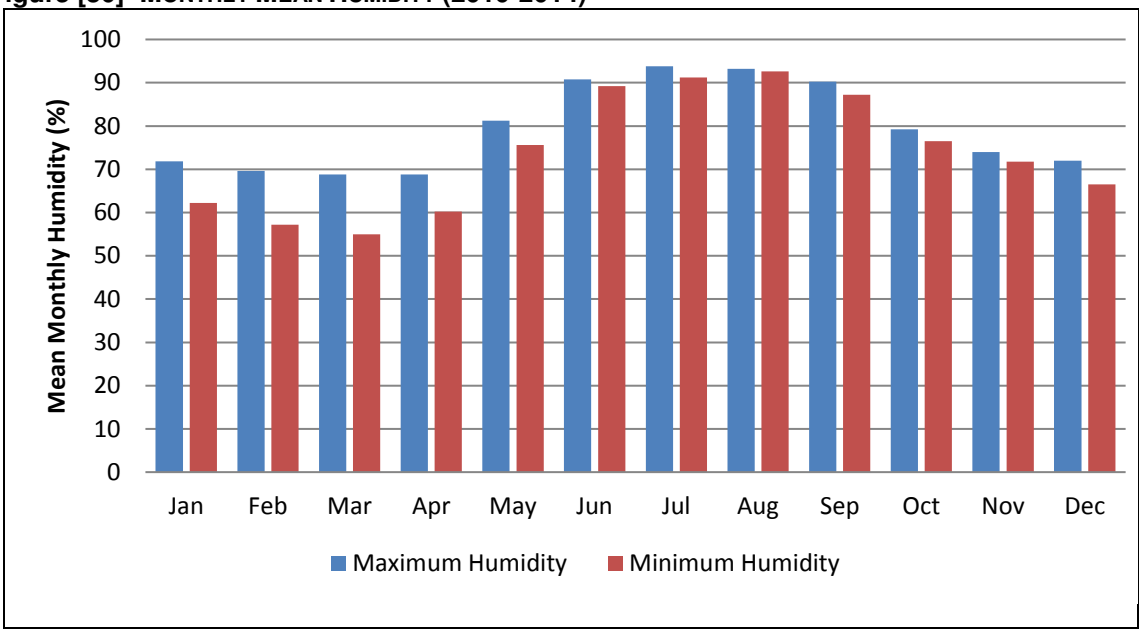
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Speed (mph) at 09:30	3.2	2.8	3.2	2.2	3.2	4.6	4.4	4.6	4.5	3	2	5.75
Speed (mph) at 18:30	1.8	3.2	5.4	8	5.4	5.6	4.8	6	4	3.75	2.25	2.5
Direction (Average)	NE	NE	SW	SW	SW	SE	SE	SE	SE	SE	NW	NE

Source: PPTA Consultant, 2015, data from Hpa-An hydro-meteorological station

4.2.4 HUMIDITY

Hpa-An has quite high humidity throughout the year by observing the 5 years data from 2011 to 2015, as shown on **Error! Reference source not found.**. It was observed that the minimum average humidity was 55% in March and the maximum humidity reaches 93.8% in July.

Figure [30] MONTHLY MEAN HUMIDITY (2010-2014)



Source: PPTA Consultant, 2015, data from Hpa-An hydro-meteorological station

4.3 Climate Change in Myanmar

Myanmar signed the UNFCC Convention on 11/06/1992 and ratified the convention on 25/11/1994. The country also ratified the Kyoto Protocol in 2003. Myanmar has recently submitted its Initial National Communication (INC) to UNFCCC. National Adaptation Programs of Actions (NAPA) have been prepared with the financial support of GEF/UNEP and are expected to be finalized in 2014.

4.3.1 THE NATIONAL TRENDS

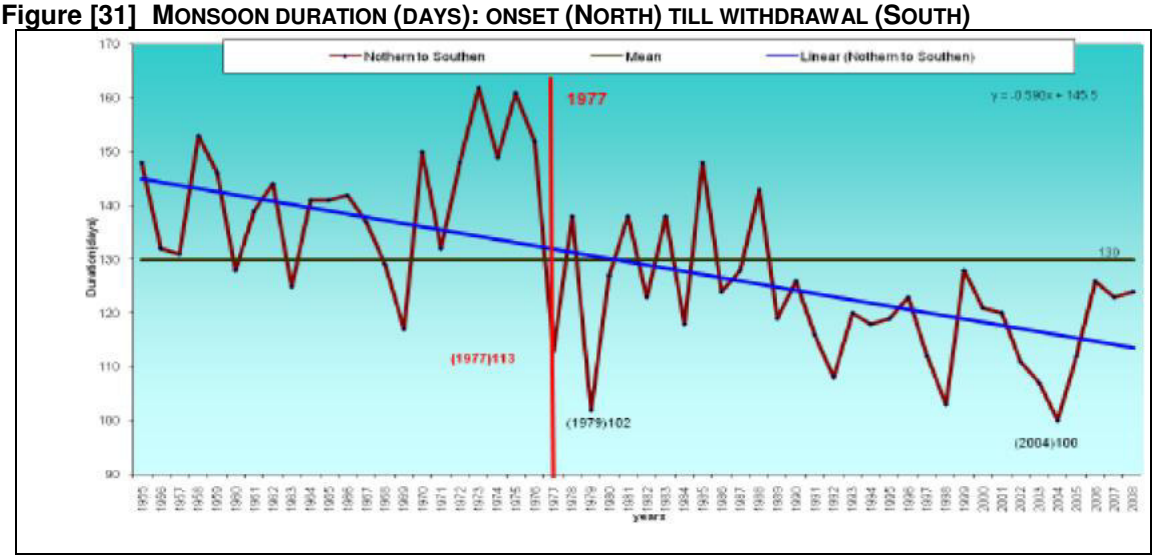
Due to its location in SE Asia and the length of its coastline, Climate Change (CC) is certainly a major concern for Myanmar. On the basis of the latest Climate Risk Index (period 1993-2012) ranking system (Global Climate Risk Index 2014, Germanwatch), Myanmar is reported as one of the most threatened country by climate change. The PPTA Consultant considers this ranking must be interpreted carefully as it is mainly based on the losses in assets and lives during major extreme events related to climate change (typhoons and floods). The high index attributed to Myanmar results in fact, for 95% of its value, from only one event: Typhoon Nargis which killed almost 150,000 peoples in 2008. If we except this unique event, Myanmar appear, for 2014, not more threaten than other neighboring countries by CC.

However, Myanmar is facing progressive climate changes which threat particularly water resources and food security: Change in rainfall distribution and quantity and raise in temperature.

Figure [31] depicts the observed change in southwest monsoon duration from 1955 to 2008. From the onset of the monsoon in Northern Myanmar until its withdrawal from the South, the monsoon duration over the last 50 years shows a significant reduction from 140-150 days in the mid-fifties to less than 120 days in 2008. Late arrival of the rain and early ending where particularly evident since the year 1977, when the duration of the rainy season dropped below 130 days, a critical limit for most cropping cycles.

According to regional information, the southwest monsoon duration has been shortened by about three weeks in northern Myanmar and one week in other parts of the country when compared to the situation observed in the fifties.

Figure [31] MONSOON DURATION (DAYS): ONSET (NORTH) TILL WITHDRAWAL (SOUTH)



Source: Some observed Climate Change Impacts in Myanmar, Dr Thin Nai Tham, Department of Meteorology and Hydrology, 2010.

Available information on climate change forecasts in Myanmar for period 2001 to 2020 anticipated:

- Slight warming of +0.5°c from June to November (rainy season) is anticipated in the whole country. During the dry season, warming will be more significant (+ 0.7 to +1.2°c) over the country, except in the delta area where temperature increase should not exceed +0.6°c.
- Only 5% increase of precipitation is forecasted for the period March-November in the whole country. During the dry season, which contributes to only 5-10% to the annual rainfall, the deficit may reach 45%, except in the delta region where dry season rain should remain normal.

4.3.2 THE SUB-NATIONAL TRENDS

Limited information has been collected so far by the PPTA Consultant at a local level. Observed temperature changes have affected some (though not all) regions to a significant degree thus far. Compared to the WMO's 1961–1990 average data, nine of the 17 state regions have observed an increase in annual temperature, two have seen decreases, and six have observed no appreciable change. Observed changes in Kayin and Mon States are provided in Table [15] presenting an analysis of records for the period 1951 to 2007 which identifies a more significant increase of temperature in Kayin State (+0.32 °C per decade) than in Mon state (+0.14°C per decade). Similarly, changes in rainfall over the same period show a decrease of 23.6 mm per decade for Kayin State while rainfall in Mon State increased by 71.57 mm per decade.

These figures have to be put into perspective with observations made in the other states of the country. Temperature increase rate in Kayin State is the highest observed in Myanmar, just followed by Lower Sagaing (0.30°c increase per decade) and Mandalay region (0.20°c increase per decade). For rainfall changes, the rainfall increase observed in Mon State is second after Upper

Sagaing Region (+215.2 mm per decade) and just before Kachin State (+64.71 mm per decade). Like Kayin State, two other places observed rainfall decrease over the observation period: Bago Region (-81.08 mm decrease per decade) and Lower Sagaing Region (-17.4 mm per decade).

Table [15] TEMPERATURE AND RAINFALL CHANGES IN KAYIN AND MON STATES

State	Station	Mean Annual Temperature (°c)	Temp. Increase per Decade (°c)	Mean Annual Rainfall (mm)	Rainfall Change per Decade (mm)
Kayin	Hpa An	27.2	0.32	4 346	-23.6
Mon	Mawlamyine	27.1	0.14	4 816	+71.57

MOECAF, 2012, Myanmar Initial National Communication to UNFCCC

4.3.3 OBSERVED TRENDS IN HPA-AN

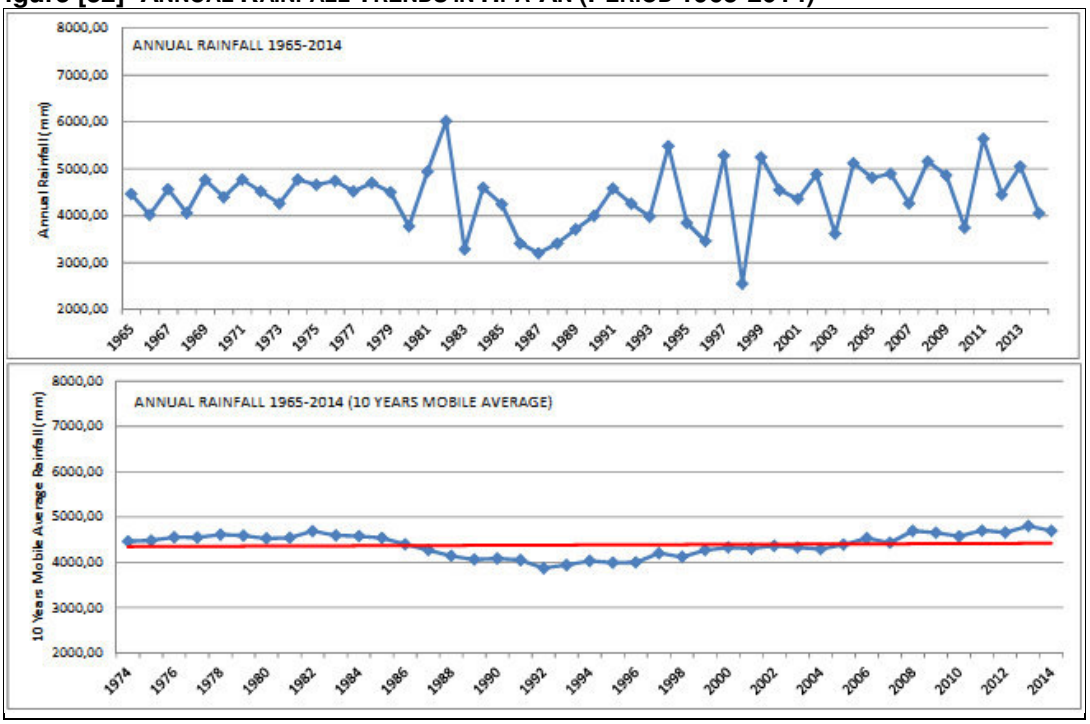
Rainfall Historical Trends

In addition to the general assessment of CC from GCM, the PPTA Consultant carried out an analysis of Hpa An hydro-meteorological station monthly data, available for the period 1965-2014 (50 years), in order (i) to confirm or infirm the general trends from the GCM and (ii) provide more specific conclusions for the Hpa-An area where the project is located. The trends over the 50 years period is identified based on the evolution of the 10 years mobile average: each point on the graph represents the average of the 10 precedent years; this approach provides a better clarity of the general trend through eliminating individual fluctuating values of each year, which reflects better the long term tendency. Figure [32] presents annual rainfall along the 50 years observation period (upper) and the same analysis but based on 10 years mobile average (lower). The 10 years mobile average does not display any particular trend except stability over the 50 years period.

Figure [33] presents a more detailed analysis for the 6 raining months (May to October) over the observation period and based on the 10 years mobile average. In red, the resulting linear trend curve. The results lead to the following observations:

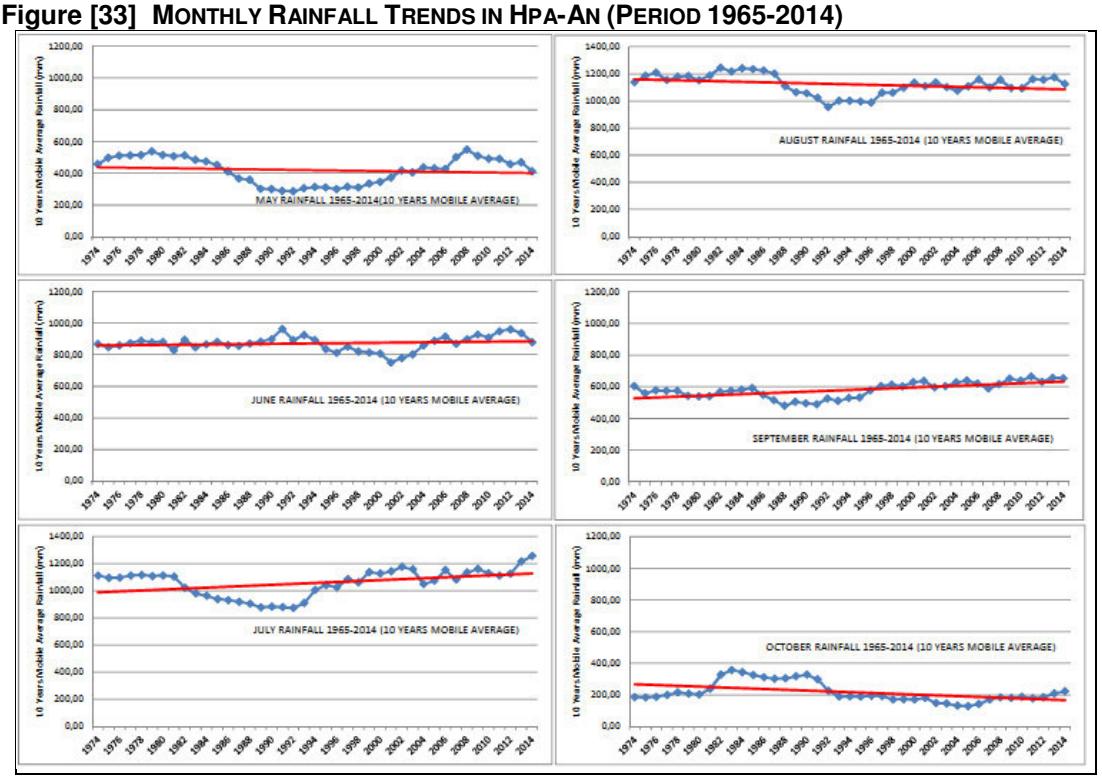
- Except July presenting a significant raising trend (about 70 mm over the whole period, or 14 mm/decade) all the other months show limited trends either raising or decreasing;
- Except August, the wettest months of the rainy season show a slight raising trend while May and October show decreasing trend.

