ABBREVIATIONS

ADB	Asia Development Bank
AIDS	Acquired Immune Deficiency Syndrome
AOI	Area of Influence
ARS	Automatic Route Setting
AS	Air Sample
ASEAN	Association of Southeast Asian Nations
ATP	Automatic Train Protection
BC	Bern Convention
Ca	Calcium
CAPEX	Capital Expenses
CBO	Community Base Organization
CDC	City Development Committee
CH4	Methane
CITIES	Convention on International Trade in Endangered Species
CNEL	Community Noise Equivalent Level
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COD	Chemical Oxygen Demand
CP	Construction Phase
CREEC	China Railway Eryuan Engineering Group Co., Ltd
CSO	Civil Society Organization
CSR	Corporate Social Responsibility
CWR	Continuous Welded Rail
DICA	Directorate of Investment and Company Administration
DMU	Diesel Multiple Unit
DO	Dissolved Oxygen
DP	Decommission Phase
DRMP	Disaster Risk Management Plan
DSLR	Department of Settlement and Land Record
DTM	Digital Terrain Model
DWIR	Directorate of Water Resources and Improvement of River System

ECC	Environmental Compliance Certificate
ECD	Environmental Conservation Department, MONREC
EEC	European Union Commissions
EGT	Ever Green Tech Environmental Services and Training Co., Ltd.
EHS	Environmental, Health & Safety
EIA	Environmental Impact Assessment
EMMP	Environmental Monitoring and Management Plan
EMMT	Environmental Management and Monitoring Team
EMP	Environmental Management Plan
EMS	Environmental Management Sysytem
EMU	Electric Multiple Unit Trains
EPA	United States Environmental Protection Agency
EPAS	Environmental Perimeter Air Station
EPRP	Emergency Preparedness and Respond Plan
ERP	Emergency Response Plan
ESIA	Environmental Social Impact Assessment
ESMP	Environmental and Social Management Plan
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FS	Feasibility Study
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GHS	Globally Harmonized System
GIS	Geographic Information Systems
GRM	Grievance Redress Mechanism
GN	Guidance Note
GOM	Government of Myanmar
GPS	Global Positioning System
GSS	Gas Sensing Semiconductor
HIA	Health Impact Assessment
HIV	Human Immunodeficiency Virus
H2S	Hydrogen sulfide
HSE	Health and Safety Executive

I&APs	Interested and Affected Parties
IBAS	Important Bird Areas
IEE	Initial Environmental Examination
IFC	International Finance Corporation
ILO	International Labor Organization
INGOs	International Non-Government Organizations
IPPC	Integrated Pollution Prevention and Control
IUCN	International Union for Conservation of Nature
IVI	Importance Value Index
K	Potassium
LER	Local Economic Development
LULC	Land Use Land Cover
MBR	Membrane Bioreactor
MEG	Myanmar Emission Guidline
Mg	Magnesium
MMR	Muse-Mandalay Railway
MOTC	Ministry of Transport and Communications
MOU	Memorandum of Understanding
MR	Myanma Railways
Na	Sodium
NAAQS	National Ambient Air Quality Standard
NAC	Noise Abatement Criteria
NDIR	Nondispersive Infrared
NEQG	National Environmental Quality (Emission) Guidelines
NGOs	Non-Government Organizations
NH	National Highways
NO	Nitrogen Monoxide
NO_2	Nitrogen Dioxide
NO_x	Nitrous Oxides
NTS	Non-Technical Summary
O3	Ozone
OHS	Occupational Health and Safety
OP	Operation Phase

OPEX	Operational Expenses
OSHA	Occupational Safety and Health Administration
PAH	Polycyclic Aromatic Hydrocarbons
PAPs	Project Affected Persons
PCA	People Centered Analysis
PCM	Public Consultation Meeting
PCPP	Public Consultation and Public Participation Process
PEA	Preliminary Ecological Assessment
PERI	Public Enterprise for Railway Infrastructure
PM	Particulate Matter
PP	Public Participation
PPE	Personal Protective Equipment
PR	Performance Requirement
PSHO	Principal Safety and Health Officer
QSHE	Quality, Safety and Health, Environmental Management
RA	Relative Abundance
RAP	Resettlement Action Plan
RCC	Remote Control Centre
R.F	Relative Frequency
RMS	Root Mean Square
SEA	Strategic Environmental Assessment
SEP	Stakeholder Engagement Plan
SIA	Strategic Impact Assessment
SMES,	Small Medium Enterprises
SMMP	Social Management and Monitoring Plan
SMP	Social Management Plan
SNAP	Selected Nomenclature on Air Pollutants
SO_2	Sulphur Dioxide
SPL	Sound Pressure Level
SR	Scoping Report
SRP	Socially Responsible Partner
SSEP	Site Specific Environmental Plans
SSHO	Site Safety and Health Officer

SWTP	Solid Waste Treatment Plant
TDS	Total Dissolved Solid
TOR	Terms Of Reference
TSI SRT	Safety in Railway Tunnels
TSP	Total Suspended Particulates
UNFCCC	United Nations Framework Convention on Climate Change
UPS	Uninterruptible Power Supply
USEPA	United States Environmental Protection Agency
VCE	Vapor Cloud Explosion
VIA	Visual Impact Assessment
WEEE	Waste Electronics and Electrical Equipment
WHO	World Health Organization
WRUD	Water Resources Utilization Department
IPP	Indigenous People Plan

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၁။အနှစ်ချုပ်အစီရင်ခံစာ

၁.၁။နိဒါန်း

နိုင်ငံတော်အစိုးရ၏ ခရီးသည် နှင့် ပို့ဆောင်ဆက်သွယ်ရေး ဖွံ့ဖြိုးတိုးတက်ရေး နည်းဗျူဟာအရ ပို့ဆောင်ရေး နှင့် ဆက်သွယ်ရေးဝန်ကြီးဌာနသည် နိုင်ငံတော်၏ သယ်ယူပို့ဆောင်မှုပမာဏတိုးမြင့်နိုင်ရေးအတွက် မူဆယ်မြို့ မှ မန္တလေးမြို့သို့ ရထားလမ်းဖောက်လုပ်မည် ဖြစ်ပါသည်။ ထို့ကြောင့် မြန်မာနိုင်ငံ၊ ပို့ဆောင်ရေးနှင့်ဆက်သွယ်ရေးဝန်ကြီးဌာန နှင့် တရုတ်ပြည်သူ့သမ္မတနိုင်ငံ၊ China Railway Eryuan Engineering Group Co.Limited (CREEC),China Railway Group Limitedတို့ အကြားမူဆယ်-မန္တလေးရထားလမ်းစီမံကိန်း၏ ဖြစ်နိုင်ခြေလေ့လာမှုအစီရင်ခံစာ အတွက်နားလည်မှု စာချွန်လွှာကို ၂၀၁၈ခုနှစ် အောက်တိုဘာလ ၂၂ရက်နေ့တွင် လတ်မှတ်ရေးထိုးခဲ့ပါသည်။ဤနားလည်မှုစာချွန်လွှာအရ CREEC မှမူဆယ်-မန္တလေးမြန်နှုန်းမြင့်လျှပ်စစ်ရထားလမ်းသစ်တည်ဆောက်ရန်အတွက်လုပ်ငန်းဖြစ်နိုင်ခြေလေ့လာခြင်း (Feasibility Study (FS)) ပြုလုပ်သွားမည် ဖြစ်ပါသည်။ ရထားလမ်းသစ် တည်ဆောက်ရေး စီမံကိန်းတွင် Environmental Conservation Law, 2012နှင့် Environmental Impact Assessment Procedure, 2015တို့အရ အဆိုပါ လုပ်ငန်းများအတွက် ပတ်ဝန်းကျင် ထိခိုက်မှုဆန်းစစ်ခြင်း Environmental Impact Assessment (EIA) ပြုလုပ်ရန် လိုအပ်ပါသည်။ ထိုသို့ ဆောင်ရွက်နိုင်ရေးအတွက် CREEC အနေဖြင့်ပတ်ဝန်းကျင် ထိခိုက်မှု ဆန်းစစ်လေ့လာခြင်း လုပ်ငန်းများဆောင်ရွက်လျက်ရှိသည့် Ever Green Tech Environmental Services and Training Co., Ltd. အားလုပ်ငန်းအပ်နှံဆောင်ရွက်ခဲ့ပါသည်။

၁.၂။စီမံကိန်းအကျဉ်းချုပ်

၁.၂.၁။စီမံကိန်းအဆိုပြုသူအကျဉ်းပတ်ဝန်းကျင်ထိခိုက်မှုဆန်းစစ်လေ့လာခြင်းအဖွဲ့.အကျဉ်း

အောက်ဖော်ပြပါဇယားသည်မူဆယ်-မန္တလေးရထားလမ်း၏လုပ်ငန်းဖြစ်နိုင်ခြေလေ့လာခြင်း (Feasibility Study (FS)) အတွက်စီမံကိန်းအဆိုပြုသူ၏အကျဉ်းဖြစ်ပါသည်။

စီမံကိန်းအဆိုပြုသူ	
စီမံကိန်းအဆိုပြုသူ	ပို့ဆောင်ရေးနှင့်ဆက်သွယ်ရေးဝန်ကြီးဌာန (MOTC)မြန်မာ့မီးရထား (MR)
စီမံကိန်းအမျိုး အစား	မူဆယ်- မန္တလေးရထားလမ်းကြောင်း
စီမံကိန်းတည် နေရာ	မူဆယ်-မန္တလေးရထားလမ်းသည် မြောက်ပိုင်းရှိ မူဆယ်မှ တောင်ပိုင်းရှိ မန္တလေး အထိတည်ရှိမည်ဖြစ်သည်။
ဆက်သွယ်ရန် ပုဂ္ဂိုလ်	၁။ဦးမျိုးဝင်း(အထွေထွေမန်နေဂျာ)မြန်မာ့မီးရထား (အထက်မြန်မာပြည်) အထက်မြန်မာပြည်အုပ်ချုပ်ရေးရုံး၊မန္တလေးဘူတာကြီး၊မန္တလေးမြို့၊ မြန်မာ။ ဖုန်း- +၉၅-၂-၃၅၁၇၂၊ Fax - +၉၅-၂-၃၅၈၂၉ အီးမေးလ် - myowingmupper@gmail.com
	၂။ဦးဖြိုးထက်ကျော်((လက်ထောက်အထွေထွေမန်နေဂျာ)(စီမံကိန်း)) စီမံကိန်းနှင့်အုပ်ချုပ်ရေးဦးစီးဌာန(မြန်မာ့မီးရထား) နေပြည်တော်ဘူတာကြီးဝင်း၊နေပြည်တော်၊မြန်မာ။ ဖုန်း- +၉၅ - ၆၇-၇၇၁၆၄(ရုံး)၊+၉၅-၉-၄၃၁၂၄၈၀၀ (mobile) Fax - +၉၅-၆၇-၇၇၁၆၄

အောက်ဖော်ပြပါဇယားသည် ပတ်ဝန်းကျင်ထိခိုက်မှု ဆန်းစစ်လေ့လာခြင်း လုပ်ငန်းများဆောင်ရွက်မည့် တတိယအဖွဲ့အစည်းဖြစ်သည့် Ever Green Tech Environmental Services and Training Co. Ltd. ၏ အကျဉ်းဖြစ်ပါသည်။

Ever Green Tech Environmental Services & Training Co., Ltd.	
Companyအမည်	Ever Green Tech Environmental Services & Training Co., Ltd.
Companyမှတ်ပုံတင်အမှတ်(DICA)	3344/2015-2016(Ygn)
Transitional Third Party မှတ်ပုံတင်အမှတ်	0047
ဆက်သွယ်ရန်လိပ်စာ	တိုက်အမှတ်(၁/၉)၊ဗဟိုလမ်း၊ ၁၆ရပ်ကွက်၊ လှိုင်မြို့နယ်၊ရန်ကုန်မြို့။
ဆက်သွယ်ရန်ဖုန်းနံပါတ်	09-5099230, 5099232
အီးမေးလ်	green.evergreentech@gmail.com 11kyawswar@gmail.com
ဆက်သွယ်ရန်ပုဂ္ဂိုလ်	ဒေါက်တာကျော်စွာတင့် Ph.D. (Mining) အဓိကအကြံပေး 09-797111000

၁.၂.၂။ ပတ်ဝန်းကျင်ထိခိုက်မှုဆန်းစစ်လေ့လာခြင်းလုပ်ငန်းများအတွက် ရွေးချယ်ထားသည့် အကြံပေးပုဂ္ဂိုလ်များ

	No.	Name	Degree	Responsibility	Area of Expertise
Our Consultants	1	Dr. Kyaw Swar Tint	Ph.D. (Mining)	Key Consultant	(a) Air Pollution Control (b) Noise and Vibration (c) Socio-Economy (d) Environmental Management and Monitoring
	2	Mr. Min Aung	M.Sc. (Chemistry)	Key Consultant	(a) Water Pollution Control (b) Modelling of Water Quality (c) Soil and Ground Water Pollution Control
	3	Dr. Thein Tun	Ph.D. (Metallurgy)	Senior Consultant	(a) Risk Assessment and Hazard Management (b) Facilitation of Meeting (c) Occupational Safety and Health
	4	Dr. Myo Min Tun	Ph.D. (Metallurgy)	Senior Consultant	(a) Evaluation of Alternatives (b) Resources Utilization and Management (d) Waste Management
	5	Dr. Sao Hone Pha	Ph.D. (Electronics)	Consultant	Map, Google Earth, Remote Sensing and GIS
	6	Ms. NandarNwe	M.S. in EIA/EMS (YTU),	Consultant	Social Impact Assessment (Household Survey)
	7	Ms. ThazinHtwe	M.S. in EIA/EMS (YTU), Dip; in Applied Psychology (YU)	Consultant	Social Impact Assessment (Public Consultation and Stakeholder Engagement)

	8	Mr. Yaw Ma Nar	B.Sc. (Forestry); Dip in EIA/EMS	Field Coordinator	Baseline Study (Traffic and Secondary Data Collection)
	9	Mr. Moe Pyi Kyaw	B.Sc. (Forestry)	Surveyor	Baseline Study (Surface Water and Soil Quality)
	10	Dr. WyneNweNweOo	Ph.D. (Boitech)	Consultant	Species Identification
	11	Dr. Nyunt Lwin	Ph.D. (Zoology)	Consultant	Fauna Diversity
	12	Dr. NyoNyo Lwin	Ph.D. (Botany)	Freeland Consultant	Flora Diversity
	13	Dr. Khon Aung	M.B.B.S. (Ygn)	Consultant	Health Impact Assessment
	14	Dr. Myo Min Nyunt	Ph.D. (Mining)	consultant	Geotechnical Engineering
	15	Dr. OhnThaik	Ph.D. (Mining)	Consultant	Geotechnical Engineering (Slope Stability)
	16	Dr. Tin Aung Myint	Ph.D. (Geology)	Consultant	Engineering Geology
	17	Dr. Win Swe	Ph.D. (Geography)	Consultant	Hydrology and Socio-economic
	18	Ms. Nay Chi Win Maung	M.E. (Civil)	Consultant	Waste management
	19	Ms. May Thet Zaw	M.E. (Civil)	Consultant	Constructional Related Impact Assessmentand Risk Assessment
	20	U Aung Naing Tun	L.L.B MBA	Consultant	Legal Requirement
Foreign Consultant	21	Mr. Cheng Liang shuang	M.Sc. (Conservation of Soil & Water)	Consultant	Water resources and high-speed railway design

၁.၂.၃။ သဘာဝပတ်ဝန်းကျင်ထိခိုက်မှု ဆန်းစစ်လေ့လာခြင်း၏ရည်ရွယ်ချက်များ

- လူမှုရေးနှင့် သဘာဝပတ်ဝန်းကျင်ဆိုင်ရာ ကိစ္စရပ်များကို ရှင်းလင်းစွာ ကိုင်တွယ်ဖြေရှင်းရန်နှင့် ဖွံ့ဖြိုးရေးနှင့် ဆုံးဖြတ်ချက်ချခြင်းလုပ်ငန်းစဉ်များတွင် ထည့်သွင်းစဉ်းစားပေးရန်။
- အဆိုပြုထားသောစီမံကိန်း ဖွံ့ဖြိုးတိုးတက်မှုများ၏ ဆိုးရွားသည့် ဇီဝရူပဗေဒဆိုင်ရာ လူမှုရေးနှင့် အခြားသက်ရောက်မှုများကို ကြိုတင်ခန့်မှန်းခြင်း၊ ရှောင်ရှားခြင်းနှင့် လျော့ချခြင်း များ ပြုလုပ်ရန်။
- သဘာဝစနစ်များ၏ ကုန်ထုတ်စွမ်းအားနှင့် စွမ်းဆောင်နိုင်မှုနှင့် လုပ်ငန်းဆောင်တာ များကို ထိန်းသိမ်းသောဂေဟစနစ်လုပ်ငန်းစဉ်များကိုကာကွယ်ရန်။
- ရေရှည်တည်တံ့ခိုင်မြဲ၍ အရင်းအမြစ်အသုံးပြုခြင်းနှင့် စီမံခန့်ခွဲမှု အခွင့်အရေးများကို အကောင်းဆုံးဖြစ်စေသောဖွံ့ဖြိုးတိုးတက်မှုကို မြှင့်တင်ရန်။

၁.၂.၄။ ပတ်ဝန်းကျင်ထိခိုက်မှု လေ့လာဆန်းစစ်ခြင်း၏ လေ့လာမှုနယ်ပယ်

အဆိုပြုရထားလမ်းကြောင်း၏ သဘာဝပတ်ဝန်းကျင်ဆန်းစစ်လေ့လာခြင်းသည် မူဆယ်မှ မန္တလေးသို့ ရထားလမ်းသစ်၏ ဆောက်လုပ်ရေးနှင့် လုပ်ငန်းလည်ပတ်ကာလအတွက်ဖူလုံသည်။ အဓိကရထားလမ်းအလျားသည် ၄၀၉.၉၆၀ ကီလိုမီတာရှိသည်။ သဘာဝပတ်ဝန်းကျင် ဆန်းစစ်လေ့လာခြင်းသည် ပတ်ဝန်းကျင်၊ လူမှုရေးနှင့် ကျန်းမာရေးဆိုင်ရာသက်ရောက်မှုများနှင့် သက်ဆိုင်ရာလျော့ချရေးနှင့် တိုးမြှင့်ရေး အတိုင်းအတာများအားလုံးအတွက် လုံလောက်သော်လည်း နိုင်ငံရေးနှင့် စီးပွားရေးကိစ္စများအတွက်တော့ လုံလောက်မှုမရှိနိုင်ပါ။

၁.၃.။ မူဝါဒ၊ ဥပဒေနှင့် အဖွဲ့အစည်းဆိုင်ရာလိုက်နာဆောင်ရွက်ချက် အကျဉ်းချုပ်

၁.၃.၁။ ဥပဒေများနှင့်စည်းမျဉ်းစည်းကမ်းဆိုင်ရာလိုအပ်ချက်များအကျဉ်းချုပ်

မြန်မာနိုင်ငံသည် ပတ်ဝန်းကျင် ထိန်းသိမ်းကာကွယ်ရေးနှင့် ပတ်သတ်သည့် ဥပဒေနှင့် စည်းမျဉ်းစည်းကမ်းများစွာကို ပြဋ္ဌာန်းထားပါသည်။ အဆိုပြုစီမံကိန်းနှင့် တိုက်ရိုက်ဖြစ်စေ၊ သွယ်ဝိုက်၍ဖြစ်စေသက်ဆိုင်သည့်ဥပဒေဆိုင်ရာစည်းမျဉ်းစည်းကမ်းများ၊နည်းဥပဒေများ၊လုပ်ထုံးလုပ်နည်းများအားအောက်ဖော်ပြပါဇယားတွင်အကျဉ်းဖော်ပြထားရှိပါသည်။

ဇယား-အလုပ်သမားများ၏ အခွင့်အရေး၊ လုပ်ငန်းခွင်ဘေးကင်းလုံခြုံမှုနှင့် ကျန်းမာရေးဆိုင်ရာ ဥပဒေများ နှင့် စည်းမျဉ်းများ

ဥပဒေနှင့်စည်းမျဉ်းစည်းကမ်းများ	ခုနှစ်
အလုပ်သမားအဖွဲ့အစည်းနည်းဥပဒေ (ဥပဒေအမှတ်၁၊၇မှ၁၁)	၂၀၁၂
အလုပ်သမားရေးရာအငြင်းပွားမှုဖြေရှင်းရေးဥပဒေကိုဒုတိယအကြိမ်ပြင်ဆင်သည့်ဥပဒေ (ဥပဒေအမှတ်၁၇)	၂၀၁၉
အလုပ်သမားရေးရာအငြင်းပွားမှုဖြေရှင်းရေးနည်းဥပဒေ(ဥပဒေအမှတ်၅)	၂၀၁၄
အလုပ်အကိုင်နှင့်ကျွမ်းကျင်မှုဖွံ့ဖြိုးတိုးတက်ရေးဥပဒေ (ဥပဒေအမှတ်၅၊၁၄၊၃၀(က၊ခ))	၂၀၁၃
ခွင့်ရက်နှင့်အလုပ်ပိတ်ရက်အက်ဥပဒေ၊၁၉၅၁ (ဇူလိုင်၂၀၁၄ဥပဒေပြင်ဆင်ခဲ့သည်)	၂၀၁၄
အနည်းဆုံးအခကြေးငွေဥပဒေ (ဥပဒေအမှတ်၁၂၊၁၃(ကမှဆ))	၂၀၁၃
အခကြေးငွေပေးချေရေးဥပဒေ (ဥပဒေအမှတ်၃၊၄၊၅၊၇၊၈၊၁၀၊၁၄)	၂၀၁၆
လူမှုဖူလုံရေးဥပဒေ (ဥပဒေအမှတ်၁၁(က)၊၁၅(က)၊၁၈(ခ)၊၄၈၊၄၉၊၇၅)	၂၀၁၂
အလုပ်သမားလျော်ကြေးအက်ဥပဒေကိုပြင်ဆင်သည့်ဥပဒေ	၂၀၀၅
ကူးစက်ရောဂါကာကွယ်တားဆီးရေးဥပဒေ (ဥပဒေအမှတ်၃၊၄၊၉၊၁၁)	၁၉၉၅
ဆေးလိပ်သောက်ခြင်းနှင့်ဆေးရွက်ကြီးပစ္စည်းသုံးစွဲမှုထိန်းချုပ်ခြင်းဥပဒေ (ဥပဒေအမှတ်၉)	၂၀၀၆
လုပ်ငန်းခွင်ဘေးအန္တရာယ်ကင်းရှင်းရေးနှင့်ကျန်းမာရေးဆိုင်ရာဥပဒေ (ပြည်ထောင်စုလွှတ်တော်ဥပဒေအမှတ်၈)	၂၀၁၉
အလုပ်သမားလျော်ကြေးအက်ဥပဒေကိုပြင်ဆင်သည့်ဥပဒေ	၂၀၀၅
တိုင်းရင်းဆေးဝါးဥပဒေ(ဥပဒေအမှတ်၇)	၁၉၉၆
ပြည်ပအလုပ်အကိုင်ဆိုင်ရာဥပဒေ(ဥပဒေအမှတ်၃)	၁၉၉၉
ဓါတုပစ္စည်းနှင့်ဆက်စပ်ပစ္စည်းများအန္တရာယ်မှတားဆီးကာကွယ်ရေးဥပဒေ(ဥပဒေအမှတ်၂၈)	၂၀၁၃

ဇယား- ယဉ်ကျေးမှုနှင့်အမွေအနှစ်ဆိုင်ရာဥပဒေများနှင့် စည်းမျဉ်းများ

ဥပဒေနှင့်စည်းမျဉ်းစည်းကမ်းများ	ခုနှစ်
တိုင်းရင်းသားလူမျိုးများ၏အခွင့်အရေးကာကွယ်စောင့်ရှောက်သည့်ဥပဒေ(ဥပဒေအမှတ်၅)	၂၀၁၅
ယဉ်ကျေးမှုအမွေအနှစ်ဒေသများကာကွယ်ထိန်းသိမ်းရေးဥပဒေ (ဥပဒေအမှတ်၁၅၊၁၆)	၂၀၁၉
ရှေးဟောင်းအဆောက်အအုံများကာကွယ်ထိန်းသိမ်းရေးဥပဒေ(ဥပဒေအမှတ်၁၂၊၁၅၊၂၀)	၂၀၁၅
ရှေးဟောင်းဝတ္ထုပစ္စည်းများကာကွယ်ထိန်းသိမ်းရေးဥပဒေ(ဥပဒေအမှတ်၁၂၊၁၅၊၂၀)	၂၀၁၅
ရှေးဟောင်းအဆောက်အအုံများကာကွယ်ထိန်းသိမ်းရေး (ဥပဒေအမှတ်၅၁)	၂၀၁၅
ရှေးဟောင်းဝတ္ထုပစ္စည်းများကာကွယ်ထိန်းသိမ်းရေးဥပဒေ (ဥပဒေအမှတ်၄၃)	၂၀၁၅
ကိုးကွယ်ရာဘာသာကူးပြောင်းခြင်းဆိုင်ရာဥပဒေ(ဥပဒေအမှတ်၄၈)	၂၀၁၅

ဇယား- လူမှုအသိုင်းအဝိုင်းဖွံ့ဖြိုးတိုးတက်မှု၊ ကျန်းမာရေးနှင့်ဘေးကင်းရေးဆိုင်ရာဥပဒေများနှင့် စည်းမျဉ်းများ

ဥပဒေနှင့်စည်းမျဉ်းစည်းကမ်းများ	ခုနှစ်
ကျေးလက်ဒေသဖွံ့ဖြိုးတိုးတက်ရေးဥပဒေ (ဥပဒေအမှတ်၃၉)	၂၀၁၉
လူဦးရေတိုးပွားနှုန်းထိန်းညှိခြင်းဆိုင်ရာကျန်းမာရေးစောင့်ရှောက်မှုဥပဒေ (ဥပဒေအမှတ်၂၈)	၂၀၁၅
တောင်သူလယ်သမားအခွင့်အရေးကာကွယ်ရေးနှင့်အကျိုးစီးပွားမြှင့်တင်ရေးဥပဒေ(ဥပဒေအမှတ်၃၂)	၂၀၁၃
နယ်စပ်ဒေသနှင့်တိုင်းရင်းသားလူမျိုးများဖွံ့ဖြိုးတိုးတက်ရေးဥပဒေကိုဒုတိယအကြိမ်ပြင်ဆင်သည့်ဥပဒေ (ဥပဒေအမှတ်၄၄)	၂၀၁၅
ပုဂ္ဂလိကကျန်းမာရေးစောင့်ရှောက်မှုဝန်ဆောင်မှုများနှင့်သက်ဆိုင်သောဥပဒေ (ဥပဒေအမှတ်၅)	၂၀၀၇
မြန်မာ့ပြည်သူ့ကျန်းမာရေးဥပဒေ (ဥပဒေအမှတ်၃၊၅)	၁၉၇၂
မြေလွတ်၊မြေလပ်နှင့်မြေရိုင်းများစီမံခန့်ခွဲမှုဥပဒေ	၂၀၁၂

ဇယား- သယ်ယူပို့ဆောင်ရေးနှင့်ဆက်သွယ်ရေးဆိုင်ရာဥပဒေများနှင့် စည်းမျဉ်းများ

ဥပဒေနှင့်စည်းမျဉ်းစည်းကမ်းများ	ခုနှစ်
မော်တော်ယာဉ်ဥပဒေ	၂၀၁၅
ရထားပို့ဆောင်ရေးလုပ်ငန်းဥပဒေ	၂၀၁၆
အမြန်လမ်းမကြီးများဥပဒေ (ဥပဒေအမှတ်၂၄)	၂၀၁၅
အမြန်လမ်းမကြီးများအက်ဥပဒေကိုပြန်လည်ပြင်ဆင်သည့်ဥပဒေ (ဥပဒေအမှတ်၃၃)	၂၀၁၄
ကုန်းလမ်းသယ်ယူပို့ဆောင်ရေးလုပ်ငန်းများဥပဒေ (ဥပဒေအမှတ်၃)	၂၀၁၆
တံတားကြီးများဥပဒေ(ဥပဒေအမှတ်၁၆)	၂၀၁၉
ဘက်စုံပို့ဆောင်ရေးဥပဒေ (ဥပဒေအမှတ်၃)	၂၀၁၄
တာတမံအက်ဥပဒေကိုပြင်ဆင်သည့်ဥပဒေ (ဥပဒေအမှတ်၂)	၁၉၉၈
လမ်းနှင့်တံတားအသုံးပြုခြင်းဆိုင်ရာဥပဒေကိုပြင်ဆင်သည့်ဥပဒေ(ဥပဒေအမှတ်၂၅)	၂၀၁၄

ဇယား- မြေယာရယူခြင်းဆိုင်ရာဥပဒေများနှင့် စည်းမျဉ်းများ

ဥပဒေနှင့်စည်းမျဉ်းစည်းကမ်းများ	ခုနှစ်
မြေလွတ်၊မြေလပ်နှင့်မြေရိုင်းများစီမံခန့်ခွဲမှုဥပဒေ	၂၀၁၂
မြေသိမ်းဆည်းခြင်း၊ပြန်လည်နေရာချထားခြင်းနှင့်ပြန်လည်ထူထောင်ခြင်းဆိုင်ရာဥပဒေ (ဥပဒေပုဒ်မ၃၉၊၄၁၊၄၂၊၄၆၊၅၄ (ခ)(ဂ)၊၅၈)	၂၀၁၉
လယ်ယာမြေအက်ဥပဒေ (ဥပဒေအမှတ်၁၁)	၂၀၁၂
လယ်ယာမြေဥပဒေ	၂၀၁၂
အမျိုးသားမြေအသုံးချမှုမူဝါဒ	၂၀၁၆

ဇယား- အဆိုပြုထားသောစီမံကိန်းအတွက်အခြားဥပဒေများနှင့် စည်းမျဉ်းများ

ဥပဒေနှင့်စည်းမျဉ်းစည်းကမ်းများ	ခုနှစ်
ရေကြောင်းအတားအဆီးများအက်ဥပဒေကိုပြင်ဆင်သည့်ဥပဒေ (ဥပဒေအမှတ်၂၆)	၂၀၁၃
မြန်မာ့သတ္တုတွင်းဥပဒေ (ဥပဒေအမှတ်၁၃)	၂၀၁၈
အီလက်ထရောနစ်ဆက်သွယ်ဆောင်ရွက်ရေးဥပဒေကိုပြင်ဆင်သည့်ဥပဒေ (ဥပဒေအမှတ်၆)	၂၀၁၄
ဆက်သွယ်ရေးဥပဒေ (ဥပဒေအမှတ်၃၁)	၂၀၁၃
ပြည်ထောင်စုသမ္မတမြန်မာနိုင်ငံတော်ဖွဲ့စည်းပုံအခြေခံဥပဒေ (ပိုဒ်ခွဲ၂၄၊၄၅၊၃၄၉၊၃၅၉)	၂၀၀၈
စံချိန်စံညွှန်းသတ်မှတ်ခြင်းဆိုင်ရာဥပဒေ (ဥပဒေအမှတ်၂၈)	၂၀၁၄
ပတ်ဝန်းကျင်ထိန်းသိမ်းစောင့်ရှောက်ခြင်းဥပဒေ (ဥပဒေအမှတ်၇၊၁၄၊၁၅၊၂၄၊၂၅၊၂၉)	၂၀၁၂
ပတ်ဝန်းကျင်ထိန်းသိမ်းရေးနည်းဥပဒေများ (စည်းမျဉ်း၅၅၊၆၉(က)၊ (ခ))	၂၀၁၄
(EIA) ပတ်ဝန်းကျင်ထိခိုက်မှုဆန်းစစ်ခြင်းဆိုင်ရာလုပ်ထုံးလုပ်နည်း(ပိုဒ်ခွဲ၁၀၂မှ၁၁၀၊၁၁၃၊၁၁၅၊၁၁၇)	၂၀၁၅
အမျိုးသားပတ်ဝန်းကျင်ဆိုင်ရာအရည်အသွေး(ထုတ်လွှတ်မှု)လမ်းညွှန်ချက်များ	၂၀၁၅
အလုပ်ရုံများအက်ဥပဒေကိုပြင်ဆင်သည့်ဥပဒေ၁၉၁ခုနှစ် (ပြည်ထောင်စုလွှတ်တော် ဥပဒေအမှတ် ၁၂/၂၀၁၆)	၂၀၁၆
ပုဂ္ဂလိကစက်မှုလုပ်ငန်းဥပဒေ	၁၉၉၀
မြန်မာ့အာမခံဥပဒေ (ဥပဒေအမှတ်၁၅၊၁၆)	၁၉၉၃
မြန်မာနိုင်ငံမီးသတ်တပ်ဖွဲ့ဥပဒေ(ဥပဒေအမှတ်၂၅)	၂၀၁၅
လျှပ်စစ်ဥပဒေ	၂၀၁၄
လျှပ်စစ်နည်းဥပဒေ	၂၀၁၅
ရေနံနှင့်ရေနံထွက်ပစ္စည်းဆိုင်ရာဥပဒေ	၂၀၁၇
ပို့ကုန်သွင်းကုန်ဥပဒေ	၂၀၁၂
မြန်မာနိုင်ငံအင်ဂျင်နီယာကောင်စီဥပဒေ (ဥပဒေအမှတ်၂၀၊၂၄၊၂၅၊၃၁ (က)၊၃၇)	၂၀၁၃
မူပိုင်ခွင့်ဥပဒေ	၂၀၁၉
ပိုးသတ်ဆေးဥပဒေ (ပြည်ထောင်စုလွှတ်တော်ဥပဒေအမှတ်၁၄/၂၀၁၆)	၂၀၁၆
သစ်တောဥပဒေ	၁၉၉၂
ဇီဝမျိုးစုံမျိုးကွဲများကာကွယ်စောင့်ရှောက်ခြင်းနှင့်ကာကွယ်စောင့်ရှောက်ထားသော ဇရိယာဥပဒေ	၂၀၁၈
ရေအရင်းအမြစ်နှင့်မြစ်ချောင်းများထိန်းသိမ်းရေးဥပဒေ (ဥပဒေအမှတ်၈၊၁၁ (က)၊၁၃၊၁၉၊၂၄ (ခ)၊၃၀)	၂၀၀၆

ရေအရင်းအမြစ်နှင့်မြစ်ချောင်းများထိန်းသိမ်းရေးနည်းဥပဒေ	၂၀၁၃
ရေချိုငါးလုပ်ငန်းဥပဒေ (ဥပဒေအမှတ်၃၆၊၄၀၊၄၁)	၁၉၉၁
တိရစ္ဆာန်ကျန်းမာရေးနှင့်ဖွံ့ဖြိုးရေးဥပဒေ(ဥပဒေအမှတ်၁၇)	၂၀၁၀
မြေဩဇာဥပဒေ(ဥပဒေအမှတ်၇)	၂၀၀၂

၁.၃.၂။ နိုင်ငံတကာကွန်ဗင်းရှင်းများ၊သဘောတူညီစာချုပ်များအကျဉ်းချုပ်

အထက်ဖော်ပြပါ ပြည်တွင်းဥပဒေများအပြင် မြန်မာနိုင်ငံသည် အောက်ဖော်ပြပါ နိုင်ငံတကာ ကွန်ဗင်းရှင်းများ၊ သဘောတူစာချုပ်များတွင် လတ်မှတ်ရေထိုးထားသည့် အဖွဲ့ဝင်နိုင်ငံ ဖြစ်ပါသည်။ ဤနိုင်ငံတကာနိုင်ငံတကာ ကွန်ဗင်းရှင်းများ၊ သဘောတူစာချုပ်များသည် အဆိုပြု စီမံကိန်း၏ လုပ်ရှားဆောင်ရွက်ချက်များနှင့်သက်ဆိုင်ပါသည်။

ဇယား-အဆိုပြုစီမံကိန်းနှင့်ဆက်စပ်သည့်နိုင်ငံတကာကွန်ဗင်းရှင်းများ၊သဘောတူညီစာချုပ်များ

နိုင်ငံတကာကွန်ဗင်းရှင်းများ၊သဘောတူညီစာချုပ်များ	ဆောင်ရွက်ချက်များ
လူ့ပတ်ဝန်းကျင်ဆိုင်ရာကုလသမဂ္ဂညီလာခံ၏ကြေငြာချက်	၁၉၇၂
အိုဇုန်းလွှာကိုကာကွယ်ရန် Vienna ကွန်ဗင်းရှင်း၊ ၁၉၈၅	၁၉၉၈
အိုဇုန်းလွှာကိုပျက်စီးစေသောအရာများအပေါ် Montreal ညှိနှိုင်းချက်မှတ်တမ်း	၁၉၉၃
Basel ကွန်ဗင်းရှင်း၊ ၁၉၈၉	၂၀၁၅
ကုလသမဂ္ဂရာသီဥတုပြောင်းလဲခြင်းဆိုင်ရာမူဘောင်သဘောတူညီချက် (UNFCCC)၊ နယူးယောက်၊ ၁၉၉၂ နှင့် ကျိုတို ညှိနှိုင်းချက်မှတ်တမ်း ၁၉၉၇	၁၉၉၅ နှင့်၂၀၀၅
ဇီဝမျိုးစုံမျိုးကွဲများဆိုင်ရာကွန်ဗင်းရှင်း၊ Rio de Janeiro၊ ၁၉၉၂	၁၉၉၄
အာရှ၏အနည်းဆုံးကုန်ကျစရိတ်ရှိသောဖန်လုံအိမ်ဓာတ်ငွေ့လျော့ချရေးနည်းဗျူဟာ (၁၉၉၈ ALGAS)	၁၉၉၈
ကုလသမဂ္ဂအစီအစဉ် 21	၁၉၉၇
မြန်မာနိုင်ငံတွင်ပြဋ္ဌာန်းထားသည့်သက်ဆိုင်ရာ ILO ကွန်ဗင်းရှင်း • C1 Hours of Work • Unemployment Convention • C14 Weekly Rest • C17 Workmen's Compensation (Accidents) • Workmen's Compensation (Occupational Diseases) Convention • C19 Equality of Treatment (Accident Compensation)	

• C26 Minimum Wage Fixing Machinery • C29 Forced Labour Convention • C42 Workmen's Compensation (Occupational Diseases) Revised 1934 • C52 Holidays with Pay • C63-Convention concerning Statistics of Wages and Hour of Work • C87- Freedom of Association and Protection of the Right to Organise Convention • C182- Worst Forms of Child Labour Convention	
အပြည်ပြည်ဆိုင်ရာသဘာဝပတ်ဝန်းကျင်ဆိုင်ရာဥပဒေ	၂၀၁၇

၁.၃.၃။ ဝန်ခံကတိပြုလွှာအကျဉ်းချုပ်

စီမံကိန်းအဆိုပြုသူသည် အောက်ဖော်ပြပါအချက်များအား လေးစားလိုက်နာ ဆောင်ရွက်သွားမည် ဖြစ်ပါကြောင်းဝန်ခံကတိပြုပါသည်။

(က) ကျွန်တော်များ မြန်မာ့မီးရထားသည် ပတ်ဝန်းကျင်ထိန်းသိမ်းရေးအစီရင်ခံစာတွင် ဖော်ပြထားသော သဘာဝပတ်ဝန်းကျင် ထိန်းသိမ်းရေးကတိကဝတ်များ၊ ပတ်ဝန်းကျင်ထိခိုက်မှု လျော့ချရေးနည်းလမ်းများ၊ စီမံခန့်ခွဲမှုအစီအစဉ်များအားအစီရင်ခံစာတွင် ဖော်ပြထားသည့် ဥပဒေစည်းမျဉ်းစည်းကမ်းများ ဖြစ်သည့် Environmental Conservation Laws နှင့် 2012 Environmental Conservation Rules 2015 များနှင့်အညီလိုက်နာဆောင်ရွက်သွားပါမည်။

(ခ) ပတ်ဝန်းကျင်ထိန်းသိမ်းရေးအစီရင်ခံစာတွင် ဖော်ပြထားသည့် သဘာဝပတ်ဝန်းကျင်ထိန်းသိမ်းရေးနှင့် လူမှုစီးပွားဖွံ့ဖြိုးတိုးတက်ရေး ခံယူချက်များအတိုင်း တသွေမတိမ်း လုပ်ဆောင်သွားပါမည်။

(ဂ) အစီရင်ခံစာတွင် ပါရှိသည့် စီမံကိန်း၏ သက်ဆိုင်ရာဥပဒေများ၊ နည်းဥပဒေများနှင့် လမ်းညွှန်ချက်များအားသိရှိပြီးလေးစားလိုက်နာသွားပါမည်။

(ဃ) အစီရင်ခံစာတွင် ချမှတ်ရေးဆွဲထားသော ပတ်ဝန်းကျင်ထိခိုက်မှု ရှောင်လွှဲနိုင်သည့် နည်းလမ်းများ၊ ထိခိုက်မှုလျော့ချရေးနည်းလမ်းများနှင့် စောင့်ကြည့်လေ့လာရေး အစီအစဉ်များကို အပြည့်အဝလိုက်နာ ဆောင်ရွက်သွားမည်ဖြစ်ကြောင်း နှင့် လိုက်နာဆောင်ရွက်ခြင်းမရှိခဲ့၍ ပတ်ဝန်းကျင် ထိခိုက်မှုတစ်စုံတစ်ရာ ဖြစ်ပေါ်ခဲ့ပါကမိမိတို့၏ တာဝန်သာဖြစ်ပါသည်။

၁.၃.၄။ရေရှည်တည်တံ့ရေးမူဝါဒအကျဉ်းချုပ်

စီမံကိန်းအဆိုပြုသူ၏ ရေရှည်တည်တံ့ရေးစံနမူနာမှာ "ရေရှည်တည်တံ့ရေး ဆောင်ရွက် ချက်ဟူသည် အစုရှယ်ယာရှင်များအတွက် တန်ဖိုးတစ်ခုဖန်တီးပေးနိုင်ခြင်း နှင့် အနာဂတ်မျိုး ဆက်သစ် များအထိသဘာဝအရင်းအမြစ်များအားမပျက်မစီးအသုံးပြုနိုင်ခြင်းအားဖြင့် လူသားများ၊ သဘာဝပတ်ဝန်းကျင်နှင့် လူမှုအသိုင်းအဝိုင်းအပေါ် အကျိုးပြုနိုင်ခြင်းပေတည်း။" ဟူ၍ ဖြစ်ပါသည်။