Figure [32] ANNUAL RAINFALL TRENDS IN HPA-AN (PERIOD 1965-2014)



Source: PPTA Consultant, 2015.

Figure [33] MONTHLY RAINFALL TRENDS IN HPA-AN (PERIOD 1965-2014)

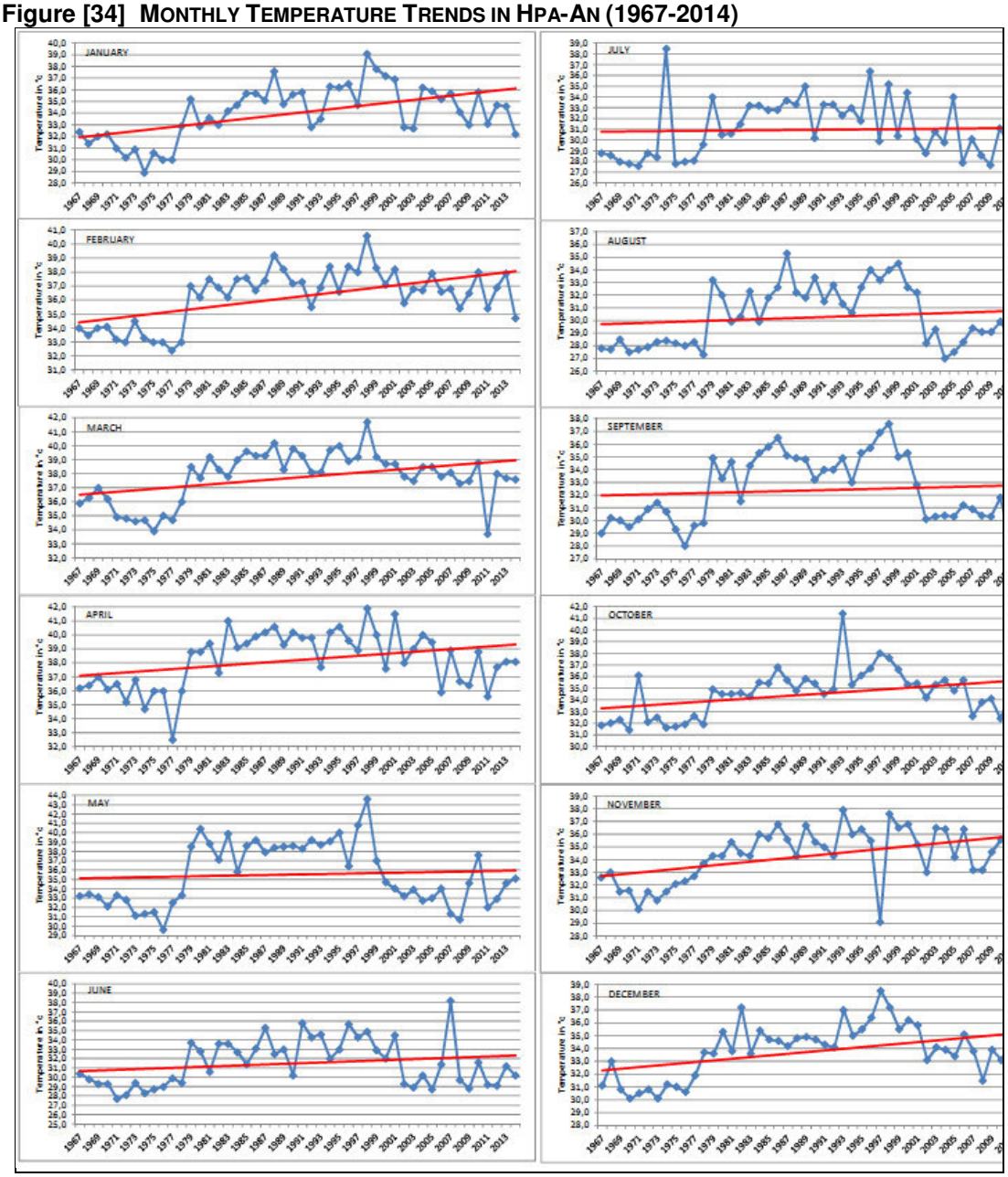


Source: PPTA Consultant, 2015.

Temperature Trends

Data on minimum and maximum monthly temperature observed in Hpa-An meteorological station were collected for the period 1967-2014 (48 years). Analysis performed on maximum monthly temperature is depicted in figure below showing the monthly maximum temperature distribution over the period and the linear trend curve (in red).

Figure [34] MONTHLY TEMPERATURE TRENDS IN HPA-AN (1967-2014)



Source: PPTA Consultant, 2015.

- All the months of the year show increasing maximum temperature trends;
- A very significant increase of temperature during the dry season: +3°C for October, November and December, +4°C for January and February, about +2°C for March and April;

- From May to September, corresponding to the wet season, temperature still increases but more modestly by about +1°C ;

The same analysis performed on the maximum annual average temperature shows an increase of about 2.2°C over the 48 years or about 0.46°C increase per decade. This value is two times higher than what is observed in Mawlamyine and significantly higher than the value of 0.32°C of increase by decade presented by MONREC as an average for the Kayin State.

Sea Level Trends

A rise in global sea levels has been observed in recent decades, and with continued global warming temperatures, the IPCC predicts this trend to continue throughout the century. There are two primary factors affecting sea level rise relating to global warming:

- First is thermal expansion: It is estimated that approximately 60 % of the global heat energy increases are stored in the upper ocean and 30 % in ocean waters at greater depths, resulting in total oceanic absorption of 90 % of heat energy increases. As ocean waters absorb heat energy, they naturally expand, contributing to rising ocean levels.
- The second primary factor is melting ice sheets and glaciers: As the Antarctic and Greenland ice sheets melt, runoff from melting glaciers empties into the world's oceans, resulting in sea level rise.
- The latest IPCC report also provides an assessment that it is very likely that mean sea levels rose worldwide by approximately 1.7 mm per year since 1901 (through 2010). Furthermore, the rate of rise has increased in recent decades, with an average of 2.0 mm per year since 1971 and 3.2 mm per year since 1993.

Table [16] IPCC PROJECTIONS: FUTURE TEMPERATURE AND SEA LEVEL CHANGES

		2046–2065		2081–2100	
	Scenario	Mean	*Likely* range[c]	Mean	*Likely* range[c]
Global Mean Surface Temperature Change (°C)[a]	RCP2.6	1.0	0.4 to 1.6	1.0	0.3 to 1.7
	RCP4.5	1.4	0.9 to 2.0	1.8	1.1 to 2.6
	RCP6.0	1.3	0.8 to 1.8	2.2	1.4 to 3.1
	RCP8.5	2.0	1.4 to 2.6	3.7	2.6 to 4.8
	Scenario	Mean	*Likely* range[d]	Mean	*Likely* range[d]
Global Mean Sea Level Rise (m)[b]	RCP2.6	0.24	0.17 to 0.32	0.40	0.26 to 0.55
	RCP4.5	0.26	0.19 to 0.33	0.47	0.32 to 0.63
	RCP6.0	0.25	0.18 to 0.32	0.48	0.33 to 0.63
	RCP8.5	0.30	0.22 to 0.38	0.63	0.45 to 0.82

IPCC, Climate Change 2013: The Physical Science Basis, 25.

- IPCC Projections for future temperatures and sea level rise are provided in table above according to various scenarios of CC. In order to be on the safe side, it is considered that a level rise of 0.5 m by 2065 and 1.0 m by 2100 is reasonable for planning projects in the coastal zone of Myanmar, including Mawlamyine and Hpa-An, both located along the lower reach of the Thanlwin river. This value does not integrate surge raise created by low pressure tropical storms (typhoons) which already occur but are anticipated to become

more frequent in the future. However, both cities are not facing directly the sea and are protected from such phenomenon, particularly for Hpa-An reasonably far from the estuary.

Conclusions

Both temperature and rainfall show increasing trends in Hpa-An along the last 50 years of observations, in line with the MONREC analysis for the Kayin State.

Annual rainfall didn't change significantly over the last 50 years. Among the wet season months (May to October), only the months of June, July and September show an increasing trend, with July showing the highest raise during the 50 years period (about 120 mm, or 24 mm per decade).

Temperature rose much more significantly during the same period. The average annual maximum temperature rose by 2,2°C over the last 48 years, or an increase of almost 0,5°C per decade, a value significantly higher than what is considered as an average increase in the Kayin State (0.32°C per decade). July and February increased by about 4°C during the period while the other dry season months increased by 2 to 3 °C. Wet season months increase was only about 1°C during the same period.

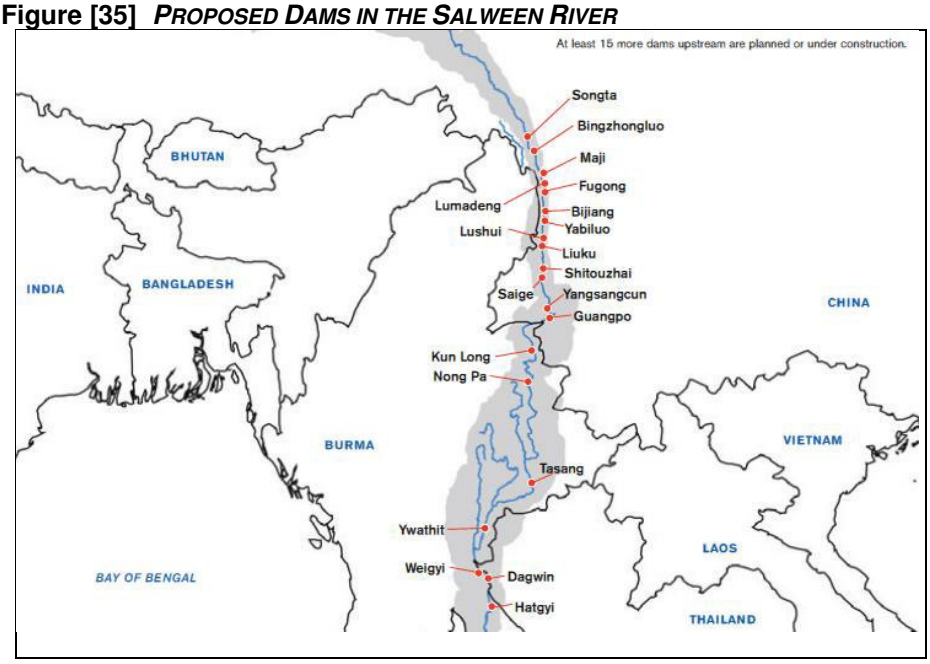
4.4 Surface Water

4.4.1 HYDROLOGY AND FLOODS

The Salween River (named Thanlwin in Myanmar) is about 2,815 km long which flows from the Tibetan Plateau into the Andaman Sea in Southeast Asia. It drains a narrow and mountainous watershed of 324,000 km² (125,000 sq. mi) that extends into the countries of China, Myanmar and Thailand. Steep canyon walls line the swift, powerful and undammed Salween, one of the longest free-flowing rivers in the world. Its extensive drainage basin supports a biodiversity comparable with the Mekong and is home to about 7 million people. In 2003, key parts of the mid-region watershed of the river were included within the "Three Parallel Rivers of Yunnan Protected Areas", a UNESCO World Heritage Site located in China, several hundreds of km upstream the project area.

In Hpa-An, where the unique gauge station is located, the Thanlwin river has an estimated discharge of 157 billion m^3/year, which means close to 5,000 m^3/s in average. Mean low flow at Hpa-An is about 2,000 m^3/s. Near the head of the delta, the mean low flow is 2 300 m^3/s and a flood discharge of 32,600 m^3/s has been reported. However, several hydroelectric projects are already identified all along the course of the river, both in China and in Myanmar, which may have drastic impact in the long term on the river hydrology. Figure [35] presents the location of sites where potential hydropower development is identified.