၁.၃.၅။ အဆိုပြုစီမံကိန်း၏ သဘာဝပတ်ဝန်းကျင်၊ လူမှုနှင့် ကျန်းမာရေးအကျိုးပြု မူဝါဒများ

စီမံကိန်းအဆိုပြုသူ၏ အဓိကမူဝါဒနှင့် ကတိကဝတ်မှာအောက်ပါအတိုင်း ဖြစ်ပါသည်။

- ပြည်သူလူထု၊ အလုပ်သမားများ နှင့် ဒေသခံများ၏ ကျန်းမာရေးနှင့် ဘေးကင်းလုံခြုံမှုအား အကာအကွယ်ပေးခြင်း။
- ဒေသခံများ၏ လူ့အခွင့်အရေး၊ စီးပွားရေးနှင့် လူမှုဖွံ့ဖြိုးတိုးတက်ရေးများအား အကာအကွယ်ပေးခြင်း။
- သဘာဝပတ်ဝန်းကျင် ကာကွယ်ရေးနှင့် ဇီဝမျိုးကွဲများနှင့် ဂေဟစနစ်ထိန်းသိမ်း စောင့်ရှောက်ခြင်း။
- လုပ်ငန်းစဉ်များ၊ ဝန်ဆောင်မှုများ၊ ထုတ်ကုန်များ၏ အရည်အသွေးအားအဆက်မပြတ် မြှင့်တင်ခြင်း။
- လုပ်ငန်းခွင်အတွင်းသဘာဝပတ်ဝန်းကျင်၊ ကျန်းမာရေး၊ ဘေးကင်းလုံခြုံမှု နှင့် သန့်ရှင်း စင်ကြယ်မှု နှင့်သက်ဆိုင်သော မြန်မာနိုင်ငံဥပဒေများ၊ နည်းဥပဒေများနှင့် စက်မှုဇုန် စံချိန်စံညွှန်းများနှင့် ကိုက်ညီမှုရှိခြင်း။
- ဝန်ထမ်းများအားအားပေးလှုံ့ဆော်ပေး၍ ကန်ထရိုက်တာများအားအောင်မြင်စေရန် စေ့စပ် ညှိနှိုင်းပေးနိုင်သော HSE ထူးချွန်မှုကို မြှင့်တင်ပေးနိုင်သောတက်ကြွသောခေါင်းဆောင်မှု။
- HSE စွမ်းဆောင်ရည်ကိုကုမ္ပဏီ၏ လုပ်ဆောင်ချက်များနှင့် အညီတိုင်းတာရန်နှင့် မြှင့်တင်ရန် လိုအပ်သောရည်မှန်းချက်နှင့် ဗျူဟာများချမှတ်ခြင်း။
- မလိုလားအပ်သည့် အဖြစ်အပျက်များကင်းစင်သောရည်မှန်းချက်အတွက် HSE အား စီမံ ခန့်ခွဲခြင်း။

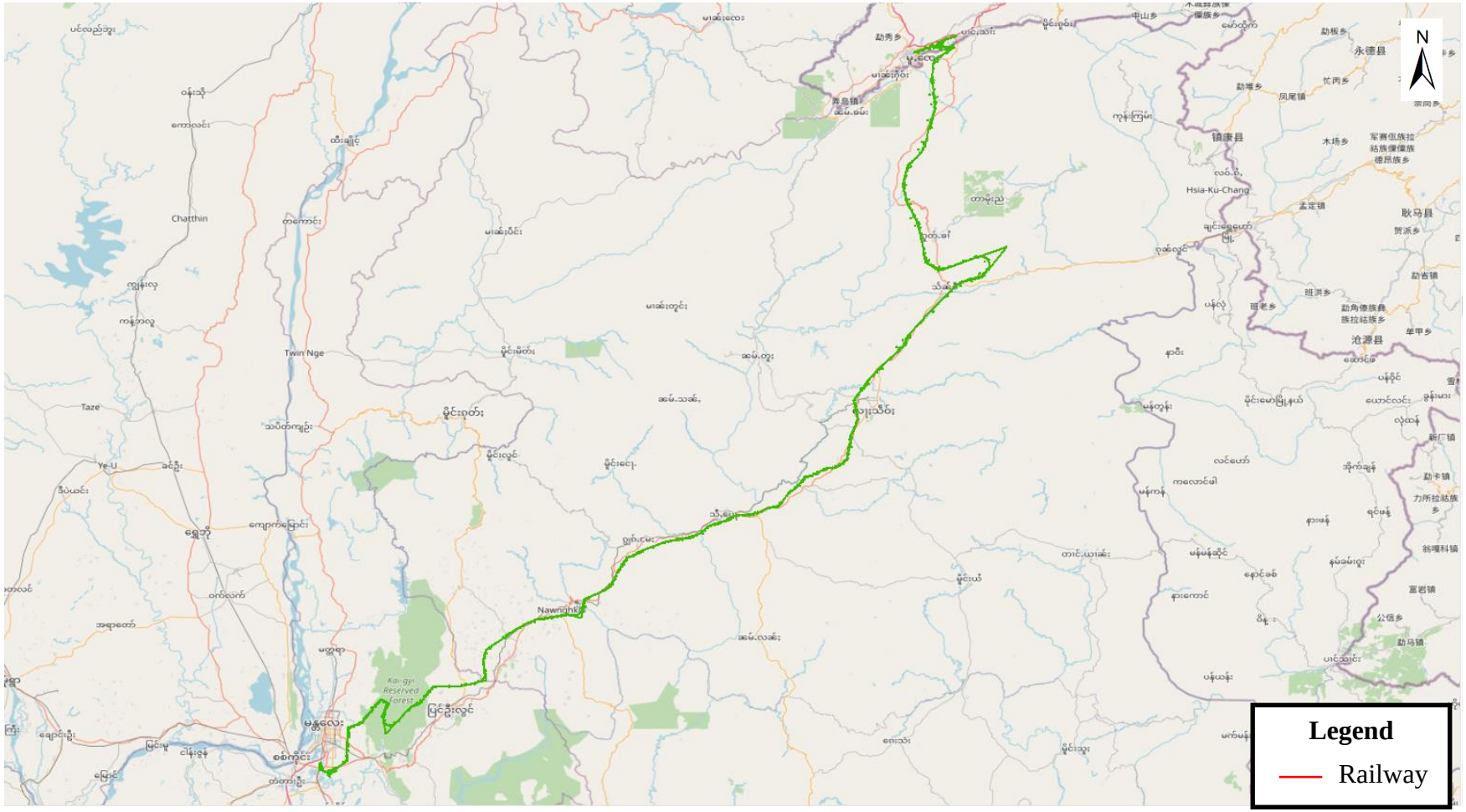
- အဆင့်မြင့် သဘာဝပတ်ဝန်းကျင်ကာကွယ်ရေးနှင့် စွမ်းအင်ထိရောက်မှု နည်းစနစ်များကို အသုံးပြုခြင်းအားဖြင့် ကျွန်ုပ်တို့၏ လုပ်ငန်းစဉ်များတွင် သတ်မှတ်ထားသော မဟာဗျူဟာများနှင့်အညီအဆက်မပြတ်တိုးတက်မှုကိုရရှိဖွေနိုင်ခြင်း။

၁.၄။စီမံကိန်းဆိုင်ရာဖော်ပြချက်အကျဉ်းချုပ်

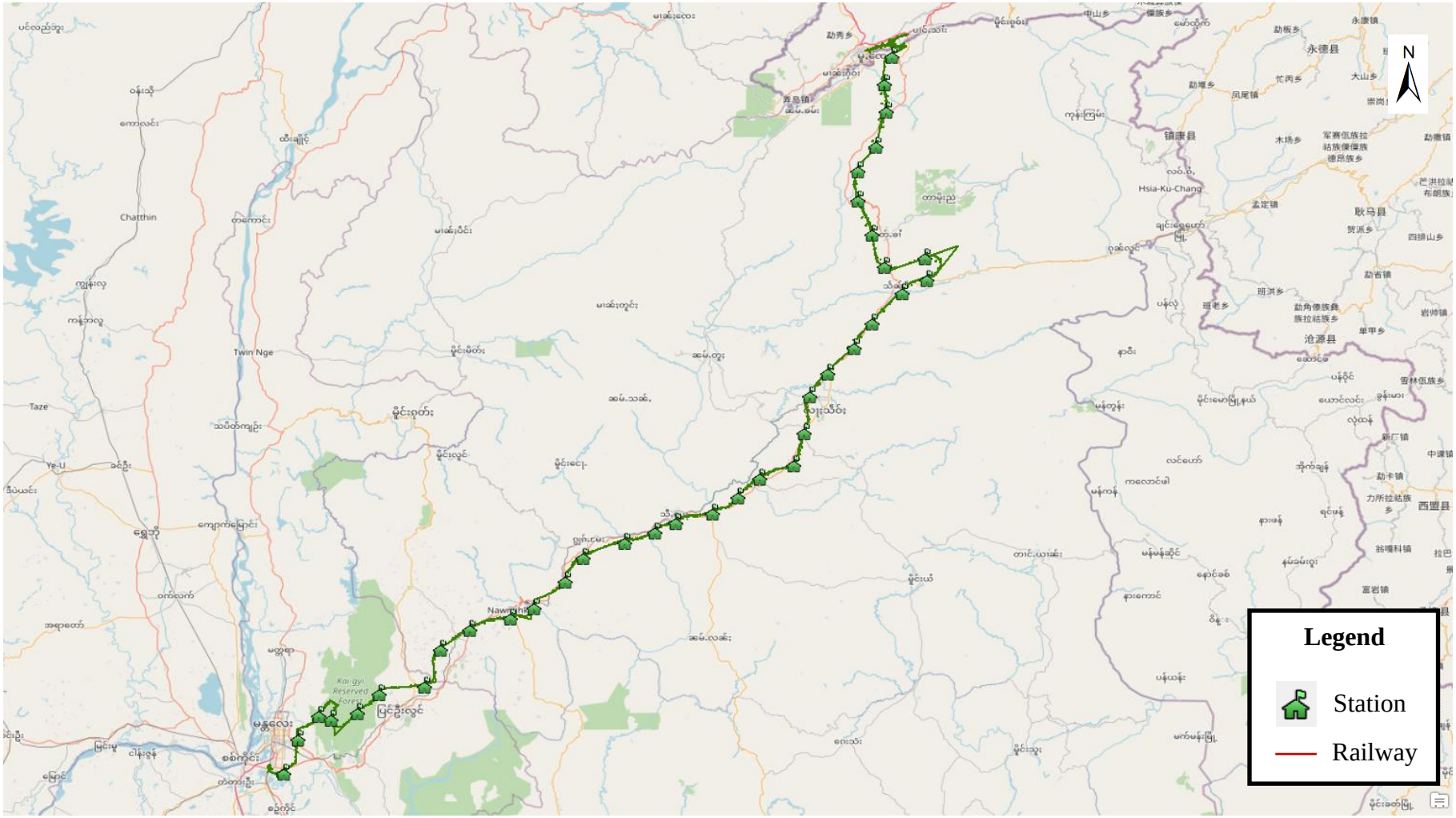
အောက်ပါတို့သည် စီမံကိန်းနှင့်ပက်သက်သော ဖော်ပြချက်အကျဉ်းချုပ် ဖြစ်ပါသည်။

၁.၄.၁။စီမံကိန်းလမ်းကြောင်း

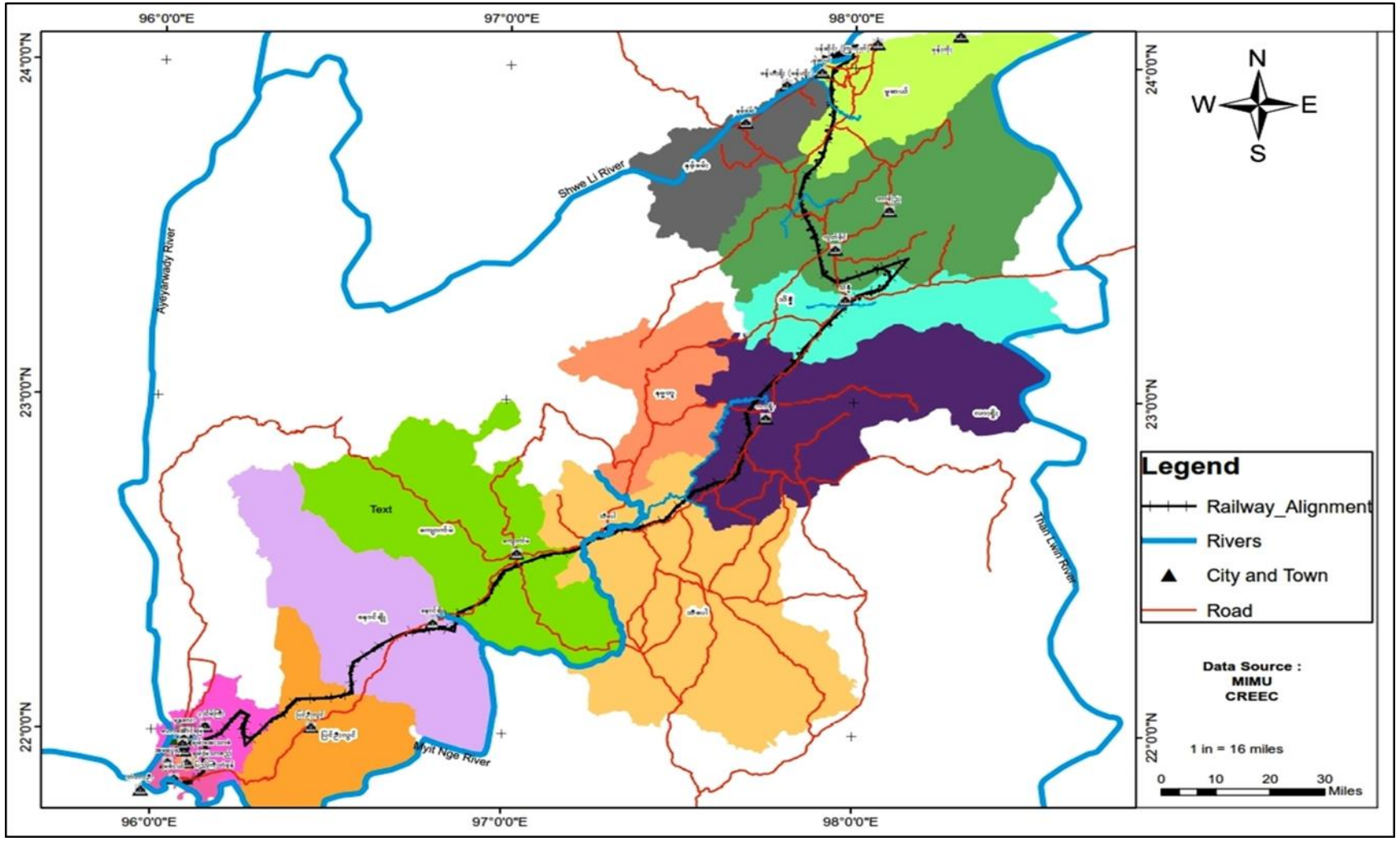
အဆိုပြုစီမံကိန်းသည် မြောက်ဘက်မူဆယ်မြို့အဝင်မှ တောင်ဘက်မန္တလေးမြို့အထိ ဖြတ်သန်း သွားမည်ဖြစ်ပါသည်။ မူဆယ်မန္တလေးရထားလမ်းသည် မြောက်ဘက်ရှိ တရုတ်နိုင်ငံ ရထားလမ်းနှင့်ချိတ်ဆက်မည်ဖြစ်ပြီးမန္တလေးရှိမြန်မာ့မီးရထားလမ်းနှင့်ဆက်လက်ချိတ်ဆက်သွားပါမည်။ ရထားလမ်းသည် ကွတ်ခိုင်၊ သိန်းနီ၊ လားရှိုး၊ သီပေါ၊ ကျောက်မဲ၊ ပြင်ဦးလွင်နှင့် မန္တလေး အစရှိသောမြို့များအားဖြတ်သန်းဖောက်လုပ်သွားမည်ဖြစ်ပါသည်။စုစုပေါင်းရထားလမ်းအရှည်မှာ ကီလိုမီတာ၄၀၉.၉၆၀ရှိပါသည်။အဆိုပြုရထားလမ်း၏စီမံကိန်းလမ်းကြောင်းအားပုံ၁.၁နှင့်၁.၂တွင် ဖော်ထြားပါသည်။



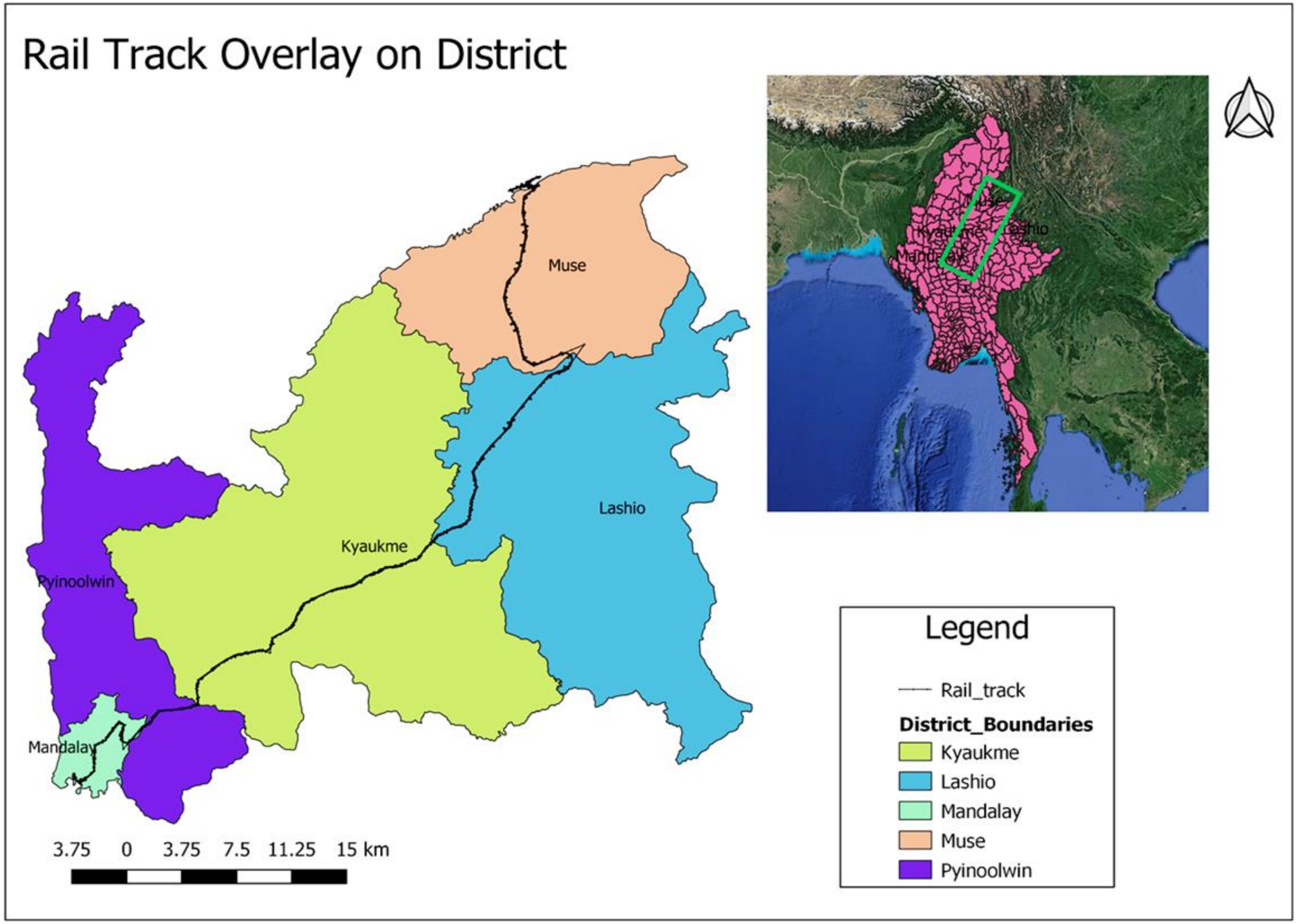
ပုံ - မူဆယ်-မွန်လေးရထားလမ်း



ပုံ -မူဆယ်-မွန္လေးရထားလမ်းတလျောက်ဘူတာရုံများ



ပုံ -အဆိုပြုရထားလမ်းကြောင်းပြမြေပုံ



ပုံ - အဆိုပြုရထားလမ်းကြောင်းဖြတ်သန်းသွားသော မြို့ရွာများ

၁.၄.၂။ရထားလမ်းစီမံကိန်းဆိုင်ရာအဓိကအချက်အလက်များ

ရထားလမ်းစီမံကိန်းဆိုင်ရာအဓိကအချက်အလက်များမှာအောက်ပါအတိုင်းဖြစ်ပါသည်။

Item	Standard
ရထားလမ်းဂရိတ်	Grade Ⅰ
ရထားဂရိတ်	1435mm
လိုင်းအရေအတွက်	Single line (reserve condition of doubling line)
လျှောစောက်အနေအထား (‰)	12‰, push grade24‰
အနည်းဆုံးမျဉ်းကွေးအချင်း	General section 2000m, difficult section 1600m
အမြန်နှုန်း	160km/h
ရထားအမျိုးအစား	Electric traction
စက်ခေါင်းအမျိုးအစား	Electrical 6-axis vehicle
တန်ချိန်	3000t
Effective length of arrival-departure	650, reserve 850
Type of blocking	Semi-automatic blocking

၁.၄.၃။ရထားလမ်းစီမံကိန်းတွင်အဓိကပါဝင်သည့်အစိတ်အပိုင်းများ

မူဆယ်-မန္တလေးရထားလမ်းစီမံကိန်းတွင်အောက်ဖော်ပြသည်များအဓိကပါဝင်ပါသည်။

စဉ်	အကြောင်းအရာ	အရေအတွက်	စုစုပေါင်းအလျား
၁။	ရထားလမ်းအရှည်	1 No.	409.960 km
၂။	တံတားအရေအတွက်	124 Nos.	69.309 km
၃။	ဥမင်လှိုဏ်ခေါင်းအရေအတွက်	60 Nos.	221.469 km
၄။	ဘူတာရုံအရေအတွက်	36 Nos.	4 km

၁.၄.၄။အခြားတည်ဆောက်မှုများ

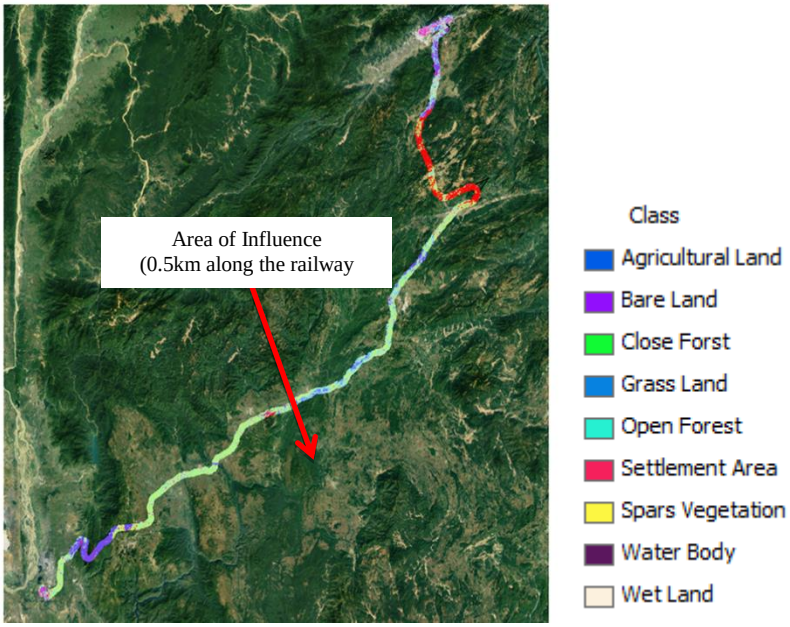
တံတားနှင့်ဥမင်လှိုဏ်ခေါင်း တည်ဆောက်ခြင်းလုပ်ငန်းများ မပါဘဲ မန္တလေးတောင်အရပ်မှ မွမ်းမံတည်ဆောက်မည့် မြစ်ငယ်ဘူတာရုံအထိ ၄.၁၇ကီလိုမီတာ တွဲလျက် ဖောက်လုပ်မည် ဖြစ်ပါသည်။

၁.၄.၅။မြေအသုံးချမှု

လူနေအဆောက်အအုံများဖြိုဖျက်မှုခန့်မှန်းအရေအတွက်မှာ ၁၂၂,၃၀၀ စတုရန်းကီလိုမီတာ ဖြစ်ပြီးမြေယာသိမ်းဆည်းမှုမှာ ၂၆,၁၄၁,၇၀၀ စတုရန်းမီတာဖြစ်သည်။ မြေကြီးလုပ်ငန်း အဆင့်ဆင့် မြေတူးမြေဖို့ပမာဏစုစုပေါင်းမှာ ၆၄.၅၁ သန်းစတုရန်းမီတာဖြစ်ပြီး ပန်းရံလုပ်ငန်းအတွက် မြေပမာဏစုစုပေါင်းမှာ ၅၉၁,၅၀၀ စတုရန်းမီတာဖြစ်သည်။ မြေအောင်မြောင်း ၈၁၉ ခု၏ စုစုပေါင်းအလျားမှာ ၃၁,၂၇၂.၁၈ မီတာဖြစ်သည်။ အဓိကရထားလမ်း၏အလျားမှာ ၄၀၉.၇၂ ကီလိုမီတာ၊ သံလမ်းဆွယ်၏အလျားမှာ ၁၂၀.၈၂ ကီလိုမီတာဖြစ်ပြီးရထားလမ်းလွှဲ ၃၄၇ ခုတပ်ဆင်မည်ဖြစ်သည်။ ရထားဘူတာ အဆောက်အအုံနေရာစုစုပေါင်းမှာ ၂၉၂,၃၀၀ စတုရန်းမီတာ ဖြစ်သည်။

(က) ရထားလမ်းကြောင်းဘေး မီတာ၅၀၀ အတွင်းမြေအသုံးချမှုအမျိုးအစားများ

GIS Study အရရထားလမ်းကြောင်းဘေး မီတာ၅၀၀ အတွင်းမြေအသုံးချမှု အမျိုးအစားများမှာ အောက်ပါ အတိုင်းဖြစ်ပါသည်။



အထက်ပါ GIS Study ကိုအသုံးပြု၍ မြေအသုံးချမှု အမျိုးအစားခွဲခြား ခြင်းအရ ရထားလမ်းကြောင်းအတွက် အသုံးပြုမည့် မြေအမျိုးအစားများမှာအောက်ပါအတိုင်းဖြစ်သည်။

No	Class	Area (Km^2)	Area (Km^2)	Area (Percentage)
1	Agricultural Land	218.9486	416.0773	52.622097
2	Bare Land	4.9292		1.184684
3	Open Forest	91.777		22.057680
4	Close Forest	44.8061		10.768696
5	Settlement	23.622		5.677310
6	Water Body	1.5959		0.383799
7	Wet Land	1.1969		0.287663
8	Grass Land	0.02		0.004807
9	Sparse Vegetation	29.1806		7.013264

အထက်ပါဇယားအရအသုံးပြုမှု အများဆုံးမြေအမျိုးအစားများမှာစိုက်ပျိုးမြေ (၅၂%)၊သစ်တောမြေ (၃၂%)၊ အခြေချမြေနေရာ (၅%) နှင့် သစ်ပင်ပန်းမန်မြေနေရာ (၇%).ကျန်မြေအမျိုးအစားများမှာ ရေထု (၀.၃%)၊ မြက်ခင်းပြင်ဧရိယာ(၁.၁%) နှင့် စိုစွတ်မြေနေရာ (၀.၂%) တို့ဖြစ်သည်။

၁.၄.၆။ စီမံကိန်းဖော်ပြချက်

ရထားလမ်းသစ်ဆောက်လုပ်ခြင်းသည် အဓိကအားဖြင့် အောက်ပါအဆင့်များအတိုင်းဖြစ်သည်။

(က) အကြိုဆောက်လုပ်ရေးလုပ်ငန်းများ

ရထားလမ်းကြောင်းမဆောက်လုပ်မီ ပြုလုပ်ရမည့် ပြင်ဆင်ရေးလုပ်ငန်းအချို့မှာ

- လုပ်ငန်းခွင်ရှင်းလင်းရေး
- Subgrade
- Subgrade drainage
- ဆောက်လုပ်ရေးလုပ်ငန်းများပြင်ဆင်ခြင်း

(ခ) ဆောက်လုပ်ရေးလုပ်ငန်းများ

ဆောက်လုပ်ရေးလုပ်ငန်းများတွင် အောက်ခင်းလမ်း(Roadbed) တည်ဆောက်ခြင်း၊ Steel bar တပ်ဆင်ခြင်းနှင့် ဇလီဖားတုံးချခြင်း၊ track panel frame များစီတန်းခြင်း၊ upper layer reinforcing steel bar နှင့် template တပ်ဆင်ခြင်း၊ အောက်ခံလမ်းကွန်ကရစ်လောင်းခြင်းနှင့် track panel frame တပ်ဆင်ခြင်းတို့ပါဝင်သည်။

(ဂ) လုပ်ငန်းလည်ပတ်ရေးနှင့် ပြုပြင်ထိန်းသိမ်းရေး

ရထားလမ်းကြောင်း လုပ်ငန်းလည်ပတ်ရေးတွင် ရထားလမ်းအား ပြုပြင်ထိန်းသိမ်းခြင်း လုပ်ငန်းလည်း ပါဝင်သည်။

၁.၄.၇။ ရေဆိုးသန့်စင်ခြင်းနှင့် စွန့်ပစ်ရေးစနစ်

အိမ်သုံးရေဆိုးသည် မိလ္လာကန်တွင်းသို့လည်းကောင်း၊ ဆီအညစ်အကြေးများသည် Oil Separation အနည်ကျကန်တွင်းသို့လည်းကောင်း စီးဝင်စေပြီးနောက် နှစ်မျိုးလုံးအား Integrated Membrane Bio-Reactor (MBR) ရေဆိုးသန့်စင်ရေးစက်တွင်းသို့ စီးဆင်းစေသည်။

၁.၄.၈။ လမ်း

လမ်းလုပ်ငန်းများအား ဘူတာသို့သွားရန်လမ်းနှင့် လုပ်ငန်းခွင်သုံးယာယီလမ်းဟူ၍ နှစ်မျိုး ခွဲခြားနိုင်သည်။ အမြဲသုံးလမ်းနှင့် ယာယီလမ်းနှစ်ခုပေါင်းသည် ယာယီလမ်းဆောက်လုပ်ရေးတွင် ထည့်သွင်းစဉ်းစားမည်ဖြစ်သည်။

၁.၄.၉။ စီမံကိန်းအကောင်အထည်ဖော်မှုအချိန်ဇယား

စီမံကိန်အကောင်အထည်ဖော်ရေးသည် စတင်သည့်နေ့မှစ၍ ၅ နှစ်ကြာမြင့်မည်ဖြစ်သည်။ ထိုကြောင့် ရထားဘူတာများသည်လည်း ၅ နှစ်အတွင်းတွင် ပြီးဆုံးမည်ဖြစ်သည်။

၁.၄.၁၀။ လုပ်သားအင်အား

စီမံကိန်းဆောက်လုပ်ရေးကာလအတွက် အင်ဂျင်နီယာများ ကျွမ်းကျင်လုပ်သားများနှင့် အထွေထွေလုပ်သားများအသုံးပြုမည်ဖြစ်ရာ စုစုပေါင်း ၃၇၅ ယောက်ရှိမည်ဖြစ်သည်။ လုပ်ငန်းလည်ပတ်ကာလအတွက် စီမံကိန်းသည် အမြဲတမ်းလုပ်သား ၂၆၄ ယောက်အသုံးပြုမည် ဖြစ်သည်။

၁.၄.၁၁။ အခြားနည်းလမ်းဖြင့် ဆောင်ရွက်နိုင်မှုစီစစ်ချက်အကျဉ်းချုပ်

အခြားနည်းလမ်းဖြင့် ဆောင်ရွက်နိုင်မှုကို ပတ်ဝန်းကျင် ထိခိုက်မှုဆန်းစစ်ခြင်း လုပ်ငန်း စဉ်ကို ပြည့်စုံစေရန် လိုအပ်သော အစိတ်အပိုင်းတစ်ခုအဖြစ် ထည့်သွင်းစဉ်းစားရပါသည်။ ၎င်း၏ရည်ရွယ်ချက်မှာ ထိခိုက်မှုများကို အနည်းဆုံးဖြစ်စေပြီး ကောင်းကျိုးများကို အများဆုံးရရှိ စေနိုင်မည့် ဖွံ့ဖြိုးရေးရွေးချယ်နိုင်မည့် အခွင့်အရေးကို ရရှိစေရန်ဖြစ်ပါသည်။

မူဆယ်-မန္တလေး ရထားလမ်းကြောင်းအတွက် အခြားနည်းလမ်းဖြင့်ဆောင်ရွက်နိုင်မှုကို (က)စီမံကိန်း ပြုလုပ်ခြင်း မရှိသည့် အခြားနည်းလမ်း စီစစ်ချက်နှင့် (ခ) ရထားလမ်းကြောင်း အတွက် အခြားနည်းလမ်းစီစစ်ချက် တို့ ပြုလုပ်ရမည်ဖြစ်သည်။စီမံကိန်းပြုလုပ်ခြင်း မရှိသည့် အခြားနည်းလမ်းစီစစ်ချက်၊ တည်နေရာ အခြားနည်းလမ်းစီစစ်ချက်၊ တည်ဆောက်ရေး နည်းလမ်းများ အခြားနည်းလမ်းစီစစ်ချက်များသည် အခြားနည်းလမ်းဖြင့် ဆောင်ရွက်နိုင်မှုအဖြစ် အသုံးပြုရာတွင် ပါဝင်သော်လည်း လုပ်ငန်းဖြစ်နိုင်ခြေလေ့လာခြင်း (Feasibility Study (FS)) အဆင့်တွင် ရထားလမ်းကြောင်းပေါ်ရှိ တံတားများ(bridges)နှင့် မြေအောက်မြောင်းများ (culverts)၏ အသေးစိတ် တိကျသော တည်နေ ရာလမ်းကြောင်းအား စီမံကိန်းအကောင်အထည် ဖော်မည့်သူမှ မသတ်မှတ်ထားသောကြောင့် လုပ်ငန်းဖြစ်နိုင်ခြေ လေ့လာခြင်းအဆင့်တွင် တံတား တည်နေရာ အခြားနည်းလမ်းစီစစ်ချက်ကို မပြုလုပ်နိုင်ပေ။ ထို့ကြောင့် အခြားနည်းလမ်းဖြင့်

ဆောင်ရွက်နိုင်မှုတွင် စီမံကိန်းပြုလုပ်ခြင်းမရှိသည့် အခြားနည်းလမ်းစီစစ်ချက်နှင့်တည်ဆောက်ရေး နည်းလမ်းများ အခြားနည်းလမ်း စီစစ်ချက်၊ တို့ကိုသာ ဖော်ပြထားပါသည်။

(က) စီမံကိန်းပြုလုပ်ခြင်းမရှိသည့် အခြားနည်းလမ်းစီစစ်ချက်

သဘာဝပတ်ဝန်းကျင်ဆိုင်ရာရှုထောင့်

ဤစီစစ်ချက်သည် မူဆယ်-မန္တလေးရထားလမ်းစီမံကိန်း အကောင်အထည်ဖော်မှု မရှိသော အခြေအနေဖြစ်သည်။ စီမံကိန်းမဖြစ်မြောက်ခဲ့ပါက သဘာဝပတ်ဝန်းကျင်နှင့် လူမှုရေး ထိခိုက်မှုများ ဖြစ်ပေါ်နိုင်ခြေမရှိချေ။ သက်ရောက်မှုများကို ဆန်းစစ်လေ့လာကြည့်ပါက အဆိုပြု ရထားလမ်း စီမံကိန်းနှင့် သက်ဆိုင်သော သဘာဝပတ်ဝန်းကျင်ထိခိုက်မှုများမှာ သင့်တော်သော နည်းလမ်းများဖြင့် လျော့ချနိုင်သည်ဖြစ်ရာ ဤစီစစ်ချက်သည် သဘာဝပတ်ဝန်းကျင်ဆိုင်ရာ ရှုထောင့်မှ ကြည့်လျှင် ပြုလုပ်သင့်သော စီစစ်ချက်တစ်ခုမဟုတ်ပါ။

လူမှုစီးပွားဆိုင်ရာရှုထောင့်

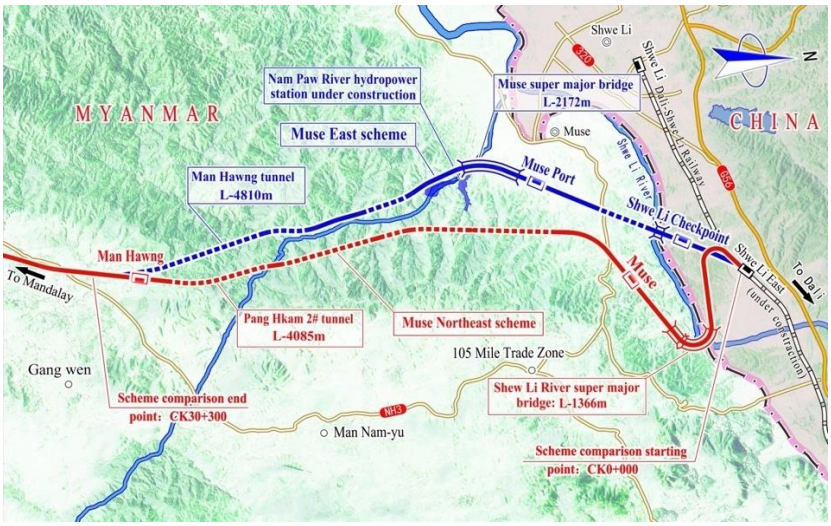
အဆိုပြုစီမံကိန်းသည် မြေအမြောက်အများအသုံးပြုမည်ဖြစ်ပြီး မြေယာရယူမှုများနှင့် ပြန်လည် နေရာချထားမှုများဖြစ်လာနိုင်ခြေရှိသည်။ သို့သော် ရထားလမ်းကြောင်းတစ်လျှောက် နောက်ပြန်ကုန်ထုတ်စွမ်းအားနှင့် အဆင်မပြေသောခရီးအသွားအလာစနစ်သည် မန္တလေးနှင့် ရှမ်းပြည်နယ်၏ စီးပွားရေးဖွံ့ဖြိုးတိုးတက်မှုကို အဟန့်အတားဖြစ်စေသည်။ မြန်မာနိုင်ငံတွင်း တွင်လည်း လမ်းကြောင်းတစ်လျှောက်ရှိလူထုကို ဆင်းရဲခြင်းဖြင့်ဆက်နေစေပြီး လူမှုရေး လုပ်ငန်း များကိုလည်း နောင့်နှေးစေလိမ့်မည်။

ဤစီစစ်ချက်၏ ဆုံးရှုံးမှုများမှာ နိုင်ငံခြားရင်းနှီးမြှုပ်နှံမှုဆုံးရှုံးခြင်း၊ ဒေသတွင်း သယ်ယူပို့ဆောင်ရေး ဖွံ့ဖြိုးမှုများ ဆုံးရှုံးခြင်း၊ ဒေသခံများအတွက် အလုပ်အကိုင် အခွင့်အလမ်းများ ဆုံးရှုံးခြင်း၊ အခြေခံအဆောက်အအုံဖွံ့ဖြိုးတိုးတက်မှုဆုံးရှုံးခြင်း၊ ဒေသတွင်း ဝန်ဆောင်မှု လုပ်ငန်းများ အတွက် စီးပွားရေးအခွင့်အလမ်းများ ဆုံးရှုံးခြင်း၊ ကျွမ်းကျင်မှုဖွံ့ဖြိုးရေးများနှင့် ရပ်ရွာ

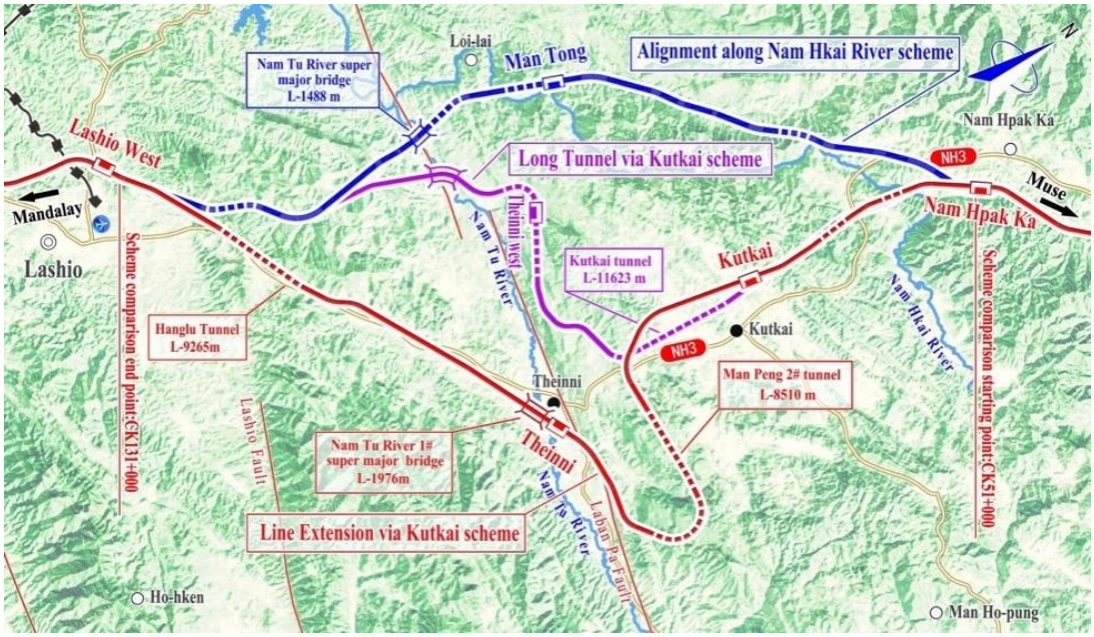
ဖွံ့ဖြိုးရေး၏ တိုးတက်သော ဝန်ဆောင်မှုများ ဆုံးရှုံးခြင်းတို့ဖြစ်သည်။ မူဆယ်-မန္တလေး ရထားလမ်း ဆောက်လုပ်ခြင်းဖြင့် လမ်းခရီးအသွားအလာများ တိုးတက်လာနိုင်ပြီး နိုင်ငံစီးပွားရေး၊ လူထု၏ လူနေမှု အဆင့်အတန်းနှင့် စီးပွားရေးဖွံ့ဖြိုးမှု တည်ငြိမ်မှုများကို အဓိကကျစေသည့် သယ်ယူပို့ဆောင်ရေးစရိတ်များ သက်သာစေနိုင်သည်။ မြန်နှုန်းမြင့်ရထားလမ်းစနစ်သည် မြန်မာနိုင်ငံ၏ သယ်ယူပို့ဆောင်ရေးစနစ်တိုးတက်မှုအတွက် ကောင်းသော သက်ရောက်မှုဖြစ်စေနိုင်မည်ဖြစ်သည်။ သို့ဖြစ်ပါ၍ စီမံကိန်းပြုလုပ်ခြင်းမရှိသည့် အခြားနည်းလမ်းစီစစ်ချက်သည် မြန်မာနိုင်ငံအတွက် အခွင့်အရေးဆုံးရှုံးမှုများဖြစ်နိုင်သည့်အတွက် လက်ရှိအခြေအနေနှင့် မကိုက်ညီပါ။ စီမံကိန်းအဆိုပြုသူသည် မြေယာရယူမှုနှင့် ပြန်လည်နေရာချထားရေးများအတွက် သင့်တော်သော Comprehensive Resettlement Plan (RAP) ကိုချမှတ်ပေးရမည်ဖြစ်သည်။