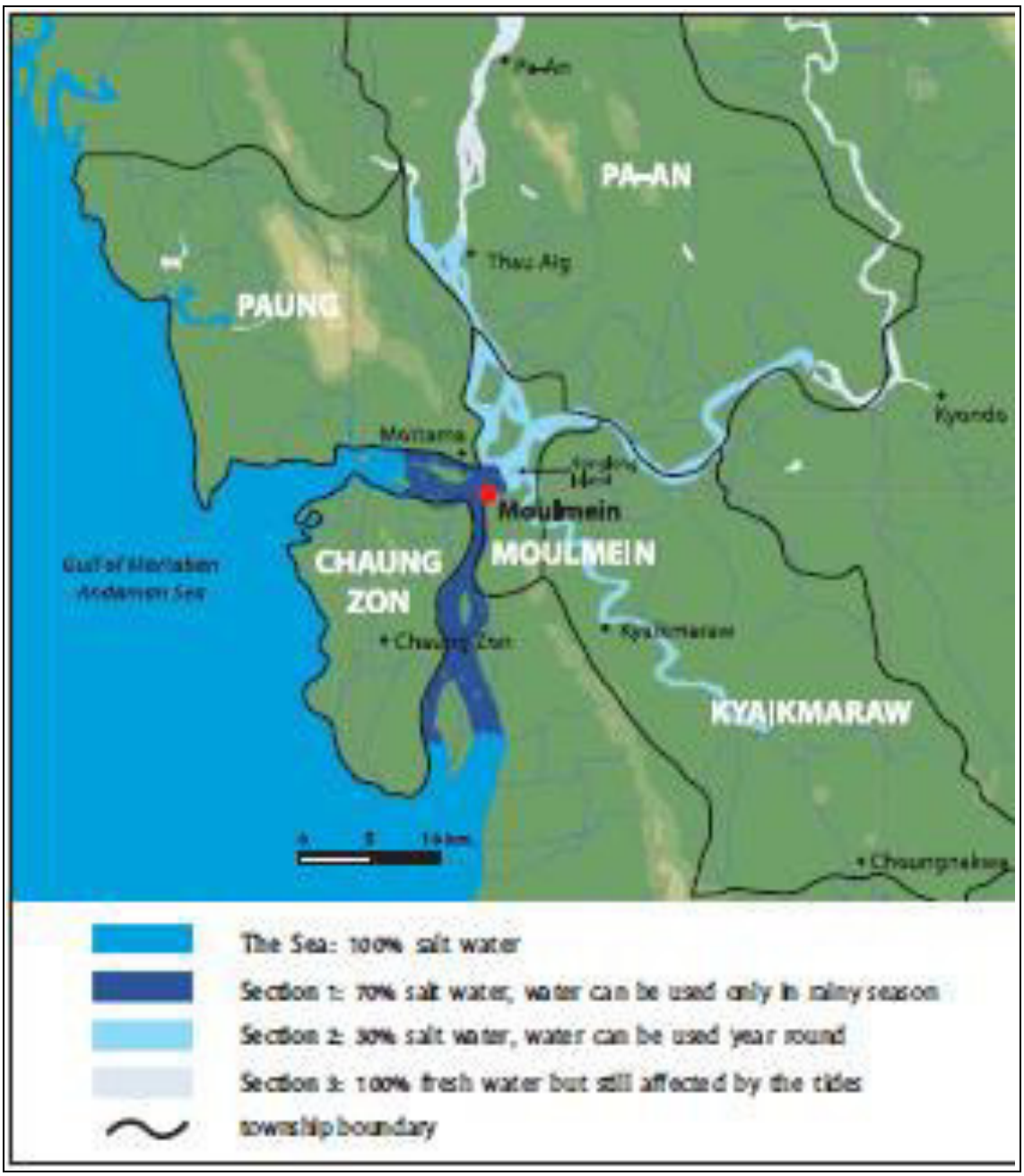
Figure [35] ***PROPOSED DAMS IN THE SALWEEN RIVER***



Source: Salween Watch, 13 March 2013

With rising sea levels and the impact of upstream reservoirs, there is a potential risk that the saline wedge of the estuary can encroach further upstream along the Thanlwin. At present there has been no attempt to simulate future saline conditions of the lower Thanlwin under different future scenarios; however, by analogy with nearby rivers the future risks can be appreciated. The risk for Hpa-An to see the salinity of river to rise up to levels endangering its water supply, shall directly depend on the modification of the river discharge resulting from damming and water use along its course (particularly irrigation). At present, and as shown in following figure, the Thanlwin river in front of Hpa An is still 100% fresh water year round. The most upstream point reached by a saline wedge with a low salinity of 30% (the water can still be used year round for water supply) is still more than 20 km downstream Hpa An.

Figure [36] EXISTING SALINITY CONDITIONS (ISOHALINES) OF SURFACE WATERS IN THE LOWER THANLWIN



Source: Salween Watch, 13 March 2013

The widespread floods mainly hit the lower and middle reaches of the large rivers such as Thanlwin, Attran and Gyaing Rivers, having a catchment area larger than few thousands of square kilometres. The water levels of the downstream/middle streams of these rivers tend to gradually rise. Because of such gradual rise of river water levels, the residents have time for evacuation from the flooded zones and therefore the human damages including the death seldom occur. However, once the river water levels exceed the river bank levels, extensive and prolonged flood inundation occur. As most major urban centres are located along the downstream reach of the large rivers and are inundated over a long period, economic damages from flood tend to be huge. For this

reason, most recorded major flood damages in the Southeast Myanmar result from the wide spread flood

In contrast to the widespread flood, flash-floods tend to occur along small rivers and creeks where the peak water level rises very rapidly immediately after the heavy rainfall event. Due to such features, flash flood results into potential risk of serious human damages including fatalities. However, since flash flood is limited to specific areas and residents being well aware of the risks, the flood damages are far smaller than those of the wide-spread flood described above (Ministry of Border Affairs & JICA, 2013).

Thanlwin River tends to be the main cause of serious flood damages in Hpa-An area. The critical level in Hpa-An above which flood start occurring in lowland areas is 7.50 m (staff gauge reading by the Department of Meteorology and Hydrology). According to the records of DMH, the river water levels in the Thanlwin River exceeded the critical level seven years out of ten (period 2003-2012) and water levels above the critical level lasted for 5 to 46 days.

However, flood is not a major issue in Hpa-An urban area as it protected by a dyke along the strand road. Flooding from the Thanlwin is more affecting the surrounding villages.

The Thaungyin (Moei) River, along which Myawaddy is located, is a tributary of the Salween River. It originates in Phop Phra district, Tak Province. Unlike most rivers in Thailand, the Thaungyin flows north. The river forms the natural border line between Thailand and Myanmar. The districts along the Thaungyin River bank of Thailand, from South to North are Mae Sot, Mae Ramat, Tha Song Yang and finally it enters the Salween River in Sop Moei district of Mae Hong Son Province. The river is about 327 km long (Hadden, 2008).

The Thaungyin (Moei) water level varies from 1 meter in dry season to 4 meters in rainy season. However an exceptional event occurred in 2013 with a peak up to 9 meters. Flood occurred then at the friendship bridge at the border crossing. The detailed design of the intake in Myawaddy should include a protection level in accordance with this flood occurrence.

4.5 Hydrogeology

In Kayin State, groundwater is abstracted by the following three kinds of wells: (i) hand-dug wells (9 to 12 meters in depth), shallow-wells (25 to 45 meters in depth), and tube wells (deeper than 50 meters) (Ministry of Border Affairs & JICA, 2013).There is not much detailed information about ground water in the regions of Hpa-An and Myawaddy.

In Hpa-An, the landfill site is proposed on a wide plateau unpopulated, covered by scrubland. Drainage around was observed dry at the time of the visits, with no underground drainage of superficial aquifer. No handwells or tubewells are observed in this area.

In Myawaddy, the proposed landfill site is also located on a plateau, nearby a deep dissection by a ravine, where no shallow aquifer seems to be drained.

4.6 Air Quality and Noise

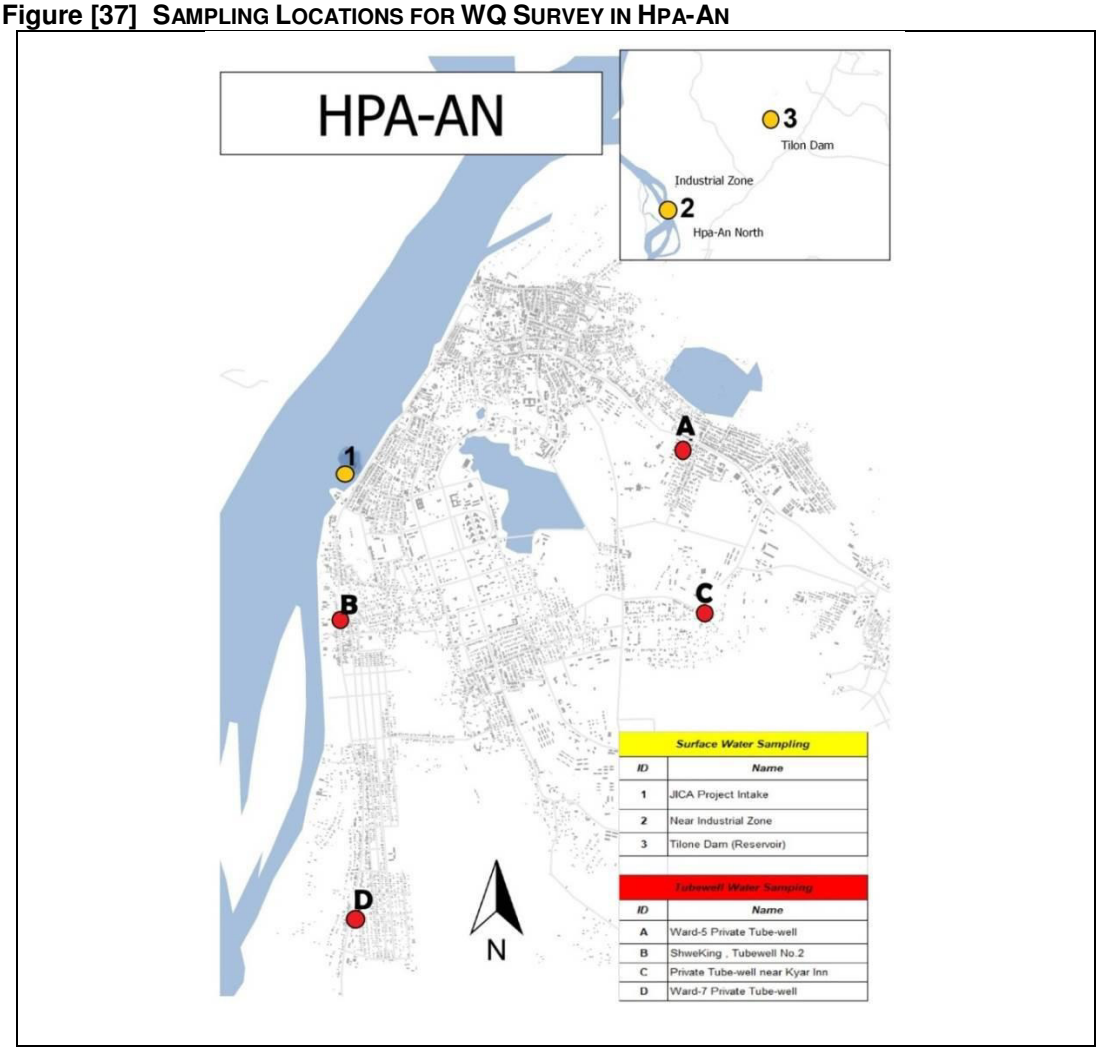
No data presently exist on air quality and noise in both concerned cities. However, considering the low industrialization of the cities, main air pollution comes from (i) dust from unpaved ways in dry season, (ii) smoke resulting from

cooking and from the burning of the solid waste dumped all over the urban areas and (iii) from road traffic, particularly in Myawaddy along the access road to the border post with Thailand, always presenting a heavy traffic.

4.7 Water Quality

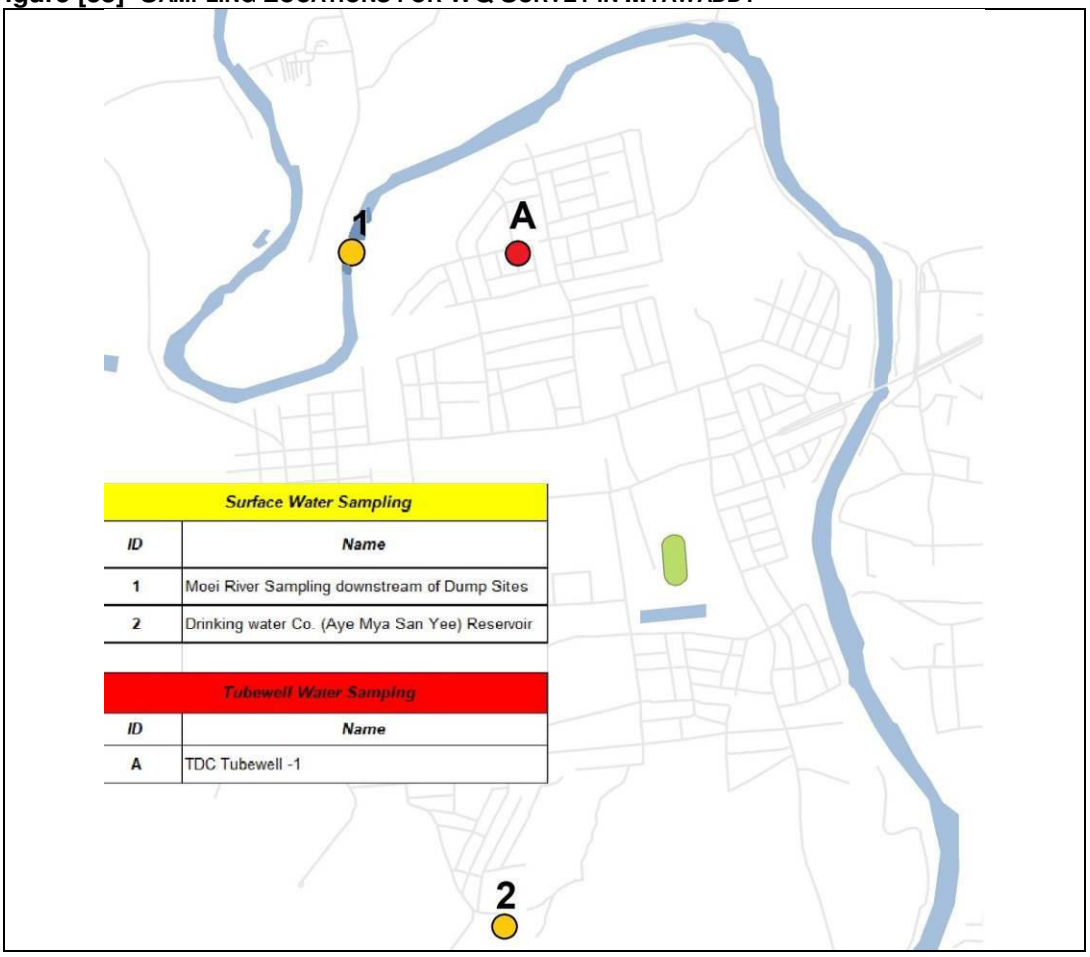
The PPTA Consultant appointed a Yangon laboratory (E-Guard) to undertake a water quality survey. Sampling was carried out in September 2015. Location of water quality samplings in Hpa-An and Myawaddy are presented in **Error! Reference source not found.** and **Error! Reference source not found.**.

Figure [37] SAMPLING LOCATIONS FOR WQ SURVEY IN HPA-AN



Source: PPTA Consultant, 2015

Figure [38] SAMPLING LOCATIONS FOR WQ SURVEY IN MYAWADDY



Source: PPTA Consultant, 2015

4.7.1 SURFACE WATER QUALITY

Surface water was sampled in 3 sites in Hpa-An and in 2 sites in Myawaddy in September 2015. Results of analysis are provided in table below.

Table [17] SURFACE WATER QUALITY ANALYSIS IN HPA-AN AND MYAWADDY

No.	Parameter	Unit	Hpa-An			Myawaddy	
			01	02	03	01	02
1	Temperature	°C	29	26.6	26.1	28.6	28.5
2	Electric conductivity	µS	49.1	223	222	233	540
3	Dissolved Oxygen	mg/l	7.96	7.78	7.88	7.26	7.63
4	pH	-	8.71	8.33	8.35	7.93	7.92
5	Turbidity	NTU	5	722	632	1338	4
6	BOD_5	mg/l	7	4	6	9	15
7	COD	mg/l	< 10	< 10	< 10	<10	31
8	TSS	mg/l	140.67	1683	1012	901.3	157.7
9	Total phosphorus	mg/l	< 0.01	0.08	0.07	0.08	0.02

No.	Parameter	Unit	Hpa-An			Myawaddy	
			01	02	03	01	02
10	Phosphate	mg/l	0.05	0.24	0.15	1.0	Nil
11	Total Nitrogen	mg/l	< 0.6	< 0.6	0.6	<0.6	<0.6
12	Nitrate	mg/l	0.12	0.58	0.05	0.56	0.43
13	Ammonia	mg/l	Nil	0.20	Nil	1.95	Nil
14	Ammonium	mg/l	Nil	0.21	Nil	Nil	2.06
15	Total Coliforms	Cfu /100ml	20	>50	Nil	5	35
16	Sulphate	ppm	48.13	154.21	171.19	13.61	114.89
17	Chloride	mg/l	1.42	5.32	1.4	4.25	5.67
18	Calcium	mg/l	7.09	46.06	47.83	52.43	147.15
19	Magnesium	mg/l	<0.5	8.60	6.45	8.21	7.18
20	Sodium	mg/l	0.79	3.76	4.15	4.84	1.98
21	Potassium	mg/l	< 0.5	1.4	1.4	2.08	0.5
22	Alkalinity	mg/l	12.5	47	47.5	47.5	110

4.7.2 UNDERGROUND WATER QUALITY

In Hpa-An 4 tubewells and in Myawaddy one tubewell were sampled in September 2015. All tubewells are located at more than 500 m from the proposed landfill site as no tubewell is observed within this range. Results of analysis are provided in table below.

Table [18] UNDERGROUND WATER ANALYSIS IN HPA-AN AND MYAWADDY

No.	Parameter	Unit	Hpa-An			Myawaddy	
			01	02	03	01	02
1	Temperature	°C	26.5	28.6	28.6	27.7	26.7
2	Electric conductivity	µS	166.5	479	719	470	1509
3	Dissolved Oxygen	mg/l	2.69	5.06	5.69	1.97	1.92
4	pH	-	5.47	7.76	7.27	7.40	6.35
5	Turbidity	NTU	2	225	2	27	2
6	BOD_5	mg/l	5	4	4	1	14
7	COD	mg/l	<10	<10	<10	<10	29
8	TSS	mg/l	29.67	145.33	98.67	51	152.3
9	Total phosphorus	mg/l	<0.01	0.47	< 0.01	< 0.01	0.05
10	Phosphate	mg/l	0.08	0.46	0.39	0.03	1.02
11	Total Nitrogen	mg/l	<0.6	0.6	0.7	1.4	1.47
12	Nitrate	mg/l	1.8	1.8	0.49	0.11	3.07
13	Ammonia	mg/l	Nil	0.39	0.38	1.32	2.68

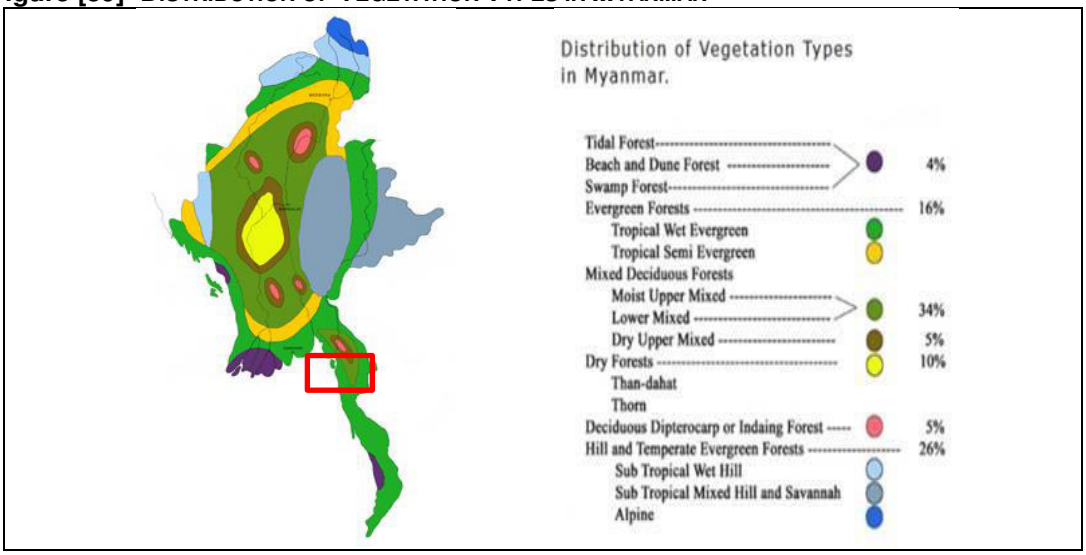
No.	Parameter	Unit	Hpa-An			Myawaddy	
			01	02	03	01	02
14	Ammonium	mg/l	Nil	0.41	0.40	1.39	2.82
15	Total Coliforms	Cfu /100ml	38	>50	>50	2	15
16	Sulphate	ppm	22.68	162.70	158.46	116.03	78.43
17	Chloride	mg/l	14.54	6.04	25.52	3.55	339.3
18	Calcium	mg/l	14.17	95.66	126.67	74.41	164.06
19	Magnesium	mg/l	1.07	5.37	9.14	17.20	2.05
20	Sodium	mg/l	19.78	6.92	27.68	17.8	169.9
21	Potassium	mg/l	5.39	0.5	1.4	< 0.5	7.22
22	Alkalinity	mg/l	20	125.5	168.5	125.5	65

4.8 Terrestrial & Aquatic Ecology

4.8.1 NATURAL AND URBAN VEGETATION

As shown on Figure [39] , there are various vegetative types ranging from Tropical Wet Evergreen, Moist Upper Mixed Deciduous forest, Lower Mixed Deciduous forest, Dry Upper Mixed Deciduous Forest, and Deciduous Dipterocarp or Indaing Forest. As Kayin State is located in the tropical climate zone with torrential rains, Evergreen forests (Tropical wet evergreen), Mixed Deciduous forests and Deciduous Dipterocarp or Indaing forests thrive naturally in the region. However, both in Hpa-An and Myawaddy areas, the vegetation cover has for long time been exploited and destroyed, leaving place mainly for scrub, secondary forest or rubber plantations, the latter two being mainly observed on the slopes of surrounding hills.

Figure [39] DISTRIBUTION OF VEGETATION TYPES IN MYANMAR



Source: A Checklist of the Trees, Shrub, Herbs, and Climbers of Myanmar. Contributions from the United States National Herbarium. Volume 45: 1-59

The most common tree and shrub species in Hpa-An and Myawaddy areas are listed in following table.

Table [19] SPECIES OF TREES FOUND IN PROJECT AREAS

Vernacular Name (Myanmar)	Scientific Name
Kyun	*Tectona grandis*
Pyin Ka Toe	*Xylia dolabriformis*
In	*Dipterocarpus tuberculatus*
Ka Nyin	*Dipterocarpus spp.*
Pyin Ma	*Legerstroemia speciosa*
Koako	*Alibizzia lebbek*
Gwe	*Spondias pinnata*
Gyo	*Schlicichera oleosa*
Kha Paung	*Stryohonos nux-blanda*
Kanaso	*Baccaurea sapida*
Padauk	*Pterocarpus macrocarpus*
Phat Than	*Heterophragma adenophyllum*
Phyuak Seik	*Holoptelea integrefollia*
Thit Saint	*Terminalia belerica*

Source: Hpa-An Township Forest Department and Myawaddy District Forest Department, Ministry of Environmental Conservation and Forestry.

Most of these trees are widely distributed in SE Asia and also widely used for community plantation in urban areas. None is registered as a protected species either at international (IUCN) or national levels.

4.8.2 AQUATIC FAUNA

Very limited information is available on the fish population in the project region. Only one study on fish composition of downstream Thanlwin River was carried out from May 2014 to October 2014 by the Department of Zoology, University of Mawlamyine (Than, Tun, & Htay, 2014). According to the study, 22 species were found in the Mottama area close to Hpa-An and the species observed are listed in **Error! Reference source not found.**table below. There are some small fish farms around Myawaddy but no fishing activity is reported from Thaungyin (Moei) River. Most of the commercially consumed fish is imported from the places which are located around the downstream of Thanlwin. No subsistence fishery activities were observed along the river at the time of the visits by the PPTA consultant. The most consumed fish species observed in the market of Myawaddy are presented in the following photographs. None of these species is registered as protected either at international or national levels.

Table [20] MAIN FISH SPECIES IN MAWLAMYINE & HPA-AN REGION WATER BODIES

Vernacular Name (Myanmar)	Scientific Name
Nga hpe	*Notopterus notopterus* (Notopteridae)
Nga tha lauk	*Tenualosa ilisha* (Clupeidae)
Mee tan thwe	*Colia dussumieri* (Engraulididae)
Nga phan ma	*Osteobrama belangeri* (Cyprinidae)
Nga khone ma	*Puntius sophora* (Bagridae)
Nga zin yine	*Mystus vittatus* (Bagridae)
Nga nu than	*Ompok bimaculatus* (Siluridae)
Ka ka loung	*Eutropiichthys vacha* (Schilbeidae)
Nga yant gaung to	*Channa orientalis* (Channidae)
Nga yant	*Channa striatus* (Channidae)
Nga mway doh kyar	*Macrognathus zebrinus* (Mastacembelidae)
Nga mway don pyaung	*Macrognathus aral* (Mastacembelidae)
Moe nga yaung	*Arius caelatus* (Ariidae)
Pin lei nga khue	*Plotosus canius* (Plotosidae)
Nga khoo	*Clarias batrachus* (Centropomidae)
Nga si ooe	*Gerres filamentosus* (Gerrreidae)
Nga pyat khone	*Johnius coitor* (Sciaenidae)
Nga poke thin	*Otolithoides pama* (Sciaenidae)
Kabu lu	*Rhinomugil corsula* (Mugilidae)
Nga pon na	*Polynemus paradiseus* (Polynemidae)
Ka tha boe	*Glossogobius giuris* (Gobiidae)
Nga bee	*Scatophagus argus* (Scatophagidae)

Nga phan ma Osteobrama belangeri (Cyprinidae)

Ka tha boe Glossogobius giuris (Gobiidae)

NGA NU THAN OMPOK BIMACULATUS (SILURIDAE)

NGA THA LAUK TENUALOSA ILISHA (CLUPEIDAE)

NGA GYIN (CIRRHINUS MRIGALA)

NGA THA LAL HTOE (LEPIDOCEPHALICHTHYS SP.)

4.8.3 TERRESTRIAL FAUNA

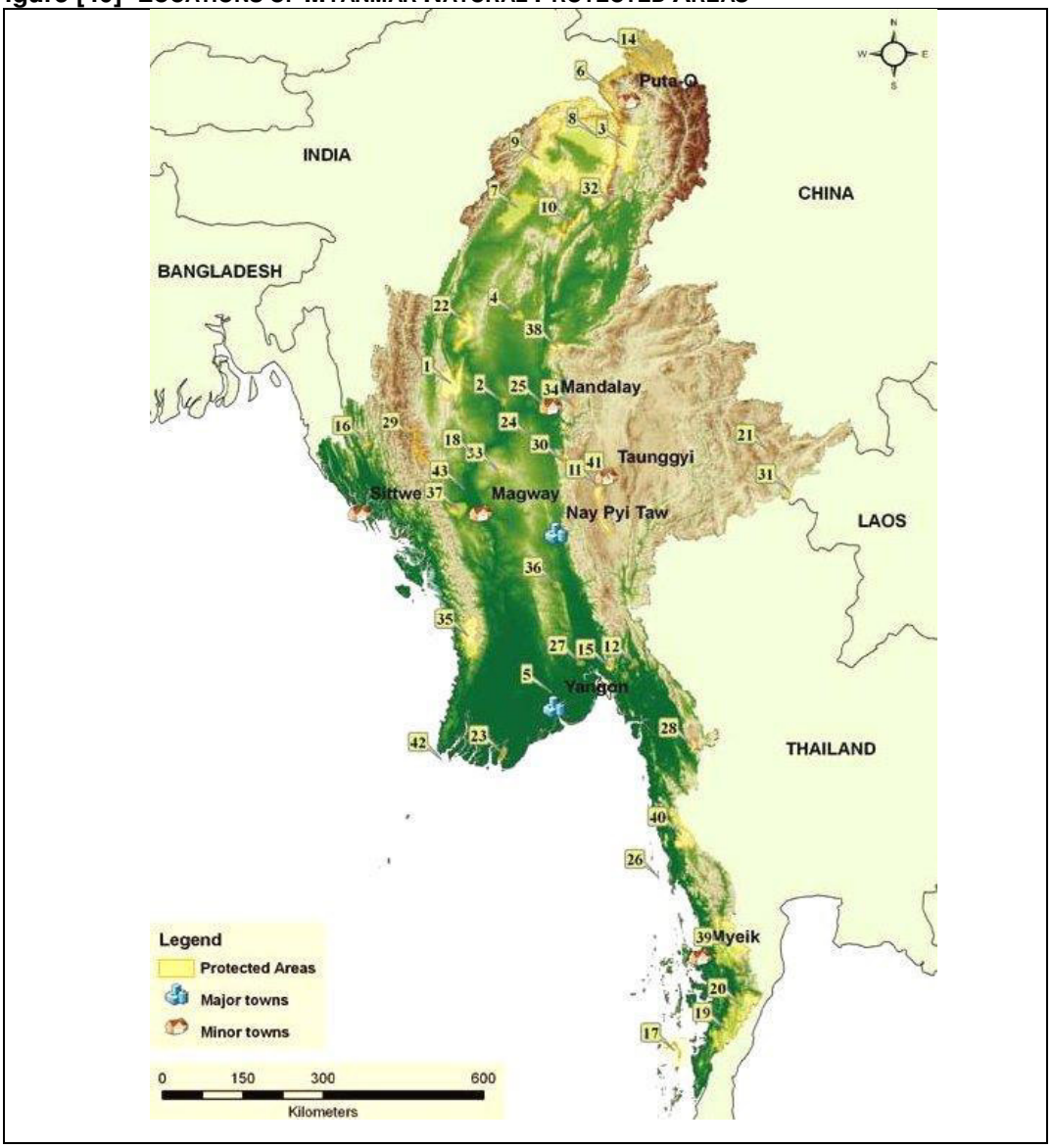
According to the world birds database (http://avibase.bsc-eoc.org) it is recorded in Kayin state a total of 602 avian species, 19 of them being identified as globally threatened and 1 as introduced species. However, project components are mainly developed in urbanized area where only few common species are observed and the project does not intend to alter or reduce any natural ecosystem of importance for the bird populations.