(ခ) ရထားလမ်းကြောင်းအတွက် အခြားနည်းလမ်းစီစစ်ချက်

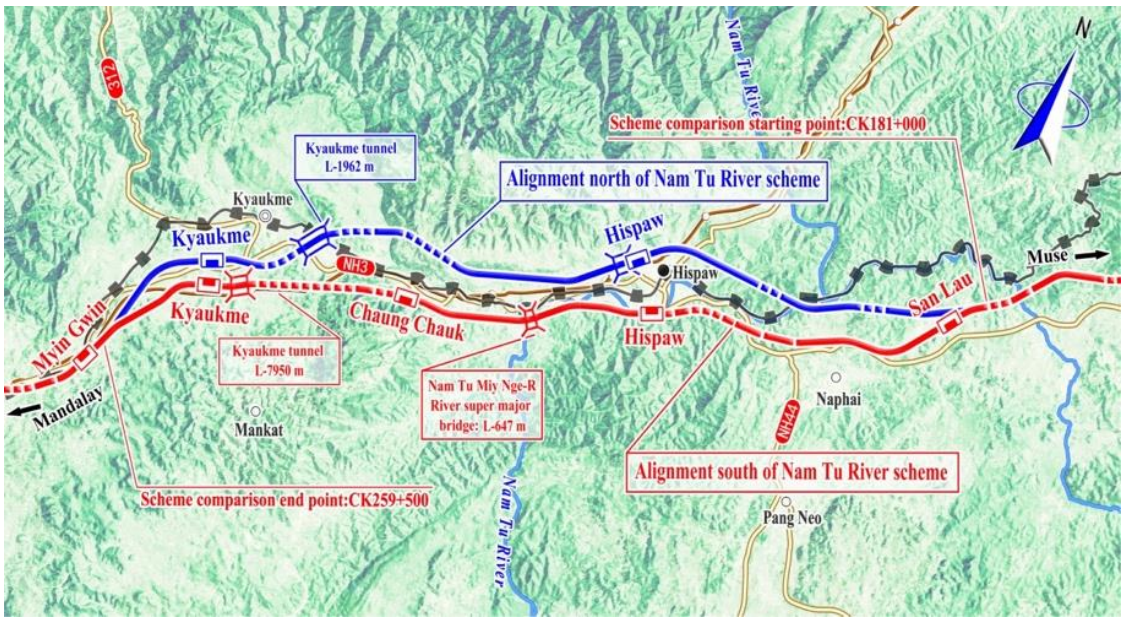
ဤစီစစ်ချက်တွင် ရထားလမ်းကြောင်းများကို နည်းပညာ၊စီးပွားရေးနှင့် ပတ်ဝန်းကျင်ဆိုင်ရာ ရှုထောင့်အသီးသီးမှနေ၍ ရွေးချယ်ခြင်း ပါဝင်သည်။ အသေးစိတ်အချက်အလက်များကို ပတ်ဝန်းကျင်ထိခိုက်မှု လေ့လာဆန်းစစ်ခြင်းတင်ပြချက်တွင် ဖော်ပြထားသည်။



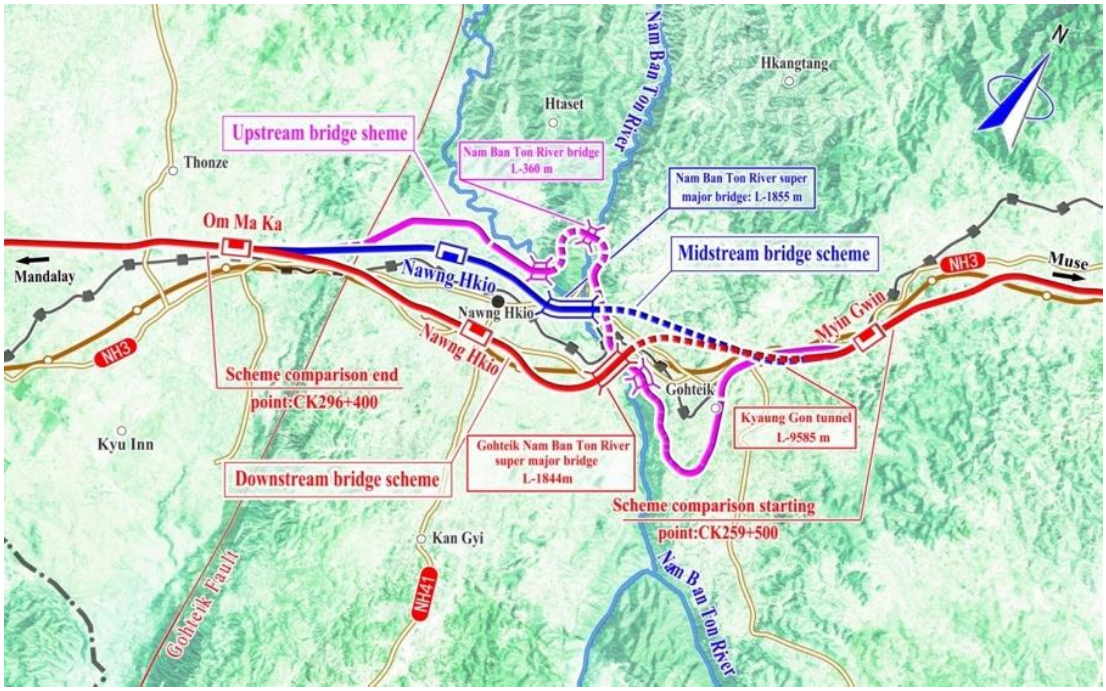
Schematic Map for Alignment Scheme of Shweli East-Man Hawng Section



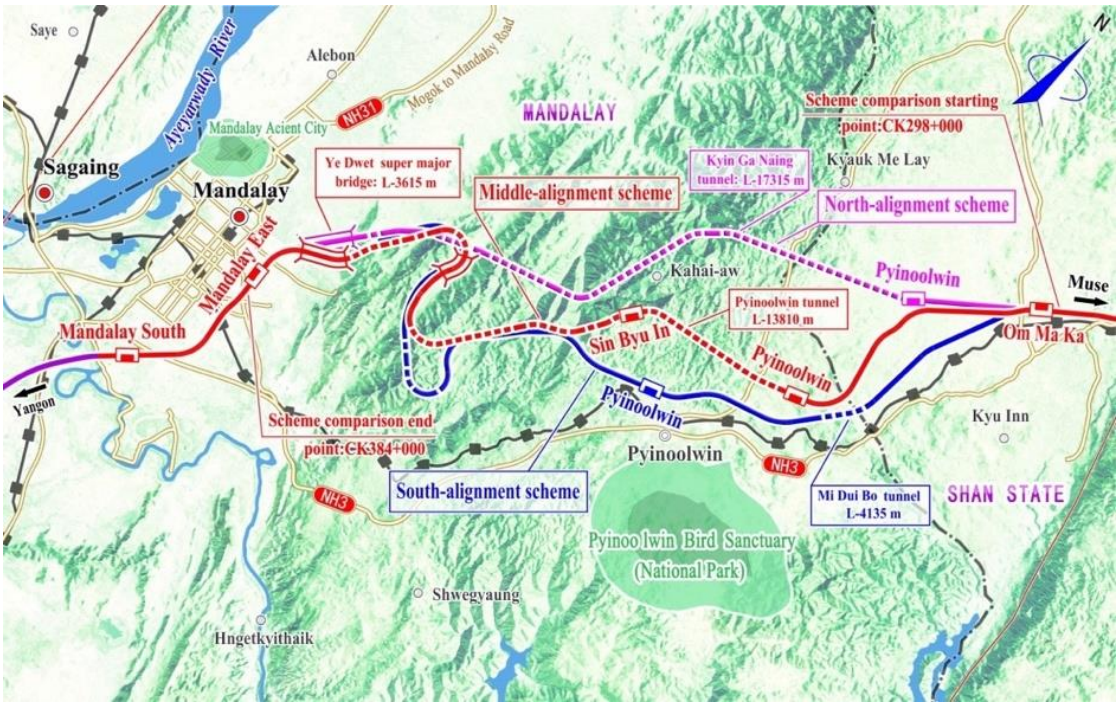
Schematic Map for alignment scheme of Nam Hpak Ka-Lashio West Section



Schematic Map of the alignment scheme of San lau-MyinGwin Section



Schematic Map for the alignment scheme of MyinGwin-Om Ma Ka section

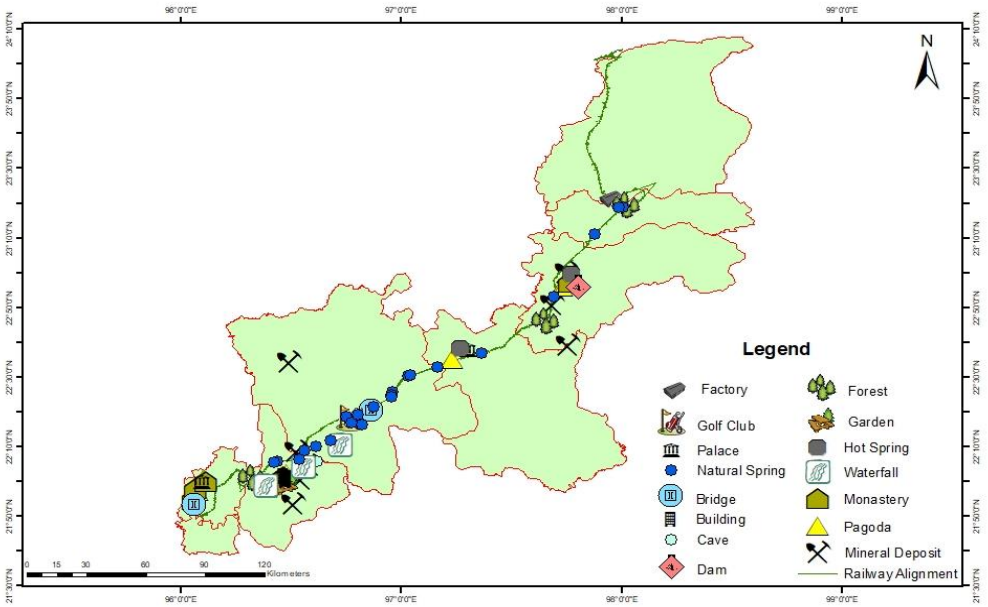


Schematic Map for the alignment scheme of Om ma ka–Mandalay section

၁.၅။ရှိရင်းစွဲပတ်ဝန်းကျင်အခြေအနေဖော်ပြချက်အနှစ်ချုပ်

၁.၅.၁။ပတ်ဝန်းကျင်ထိရှလွယ်သည့်နေရာများ

မူဆယ်-မွန္လေးရထားလမ်းကြောင်း တစ်လျှောက်ရှိ စိုက်ပျိုးမြေများ၊ သစ်တောဇရိယာများ၊ သဘာဝရေထွက်များအားလုံးကို ပတ်ဝန်းကျင်အရထိရှလွယ်သည့် နေရာများ အဖြစ်သတ်မှတ်လေ့လာ သွားမည်ဖြစ်ပါသည်။



ပုံ- မူဆယ်-မွန္လေးရထားလမ်းတစ်လျှောက်ရှိပတ်ဝန်းကျင် ထိရှလွယ်သည့်နေရာများ*(Source: EGT EIATeam, 2020)*

၁.၅.၂။စစ်တပ်နယ်မြေများ

နမ့်ဖက်ကာ၊ လားရှိး၊ ပြင်ဦးလွင်နယ်မြေနှင့် အခြားနယ်မြေ အချို့တွင် စစ်တပ်နယ်မြေများရှိပါသည်။

၁.၅.၃။ စက်မှုဇုန်နှင့် သတ္တုတူးဖော်ရေးလုပ်ငန်းများ

ရထားလမ်းတစ်လျှောက်တွင် အသေးစားကျောက်မိုင်းများရှိသည်။

၁.၅.၄။ ဘူမိနည်းပညာဆိုင်ရာစရိုက်လက္ခဏာများ

မူဆယ်-မွန္းလေးရထားလမ်းတစ်လျှောက်ရှိဘူမိနည်းပညာဆိုင်ရာစရိုက်လက္ခဏာများမှာ

i. Karst

ii. Landslide and Talus

iii. Unstable Rocks and Rock-Fall

iv. Bedding

v. Seismic Liquefaction

vi. Soft Soil and Mollisol

vii. Expansive Soil

viii. Expansive Rock

ix. High Ground Stress

၁.၅.၅။တွင်းထွက်သတ္တုသိုက်များ

ရှိရင်းစွဲဘူမိဗေဒ မှတ်တမ်းများအရ တွင်းထွက်သတ္တုသိုက်များတွင် ခဲ-ဇင့်-ငွေ၊ အန်တီမိုနီ၊ ရွှေ ပါဝင်နေမည်ဟုမျှော်မှန်းရသည်။ ကျောက်မီးသွေးနှင့် ဖော့စဖရပ်သတ္တုသိုက်များ လည်းတွေ့နိုင်သည်။ အချို့သောသတ္တုသိုက်များသည် ရထားလမ်းနှင့် ဝေးရာတွင်ရှိနေသည်။ တွင်းထွက်သတ္တုသိုက်များသည် N-S direction အတိုင်းရှိနိုင်ပြီးဥမင်လှိုက်ခေါင်း၊ တံတား၊ ရထားဘူတာနှင့် ရထားလမ်းဆောက်လုပ်ရေးကာလများအတွင်းတွင်လည်းရှာတွေ့နိုင်သည်။ ဥပမာအနေဖြင့် ဖယောင်းတာင်ရွှေသည် ဆောက်လုပ်ရေးမှ ဝေးနိုင်ပြီးရွှေတွေ့ရှိမှုများကို ရှုမ်းပြည်နယ် အနောက်ဘက် တစ်လျှောက်တွင် တွေ့နိုင်သည်။ ရတနာသိဒ္ဓိ ခဲ-ဇင့်-ငွေ သတ္တုသိုက်အတွက် မူခပ်ဆင်ဆင်သတ္တုသိုက်များကို ပြင်ဦးလွင်၊ နောင်ချို နှင့် ကျောက်မဲတစ်လျှောက်တွင် တွေ့နိုင်

သည်။ ဘော်တွင်းသတ္တုတွင်းနှင့် မိုဟိုချောင်းသတ္တုတွင်းများမှ သတ္တုသိုက်များသည် သီပေါ၊ လားရှိုး၊ ကွတ်ခိုင်နှင့် နမ့်ဖက်ကာဒေသများတစ်လျှောက်တွင် ထပ်မံတွေ့ရှိနိုင်သည်။

၁.၅.၆။ သတ္တုလုပ်ငန်းများ

မူဆယ်-မန္တလေးရထား လမ်းတစ်လျှောက်တွင် တွင်းထွက်သတ္တုလုပ်ငန်းများ ရှိသည်။ သို့ရာတွင် သတ္တုတွင်းလုပ်ငန်းများအားလုံးသည် ရထားလမ်းဥမင်လိုဏ်ခေါင်းများမှ သက်ရောက်မှုဇုန်များနှင့် ဝေးရာတွင်ရှိသည်။

၁.၅.၇။ လေထုအရည်အသွေးနှင့် ဆူညံသံ

စက်မှုလုပ်ငန်းများတိုးတက်ဖွံ့ဖြိုးမှုနည်းသောနယ်မြေ၊သယ်ယူပို့ဆောင်ရေး အသွားအလာနည်းပါးသော နယ်မြေဖြစ်သောကြောင့် ဓာတ်အားခွဲစက်ရုံတည်ဆောက်သွားမည့် ရထားလမ်းဘူတာတစ်လျှောက်တွင် လေထုအရည်အသွေးသင့်တော်ကောင်းမွန်ပါသည်။

၁.၅.၈။ တုန်ခါမှုအတိုင်းအတာ

တုန်ခါမှုအဆင့်များသည် အဆိုပြု မူဆယ်-မန္တလေးရထားလမ်းတစ်လျှောက် တိုင်းတာခဲ့သည်။ တိုင်းတာခဲ့သော နေရာများမှာ ပြင်ဦးလွင် အုတ်ဖိုရွာ (ဘုန်းကြီးကျောင်း) ၊ နောင်ချိူ - ရွှေပြည်ညွှန့်ရွာ၊ ဂုတ်ထိပ်၊ သီပေါ (ဘော်ကြိူဘုရားနား)၊သီပေါအလွန် (စံလောင်း)၊ လားရှိုး၊ ဆည်နီ၊ နမ့်ဖက်ကာနှင့် မူဆယ်တို့ဖြစ်သည်။ တိုင်းတာမှုအားလုံးသည် လက်ခံနိုင်သော အဆင့်အတွင်းရှိပါသည်။

၁.၅.၉။ ရေထုအရည်အသွေး

ရထားလမ်းကြောင်းတစ်လျှောက်ရှိ မြစ်ချောင်းများအတွင်းမှ ရေအရည်အသွေးအားလုံးအား ကောက်ယူတိုင်းတာခဲ့ရာတိုင်းတာမှုရလဒ်များအရအိမ်သုံးရေအတွက် သင့်တော်ကောင်းမွန် ပါသည်။

၁.၅.၁၀။ ရေကာတာနှင့် ရေအားလျှပ်စစ်

မြစ်ငယ်မြစ်နှင့် ရွှေလီမြစ်များတွင် ရေအားလျှပ်စစ်နှင့် စိုက်ပျိုးရေးအတွက် ဆောက်လုပ်ထားသော ရေကာတာများတည်ရှိသည်။ နမ္မတူ-မြစ်ငယ်မြစ်ပေါ်တွင် ရဲရွာရေကာတာသည် ဆောက်လုပ်ပြီးစီးပြီးဖြစ်သည်။ နမ္မတူရေကာတာနှင့် အထက်ရဲရွာ ရေကာတာတို့သည် ဆောက်လုပ်ဆဲ ဖြစ်ပြီးအလယ်ရဲရွာရေကာတာနှင့် ဒီးဒုတ်ရေကာတာတို့သည် ဆောက်လုပ်ရန် စီစဉ်ထားဆဲဖြစ်သည်။ ရွှေလီမြစ်ပေါ်ရှိရွှေလီ ၁ ရေအားလျှပ်စစ် စီမံကိန်းသည် ဆောက်လုပ်ပြီးဖြစ်ပြီး ရွှေလီ၂ နှင့် ၃ သည် ဆောက်လုပ်ဆဲကာလဖြစ်သည်။ ရထားလမ်းတစ်လျှောက်နှင့် အနီးတစ်ဝိုက်တွင် သဘာဝရေကန်များ၊ ရေအိုင်များ၊ ရေတံခွန်များ၊ စမ်းချောင်းများနှင့် ရေလှောင်ကန်အသေးစားများရှိနိုင်ပြီး ဒေသခံပြည်သူသည် ၎င်းတို့မှ ရေကိုစိုက်ပျိုးရေးနှင့် အိမ်သုံးရေအဖြစ် အသုံးပြုခြင်းကိုအလေ့အကျင့်ရနေပြီးဖြစ်သည်။