4.9 Protected Areas and Species

According to Forest Department (2009), 43 protected areas exist in Myanmar. Thirty-five sites were designated from 1918 to 2010. Eight additional sites proposed from 1997 to 2008 are still under examination. The 35 designated protected areas cover approximately 42,000 km² of land, representing 6.2% of the total country area. In case of establishment of eight additional protected areas, proposed from 2001 to 2008, the area would increase 7,400 km² (1.1%), and the total area would be 49,500 km², representing 7.3% of the total land area. Two protected areas were notified in the Mon State and one in Kayin State (Mitsui & Co., Ltd, 2015).

The protected area found within Kayin States is Mulayit wildlife sanctuary (Site ID 28 in Figure [40]) which is located in Kya-in Seik-kyi Township, Kayin State. This wildlife sanctuary is composed with variety of habitats including grassland, evergreen Forest (typical), mixed deciduous forest (moist upper), and hill forest (evergreen) (Myanmar Protected Areas, 2011). Mulayit wildlife sanctuary is founded since 1936 and it's IUCN status is IV. The observed animals are Barking Deer, Tiger, Leopard and avian species (Istituto Oikos and BANCA, 2011). It is 125 km away from Hpa-An, and 64 km away from Myawaddy.

Figure [40] LOCATIONS OF MYANMAR NATURAL PROTECTED AREAS



However, it is obviously observed that no terrestrial protected natural area is located within, in or near the vicinity of the Project zone. Locations of Protected Areas are presented in Table [21].

In Hpa-An Township, the existing 5 water supply reservoirs are located at the top of a small hill, Bar Mae Taung located inside the urban area which slopes are covered by a dense tree cover. Tree cutting is not allowed on this hill except if prior authorisation of Kayin State Forestry department in Hpa An. Preliminary

design of project intends to develop the new reservoir on the location of the 5 demobilised reservoirs, without need for extension of the area.

Table [21] NUMBERS OF PROTECTED AREAS IN KAYIN STATE

State	Item	Reserved Forest	Protected Area	Wildlife Sanctuary	Total
Kayin	No. of sites	55	31	2	88
	Area (ha)	454,625	39,467	44,514	538,060

Source: Statistical Yearbook 2011, Central Statistical Office, Ministry of National Planning and Economic Development, 2012

4.10 Social and Cultural baseline

4.10.1 ADMINISTRATIVE ORGANIZATION

The division of administrative areas in Kayin States follows the same dissecting arrangements as other states and regions. It starts with State which is divided down the line into Districts, Townships and Sub townships, Towns/Sub-towns, Wards/Village Tracts and Villages. The list in table below shows the division of administrative areas in Kayin States.

Administrative Officers are placed in each level of structure starting from State level down to village level. All of them are employees of General Administrative Department (GAD) under the Ministry of Home Affairs. Administrative Officer at State level has the official position of Director/Deputy Director in the department. Administrative Officer at ward or village level is however elected by constituents of wards or villages but paid monthly allowances by GAD.

Table [22] TABLE 4-1: DIVISION OF ADMINISTRATIVE AREAS IN KAYIN STATE

Township	Towns/sub-towns	No. of Ward	No. of Villages
Hpa-An	Hpa-An	9	476
Myawaddy	Myawaddy	5	42
	Su Ka Li	1	9
	Waw Lay Myaing	2	13

Source: UNDP Myanmar Information Management Unit

4.10.2 POPULATION

Population and Trends

According to the 2014 census result, Hpa-An has the urban population of 75,141 and Myawaddy has the urban population of 113,155 and they are expected to have the projected urban population of 143,936 and 246,844 respectively in 2040.

Ethnic Groups

Following table**Error! Reference source not found.** shows the ethnicity in Hpa-An and Myawaddy, and in the wards where the project components are being proposed.

Table [23] ETHNICITY IN HPA-AN AND MYAWADDY TOWNSHIPS

Area	Ethnic Minorities in Hpa-An and Myawaddy (Kayin State)								Total Ethnic Pop
	Kachin	Kayah	Kayin	Chin	Mon	Rakhine	Shan + Pao	Bamar	
Hpa-An	54	1	211718	73	54772	394	41683	46829	304695
Myawaddy	92	3	50576	145	3633	1275	10454	45904	112082
Total	146	4	262292	218	58405	1669	92733	92733	354284

Source: Township Administrative Department, 2015

4.10.3 PUBLIC HEALTH

Hospitals, dispensaries and health centres are being expanded to provide health care services in Kayin State. The numbers of hospitals, Rural Health Centres (RHC) and Sub Health Centres (SHC) are mentioned in table below.

Table [24] NUMBERS OF HEALTH FACILITIES AND STAFF IN HPA-AN AND MYAWADDY

Township	No. of Doctor	No. of Nurse	No. of Mid-wife	No. of Health Centers		
				Hospital	RHC	SHC
Hpa-An	11	200	100	6	17	75
Myawaddy	13	53	21	4	4	17

4.10.4 WATER SUPPLY IN HPA-AN

The public water supply system of Hpa-An comprises a central sub-system (the Bare Mae system) with one main storage facility and related distribution network (1 river intake, 2 tubewells and 5 tanks). Other facilities are small independent systems relying on river intakes or tubewells. With regard to these systems the following remarks have been made:

- Production & treatment: water resources are various with 3 small river intakes (among which one is supplying its own system) and several small tubewells (≤150mm) most of which are out of service. None of existing facilities include treatment (not even disinfection). Hence, only raw water is distributed with regular presence of bacteria and sometimes very high turbidity. The existing capacity is insufficient to cover future water demand. Implementation of a central production system able to treat raw water especially during the monsoon season and fulfil the water needs for the medium and long term is a clear requirement.
- Storage: Currently, main storage facilities consists of Bare Mae reservoirs, composed of 5 tanks for an overall capacity of 0.52 Mgal (i.e. 2,300m^3), since other smaller tanks remains secondary (≤ 220m^3). However, among the 5 tanks, 3 of them are in very poor condition with presence of leakages due to the age of the civil work (nearly 50 and 40 years old) and absence of maintenance. Furthermore, existing capacity appear to be insufficient looking at future water demand. Apart from this storage, a lack of main storage is noticeable in the Eastern part of the city, where urban development is undergoing. Rehabilitation of this facility has not been selected as an acceptable option by the PPTA consultant. Implementation of a new storage facility would appear necessary while increasing the coverage.

EXISTING RIVER WATER INTAKE FROM THAN LWIN RIVER

EXISTING TUBE WELL INTAKE

THE 3 RESERVOIRS ON BAR MAE HILL TO BE RECONSTRUCTED AS ONE LARGE RESERVOIR

ONE OF THE RECENT EXISTING RESERVOIRS ON BAR MAE HILL TO BE KEPT

- Distribution: Under existing conditions, the absence of a structural network or main distribution lines is noticeable since no distribution pipeline exceeds 150mm in the entire network. The existing distribution network represents a total length of nearly 30 km with the oldest pipes laid in the 60s-70s; the number of connections estimated to be around 1,150 mainly equipped with Chinese water-meters of which accuracy seem questionable. The coverage for the urban area is around 10.5%. Not only is there a need to increase the service coverage, but also to secure, strengthen and re-organize the distribution system according to the future water demand.
- Operation and Management: Hpa-An has limited human and technical resources at the township level with only 21 staff primarily involved in water supply (many of which appear to have other engineering functions). There is a lack of planning, poor overall maintenance of facilities and an equally poor or quasi inexistent commercial management. This is reflected in the high levels of NRW covering both commercial and physical losses probably in excess of 70%. Undoubtedly, capacity building and strengthening of the water supply utility is crucial

4.10.5 WATER SUPPLY IN MYAWADDY

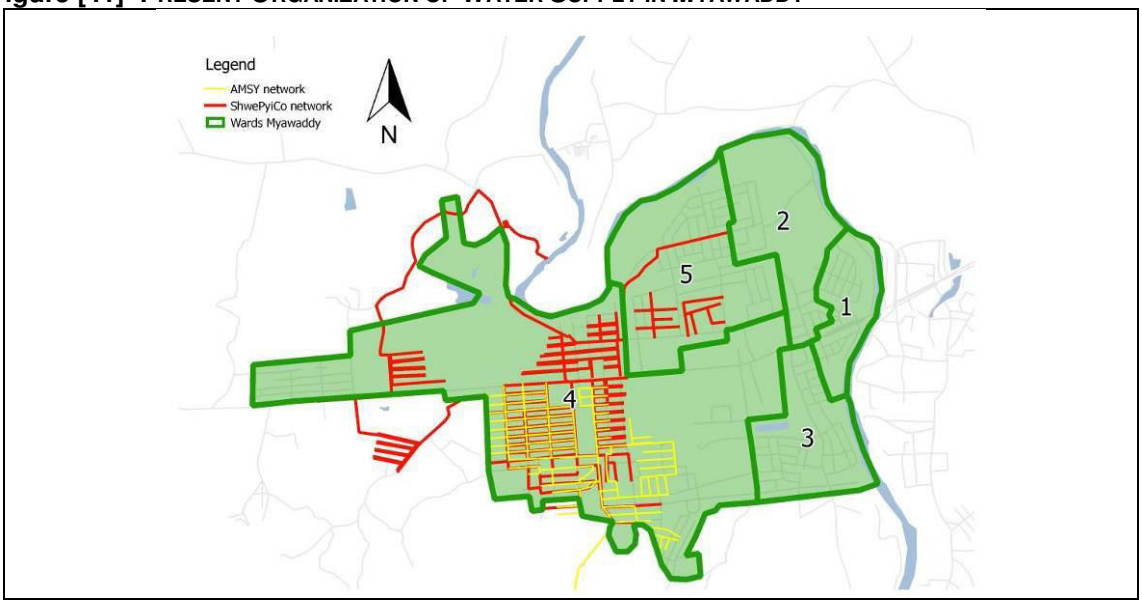
The provision of urban environmental services in Myawaddy Township is the responsibility of the Myawaddy District Development Committee (MDDC). Two private operators have been granted the right to distribute piped water to different wards in the township as shown on Figure [41] . These networks are extended on a rather ad hoc basis without any formal planning in response to customer demand for connections.

- ShwePyi Co., the "Northern Company", supplies ward #4 and recently extended to ward #5. They are extending their network out of the township boundaries on the western side. Myawaddy ShwePyi Company is managing a network of nearly 35 km, from 50 to 250mm diameter, with water pumped from the alluvial aquifer of the Thaungyin (Moei) River. Present total abstraction rate is 450 m^3/day.
- AyeMyaSanYae Company (AMSY) has a more modest network (17km) located in ward #4. AMSY Co. is a private company collecting the water from LatKhatTaung, a series of hills located 6 km in the South of Myawaddy. This company faces a lack of resources during the dry season limiting it expansion.
- The two networks are overlapping in ward #4 and some customers receive water from both companies, opening the tap depending on resource availability. None of the two systems is equipped with reliable treatment facility. Hence, there is no water supply system in the Eastern part of the city. In this area, people can get water from public tubewells managed by TDC (among the 26 existing tubewells, 9 are not currently functioning)

The requirements for future water supply provision are based upon the concept plans developed by DUHD and discussed in the overall FSR for Kayin State in which the population is set to grow at around 3% per annum reaching almost 150,000 by 2025 and 250,000 by 2040.

Taking into consideration the current situation and existence of private operators, it is proposed that water supply project focuses on the unserved area, that is to say the eastern part of the city.

Figure [41] PRESENT ORGANIZATION OF WATER SUPPLY IN MYAWADDY



Source: PPTA Consultant, 2015

4.10.6 SANITATION SYSTEM

Wastewater treatment consists entirely of septic tanks and discharges to the natural or storm drains crossing the city and discharging directly to the Thanlwin river for Hpa-An or to the Thaungyin river for Myawaddy. None of the cities disposes of a collective sewerage system.

4.10.7 SOLID WASTE MANAGEMENT (SWM)

SWM in Hpa-An

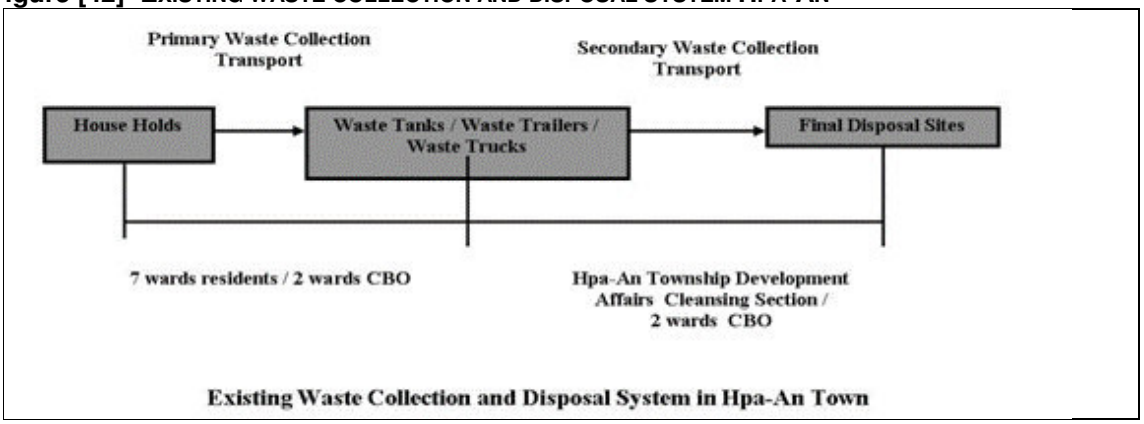
The Hpa-An Development Committee Cleansing Department has implemented a detailed cleansing program to collect solid waste from the 9 wards as shown on Figure [42] .