၁.၅.၁၁။ မြေအောက်ရေတွေ့ရှိမှုနှင့် ဖြန့်ဖြူးရေး

ရထားလမ်းတစ်လျှောက် မြေအောက်ရေသည် အောက်ပါအတိုင်း အမျိုးအစားများ တွေ့ရှိနိုင်သည်။

၁. Loosely cemented soil နှင့် သက်တမ်းနသောကျောက်များတွင်းရှိ pore-water

၂. ကျောက်တုံးများနှင့် ပုံဆောင်ခဲကျောက်ဆောင်များရှိ bedrock fissure

၃. ကာဗွန်ကျောက်များရှိ karst water

၄. မြေတွင်းမှ geothermal water

မြန်မာနိုင်ငံရှိရေအောင်းလွှာများသည် ရှေးနှစ်ပေါင်းများစွာမှ ယနေ့ခေတ်အထိ တည်ရှိခဲ့ပြီး ကမ်းခြေပိုင်းမှ တောင်မြောက်မဟာဗျူဟာကျကျ ထိန်းချုပ်ထားသောချိုင့်ဝှမ်းများအထိရှိသည်။ အဓိက မြေအောက်ရေစီးဆင်းမှုမှာဖွန်လမှ စက်တင်ဘာအထိ တိုးသော မုတ်သုံမိုးရွာသွန်းမှုကြောင့်ဖြစ်သည်။ မိုးရေချိန်မှာ မြစ်ဝကျွန်းပေါ်ဒေသများတွင် ၃၀၅၀ မီလီမီတာထိ၊ မြောက်ဘက်ပိုင်းတွင် ၃၈၁၀ မီလီမီတာ၊ အရှေ့ဘက်တောင်တန်းဒေသများတွင် ၂၀၀၀ မီလီမီတာနှင့် အလယ်ပိုင်းခြောက်သွေ့ဒေသများတွင် ၇၆၀ မီလီမီတာထိရှိနိုင်သည်။ အကြီးဆုံး ရေအောင်းလွှာသည် ဇရာဝတီမြစ်ဝှမ်းဖြစ်ပြီး IGBM မြစ်ဝှမ်းသည် ရေထွက်များသော ရေအောင်းလွှာ

ဖြစ်သည်။ သို့ရာတွင် ချိုင့်ဝှမ်းအများအပြားရှိရေအောင်းလွှာများသည် အာဆင်းနစ်ပါဝင်သော မြေအောက်ရေများရှိကြောင်း သက်သေပြထားပြီးဖြစ်သည်။ အခြားသော ရေအောင်းလွှာများသည် သံလွင်၊ ချင်းတွင်းနှင့် စစ်တောင်းမြစ်များတွင် ရှိသည်။

၁.၅.၁၂။ မြေအရည်အသွေး

မြေ sample များအားရထားလမ်းတစ်လျှောက်တွင် ကောက်ယူခဲ့ပြီး ရန်ကုန်စိုက်ပျိုးရေး ဌာနတွင် စမ်းသပ်ခဲ့ပါသည်။ စမ်းသပ်ချက်ရလဒ်များအရမြေ sample များအားလုံးသည် စိုက်ပျိုးရေး လုပ်ငန်းအတွက် သင့်တော်ပါသည်။

၁.၅.၁၃။ လူမှုစီးပွားရေး

အဆိုပြုရထားလမ်းသည် ရှမ်းပြည်တွင် အများအပြားဖြတ်သွားပြီးမွန္နလေးဒေသများတွင် တစ်စိတ်တစ်ပိုင်းဖြတ်သွားမည်ဖြစ်သည်။ ဤဒေသနှစ်ခုတွင် မတူညီသော လူမှုစီးပွားရေးဆိုင်ရာ အခြေအနေများရှိသည်။ ရထားလမ်းဖြတ်သွားမည့် ရှမ်းပြည်နယ်ဒေသများရှိ လူမှုစီးပွားဆိုင်ရာ အခြေအနေများသည် လယ်ယာစိုက်ပျိုးရေးလွှမ်းမိုးပြီးဖွံ့ဖြိုးမှုနည်းပါးသည်။

၁.၅.၁၄။ ရှေးဟောင်းယဉ်ကျေးမှုအမွေအနှစ်

လေ့လာချက်များအရ ရှေးဟောင်းသမိုင်းဝင် စေတီပုထိုးများသည်ယာယီ သတ်မှတ်လမ်းကြောင်း အတွင်းပါဝင်ခြင်းမရှိသော်လည်းလေ့လာဆန်းစစ်သွားမည်ဖြစ်ပါသည်။

၁.၅.၁၅။ စေတီများနှင့်ဘုရားများ

လေ့လာချက်များအရ ရှေးဟောင်းသမိုင်းဝင် စေတီပုထိုးများသည် ယာယီသတ်မှတ်လမ်းကြောင်း အတွင်းပါဝင်ခြင်းမရှိသော်လည်းလေ့လာဆန်းစစ်သွားမည်ဖြစ်ပါသည်။

၁.၆။ဖြစ်ပေါ်နိုင်သည့်ထိခိုက်မှုများနှင့်လျော့နည်းသက်သာစေရန်လုပ်ဆောင်ရမည့်နည်းလမ်းများ

ရထားလမ်းဖောက်လုပ်ခြင်း လုပ်ငန်းစဉ်ကြောင့် ဖြစ်ပေါ်လာနိုင်သည့် ထိခိုက်မှုများနှင့် လျော့နည်း သက်သာစေရန် လုပ်ဆောင်ရမည့် နည်းလမ်းများအား အောက်ဖော်ပြပါ ဇယားတွင် ဖော်ပြထား ရှိပါသည်။

ဇယား-ဖြစ်ပေါ်နိုင်သည့်ထိခိုက်မှုများနှင့်လျော့နည်းသက်သာစေရန် လုပ်ဆောင်ရမည့် နည်းလမ်းများ

အကြောင်းအရာ	ဖော်ပြချက်	ဖြစ်နိုင်ချေရှိသောပတ်ဝန်းကျင်နှင့် လူမှုရေးသက်ရောက်မှုများနှင့် အရင်းအမြစ်များ	Receptors	လျော့ချရေးအတိုင်းအတာများ
ဆောက်လုပ်ရေးမတိုင်မီကာလ				
လုပ်ငန်းခွင်ရှင်းလင်းခြင်းနှင့် မြေလုပ်ငန်းများ	**လေထုပတ်ဝန်းကျင်အပေါ် သက်ရောက်မှု**	(က) ဖုန်မှုန့်ထုတ်လွှတ်မှု - လုပ်ငန်းခွင်ရှင်းလင်းရေးနှင့် မြေသားဖယ်ရှားခြင်း လုပ်ငန်းများတွင် အသုံးပြုသော မြေတူးစက်များ မြေသယ် ကားများမှ ထွက်သောဖုန်မှုန့်များ	၁။ အနီးအနားကျေးရွာများမှ ဒေသခံများ ၂။ သယ်ယူရေးလမ်းတစ်လျှောက်ရှိ ပြည်သူများ ၃။သယ်ယူရေးလမ်းတစ်လျှောက်ရှိ သစ်ပင်မျိုးစုံမျိုးကွဲများ	- ဆောက်လုပ်ရေး လုပ်ငန်းခွင်နှင့်လမ်းမများတစ်လျှောက် ရေဖြန်းပေးခြင်း။ - လက်ကိုင်စပရေးဖြင့် ရေဖြန်းခြင်း။
		(ခ) မော်တော်ယာဉ်များမှ ဓာတ်ငွေ့ထုတ်လွှတ်မှု - မော်တော်ယာဉ်များနှင့် စက်ပစ္စည်းများမှ ထွက်သောဓာတ်ငွေ့များ	ပတ်ဝန်းကျင်လေထုအရည်အသွေး	- အလုပ်ချိန်အတွင်းမလိုအပ်ပဲလုပ်ငန်းဆိုင်းငံ့ထားချိန်များလျော့ချရန်။ - ဒေသတွင်းလမ်းကြောပိတ်ဆို့မှုများရှောင်ကြဉ်ရန်။ - အင်ဂျင်ကောင်းသောစက်များအသုံးပြုရန်။ - မော်တော်ယာဉ်များနှင့် စက်ပစ္စည်းများကိုပုံမှန်ပြုပြင်ထိန်းသိမ်းရန်။
		(ဂ) ဆူညံသံတိုးပွားမှု - စက်ကြီးများနှင့် မော်တော်ယာဉ်များမှ ထွက်သောဆူညံသံ	အနီးအနားကျေးရွာများမှ ဒေသခံနေထိုင်သူများ	- ညအချိန် အလုပ်လုပ်ခြင်းနှင့် ဆူညံသော စက်များအသုံးပြုခြင်းကိုကန့်သတ်ရန်။ - ညအချိန်ပြုလုပ်ရန် လိုအပ်သော ဆောက်လုပ်ရေးလုပ်ငန်းများကိုစနစ်တကျ စီမံရန်။ - စက်ပစ္စည်းများကိုပုံမှန် ပြုပြင်ထိန်းသိမ်းရန်။

	မြေပေါ်ရေပတ်ဝန်းကျင်အပေါ် သက်ရောက်မှု	(က) စွန့်ပစ်အရည် -မြေတူးခြင်းလုပ်ငန်းများကြောင့် ယာယီရေညစ်ညမ်းခြင်း -မြေပေါ်ရေစီးဆင်းမှု ကွန်ယက်များ ညစ်ညမ်းခြင်း -လောင်စာဆီနှင့် ချောဆီများကိုင်တွယ်မှု မမှန်ခြင်း။	မြေပေါ်ရေအရည်အသွေး	- ဓာတုပစ္စည်းများနှင့် လောင်စာများကို MSDS လမ်းစဉ် အရမှန်ကန် သင့်လျော်စွာကိုင်တွယ်ရန် အလုပ်သမား များအား သင်တန်းပေးခြင်း။ - ယာယီမိလ္လာကန်များနှင့်စွန့်ပစ်ရေပုံပိုးမှုများထားရှိရန်။ - စွန့်ပစ်ဇရိယာတစ်ဝိုက်တွင် သင့်တော်သောရေနုတ်မြောင်းစနစ်ရှိသည့် အနည်ထိုင်ကန်များအသုံးပြုရန်။
		(ခ) စွန့်ပစ်အစိုင်အခဲ -မြေသားဖယ်ရှားခြင်းမှ ထွက်သော မသင့်တော်သည့် မြေစိုင်ခဲများ -အိမ်သုံးစွန်ပစ်အစိုင်အခဲ	မြေပေါ်ရေအရည်အသွေး	- အိမ်သုံးစွန့်ပစ်ပစ္စည်းများအားလျော့ချခြင်း၊ ပြန်လည်အသုံးပြုခြင်းနှင့် ထပ်မံအသုံးချခြင်း။ - မလိုအပ်ပဲမြေသားဖယ်ရှားခြင်းများကန့်သတ်ရန်။ - အလွန်အကဲတူးဖော်ခြင်းများအားတားမြစ်ရန်။ - အချိန်ကာလတစ်ခုအတွင်းသေးငယ်သောဇရိယာတွင် အလုပ်လုပ်ရန်။
	မြေဆီလွှာနှင့် မြေအောက်ရေပတ်ဝန်းကျင်အပေါ် သက်ရောက်မှု	-အလုပ်သမားများ၏ အိမ်သုံးစွန့်ပစ်ပစ္စည်းများ -ဇီဝလောင်စာနေရာရှင်းလင်းခြင်းနှင့် သစ်ပင်ခုတ်ခြင်း -မြေဖယ်ခြင်းလုပ်ငန်းများမှ မြေသားများ	မြေဆီလွှာညစ်ညမ်းခြင်းနှင့် မြေအောက်ရေအရည်အသွေး	- စည်ပင်၏ ဥပဒေနှင့် နည်းဥပဒေများနှင့် အညီ စွန့်ပစ်ရန်။ - စွန့်ပစ်အစိုင်အခဲစီမံခန့်ခွဲမှု။
	ဇီဝမျိုးစုံမျိုးကွဲမျာ းအပေါ် သက်ရောက်မှု	(က) သစ်ပင်မျိုးစုံမျိုးကွဲများအပေါ် သက်ရောက် မှု -ရထားလမ်းတစ်လျှောက်နှင့် ဘူတာများ ဆောက်လုပ်ရေးအတွက် သစ်ပင်များရှင်းလင်းခြင်း။	သစ်ပင်မျိုးစုံမျိုးကွဲများ	- လမ်းနံဘေးသစ်ပင်များနှင့် ခြံစည်းရိုးသစ်ပင်များကိုခုတ်ပစ်ခြင်းမပြုရန်။ - ဆူညံသံမြင့်မားသော စက်များ၏ လည်ပတ်မှုနှင့် ညအချိန် အလုပ်လုပ်ခြင်းကိုကန့်သတ်ရန်။

		(ခ) တိရစ္ဆာန်မျိုးစုံမျိုးကွဲများအပေါ် သက်ရောက်မှု ဆူညံသံများပြားခြင်းကြောင့် တော်ရိုင်း တိရစ္ဆာန်များ၏ အစာစားပုံ၊ မျိုးပွားမှုနှင့် လှုပ်ရှားသွားလာမှုကိုထိခိုက်စေနိုင်သည်။	တိရစ္ဆာန်မျိုးစုံမျိုးကွဲ	- အသံလုံတိုင်းတာမှုကိုဇီဝမျိုးစုံမျိုးကွဲများထိခိုက်နိုင်သော ဒေသများတွင်ပြုလုပ်ရန်။ - တွင်းနက်များရှိနိုင်ပါကတိရစ္ဆာန်မျိုးကွဲများ၏ ဝေးရာတွင် ထားရန်။
	လူထုပတ်ဝန်းကျင် အပေါ် သက်ရောက်မှု	လူမှုစီးပွားဆိုင်ရာသက်ရောက်မှုများ လူမှုစီးပွားဆိုင်ရာကောင်းသော သက်ရောက်မှု - ဒေသခံအလုပ်သမားအနည်းဆုံး ၃၀၀၀ ကျော် ခန့်ထားရန်။	ဒေသခံပြည်သူ	- ဒေသခံပြည်သူအများအပြားခန့်ထားရန် မူဝါဒ။
		လူမှုစီးပွားဆိုင်ရာထိခိုက်မှုများ **မြင်ကွင်းအပေါ်သက်ရောက်မှု** လုပ်ငန်းခွင်ရှင်းလင်းခြင်းနှင့် ရထားလမ်း တစ်လျှောက် အပင်ခုတ်ခြင်း လုပ်ငန်းများ မှထွက်သော မြင်ကွင်းပျက်စီးမှုများ	ဒေသခံပြည်သူ	- လိုအပ်ချက်အရအထောက်အကူပြု၍ အချိန်မှန်သော ဖြို့ခွဲခြင်းလုပ်ငန်းများနှင့် ဆောက်လုပ်ရေးစွန့်ပစ်ပစ္စည်း ဖယ်ရှားမှု။
		မြေယာရယူမှုနှင့် ဆန္ဒမပါသော ပြန်လည် နေရာချထားရေး -မြေယာရယူမှုနှင့် အတင်းအကြပ် မဟုတ်သော ပြန်လည်နေရာ ချထားရေး သည် ဒေသခံများ၏ လူမှုစီးပွား အခြေအနေ များကိုထိခိုက်စေသည်။ - အဆောက်အဦးများနှင့် အခြား ပစ္စည်း များ၏ ပြန်လည်နေရာချထားရေးကြောင့်	ရထားလိုင်းအနီးရှိဒေသခံပြည်သူ	- ထိခိုက်သောအဆောက်အအုံများနှင့် သီးပင်စားပင်များအတွက် လျော်ကြေးနှင့် RAP အရ အသက်မွေးဝမ်းကြောင်း ပြန်လည်ထူထောင်ရေးအတွက် အကူအညီများ။ - ရွှေ့ပြောင်းခံရသောဆိုင်ခန်းများအတွက် သင့်လျော်သည့် ပေးလျော်ခြင်းနည်းစနစ်များ။ - RAP ၏ လျော်ကြေးနည်းစနစ်များအရစိုက်ပျိုးမြေများ၊ သမိုင်းဝင်မြေများ၊ ရှုးဟောင်းသုတေသနမြေများ၊

		အပြောင်းအလဲများဖြစ်နိုင်သည်။ - ဆောက်လုပ်ရေးလုပ်ငန်းကြောင့် ထိခိုက်ရသောဆိုင်ရှင်များ၊ ဆိုင်ခန်းများနှင့် လယ်သမားများ၏ ပြန်လည်နေရာ ချထားရေးကြောင့် အချို့သော PAP များ၏ ဝင်ငွေ အခွင့်အလမ်းဆုံးရှုံးမှု		သစ်တော်ဇရိယာနှင့် ဂေဟစနစ်အထိခိုက်မခံသောနေရာများတွင် မြေအသုံးပြုမှုများကိုရှောင်ကြဉ်ရန်။
ဆောက်လုပ်ရေးကာလ				
ဆောက်လုပ်ရေးလုပ်ငန်းများ	**လေထုပတ်ဝန်းကျင်အပေါ် သက်ရောက်မှု**	(က) ဖုန်မှုန့်ထုတ်လွှတ်မှု -ဆောက်လုပ်ရေးယာဉ်များနှင့် ဆောက်လုပ်ရေးလုပ်ငန်းများမှထွက်သော ဖုန်မှုန့် -ဆောက်လုပ်ရေးနှင့် ဖြိုဖျက်မှု စွန့်ပစ်ပစ္စည်းများ သယ်ယူပို့ဆောင်ခြင်းနှင့် လမ်းမများတွင် ထွက်သောအမှုန်များ	၁။ အနီးအနားကျေးရွာများမှဒေသခံများ ၂။ သယ်ယူရေးလမ်းတစ်လျှောက်ရှိပြည်သူများ	- အရာဝတ္ထုများကိုင်တွယ်သည့် ရင်းမြစ်များအပေါ်တွင် အဖုံးအအုပ်များအသုံးပြုရန်။ - သင့်လျော်သောသိုလှောင်သိမ်းဆည်းခြင်းနှင့် စစ်ဆေးခြင်းအားဖြင့် လုပ်ငန်းခွင်ကိုပိတ်ထားရန်။ - တူးဖော်ရရှိသောမြေဆီလွှာများနှင့် ဖြိုဖျက်ခြင်းစွန့်ပစ်ပစ္စည်းများကိုကာကွယ်ထားရန်။ - ရေကိုလိုအပ်သလိုဖုန်မှုန့်လျှော့ချခြင်းအတွက် အသုံးပြုရန်။
		(ခ) ဓာတ်ငွေ့ထုတ်လွှတ်မှု မီးစက်များ၊ ကွန်ကရစ်ဖျော်စက်များနှင့် မော်တော်ယာဉ်များမှ ထွက်သောဓာတ်ငွေ့များ	ပတ်ဝန်းကျင် လေထုအရည်အသွေး	- အထွတ်အထိပ်စီးဆင်းမှုကိုရှောင်ရှားရန် ဝန်ထမ်းများနှင့် ပစ္စည်းများ သယ်ယူပို့ဆောင်ရေး အချိန်ဇယား ထားရှိရန်။ - ပြုပြင်ထိန်းသိမ်းမှုကို မြှင့်တင်ရန်။ - ယာဉ်ကြောပိတ်ဆို့မှု ကြာချိန်ကိုလျှော့ချရန်။ - အထွတ်အထိပ်စီးဆင်းမှုကာလကိုရှောင်ရှားရန်။ - ပစ္စည်းကိရိယာများကိုပုံမှန်ပြုပြင်ထိန်းသိမ်းရန်။

		(ဂ) ဆူညံသံ -မြေဖယ်ခြင်းနှင့် မြေတူးခြင်း စက်ကိရိယာများ၊ မီးစက်များနှင့် ကွန်ကရစ်ဖျော်စက်များမှ ထွက်သောဆူညံသံ	အနီးအနားကျေးရွာများမှ ဒေသခံများ	- ညအချိန်တွင် စက်ကြီးများလည်ပတ်မှုကိုကန့်သတ်ရန်။ - အသံကာကိရိယာများပါသောတိတ်ဆိတ်သည့် စက်ပစ္စည်းများအသုံးပြုရန်။ - ဆူညံသံ မြင့်မားသောနေရာများတွင် သတိပေးဆိုင်းဘုတ်များ တပ်ဆင်ရန်။ - စက်ကိရိယာများ၏ အမြန်နှုန်းကိုတတ်နိုင်သမျှ လျှော့ချရန်။ - ဆူညံသောလုပ်ငန်းများကိုနံနက်ခင်းပိုင်းတွင် ဆောင်ရွက်ရန်။
	မြေပေါ်ရေပတ်ဝန်းကျင်အပေါ် သက်ရောက်မှု	(က)ဆောက်လုပ်ရေးမှ စွန့်ပစ်ပစ္စည်း -ထုတ်ပိုးပစ္စည်းများ၊ ထုတ်ပိုးခြင်း သေတ္တာများ၊ စတီးဖြတ်တောက်ခြင်းနှင့် ကွန်ကရစ် အမှိုက်များ ကဲ့သို့သော စွန့်ပစ်ပစ္စည်းများ -ဆောက်လုပ်ရေးစွန့်ပစ်ကန်များမှ စိမ့်ထွက်သောရေ	မြေပေါ်ရေအရည်အသွေး	- မုန်တိုင်းရေစီးဆင်းမှုနှင့် ထိတွေ့သော တိုက်စားနိုင်သော မြေများနှင့် မည်သည့် စွန့်ပစ်ပစ္စည်း မဆိုထိတွေ့နိုင်သည့်အချိန်ကိုလျှော့ချရန်။ - လိုအပ်သောလုပ်ငန်းနယ်မြေများရှိမြေယာရှင်းလင်းရေးလုပ်ငန်းများကိုအနည်းဆုံးဖြစ်အောင်လုပ်ရန်။ - မိုးရာသီတွင် အနည်ကျမှုများကိုဂရုတစိုက်ထိန်းချုပ်ရန်။ - လမ်းများတတ်နိုင်သမျှ ခင်းရန်။
		(ခ)ရေနုံနှင့် အမဲဆီ -ဆောက်လုပ်ရေးပစ္စည်းများ သယ်ယူပို့ဆောင်ခြင်းမှ စိမ့်ထွက်လာသော လောင်စာဆီများ -ဆောက်လုပ်ရေးစက်ကိရိယာများ မှ ထွက်သောချောဆီနှင့် ရေနုံချေး။	မြေပေါ်ရေအရည်အသွေး	- ဆောက်လုပ်ရေးလုပ်ငန်းတစ်ခု ပြီးဆုံးတိုင်းလုပ်ငန်းခွင်ဇရိယာများ ပြန်လည်ရယူရန်။ - မိုးရာသီတွင် ဆောက်လုပ်ရေးလုပ်ငန်းများကိုရှောင်ကြဉ်ရန်။ - ဆောက်လုပ်ရေးကာလတွင် အသုံးပြုသောမော်တော်ယာဉ်များနှင့် စက်ပစ္စည်းများမှ

		-အုတ်မြစ်ပြင်ဆင်ရေးမှ မလိုအပ်သော မြေစိုင်ခဲများ		ဆီနှင့် ချောဆီများစိမ့်ထွက်ခြင်းကိုရှောင်ကြဉ်ရန်။
		(ဂ) ဆောက်လုပ်ရေးလုပ်သားများထံမှ အိမ်သုံးစွန့်ပစ်ပစ္စည်းများ -ဆောက်လုပ်ရေးလုပ်သားများမှ စွန့်ပစ်ပစ္စည်းများထွက်ရှိခြင်း။ -လုပ်သားစခန်းများထူထောင်ရေးမှ မမှန်ကန်သောစွန့်ပစ်မှု။	မြေပေါ်ရေအရည်အသွေး	- စွန့်ပစ်ရေမြောင်းများနှင့် မိလ္လာကန်များဆက်သွယ်ထားရန်။ - ဆောက်လုပ်ရေး ပြီးဆုံးသည့်အခါ ရှင်းလင်းသော ဇရိယာများတွင် အပင်စိုက်ပေးရန်။ - အဓိကအားဖြင့် စိုစွတ်သော ရာသီဥတုတွင် တိုက်စားမှုကိုကာကွယ်ရန် အဆောက်အဦးအုတ်မြစ်များ ဆောက်လုပ်ပြီးသည်နှင့် မြေသားသိပ်သည်းမှုရှိစေရန်။
	မြေဆီလွှာနှင့် မြေအောက်ရေ ပတ်ဝန်းကျင်	- ပစ္စည်းကိရိယာများသေသပ်စွာမကိုင်တွယ်နိုင်မှုကြောင့် ဖြစ်ပေါ်လာသောလောင်စာဆီနှင့် ချောဆီများမတော်တဆဖိတ်စင်မှုများ - ပြုပြင်ဆိုင်များနှင့် လျှော်ဖွတ်နေရာများမှ စွန့်ပစ်ရေ - ဆောက်လုပ်ရေးအမှိုက်နှင့် လုပ်သားများ၏ အိမ်သုံးစွန့်ပစ်ပစ္စည်း - စွန့်ပစ် အစိုင်အခဲများ မမှန်ကန်သောထားရှိမှုကြောင့် မြေဆီလွှာနှင့် မြေအောက်ရေညစ်ညမ်းမှု - ဆောက်လုပ်ရေးစွန့်ပစ်ကန်များမှ စိမ့်ထွက်ရေ	မြေဆီလွှာနှင့် မြေအောက်ရေအရည်အသွေး	- ပြန်လည်ပြုပြင်ရန်ရည်ရွယ်ချက်ဖြင့် ထုတ်လုပ်ထားသောပစ္စည်းများကိုလိုအပ်သလိုသက်ဆိုင်သည့်အခါတိုင်းအသုံးပြုရန်။ - ဂရုတစိုက် စီစဉ်ဆောင်ရွက်ခြင်းဖြင့် ဆောက်လုပ်ရေးစွန့်ပစ် ပစ္စည်းများကိုလျှော့ချရန်။ - ဓာတုစွန့်ပစ်ပစ္စည်းများအားလုံးကိုအမှတ်အသားပြုပြီး တိုက်စားမှုခံနိုင်သောသေတ္တာများတွင် သိမ်းဆည်းပါ။ - အန္ဓနှင့် ပိုးမွှားကူးစက်မှုကိုလျှော့ချရန်အတွက် ဆောက်လုပ် ရေးစွန့်ပစ်ပစ္စည်းများကိုဖယ်ရှားရန် အချိန်ဇယားနှင့် သိုလှောင်နေရာများသတ်မှတ်ပေးရန်။ - စွန့်ပစ်ကန်များအနီးတစ်ဝိုက်တွင် သင့်လျော်သောရေနုတ်မြောင်းစနစ်ပါရှိသောအနည်ကျကန်။

		အဆိပ်သင့်စွန့်ပစ်ပစ္စည်းများကြောင့် မြေဆီလွှာအပေါ် သက်ရောက်မှုများ - VOC ပါဝင်သောဆီဆေးများသည် စနစ်တကျ မစွန့်ပစ်ပါက ပတ်ဝန်းကျင်ကိုထိခိုက်စေနိုင်သည်။ - ဘူတာများ ဆောက်လုပ်ရေးတွင် သုံးသော သံမဏိကိုယ်ထည်များအတွက် ခဲပါဝင်သောသုတ်ဆေးများ	မြေဆီလွှာညစ်ညမ်းခြင်း	- ဖြစ်နိုင်ပါကသုတ်ဆေးများကိုဆီဆေးအစားရေဆေးသုံးရန်။ - ဆီဆေးများကိုရေမြောင်းများကသွန်မချရန်။ - အဆိပ်သင့်ပစ္စည်းများကို CDC ၏ နည်းစနစ်များနှင့် အညီစွန့်ပစ်ရမည်။
	ဇီဝမျိုးကွဲ ပတ်ဝန်းကျင် အပေါ် သက်ရောက်မှု	(က) အပင်မျိုးစုံမျိုးကွဲများ အပင်နှင့် သဘာဝသီးပင်များရှင်းလင်းခြင်း	အပင်မျိုးစုံမျိုးကွဲများ	- မျိုးစိတ်တိကျသောသတင်းအချက်အလက်များကိုအခြေခံ၍ ဖြတ်ကျော်အဆောက်အဦးများ၏ သင့်လျော်သော အရေအတွက်၊ အကွာအဝေးနှင့် တည်နေရာကို ဆုံးဖြတ်၍ ဆောက်လုပ်ရန်။ - လှုပ်ရှားမှုကိုနှောင့်ယှက်သော detritus သို့မဟုတ် silt ကဲ့သို့သောအတားအဆီးများကိုစောင့်ကြည့်ရန်။ - ခြံစည်းရိုးနှင့် ဆိုင်းဘုတ်များအသုံးပြုခြင်းဖြင့် တိရစ္ဆာန်များ ဖြတ်သွားရာအဆောက်အဦးများပေါ်တွင် လူသားများ ဖြတ်သန်းသွားလာမှုကိုစီမံခန့်ခွဲရန်။
		(ခ) တိရစ္ဆာန်မျိုးစုံမျိုးကွဲများ -အပင်များရှင်းလင်းထားမှုကြောင့် ငှက်များနှင့် လိပ်ပြာများ၏ ကျက်စားရာနေရာများအပေါ် အနှောင့်အယှက်ဖြစ်နိုင် -ဆောက်လုပ်ရေးလုပ်ငန်းများမှ ထွက်သောဆူညံသံများသည်	တိရစ္ဆာန်မျိုးစုံမျိုးကွဲများ	- သတ်မှတ်ဇရိယာများတွင် ကျက်စားလိုကြသောတိရစ္ဆာန်မျိုးစိတ်များအတွက် သတ်မှတ်ထားသော ဖြတ်ကျော် အဆောက်အဦးများတည်ဆောက်ပေးရန်။ - ရှိရင်းစွဲသယ်ယူပို့ဆောင်ရေးလမ်းကြောင်းများကိုတိရစ္ဆာန်များရွှေ့ပြောင်းရေးကိုထိန်းသိမ်းပေးသည့်

		ခြောက်သွေ့သောဒေသရှိတောရိုင်းတိရစ္ဆာန်များအတွက် အနှောင့်အယှက်ဖြစ်နိုင်		လမ်းကြောင်းများသို့မဟုတ် ဖြတ်ကျော်များကို ထည့်သွင်း စဉ်းစားခြင်းဖြင့် ဒီဇိုင်းလုပ်နိုင်သည်။
	လူထုပတ်ဝန်းကျင်အပေါ် သက်ရောက်မှု	လူမှုစီးပွားဆိုင်ရာကောင်းသောသက်ရောက်မှုများ **(၁) အလုပ်အကိုင် အခွင့်အလမ်း**	ဒေသခံပြည်သူ	- ကျွမ်းကျင်မှုမလိုအပ်သောအလုပ်အကိုင်အခွင့်အလမ်းများကိုဒေသခံများအတွက် ဖန်တီးပေးရန်။ - တင်ဒါစနစ်အနေဖြင့် ဒေသခံအလုပ်သမားများသုံးရန် သဘောတူစာချုပ်တွင် ထည့်ရန်။
		(၂) ဒေသခံပြည်သူများ၏ ကျွမ်းကျင်မှု တိုးတက်ရေး	ဒေသခံပြည်သူ	- ဆောက်လုပ်ရေးမတိုင်ခင်သာမကဆောက်လုပ်ရေးကာလအတွင်းပါ ဒေသခံအလုပ်သမားများအတွက် လေ့ကျင့်ရေး အစီအစဉ်များဖန်တီးပေးရန်။
		(၃) ဒေသစီးပွားနှင့် လုပ်ငန်းများ တိုးတက်နိုင်မှု		- ဆောက်လုပ်ရေးအလုပ်သမားများမှ အနီးအနား ကျေးရွာများရှိအစားအသောက်နှင့် လူသုံးကုန်ပစ္စည်းများဝယ်ယူခြင်း - ကန်ထရိုက်တာနှင့် ပူးတွဲကန်ထရိုက်တာများအားတင်ဒါစနစ်အနေဖြင့် အသေးစားဒေသစီးပွားရေးလုပ်ငန်းများပေါ်ထွက်လာစေရေးလုပ်ဆောင်ပေးရန် တိုက်တွန်းခြင်း။
		လူမှုစီးပွားဆိုင်ရာထိခိုက်မှုများ **(က) ယာဉ်ကြောပိတ်ဆို့မှု** ဆောက်လုပ်ရေးကာလအတွင်းအနီးအနားရှိလမ်းများပိတ်ဆို့မှု	ရထားလမ်းအနီးရှိဒေသခံပြည်သူများ	- ဒေသသုံးလမ်းများကိုအသုံးပြုရှိန်တွင် ဆောက်လုပ်ရေးသယ်ယူပို့ဆောင်ရေးလုပ်ငန်းများကိုစနစ်တကျ စီမံရန်။ - အများပြည်သူသုံးလမ်းများအစားအခြားလမ်းများဖောက်လုပ်အသုံးပြုရန်။

		(ခ) အသက်မွေးဝမ်းကြောင်းနှင့် စီးပွားရေး -လမ်းကြောင်းတစ်လျှောက် စီးပွားရေးလုပ်ငန်းများကြောင့် အသက်မွေးဝမ်းကြောင်းနှင့် စီးပွားရေးအခက်အခဲဖြစ်နိုင်။ -ရှိရင်းစွဲသယ်ယူပို့ဆောင်ရေးစနစ်နှင့် အသက်မွေးဝမ်းကြောင်းစနစ် ဆက်စပ်နေသော ပြည်သူများအပေါ် သက်ရောက်မှု	ရထားလမ်းတစ်လျှောက်ရှိဒေသခံ ပြည်သူများ	- လုပ်ငန်း၊ အသက်မွေးဝမ်းကြောင်းနှင့် လစာများဆုံးရှုံးမှု အတွက် ပေးလျော်ငွေ (ယာယီသို့မဟုတ် အမြဲ) - စီမံကိန်းကြောင့်ထိခိုက်နိုင်သောပုဂ္ဂိုလ်များ (PAPs) များ အတွက် လျော်ကြေးအထောက်အပံ့ - လုပ်ငန်းခွင်သက်ဆိုင်ရာလျှော့ချရေးအစီအမံများကိုဆုံး ဖြတ်ချက်ချရန် PAPs နှင့် အမြဲတမ်း အဆက်အသွယ်ပြုလုပ်ရန်။ - စီမံကိန်းကြောင့် သယ်ယူပို့ဆောင်ရေးပုံစံပေါ် မူတည်နေသည့် အသက်မွေးဝမ်းကြောင်းမှုများထိခိုက်နိုင်သော ပြည်သူများအတွက် ဆွေးနွေးတိုင်ပင်ခြင်း။ ယင်းတို့သည် အသွားအလာစီမံခန့်ခွဲမှု တိုးတက်ရေး အစီအစဉ်တွင် ပါဝင်သည်။
		(ဂ) ရေနုတ်မြောင်းပိတ်ဆို့ခြင်း - မြေဖို့ခြင်းကြောင့် ရေနုတ်မြောင်း၊ သဘာဝရေပူစမ်းနှင့် ကျေးရွာလမ်းများပိတ်ဆို့ခြင်း။ -အနီးအနားရှိစိုက်ပျိုးမြေများတွင် ရေကြီးနိုင်မှုအလားအလာ။	ရထားလမ်းတစ်လျှောက်ရှိဒေသခံ ပြည်သူများ	- အခြားရေစီးလမ်းကြောင်းဖန်တီးပေးရန်။ - စိုက်ပျိုးရေစိမ့်ထွက်နိုင်ရန် ရေဆင်းကြောင်းအထောက်အပံ့များကိုအသုံးပြုရန်။
		(ဃ) လူမှုရေးတင်းမာမှု - ရှုမ်းမဟုတ်သောလူမျိုးစုများနှင့် ရှမ်းလူမျိုးများအကြားအငြင်းပွားမှုများ - နာမည်ခေါ်ခြင်း၊ တံထွေးဖြင့်ထွေးခြင်း၊ ကြမ်းတမ်းသောအပြုအမူများ၊	ရထားလမ်းအနီးရှိဒေသခံ ပြည်သူများ	(၁) ဒေသခံအလုပ်သမားများတတ်နိုင်သမျှ များများ အသုံးပြုရန်။ (၂) နိုင်ငံခြားသားအလုပ်သမားများ၏ ညထွက်ချိန်ကို ကန့်သတ်ရန်။ (၃) ကန်ထရိုက်တာပူးတွဲကန်ထရိုက်တာများနှင့် သဘော

		ပိုင်နက်ဖျက်ဆီးမှုနှင့် လူမျိုးရေးအရအကြမ်းဖက်မှုများ ဖြစ်နိုင်ချေရှိသည်။		တူညီမှု စာချုပ်များတွင် ဒေသခံအလုပ်သမားတတ်နိုင်သမျှ များများသုံးရန် ထည့်သွင်းခြင်း။
		(c) လူမှုရေးဝန်ဆောင်မှုများ အပေါ် သက်ရောက်မှု ဆောက်လုပ်ရေးကာလအတွင်းလူဦးရေ တိုးတက်လာမှုကြောင့် အစားအသောက်နှင့် လူမှုရေးဝန်ဆောင်မှုများအသုံးပြုမှု မြင့်တက်လာခြင်း	ရထားလမ်းအနီးရှိဒေသခံ ပြည်သူများ	- ဆောက်လုပ်ရေးလုပ်သားများအတွက် ကိုယ်ပိုင် ကျန်းမာရေးဝန်ဆောင်မှုများထားရှိပေးရန်။ - ဒေသခံအလုပ်သမားများခန့်ထားရန်။
		(စ) ပြစ်မှုတိုးပွားလာမှုနှင့် လုံခြုံရေး ရွှေ့ပြောင်းဆောက်လုပ်ရေးအလုပ်သမား များဝင်ရောက်လာမှုကြောင့် ဒေသတွင်းလူမှုရေးပဋိပက္ခများနှင့် ရာဇဝတ်မှုများတိုးလာခြင်း။	ရထားလမ်းအနီးရှိဒေသခံ ပြည်သူများ	- ဆောက်လုပ်ရေးလုပ်သားများကိုရှင်းလင်းစွာခွဲခြား သတ်မှတ်ရန်။ - ဆောက်လုပ်ရေးလုပ်ငန်းခွင်သည် ခြံစည်းရိုးကာရံထားရမည်ဖြစ်ပြီးလုပ်ငန်းခွင်ဝင်ခွင့် သည်လည်းထိန်းချုပ်ထားရမည်။
		(ဆ) ရှုမ်းလူမျိုးများ၏ ရိုးရာနှင့် ယဉ်ကျေးမှု အပေါ် သက်ရောက်မှု	ရှုမ်းပြည်နယ်ရှိဒေသခံပြည်သူများ	- ရထားလမ်းဒီဇိုင်းတွင် ရှုမ်းလူမျိုးများအား ရိုးရာ ယဉ်ကျေးမှု ပုံရိပ်များထင်ဟပ်နေရမည်။ - စီမံကိန်းအဆိုပြုသူသည် လာရောက် လည်ပတ်သူများ ဒေသခံတို့၏ ရိုးရာယဉ်ကျေးမှုကိုလေးစားရန် တိုက်တွန်း ရမည်။
		(ဇ) ရုတ်တရက်လူဦးရေတိုးပွားမှုကြောင့် သက်ရောက်မှုများ	ရထားလမ်းအနီးရှိဒေသခံ ပြည်သူများ	- အမျိုးသမီးများကိုလည်းအမျိုးသားများနှင့် တန်းတူအလုပ်အကိုင် အခွင့်အလမ်းများဖန်တီးပေးရန်။

		- လူမှုရေးတင်းမာမှုများ၊ ကူးစက်နိုင်သော ရောဂါများ ပြန့်ပွားမှု၊ ကျန်းမာရေး လုံခြုံရေးအန္တရာယ်များ၊ အမှိုက်ထွက်ရှိမှုနှင့် ရေဆိုးနှင့် သယံဇာတများအပေါ် ဖိအားများသက်ရောက်မှုများတိုးပွားလာနိုင်ခြင်း		- ဒေသတွင်းယဉ်ကျေးမှုဓလေ့များအကြောင်း အသိအညာပေးရန်။
		(စ၅) ဒေသသုံးလမ်းများပျက်စီးနိုင်မှု	ဆောက်လုပ်ရေးလုပ်ငန်းခွင်များသို့ ဆက်သွယ်ထားသော လမ်းသည် ဒေသသုံးလမ်းများကို ထိခိုက် နိုင်သည်။	- ရွာလမ်းများပျက်စီးခဲ့ပါက ပြန်လည်ပြုပြင်ပေးခြင်း - မြို့ရှောင်လမ်းများအသုံးပြု၍အဆင်မပြေပါကလမ်းတံတားများ၏ ခံနိုင်ရည်ထက်ကျော်လွန်၍ အသုံးမပြုခြင်း။
		(ည)တိုင်းရင်းသားလက်နက်ကိုင်အဖွဲ့အစည်းများနှင့် အငြင်းပွားမှု	ဆောက်လုပ်ရေးလုပ်သားများနှင့် ဒေသခံပြည်သူ	- စီမံကိန်းဖွဲ့စည်းမှုအဆင့်တိုင်းအတွက် ပွင့်လင်းမြင်သာမှုရှိရန်။ - စီမံကိန်း၏ မည်သည့်ဖွံ့ဖြိုးမှု အဆင့်မဆိုတိုင်းရင်းသားအဖွဲ့အစည်းများအားအသိပေးရန်။ - အငြင်းပွားဖွယ်ရာများရှိခဲ့ပါကယင်းတို့နှင့် တိုင်ပင်ဆွေးနွေးရန်။
		ရှေးဟောင်းသုတေသနနှင့် ယဉ်ကျေးမှုအမွေအနှစ် - မြေပုံနှံထားသောယဉ်ကျေးမှုအမွေအနှစ်အကြွင်းအကျန်များ - ဆောက်လုပ်ရေးလုပ်ငန်းများကြောင့် ယဉ်ကျေးမှုအမွေအနှစ်များအားအမြဲတမ်းသက်ရောက်မှုများ ဖြစ်ပေါ်နိုင်ချေ	ဆောက်လုပ်ရေးလုပ်ငန်းခွင်အနီးရှိ ယဉ်ကျေးမှုနှင့် ဘာသာရေးထုံးစံများ	- မြေပုံနှံထားသောရှေးဟောင်း သုတေသန အကြွင်းအကျန်များ ရှာဖွေရန်၊ စရိုက်လက္ခဏာဖော်ရန်နှင့် မှတ်တမ်းယူရန် ဒီဇိုင်းလုပ်ရမည့် အစီအစဉ်များ - ရှေးဟောင်းသုတေသနအကြံပေးများကထောက်ပြသည့် ရှေးဟောင်းမြေပြင်များကိုရှောင်ကြဉ်ရန်။