For this four garbage trucks are used operating 3 trips each per day and disposing their waste at the dumpsite. A number of wards are operating successful community based collection systems.

HTDA with only 4 vehicles cannot cover all the wards and streets. It can cover only the main streets. For the lanes with the bell ringing system the waste vehicle will stop at the corner of the streets and the people would come and disposed their household waste to the vehicle. Mostly they try every 2 days one trip per ward. See below photograph for collection vehicles in Hpa An.

Hpa-An Township Development Committee had implemented a cleansing program in the town area to clean up waste, to enhance the participation of the community to interest in the environmental protection programs such as collecting, transportation and disposal of the waste, recycling of the recyclable waste, composting of the waste etc.

Figure [42] EXISTING WASTE COLLECTION AND DISPOSAL SYSTEM HPA-AN



There are 9 wards in the town area; every day 4 Garbage trucks make 3 trips per truck per day and transport the waste to the dump site named Htan Koe Pin, which is about 11 km away from the town, near ZweKabin Hill.

SWM in Myawaddy

The 5 Ward Development Committees execute the collection, transport and disposal to the dump site by themselves. Private owned waste trucks are hired by the Ward Development Committees. The town generates about 64 tons of solid waste per day (estimation 2015: 0.55 kg/capita/day x 116,550 persons).

Half of the collected waste is dumped at two open dump sites located on the bank of the Thaungyin (Moei) River. The remaining is dumped illegally along streets and in water bodies such as the Thaungyin River. People living along the Thaungyin River in Ward no. 1 and Ward no. 2, next to the river simply throw their waste rubbish into this river. During the rainy season, when the river water is high, most of the waste from this dump site is taken away by the floods and flows into the Thaungyin river and finally into the Thanlwin river.

DUMPING SITE ALONG THAUNGYIN RIVER SEEN FROM THAILAND

SAME DUMPING SITE SEEN FROM MYANMAR SIDE

Medical waste is collected and transported by the TDC to the dumpsite near ward N°5. There is no soil covering at the dump site and the scavengers can easily come in contact with the hospital waste with all health and hygiene hazards. At the moment the hazardous waste is not separately collected but mixed with household waste.

MEDICAL WASTE IN THE DUMPING SITE

SCAVENGERS IN 2ND DUMPING SITE ALONG THAUNGYIN RIVER

It is worth to mention that the present intake for water supply in the Thaungyin River is located only 800 m downstream the two dumping sites, with evident sanitary risks. With the proposed project, landfill will be displaced inland far from river sides and the water intake shifted upstream the urban area.

4.10.8 UNEXPLODED ORDINANCES (UXO)

The PPTA Consultant was informed of the possibility of UXO in some areas of the region of Myawaddy, mainly remnant mines from past conflicts with rebel groups. However the risk is not reported from the immediate surroundings of the town where project components are located. A precautionary approach shall be considered before starting excavation works particularly for the proposed landfill.

5 IMPACT ANALYSIS

5.1 Methodology

The impacts were identified by confronting the environmental and social baseline situation of the area with the activities related to each component and stage of the project. For every interrelation between Project activities and each pertinent environmental component, all probable impacts have been identified.

This identification was mainly based on:

- The technical information related to project components design and operation as presented in Section 3 of this report;
- Field visits conducted in August-September and November 2014 by the Consultant in the Project area;
- The Consultant experience of environmental impacts of a variety of projects including urban development, water supply, sanitation and waste management;
- The checklists of potential impacts from various types of projects drawn up by international financial organizations (WB, ADB, AFD).

The result of this analysis is presented in the following sections covering 1) impacts connected with the location of the projected facilities, 2) impacts

connected with construction activities and 3) impacts connected with the actual operation of the facilities.

The potential impacts for each of these sections are presented in a summary table, followed by descriptions and analyses of the most probable significant impacts. These tables present, successively, the cause of the impact, the potential impact along with its risk level, the corrective measure along with the ease/difficulty of implementing it and the residual risk level after implementing the measure.

Table [25] IMPACT ASSESSMENT CRITERIA

Criterion	Level 1	Level 2	Level 3
Difficulty for implementing corrective measures	Easy, inexpensive and generally effective	Demands special attention (monitoring or training, for example)	Difficult due to complexity or cost
Probability of occurrence of the impact	Low: can be seen in cases of negligence or accident	Medium: generally seen a few times during construction or during the operation of the concerned facility	High: consistently seen if effective corrective measures are not put in place
Gravity of the impact	Generally limited impact in terms of intensity, duration or extent	Significant environmental impact but not endangering human or animal populations	Major environmental impacts with risks to people or special-status animals
Overall Risk	Low: subject of routine monitoring but impacts are minor and easily manageable	Significant: merits special attention	Major: merits close monitoring and the implementation of effective measures

Each summary table shows, for each identified impact, an assessment of the overall risk level, taking three criteria into a consideration: the probability of occurrence of the impact as part of the project, the expected gravity of such an impact given no special corrective measures, and the difficulty of implementing the proposed corrective measures.

- The probability of occurrence reflects how often the impacts are observed during construction and operation of similar projects: some impacts are inevitable (noise, dust, suspended sediment in surface water) whereas others occur only exceptionally (accident, explosion).
- The gravity of an impact incorporates various considerations of intensity of effects on the natural or human environment, its extent and its duration. All necessary efforts must be made to implement corrective and monitoring measures on impacts that are judged to be potentially serious.
- The overall risk relating to an impact, rated from 1 (low) to 3 (high) takes into account the abovementioned criteria as shown in Table 25.

5.2 Anticipated Benefits from the Project

The components of the Project are anticipated to significantly improve the environmental conditions and quality of life of the population in Hpa-An and Myawaddy through the following results:

In Hpa-An:

- Better quality of life and public health by the improvement of the water supply services and security through (i) increasing the water supply service in terms of satisfaction of the demand, 24/7 supply and good water pressure, storage capacity of the system by the construction of a new storage on Kyar Inn hill, (ii) reduction of non-revenue water and extension of serviced area, (iii) construction of a water treatment plant and (iv) improving and extending the distribution network;
- Better quality of life and public health by the improvement of solid waste management through better collection and safe disposal of waste: increased number of collection vehicles and collection points and new sanitary landfill and closure of existing dumping site;
- Better quality of life and public health by improving indirectly rainfall drainage: improvement of solid waste collection shall reduce the volume of waste presently dumped in the drains and clogging the system. This shall also reduce the temporary and localised flooding which occurs during heavy rainfall.
- Contribution towards Green City Principles through the implementation of a composting plant for solid waste. When compared to the "No Project" option, the Project solid waste component shall reduce the GHG emissions in Hpa-An by as much as 13,500 tons of CO2-eq per year in 2020 and 42,000 tons of CO2-eq per year in 2040;

In Myawaddy:

- Better quality of life and public health by the improvement of the water supply services and security through (i) increasing the water supply service in terms of satisfaction of the demand, 24/7 supply and good water pressure by the construction of a new water intake, storage capacity of the system by increasing the existing storage, (ii) reduction of non-revenue water and extension of serviced area, (iii) construction of a water treatment plant and (iv) improving and extending the distribution network;
- Better quality of life and public health by the improvement of solid waste management through better collection and safe disposal of waste: increased number of collection vehicles and collection points and new sanitary landfill to replace the existing dump site;
- Better quality of life and public health by improving indirectly rainfall drainage: improvement of solid waste collection shall reduce the volume of waste presently dumped in the drains and clogging the system.
- Contribution towards Green City Principles through the implementation of a composting plant for solid waste. When compared to the "No Project" option, the Project solid waste component shall reduce the GHG emissions Myawaddy by as much as 18,500 tons of CO2-eq per year in 2020 and 66,700 tons of CO2-eq per year in 2040;

Improvement of solid waste management shows that GHG emissions from solid waste in Hpa-An and Myawaddy could be reduced by 32,000 t CO2-eq/year in 2020 and even reach 108,000 t CO2-eq/year in 2040 when compared to a "No Project" option.

5.3 Impacts related to Project Location

5.3.1 IMPACTS FROM SITE LOCATIONS IN HPA-AN

Water Supply Components

Water Intake

The proposed river water intake is situated on the bank of the Thanlwin River. The land is owned by the Development Affairs. In the area of the proposed land, there are some medium sized trees such as Banda (*Terminalia catappa, Combretaceae*), Thayat *(Mangifera indica*) and Malaysia Padauk (*Acacia auriculiformis*). There is one small bricked building next to the premises owned by the Development Affairs. Land side of the site is used as a parking area for public transportation buses.

No land acquisition from private owner is necessary.

EXISTING SMALL PUMPING STATION AT PROPOSED SITEON THE THANLWIN RIVER

BUS PARKING NEXT TO PROPOSED SITE

Water Treatment Plant

The proposed land is a floodable area about three meters lower than the nearby road, under the influence of the Hpa-An lake, a large reservoir in the center of the city used for drainage of water and recreation,. Vegetation is mainly scrubs, grassland (Cyperus) with scattered water hyacinth *(Eichhornia crassipes*) in the remaining small water pockets at the time of the visit. Some trees, Pyin-ma (*Lagerstroemia reginae*) are observed along the road. The land is owned by a private and sale to KSG is currently under discussion. Land requirement is 5,000 m² (1.25 acre). No access road is required. The project design takes this situation into consideration and the facility will be raised to a safe level. As the facility requires only 5,000 m2 next to the dike, a small area compared to the srea of the floodable plain, no significant impact on future flood levels is anticipated.

VIEW OF PROPOSED SITE

ACCESS ROAD NEXT TO SITE WITH LAGERSTOEMIA TREES

Bar-Mae Hill Water Storage

Existing storages (5 units) are located on the Bar-Mae Hill, from which at least the 3 oldest shall be demolished and reconstructed as storage with increased capacity. Bar Mae Hill forest vegetation around the reservoirs consists of dense forest of large and old trees. The closest trees include Latpan (*Beaumontia grandiflora, Apocynaceae*), Sit (*Albizia procera, Mimosaceae*), Banda (*Terminalia catappa, Combretaceae*), Kyun (*Tectona grandis, Verbenaceae*), Ondon (*Litsea glutinosa, Lauraceae*), Thitsi (*Melanorrhoea glabra*), Tha Phan (*Ficus glomerata)*, Pinle-kabwe (*Casuarina equisetifolia*) and Letpan (*Salmalia malabarica)*. No extension of the existing storage site is anticipated, the new reservoir being built on the site of the demolished ones. No land acquisition required And access road already exists. The preliminary design of the proposed concrete storage takes full consideration of the area available for the construction and the fact that no tree can be cut without prior clearance from Kayin State Forestry Department.

Kyar Inn Montain water storage

A new water storage is proposed for the eastern part of the town, located on the Kyar Inn Mountain. The proposed site is an unused natural water storage belonging to a religious complex including a monastery, a school and a meditation centre. The pond is located outside the built up area, at least 200 m from the nearest building. The storage is not more used by the community for several years and its area is considered for the construction of a concrete storage. It is surrounded by planted trees of medium size, mainly Malaysia Padauk (*Acacia auriculiformis*) and some other local species such as Padauk (*Pterocarpus macrocarpus*).Only 1,600 m² of land need to be acquired. No impact on built-up properties or agricultural production. Presence of a tubewell station 50-80 m from the site, at a higher elevation.. Existing good road up to the site. No additional access road required.

Distribution System

Development of the water distribution system will follow roads and streets. No land acquisition anticipated.

BAR MAE HILL: 3 STORAGES TO BE DEMOLISHED (2 CONCRETE & 1 METALLIC)

VIEW OF THE AREA FROM A STORAGE

BAR MAE HILL: VIEW OF SURROUNDING VEGETATION...

...AND ACCESS ROAD TO THE SITE

VIEW OF PROPOSED SITE IN KYAR INN MOUNTAIN

ACCESS ROAD TO KYAR INN MOUNTAIN

Solid Waste Components

VIEW OF PROPOSED LANDFILL SITE

ACCESS ROAD TO LANDFILL FROM IZ EXTENSION

Landfill and Composting Plant

The proposed area for the composting plant and sanitary landfill is located at the Northern side of the future industrial zone extension. The wide area is recovering from recent vegetation clearing (3-4 years?) carried out over the whole Industrial Zone (IZ) (170 ha). Natural and dense regrowth of *Dipterocarpus tuberculatus* is observed over the whole area. Land is owned by the State Government, is presently unused and devoid of any built-up structures. Access road from the future IZ extension already exists.

Land requirement for the facilities is 10 ha (25 acres). No resettlement is required as the area is devoid of any building structure within a radius of more than 500 m.

The old site currently used by TDC near ZweKabin Mountain will be closed. The wastepickers currently living in the area will receive compensation according to the preconisation of the Resettlement Plan implemented under PPTA 8758. They will be proposed for recruitment on the future landfill.

5.3.2 IMPACTS FROM SITE LOCATIONS IN MYAWADDY

Water supply Components in Myawaddy

Water Intake

The proposed water intake by infiltration gallery is located on a TDC land along the Thaungyin (Moei) River South of Myawaddy.

Currently the site is used by a small intake and some dredging activities downstream. The access road to this site will belong to Myawaddy TDC. The land is covered by bushes.

ACCESS ROAD TO THE INFILTRATION GALLERY

BANKS OF THE MOEI RIVER NEAR THE PROPOSED SITE

Water Treatment Plant

The proposed water treatment plant is located in a wide opened grassland next to the proposed water intake by infiltration gallery. The total available area is 3.2 ha (8 acres) while space needed is 4,000 m² (1 acre). No built up properties nearby to be affected. No natural vegetation or trees in the proposed site. The area is located along the asphalted road.

AREA PROPOSED FOR THE WTP

ACCESS ROAD TO SITE

New water storage

A new water storage is proposed south of the city near the Myawaddy cemetery.

The proposed site is a vacant lot occasionally used for car parking. Myawaddy TDC planned to rearrange the facilities surrounding the cemetery and a specific area is dedicated to the future reservoir.

Only 2,000 m² of land need to be acquired. No impact on built-up properties or agricultural production. No access road required.

PROPOSED CADASTRAL MAP BY TDC

SATELLITE VIEW OF THE SITE

VIEW OF SITE FOR PROPOSED CONCRETE WATER STORAGE

Distribution network

Development of the water distribution system will follow roads and streets. No land acquisition is anticipated.

Solid Waste Components

Sanitary Landfill and Composting Plant

The land requirement will be 12.5 ha (31 acres) presently owned by the Township Development Affairs within the Trade Zone. The total area secured for the long term development of the trade zone is 270 hectares (668 acres).

The site presents scrub vegetation on its slopes and some common trees

The site development shall not involve resettlement or private land acquisition. 300 meters buffer zone is respected, the closest building being a storage warehouse. No residential buildings within 500 m radius.

The existing dumping site, currently used by TDC to transfer waste from the two closed dumpsites located on the river bank, will be closed. The wastepickers currently living in the area will receive compensation according to the preconisation of the Resettlement Plan and offer for recruitment to work on the new landfill.

CADASTRAL MAP LOCATING THE SITE IN THE TRADE ZONE

VIEW OF THE SITE

5.3.3 IMPACTS FROM OR TO CLIMATE CHANGE AND NATURAL HAZARDS

Climate Change (CC) or natural hazards are not anticipated to represent a significant risk in relation to project components location:

- Hpa-An water intake shall be located on the left bank of the Thanlwin River. The design of the facility takes into consideration the large amplitude of the water level depending the season (by the use of an oscillating and floating mast equipped with a suction strainer) and will also integrate a safety free board to avoid any risk of flooding of the electrical equipment in particular;
- Hpa-An water treatment site is located close to Hpa-An urban lake in a low lying area subject to flooding from the lake. The design takes into consideration a reclamation of the land up to a level at least 1 m above the highest recorded flood level (which corresponds to an estimated return period >500 years);
- Hpa-An storages are all located on small hills with smooth slopes and well forested. These areas are rocky and not landslide prone and not affected by CC. Design shall integrate the requirements related to earthquake (steelbars arrangements, subdivision of storage in cells to limit water oscillation, any other measures deemed necessary by the DD engineer), but taking into consideration that the region remains classified as low regarding seismic hazard.
- Myawaddy water intake (infiltration gallery) shall be located on a stable river bank in the upstream part of the town. Thaungyin (Moei) River has a large water level amplitude and the design take this in account to avoid any risk of flooding of the electrical equipment;
- The general topography is rather smooth, not prone to landslide.
- Seismic risk in Hpa-An and Myawaddy is considered as low ((low Peak Ground Acceleration of 0.11 only);

None of the Hpa-An and Myawaddy Third GMS Corridor Project component is anticipated to be eventually affected by CC or natural hazards.

5.3.4 IMPACTS ON CULTURAL HERITAGE

None of the Project sites considered in Hpa-An and Myawaddy are anticipated any known cultural heritage resource.

5.3.5 IMPACTS ON NATURAL RESOURCES

As presented in the previous sections, most of the proposed sites are either urban areas with no natural resources or already altered natural areas presenting a limited value regarding vegetation cover: grass or scrub vegetation, secondary or planted tree vegetation. Only in Hpa-An, the Bar-Mae Hill site where existing reservoirs will be demolished and a new reservoir will be constructed is surrounded by a valuable forest which will be protected against cutting of trees. Detailed design will adapt to the available area and Kayin State Forestry Department will provide regular inspection of the site during works. Recommendations for avoiding tree cutting through appropriate measures are presented in the EMP.

A Summary of Impacts and Mitigation Measures is shown on Table [26].

Table [26] SUMMARY OF IMPACTS RELATED TO PROJECT COMPONENTS LOCATION IN HPA-AN AND MYAWADDY

Component or activity	Potential risks	Potential impact	Impact assessment			Corrective or support measure		Overall risk after correction
		Description of impact	Probability	Gravity	Overall Risk	Description of measure	Easiness of implementation	
Improved Water Supply System								
New water intake in Hpa-An	Permanent and temporary land occupation	No private land acquisition required. Area owned by Development Affairs of Hpa-An TDC. Available area around site for the needs of the construction (area used as bus parking).	-	-	-	No particular measure required	-	-
Rehabilitation of Bar-Mae Hill reservoirs	Permanent and temporary land occupation	No land acquisition is required, no built-up property is affected. A new reservoir will be built on the site occupied by the 3 reservoirs to be demolished. Risk to have tree cutting around site.	2	1	2	Monitor during construction that no forest tree is cut without authorization from Department of forestry.	1	1
Construction of a new storage on Kyar-Inn hill	Permanent and temporary land occupation	Land belongs to a monastery, but site is presently an unused pond. No building nearby, except a tubewell house. Surrounding vegetation consists of planted Acacia auriculoformis. Access road available and large area for temporary use during construction. No nuisance risk.	-	-	-	No particular measure required	-	-
Construction of a Water Treatment Plant In Hpa An	Permanent and temporary land occupation	5 000 m² (1.25 acre) required of land belonging to private owner and discussion with KSG for purchasing at this stage; land acquisition is required. No built-up or crop production to compensate. Access road existing. Land available large enough to satisfy temporary needs during construction. Floodable area, involving preliminary land reclamation (or adapted foundation design). No nearby residences (>300 m)	3	2	2	Provide fair acquisition price. Monitoring during construction to ensure no encroachment happens outside dedicated area.	2	1
	Vegetation clearing	No forest or large trees concerned. Only open scrub and wet grassland	-	-	-	No specific measure required.	-	-

Component or activity	Potential risks	Potential impact	Impact assessment			Corrective or support measure		Overall risk after correction
		Description of impact	Probability	Gravity	Overall Risk	Description of measure	Easiness of implementation	
New intake by infiltration gallery in Myawaddy	Permanent and temporary land occupation	No private land acquisition required. Area owned by Myawaddy TDC. Available area around site for the needs of the construction. The detailed design must integrate water level variations of the river.	-	-	-	No specific measure required.	-	-
Construction of a Water Treatment Plant In Myawaddy	Permanent and temporary land occupation	4,000 m² (1 acre) required in a 3.2 ha area owned by TDC. . No built-up or crop production to compensate. Land available large enough to satisfy temporary needs during construction. Land located along the main asphalted road.	-	-	-	No specific measure required.		
	Vegetation clearing	No forest or large trees concerned. Only open scrub and wet grassland	-	-	-	No specific measure required.	-	-
Construction of a new storage near Myawaddy cemetery	Permanent and temporary land occupation	No land acquisition is required, No built-up property is affected as TDC secured a specific area for the reservoir.	-	-	-	No specific measure required.	-	-
Rehabilitation and extension of water supply network in both cities	Permanent and temporary land occupation	Short term land occupation required during works which may locally impact road traffic and access to house or business in urban area. Possible need for urban tree cutting. No land acquisition as works are in streets and along roads	2	2	1	Minimize as much as feasible tree cutting; Compensate by 2 trees planted for 1 tree cut;	1	1
Improved Solid Waste Management								
Construction of new Sanitary Landfill and closing of the existing one in Hpa-An	Permanent and temporary land occupation	Large land available at the northern limit of the IZ extension. Land belongs to Kayin State Government. No private land acquisition required. No built up property on land. Access road already available. Vegetation only regrowth from recent clearing. Risks of nuisances for the IZ in the long term	2	1	2	Ensure a minimum of 250 m buffer zone between landfill and nearest IZ building, densely planted by fast growing trees.	2	1

Component or activity	Potential risks	Potential impact	Impact assessment			Corrective or support measure		Overall risk after correction
		Description of impact	Probability	Gravity	Overall Risk	Description of measure	Easiness of implementation	
Creation of a Composting Plant for Hpa-An	Permanent or temporary occupation of land	Plant located on the premises of the landfill site. No further land required. No residents within a radius of >500 m at present and no resident in the future (industrial zone)	-	-	-	No particular measure required	-	-
Construction of new Sanitary Landfill and closing of the existing one in Myawaddy	Permanent and temporary land occupation	New landfill located in the Trade zone in a delimited area managed by Myawaddy TDC. No built-up or crop production to compensate. Access road existing. Land available large enough to satisfy temporary needs during construction. Risk of nuisance for the future trade zone.	2	1	2	Ensure a minimum of 50 m buffer zone between landfill and trade zone, densely planted by fast growing trees.	2	1
Creation of a Composting Plant for Myawaddy	Permanent or temporary occupation of land	Plant located on the premises of the landfill site. No further land required.	-	-	-	No particular measures required	-	-
Improved Waste Collection equipment	Need for garage & parking area	No land required as parking & maintenance area installed in Municipality compound	-	-	-	-	-	-
Closing the old dump site	Permanent land occupation	Disturbances regarding wastepickers available work.	-	-	-	Measures are included in resettlement plan.	-	-

5.4 Impacts & Mitigation during Construction stage

DISRUPTION TO COMMUNITY UTILITIES

Construction works in urban areas, particularly those involving ground excavation works, may involve a temporary disruption of utilities for individuals or groups of residents. The following components of the project may involve such impacts:

- Water supply network rehabilitation poses only a short term concern to residents affected by construction activities. Interruptions to power and communication, disruption of water supply, discoloration of water from re-located pipes can be anticipated but should not exceed periods of few consecutive days; Contamination of water during replacement of pipes along the network may happen, but with limited risks for public health as water distributed presently is not potable and not used directly by the population as drinking water.
- Water supply network extensions shall not create any significant disruption in existing water supply as population in concerned areas relies either on tube wells, shallow wells or small independent distribution systems.
- Some disruption related to electricity supply, to accesses to households and shops or to road traffic may be temporarily and locally observed when lying down the main pipes along the streets.

To minimize impacts, the contractor shall implement the following measures:

- Water supply pipelines, power supply, communication lines and other utilities shall be re-provisioned before construction works commence;
- Provisions shall be made to preserve the operation of current facilities in sufficient quantity and in agreement with the local community;
- Re-provisioning shall be undertaken in coordination with municipal services and other concerned utility companies;
- Affected households and establishments shall be notified at least 3 days in advance of such disruption if its duration is less than 24 hrs. Notification shall be given at least 1 week in advance if disruption is anticipated to last more than 24 hrs.

5.4.1 IMPACTS ON AIR QUALITY

Main Sources of Impacts

The main sources of air pollution are machines burning fuel for digging, transportation and loading. Dust and waste gas from these machines affect air quality in the surroundings of construction work places. Areas most affected are located in a range of around 50 m all around project sites, but also along the main access roads to sites which will be supporting heavy traffic of trucks. Carbon dioxide and other harmful pollutants may also be released through the burning of waste on construction sites, including plastics.

The production of dust is generally the most widely perceived nuisance generated by earthworks and transport on non-surfaced roads during dry season. Works carried out for water supply network rehabilitation may significantly generate dust if no preventive measure is applied during excavations.

Mitigation Measures

Best management practices will be adopted during construction to minimize dust and combustion exhaust emissions. Mitigation measures to be implemented by the Contractors to minimize impacts on air quality shall comply with IFC guidelines on construction, which shall be at a later stage detailed in the bidding specifications. Main mitigation measures include:

- Reduce pollutant emission at source: Wherever possible, use electrically-powered equipment rather than gas or diesel-powered equipment; Use only vehicles and equipment in good condition for works in densely urbanised areas; Construction equipment and vehicles shall be well-maintained and meet with applicable national emission standards (MONREC, 2015); Undertake immediate repairs of any malfunctioning construction vehicles and equipment, particularly regarding smoke emission and noise. Maintenance and control of equipment shall be done by the Contractor under the supervision of the PMO..
- Burning of wastes generated at the construction sites, work camps and other project-related activities shall be strictly prohibited.
- Position any stationary emission sources (e.g., portable diesel generator, compressor, etc.) as far as is practical from sensitive receptors and residents.
- Control the risk of dust release: Keep excavated soil moist and cover vehicles and stockpiles with tarpaulin sheets or other suitable materials to minimize dust emission and prevent spillage of materials (e.g. soil, cement, stone, sand, aggregates, etc.). In dense residential area, spoils shall be loaded and transported immediately; provide wheel cleaning for any truck/car leaving muddy construction site (as the future new landfill or the water treatment plant) and accessing to public road; clean daily road surfaces of debris/spills from construction equipment and vehicles in the vicinity of activities.
- Ensure availability of water spaying facility on site if the works area is not surfaced, or dry and dusty, near sensitive receptors (i.e. residential areas, roadside tea and food stalls, monasteries, schools, hospitals and other sensitive receptors). Spray water on the exposed surfaces to reduce dust emission.
- Impose compliance with speed limits of construction vehicles (generally 30 km/h) to minimize dust emission (as well as the risk of traffic accident).
- Provide prior notification to the community on schedule of construction activities which may generate some dust and implement 24 hour community grievance hotline.

5.4.2 IMPACTS FROM NOISE AND VIBRATION

Sources of Impacts

Works for the rehabilitation of the water supply network could be the most impacting activity in terms of noise nuisances due to the operation of equipment like backhoes or jackhammers in the immediate vicinity with residences. Along the hauling roads for material and equipment, the average noise level will probably rise because of increased truck traffic.

Table [27]**Error! Reference source not found.** provides some typical noise levels measured at various distances from the emission point related to various construction machineries. . These values are indicative and already used since several years. More efficient systems of noise abatement are available on recent equipment.

Table [27] NOISE LEVEL OF VARIOUS CONSTRUCTION EQUIPMENT IN DBA

Equipment Type	15 m	30 m	50 m	100 m	200 m
Excavator / Backhoe	78	72	67	61	53
Bulldozer	78	72	67	61	53
Jackhammer	89(1)	83	78	72	66
Air compressor	75	69	64	58	52
Vibrator	76	70	65	59	53
Mixer	75	69	64	58	52
Truck	76	70	65	59	53

(1): According to IFC-EHS Guidelines, PPE (ear plugs) must be provided to staff working in noisy environment starting from 80dBA.

At night, construction noise would impose a severe nuisance on the residents in the vicinity, especially those located at less than 50 m from activities. Night working and especially the use of the noisiest equipment during the night should then be strictly prohibited.

The present draft of the National Environmental Quality (Emission) Standards of Myanmar (December 2014) imposes restrictions regarding noise levels which should not exceed the values presented in Table [28], or result in a maximum increase in background levels of 3 dBA at the nearest receptor location off-site.

Table [28] DRAFT NATIONAL STANDARDS FOR NOISE LEVELS

Receptor	One Hour LAeq (dBA)	
	Day time 07:00 – 22:00 (10:00 – 22:00 for Public holidays)	Night time 22:00 – 07:00 (22:00 – 10:00 for Public holidays)
Residential, institutional, educational	55	45
Industrial, commercial	70	70

Source: MOECAF, 2014 and IFC EHS, 2007

Mitigation Measures

- Before site works commence, a Noise Control Plan shall be prepared by the Contractor and shall be non-objected by the PMO. The plan shall provide details of mitigation measures, specific location and schedule where such measures shall be implemented to minimize impacts to sensitive receptors (residential areas, schools, hospitals, etc.) due to construction works, sourcing and transport of construction materials, and other project-related activities.
- Restriction of noisy construction activities as well as the transport of materials to day time from 7:00 AM (10:00 AM on public holidays) to 10:00 PM, and enforce in residential areas the suspension of the works during night time.
- Reduction of noise level for surrounding population through a set of measures: Select equipment with lower sound power levels, install silencers for fans, install suitable mufflers on engine exhausts and compressor components, install acoustic enclosures for equipment casing radiating noise, install acoustic barriers without gaps and with a continuous minimum surface density of 10 kg/m2 in order to minimize the transmission of sound through the barrier, position any stationary equipment that produce high noise levels (e.g., portable

diesel generators, compressors, etc.) as far as is practical from sensitive receptors. Whenever possible, completely enclose noisy equipment which can reduce noise level by 15-25 dB(A) and restrict duration of use of noisy equipment (e.g. 15 min for every consecutive 30 min period); erect temporary walls around the construction sites, as necessary, especially near sensitive areas such as schools, hospitals, administration buildings, monasteries, etc. All construction equipment and vehicles shall be well maintained, regularly inspected for noise emissions, and shall be fitted with appropriate noise suppression equipment consistent with applicable national regulations;

- Training of truck drivers: minimization of the use of horn, compliance with speed limitation particularly in residential zones.
- Provide prior notification to the community on schedule of noisy construction activities and implement 24 hour community complaint hotline.

5.4.3 OFF SITE PUBLIC SAFETY AND INCONVENIENCE

Source of Impacts

All activities involving work along public roads (as construction of solid waste collection, water supply network rehabilitation or extension) will definitely reduce the accessibility to certain streets, reduce the number of usable lanes and create traffic congestion. The presence of population including children next to construction activities where heavy machinery is operating and with the presence of excavations and construction equipment will create additional risks for public safety.

Also, the working area may temporary alienate access to work sites, schools and community facilities. In addition, retail merchants may suffer economic losses if access is denied to their establishments. The project will be required to take all the necessary measures in order to minimize the detrimental side effects of construction activities particularly regarding traffic and public safety.

Mitigation Measures

The following measures shall be implemented by the contractor to address impacts to traffic flow and access to properties:

- Before site works commence, a Traffic Management Plan for the construction phase shall be prepared by the concerned contractors and shall be approved by the PIC. The plan shall be designed to ensure that traffic congestion due to construction activities and movement of construction vehicles, haulage trucks, and equipment is minimized. The plan shall be prepared in consultation with local traffic police. The plan shall identify traffic diversion and management, define routes for construction traffic from materials storage/parking areas to construction site and from construction site to waste disposal locations, traffic schedules, traffic arrangements showing all detours/lane diversions, modifications to signals at intersections, necessary barricades, warning/advisory signs, road signs, lighting, and other provisions to ensure that adequate and safe access is provided to cars, motorists and pedestrians in the affected areas.
- Provide signs advising road users that construction is in progress and that the road narrows to one lane using cones.
- Employ flag persons to control traffic at sites for safety reasons when construction equipment is entering or leaving the work area.

- Lanes through the work site created by rope or flagging, shall be developed to minimize risks of injuries.
- Post traffic advisory signs (to minimize traffic build-up) in coordination with local authorities
- Provide road signs indicating the lane is closed 200 m before the worksite and signs to indicate the proposed detour road.
- Provide sufficient lighting at night within and in the vicinity of construction sites.
- Regularly monitor traffic conditions along access roads to ensure that project vehicles are not causing congestion.
- As much as possible, schedule delivery of construction materials and equipment as well as transport of spoils during non-peak hours.
- Implement suitable safety measures to minimize risk of adverse interactions between construction works and traffic flows through provision of temporary signals or flag controls, adequate lighting, fencing, signage and road diversions.
- Comply with traffic regulations and avoid, where possible, roads with the highest traffic volumes, high density of sensitive receivers or capacity constraints are not used as access to and from the construction areas and spoils disposal sites.
- Provide induction training on road safety to drivers and ensure they comply with regulations regarding speed and the ban of alcohol when on duty.
- Install temporary accesses to properties affected by disruption to their permanent accesses.
- Reinstate good quality permanent accesses following completion of construction.

5.4.4 IMPACTS FROM WASTE PRODUCTION

Source of Impacts

Quantities of solid waste will be generated by construction activities or by worker camps and canteens. A plan for managing all these types of waste needs to be put in place. There are three categories of waste to consider: domestic waste, inert construction waste and hazardous waste.

The quantity of domestic waste, mainly produced by temporary or permanent camps set up for the needs of the project, can be estimated at 0.5 to 0.7 kg/person/day. This waste mainly includes waste from canteens, packaging, plastic bottles, glass bottles, paper and cardboard. As the project is located in an urban area which may supply most of the manpower required, it is not anticipated large worker camps, but small camps on the sites to ensure a presence 24h and the protection of the equipment. Production of waste should be rather limited nevertheless it is worth being properly managed.

Inert construction waste is generated on the construction sites in variable quantities. It consists mainly of wood, packing boxes, scrap, plastics and concrete debris (the later coming from the few demolition required). This waste is generally disposed of, and landfilled in appropriated sites or in permanent inert materials sites. They represent no direct danger to health. Scrap metal is generally collected for recycling. Wood and cardboard waste if burnt on site will produce fumes and nuisance for the neighbourhood.

Hazardous waste such as vehicle batteries, oil filters, various containers that had held hazardous products (mainly paints, solvents, glue) and other alkaline/lithium ion batteries is generated by construction activities, but in specific places and in limited quantities. This waste is harmful to the environment and public health and must receive appropriate treatment so as to ensure it is eliminated safely. The main risk comes from used engine and hydraulic oil resulting from the maintenance on site of heavy equipment (backhoe, bulldozer, levellers, etc.) and which may be produced in significant quantities. If released on the ground, these hydrocarbons will involve surface and underground water pollution. The present project does not anticipate the maintenance of trucks on site, as the project is developed in an urban area where garage facilities are available for trucks. Hazardous waste also includes sludge from temporary toilets to be installed on construction sites within urbanized areas.

Mitigation Measures

EHS specifications for bidding documents will follow and detail EHS guidelines from IFC (2007). Prior to the start of the works, the contractor shall be requested to prepare a Waste Management Plan addressing the management issues related to all types of waste and providing anticipated production and schedule, collection system proposed, disposal methods and location. The Plan shall reflect the following obligations:

For Non-hazardous Waste

- Provide garbage bins and facilities within the project sites for temporary storage of construction waste and domestic solid waste and ensure that wastes are regularly removed by the concerned department of Hpa-An or Myawaddy Township Development Committee and transferred to the existing landfill until new landfill is operational.
- Promote recycling on site and store material in appropriate storage areas before removal by/transport to recycling companies.
- Implement an employee awareness program in waste management and site cleanliness.

For Hazardous Waste

- Any waste engine oil and hydraulic lubricants from heavy machinery and the floating oily residue from oil separators will be collected and stored in tightly sealed containers to avoid contamination of soil and water resources. Transport and off-site storage of such wastes for recycling shall be presented in the Plan.
- Any container of such waste will be stored in a dedicated area with waterproof floor surrounded by a bund the height of which will ensure retention of a volume equal to at least 110% of that of the largest container stored in the area.
- Batteries, vehicle batteries, oil filters from the site will be sorted and deposited in separate containers. The contractor will identify a circuit for elimination/recycling of these products and will submit his choice to the PMO for non-objection.
- Any medical waste (in probably very small quantities) from the First Aid station on site shall be safely stored in a container before being delivered to the landfill area where the content will be burnt as none of the hospital or clinics is equipped with an incineration system.
- Metal or plastic containers that have contained hazardous or toxic chemical substances (mainly hydrocarbons, paints and glue) shall be collected with other

hazardous waste for treatment and safe storage prior to recycling in a metal smelter facility).

As no facility does exist in Hpa-An and Myawaddy or even in Myanmar for the treatment and safe disposal of hazardous waste, it is proposed to implement, within the premises of the landfill area a temporary disposal area for hazardous waste, where the contractors will deliver all hazardous waste produced on the construction sites. This disposal area shall be implemented in priority at the start of the landfill construction works in order to service all contractors involved in the project.

5.4.5 HAZARDOUS MATERIAL MANAGEMENT AND ACCIDENTAL SPILL

According to the type of construction activities anticipated for the present project components, it is not anticipated any significant storage of fuel on sites, as works are mainly implemented in urbanized areas with gasoline stations available. However, small quantities will probably be stored on site in jerry cans or 200 l drums to refill small equipment (compressor, generator) or heavy machinery (backhoe, bulldozer etc.) with related risks of accidental spillage. To avoid any leakage when refuelling on site, the contractor will be required:

- To store fuel or engine oil (as well as any other hazardous product as paint or solvent) in dedicated storage areas compliant with applicable good practice: storage bottom waterproof surrounded by a bund providing a safe retention capacity in case of accidental spillage or leakage of at least 110% of the largest container stored. The storage area shall be covered to be protected from the rain.
- To set-up a refuelling procedure for mobile equipment involving (1) the use of leakage-collection equipment, (2) a training program for the workers in charge of refuelling, (3) the availability of spill clean-up materials (e.g., absorbent pads, fine sand, etc.) specifically designed for petroleum products, and (4) the availability of an extinguisher.
- To train relevant construction personnel in handling of fuels and spill control procedures.

5.4.6 IMPACTS ON WATER RESOURCES QUALITY AND USE

Source of Impacts

A water intake in Hpa-An will be constructed respectively on the Thanlwin river. Works will involve some activities on the river banks, with potential water pollution risks. The receiving environment, both terrestrial and aquatic represented by the Thanlwin river bank in a densely populated urban area presents a low sensitivity regarding ecology: limited vegetation, mainly weeds, and limited aquatic ecology as the foot of the river bank is mainly muddy. However, the risk of accidental spill of chemical (diesel, oil, paint) as well as the increased turbidity of the water during works in the water or just nearby could happen and needs to be minimized if not avoided by appropriate preventive measure to be implemented by the contractor:

- Release of suspended sediments during excavation works on the bank of the river as required for the construction of the structure and the transmission pipe;
- Chemical contamination by leakages of engine oil, hydraulic fluids or fuel from the machinery during works;
- Biological contamination from the workers;

- Release of solid waste from the workers.

Works for the rehabilitation of the existing water supply network, particularly the change of the main pipes, may alter the quality of the water distributed by increasing temporarily sediment load or by creating contamination sources.

Mitigation Measures

The contractor shall be required the following prevention measures for works carried out adjacent to river body:

- Ensure equipment used for works is free of leaks and excess oil or grease
- Storage of fuel and chemicals and equipment refuelling operations shall be organized at least 50 m away from the water body on an efficient retention storage facility;
- The contractor shall submit an emergency plan in case of accidental spillage of hazardous product into the reservoir, describing the measures it intends to take in case of such event.
- Minimize disturbance of vegetation on surrounding areas. Cut brush off to ground height where needed but without disturbing the roots, to allow vegetation regrowth from root stocks and reduce risk of erosion and sediment transfer to the river.
- When muddy water is pumped from excavation works, it shall be transferred into a sediment trap or pond to collect as much as possible sediment before returning water in the river.;
- Equipment shall be washed in a dedicated area located at least 30 m from the river bank and the resulting wastewater (including grease, oil or cement) collected in a sediment pond.

For rehabilitation works on the main water supply network system, methods shall be selected to avoid risks of contamination of water supplied. Prevention of earth and wastewater or any contaminated water or chemicals from entering the distribution system shall be implemented. Training of workers shall be required to ensure the respect of the specific measures to be developed.

5.4.7 IMPACTS ON CULTURAL HERITAGE RESOURCES

Source of Impacts

Even if no valuable physical cultural resource has been identified from the project sites in Hpa-An and Myawaddy, impacts on archaeological relicts may still happen, particularly during earthwork excavation in the streets for the rehabilitation of the water supply network.

Mitigation Measures

The following measures shall be implemented by the Contractor:

- For any works carried in streets following religious and cultural heritage buildings, a protection of the surrounding walls shall be put in place in the areas the closest to the works. The protection shall consist of a mobile fence to ensure at least 1m safety distance between works and the preserved structure. This safety distance shall also be used for the passage of pedestrians.

- No activity generating vibrations shall be authorised next to a cultural heritage building to avoid any risk of degradation. Appropriate equipment and methods shall be implemented in such places.
- Any time, to dispose earth, materials, pipes, equipment etc. directly against a heritage structure (or its surrounding wall) shall be strictly forbidden.
- The owner of the building or the monk community and the government heritage staff concerned shall be informed of the measures imposed to the contractor and will ensure these are enforced 24/7 during the works. In case of breach with these obligations, the PMO shall be contacted for immediate corrective measure.

The contractor shall implement a "chance to find" procedure throughout the construction works to account for any undiscovered items identified during construction/excavation works. The procedure shall include the followings:

- Workers will be trained in the location of heritage zones within the construction area and in the identification of potential items of heritage significance. This training shall be provided by an experienced professional in cultural heritage;
- Should any potential item be located, the site supervisor will be immediately contacted and work will be temporarily stopped in that site.
- If the site supervisor determines that the item is of potential significance, a representative from the Department of Archaeology and National Museum (DANM, Ministry of Culture) shall be invited to inspect the site and work will be stopped until he has responded to this invitation.
- Work will not resume in this location until agreement has been reached between Kayin State Government and DANM of Hpa-An as to any required mitigation measures, which may include excavation and recovery of the item.
- A precautionary approach shall be adopted in the application of this procedure.

5.4.8 HEALTH AND SAFETY OF WORKERS

Source of Impacts

The project will concentrate a number of workers, mostly recruited from Hpa-An or Myawaddy. Inappropriate accommodation or food quality may result in communicable diseases and outbreak of water, hygiene and mosquito related infections. Inappropriate safety conditions on construction sites may lead to accidents, muscular diseases and eventually fatalities. Issue of occupational health and safety (OHS) is a major one in Myanmar, where these aspects are hardly considered on most construction sites observed. It may also represent a risk for the surrounding community if construction sites are not sufficiently fenced.

Mitigation Measures

To ensure appropriate health and safety conditions for the workers, and in compliance with the requirements of the ADB or any other international lending Agency, a Health and Safety Management Plan shall be prepared by the concerned contractors and shall be apprnon-objectedoved by the PMO. The Plan shall be designed to ensure that Myanmar labour regulations and international good practices (ILO, IFC ESHS Guidelines) related to health and safety are complied with and measures efficiently implemented on site. This Plan shall also be considered as a pilot experience for the Hpa-An and Myawaddy municipalities to be systematically replicated for further construction projects.