		လူထုကျန်းမာရေးအပေါ်သက်ရောက်မှုများ (က) လေမှတဆင့် ကူးစက်သော ရောဂါများအလုပ်သမားဦး ရေရှုတ်တရက် တိုးပွားလာမှုကြောင့် လေမှ တဆင့် ကူးစက်နိုင်သောရောဂါများ ပြန့်ပွားမှု	လူထုကျန်းမာရေး	- ဆောက်လုပ်ရေးလုပ်သားများအတွက် ပုံမှန်ကျန်းမာရေးစစ်ဆေးမှု
		(ခ) ဖုန်မှုန့်ထုတ်လွှတ်မှုဒေသခံ ပြည်သူများအားလည်ချောင်းနှင့် အသက်ရှူလမ်းကြောင်းဆိုင်ရာရောဂါများဖြစ်စေနိုင်သည်။	လူထုကျန်းမာရေး	- ရေဖြန်းခြင်းဖြင့် လမ်းများကိုစိုစွတ်စေခြင်း - အစေ့များသိုလှောင်မှုနှင့် တောင်ပို့မျက်နှာပြင်များ တတ်နိုင်သမျှ အမြန်ဆုံးဆောင်ရွက်ရန်။ - တူးဖော်ထားသောတောင်ပို့များ၏မျက်နှာပြင်များကို - ပုံမှန် ရေဖြန်းခြင်း။ - မော်တော်ယာဉ်အမြန်နှုန်းကိုကန့်သတ်ခြင်း။ - လမ်းများပေါ်တွင် ရေဖြန်းခြင်း။
		(ဂ) ရေမှတဆင့်ဖြစ်သောရောဂါများ - မြေတူးခြင်းမှ မြေသားများ မြစ်ထဲသို့ ဆေးချခြင်း - မြေစိုင်ခဲများနှင့် အိမ်သုံးစွန့်ပစ် ပစ္စည်းများစွန့်ပစ်မှုမမှန်ကန်သည့်အခါ မြေအောက်ရေညစ်ညမ်းမှု ဖြစ်စေနိုင်သည်။	ဆောက်လုပ်ရေးလုပ်သားနှင့် လူထုကျန်းမာရေး	- မိုးရာသီတွင် ဆောက်လုပ်ရေး လုပ်ငန်းချိန်များ ရှောင်ကြဉ်ရန်။ - ဆောက်လုပ်ရေးစွန့်ပစ်ပစ္စည်းများရေရင်းမြစ်ထဲမဝင်စေရန် နှင့် မြေစာပုံများမြေပေါ်ရေနှင့် အဝေးတွင် ထားရှိရန်။ - ဟိုက်ဒရိုကာဗွန်ညစ်ညမ်းမှုကိုကာကွယ်ရန် လောင်စာသိုလှောင်ရုံများအားလုံးကိုကန့်သတ်ရမည်။
		(ဃ) ခြင်မှတဆင့် ကူးစက်သော ရောဂါများ - ဆောက်လုပ်ရေး ကာလအတွင်း ရေသေများသည့် ခြင်များ ပေါက်ပွားရာ နေရာများ	ဆောက်လုပ်ရေးလုပ်သားနှင့် လူထုကျန်းမာရေး	- မိုးရာသီတွင် ဆောက်လုပ်ရေး လုပ်ငန်းချိန်များ တတ်နိုင်သမျှ ရှောင်ကြဉ်ရန်။ - ဆောက်လုပ်ရေးကာလအတွင်းဖုံးအုပ်ထားခြင်းမရှိသော ရေသေကန်များမရှိစေရန်။

		ဖြစ်သည်။ - အဓိကအားဖြင့် မိုးရာသီတွင် ခြင်ကြောင့် ဖြစ်သောရောဂါများ ဖြစ်နိုင်ချေများသည်။		- သင့်လျော်သော ယာယီ သို့မဟုတ် အမြဲတမ်း ရေနုတ်မြောင်း စနစ်။
		(c) လိင်မှတဆင့် ကူးစက်သောရောဂါများ	ဆောက်လုပ်ရေးလုပ်သားနှင့် လူထုကျန်းမာရေး	- အလုပ်သမားများနှင့် ဒေသခံပြည်သူလူထုအတွက် ကျန်းမာရေးဗဟုသုတဆိုင်ရာအသိပေးအစီအစဉ်များ ဖော်ဆောင်ပေးခြင်း။
		(စ) ဆူညံသံမှတဆင့် ဖြစ်သောရောဂါများ	ဆောက်လုပ်ရေးလုပ်သားနှင့် လူထုကျန်းမာရေး	- ဆူညံသံကိုလျှော့ချရန် စီမံကိန်းအတွင်းထရပ်ကားများ၏ အမြန်နှုန်းကိုလျှော့ချရန်။ - ညအချိန်အလုပ်လုပ်ခြင်းကိုရှောင်ကြဉ်ရန်။
		(ဆ) ယာဉ်ကြောပိတ်ဆို့မှုများ	ဒေသခံပြည်သူ	- ဒေသသုံးလမ်းကြောအချိန်နှင့် ညအချိန်များတွင် ဆောက်လုပ်ရေးသယ်ဆောင်မှုများကိုစီမံရန်။ - ဖြစ်နိုင်ပါကအခြားလမ်းများအသုံးပြုရန်။
		အမြင်ပသာဒ - ဆောက်လုပ်ရေးပစ္စည်းများနှင့် ကိရိယာများကဲ့သို့သောအမြင်အာရုံဆိုင်ရာထိခိုက်စေမှုများ - အမြင်ပသာဒ ကျူးကျော်ဖျက်ဆီးမှုများသည် ဆောက်လုပ်ရေးပစ္စည်းများကိရိယာများ၊ သယ်ယူရေးယာဉ်များနှင့်မြေသားနှင့် အမှိုက်ပုံများမှ ဖြစ်နိုင်သည်။	ဒေသခံပြည်သူ	- အနီးအနားရှိအမြင်အာရုံသက်ရောက်မှုများကိုအနည်းဆုံးဖြစ်စေရန် ဆောက်လုပ်ရေးစခန်းများအားဖောက်ထွင်းမမြင်ရသောခြံစည်းရိုးများနှင့် ပိတ်ထားရန်။ - စီမံကိန်းနေရာကိုသန့်ရှင်းစွာထားရန်နှင့် အမြင်ပသာဒထိခိုက်မှုများကိုကန့်သတ်ရန်။ - လိုအပ်ချက်များနှင့် အညီဆောက်လုပ်ရေးအမှိုက်များကို ထိရောက်စွာနှင့် အချိန်မှန်စွာ ဖယ်ရှားခြင်း။

	သုံးစွဲမှုများမှ သက်ရောက်မှု	**(က) ရေသုံးစွဲမှု** -ဆောက်လုပ်ရေးလုပ်ငန်းများနှင့် လုပ်သား များအတွက် အသုံးပြုသော ရေကြောင့် ဒေသသုံးရေတွင် ထိခိုက်မှု	ဒေသခံပြည်သူ	- ရေအရင်းအမြစ်ရရှိနိုင်သောနေရာများတွင် မြေပေါ်ရေနှင့် မြေအောက်ရေအရင်းအမြစ်များမှ ရေကို သုံးစွဲနိုင်သည်။ - စမ်းချောင်းရေနှင့် မြေအောက်ရေများကဒေသသုံးရေအရင်းအမြစ်များဖြစ် ပါကရွာသူကြီးနှင့် သဘောတူညီမှုစာချုပ်တွင် နေထိုင်သူများ၏ ထင်မြင်ချက်များကိုထည့်သွင်းစဉ်းစားရန်။ - ရေအရင်းအမြစ်ထိန်းသိမ်းမှုအသိပညာပေးနည်းလမ်း များ။
		(ခ) အပေါ်ယံမြေဆီလွှာသုံးစွဲမှု အပေါ်ယံမြေဆီလွှာကိုစိုက်ပျိုးမြေများနှင့် သီးနှံမြေများကဲ့သို့သောအနီးအနားမြေများမှ သုံးမည်ဆိုပါက ဒေသ ပတ်ဝန်းကျင်ကိုထိခိုက်စေနိုင်သည်။	အနီးအနားရှိမြေများ	- မြေပိုင်ရှင်နှင့် ပေးလျော်ခြင်းဆွေးနွေးချက်များ
		(ဂ) ကျောက်သားသုံးစွဲမှု ကျောက်နှင့် ကျောက်စရစ်ခဲများကို ကိုယ်ပိုင်ကြိတ်ခွဲစက်များနှင့် ပြုလုပ်မည်ဆိုပါကပတ်ဝန်းကျင်ကိုထိခိုက် နိုင်သည်။	ဒေသခံပြည်သူ	- ဒေသခံကျောက်စရစ်ကုန်သည်များဆီမှ ပထမတန်းစားကျောက်စရစ်များဝယ်ယူခြင်း။ - ကိုယ်ပိုင်ကြိတ်ခွဲစက်များနှင့် ကျောက်စရစ်များ ပြုလုပ်ခြင်းကိုရှောင်ကြဉ်ခြင်း။

		(ဃ) လောင်စာသုံးစွဲမှု - စွမ်းအင်ပုံစံအမျိုးမျိုးသည် ဆောက်လုပ်ရေး လုပ်ငန်းများတွင် အမျိုးမျိုးသောရည်ရွယ်ချက်များဖြင့် အသုံးပြုသည် - ရှိရင်းစွဲပါဝါလိုင်းများမှ လျှပ်စစ်မတ်အားကိုသုံးရန်မဖြစ်နိုင်သည့်အတွက် လောင်စာသုံးမီးစက်များအဓိကထား အသုံးပြုရမည်ဖြစ်သည်။	ဒေသခံပြည်သူ	- ဆောက်လုပ်ရေးစက်ပစ္စည်းများကိုထိရောက်စွာ အသုံးပြုရန်။ - လုပ်သားများကိုစွမ်းအင်ထိန်းသိမ်းရေးအသိပညာနှင့် လေ့ကျင့်ရေးများပေးရန်။ - ထိရောက်သောဆောက်လုပ်ရေးလုပ်ငန်းခွင် စီမံခန့်ခွဲမှုကိုလေ့လာရန်။
လုပ်ငန်းလည်ပတ်ကာလ				
ရထားလမ်းတစ်လျှောက် ရထားများသွားလာခြင်း	**လေထုပတ်ဝန်းကျင်အပေါ်သက်ရောက်မှု**	- မြန်နှုန်းမြင့်ရထားမှ ဖြစ်ပေါ်လာမည့် ဆူညံသံနှင့် တုန်ခါမှု	ရထားလိုင်းအနီးနေထိုင်သူများ	- အများပြည်သူသုံးနေရာများတွင် အသံလုံတိုင်းတာမှုများ ပြုလုပ်ရန်။ - အသံနှင့် တုန်ခါမှုကိုကားဘီးနှင့် မော်တော်ယာဉ်များ ပြုပြင်ထိန်းသိမ်းခြင်းဖြင့် ထိန်းချုပ်နိုင်သည်
	မြေပေါ်ရေအပေါ် သက်ရောက်မှု	- ဘူတာနှင့် သိုလှောင်ရုံများတွင် ရေနုတ်မြောင်းများပိတ်ဆို့ခြင်း	ရထားလိုင်းအနီးနေထိုင်သူများ	- သိုလှောင်ရုံများမှထွက်သောညစ်ညမ်းရေအမျိုးအစားအတွက် သန့်စင်ရေးစနစ် ထားရှိပေးရန်။ - စွန့်ပစ်ရေများမှ ဆီချေးများကိုဖယ်ရှားရန် ဆီစုတ်ယူသောအခင်းများထားရှိရန်။
	မြေဆီလွှာနှင့် မြေအောက်ရေအပေါ် သက်ရောက်မှု	- သိုလှောင်ရုံများတွင် ရထားများ ပြုပြင်ထိန်းသိမ်းရေးမှထွက်သောဆီနှင့် ဆီချေးများအဆိပ်သင့်မာတုပစ္စည်းများ	ရထားလိုင်းအနီးနေထိုင်သူများ	- MSDS အရမာတုပစ္စည်းများကို စနစ်တကျ ကိုင်တွယ်ခြင်း နှင့် ဆီနှင့် ဆီချေးများစိမ့်ထွက်မှုကိုထိန်းချုပ်ခြင်း။

	ဇီဝမျိုးစုံမျိုးကွဲများအပေါ် သက်ရောက်မှု	- အထူးသဖြင့် ယာဉ်သွားလာမှုများကြောင့် ကာကွယ်ထားသောမျိုးစိတ်များသေဆုံးမှု - အပင်များနှင့် တိရစ္ဆာန်များအထူးသဖြင့် လင်းနို့များ လူလုပ်အလင်းရောင်များကြောင့် အနှောင့်အယှက်ဖြစ်ခြင်း - ထိန်းသိမ်းထားသည့် နေရင်းဒေသများနှင့် မျိုးစိတ်များ၊ ယင်းတို့၏ အနားယူရာနှင့် မျိုးပွားရာ ဒေသများကို နှောင့်ယှက်ရန် အလားအလာ	သစ်ပင်နှင့် တိရစ္ဆာန်မျိုးစုံမျိုးကွဲများ	- ရထားလမ်းသည် အကာအရံများရှိရမည်။ - အထိခိုက်မခံသောအပင်မျိုးစိတ်များဒေသတွင် အသံလုံအတားအဆီးများနှင့် တိရစ္ဆာန်မျိုးစိတ်များ၏ ဒေသတွင် မြေပြိုမှုအကာအရံများထားရှိရန်။
	လူ့ပတ်ဝန်းကျင်အပေါ် သက်ရောက်မှု	**လူမှုစီးပွားဆိုင်ရာကောင်းသော သက်ရောက်မှုများ** (၁) အသက်မွေးဝမ်းကျောင်းနှင့် စီးပွားရေးဖွံ့ဖြိုးမှု	ဒေသခံလူထု	- ပြန်လည်နေရာချထားရေး အစီအစဉ်များ အကောင်အထည်ဖော်ရန် စောင့်ကြည့်လေ့လာခြင်း
		(၂) ခရီးသွားဂယက် - ခရီးသွားအရေအတွက်တိုးပွားလာခြင်း (အဓိကအားဖြင့် ယူနန်မှ တရုတ်လူမျိုးများ)	ဒေသခံလူထုနှင့် အစိုးရ	- မြန်မာနိုင်ငံ၏ ခရီးသွား လုပ်ငန်းဖွံ့ဖြိုးမှုကို အထောက်အပံ့ပေးခြင်း။
		(၃) နိုင်ငံစီးပွားရေးအတွက် ကောင်းကျိုးများ	ဒေသခံလူထု	- ထိရောက်ပြီးပွင့်လင်းမြင်သာမှုရှိသောအခွန်ကောက်ခံမှုနည်းလမ်းများကိုမိတ်ဆက်၊ အရှိန်မြှင့်။
		(၄) ဒေသစီးပွားရေးအတွက် ကောင်းကျိုးများ	ဒေသခံလူထု	- စီမံကိန်းဖွံ့ဖြိုးမှုများနှင့် ဒေသခံလူထုကိုဆက်စပ်ပေးရန် နည်းလမ်းကောင်းများ။

		(၅) သယ်ယူပို့ဆောင်ရေးကဏ္ဍ တိုးတက်မှု	ဒေသခံလူထု	- ရထားလမ်းနှင့် အခြားသောလမ်းများ၏ကွန်ရက်ကိုထည့်သွင်းစဉ်းစားရန်။ - ဒေသွန္တရအာဏာပိုင်များ၊ CBO များ၊ NGO များမှ ကိုယ်စားလှယ်များနှင့် ဆွေးနွေးပြီးနှစ်စဉ် ဘတ်ဂျက်ခွဲဝေမှုကိုညှိနှိုင်းရန်နှင့် လူမှုအသိုင်းအဝိုင်း၏ လိုအပ်ချက် များနှင့် ကိုက်ညီသော CSR လုပ်ဆောင်မှုများကိုဦးစားပေးခြင်းဖြင့် ပိုမိုကောင်းမွန်အောင် ဆောင်ရွက်ခြင်း။
		လူမှုစီးပွားဆိုင်ရာထိခိုက်မှုများ (၁) လူကုန်ကူးမှုတိုးပွားလာခြင်း	ဒေသခံလူထု	- လူကုန်ကူးမှုကာကွယ်ရေးအဖွဲ့အစည်းများနှင့် ပူးပေါင်းဆောင်ရွက်ခြင်း။
		(၂) မူးယစ်ဆေးကုန်သွယ်မှု တိုးပွားလာခြင်း	ဒေသခံလူထု	- မူးယစ်ဆေးထိန်းချုပ်မှုနှင့် လာဘ်စားမှုပပျောက်ရေးကြိုးပမ်းမှုအားနှစ်ဆတိုးမြှင့်ခြင်း။
		(၃) ရှမ်းရိုးရာများအပေါ် သက်ရောက်မှု	ရှမ်းပြည်နယ်ရှိဒေသခံပြည်သူ	- ရထားဘူတာရုံများတွင် ရှမ်းရိုးရာယဉ်ကျေးမှုနှင့်အညီဆောက်လုပ်ရန်။ - ရထားဘူတာရုံများတွင် ရှမ်းဒေသစားသောက်ကုန်များအားမိတ်ဆက်ရောင်းချပေးရန်။
		(၄) မူဆယ်-မွန္လေးအမြန်လမ်းရှိ စီးပွားရေး များအားထိခိုက်ခြင်း	မူဆယ်- မွန္လေးအမြန်လမ်းရှိ ဒေသခံစီးပွားရေးများ	- မူဆယ်-မွန္လေးအမြန်လမ်းရှိ စီးပွားရေးပိုင်ရှင်များအား ရထားဘူတာရုံများအနီးတွင် စားသောက်ဆိုင်များဖွင့်နိုင်ရန် အစီအစဉ်များ ပြုလုပ်ညှိနှိုင်းခြင်း။

		(၅) ရထားလမ်းတစ်လျှောက်မတော်မဆမှုများ	ရထားလမ်းတစ်လျှောက်ရှိ ဒေသခံပြည်သူများ	- ရထားလမ်းတစ်လျှောက်တွင် ခြံစည်းရိုးများကာရံခြင်း။ - ရွာလမ်းများနှင့် ရထားလမ်းဖြတ်သောနေရာများတွင် အတားအဆီးဂိတ်များထားရှိခြင်း။ - အထူးသဖြင့် ရွာလမ်းများနှင့် ရထားလမ်းဖြတ်သောနေရာများတွင် ကောင်းမွန်သောမီးပေးစနစ်ထားရှိခြင်း။
		(၆) လူထုတင်းမာမှု	ဒေသခံပြည်သူ	- စီမံကိန်းမစမီတွင် ဖြစ်နိုင်မည်ဆိုပါက ဒေသခံပြည်သူများအတွက်ပါ လျှပ်စစ်မီးဖြန့်ဝေပေးနိုင်ရန် ထည့်သွင်းစဉ်းစားခြင်း။ - ဒေသခံပြည်သူများအတွက် ဆိုလာမီးများ ထောက်ပံ့ပေးခြင်း။
		ရှေးဟောင်းသုတေသနနှင့် ယဉ်ကျေးမှုအမွေအနှစ်အပေါ် သက်ရောက်မှု -လူဦးရေတိုးတက်လာမှုကြောင့် မန္တလေးနှင့် ရှမ်းဒေသများရှိယဉ်ကျေးမှုနှင့် ဘာသာရေးအပေါ် သက်ရောက်မှု - မြေပဲနံထားသောရှေးဟောင်းသုတေသနမြေနေရာများအပေါ် သက်ရောက်မှု	ဒေသခံပြည်သူ	- မန္တလေးနှင့် ရှမ်းဒေသတွင်းရှိယဉ်ကျေးမှုနှင့်ဘာသာရေးပွဲတော်များတွင် ပါဝင်ခြင်း။ - နိုင်ငံခြားသားများအားဒေသခံယဉ်ကျေးမှုဓလေ့များနှင့် ပက်သက်၍ အသိပေးခြင်း။
		ကျန်းမာရေးအပေါ်သက်ရောက်မှု (က) လိင်မှတဆင့် ကူးစက်သောရောဂါများ - လူဦးရေရုတ်တရက် တိုးတက်လာမှုကြောင့် HIV AIDS ကဲ့သို့သော လိင်ပိုင်း	ဒေသခံပြည်သူ	- အလုပ်သမားများအားကျန်းမာရေးစစ်ဆေးမှုများကြီကြတင်ပြုလုပ်ခြင်း။ - ဒေသခံပြည်သူများအတွင်းကူးစက်မှုလျော့နည်းစေရန် အသိပညာပေးခြင်း။

		ဆိုင်ရာရောဂါများအန္တရာယ်		
		(ခ) ရပ်ရွာကျန်းမာရေး - အကြမ်းဖက်မှုများတိုးပွားမှု၊ မူးယစ်ဆေး၊ ခိုးဝှက်မှု၊ ရာဇဝတ်မှု နှင့် လူကုန်ကူးမှုများကဲ့သို့သောလူမှုရေးရောဂါဗေဒနှင့်ပြစ်မှုများသည် အနီးအနားကျေးရွာများမှ ပြည်သူလူထု၏ စိတ်ပိုင်းဆိုင်ရာကျန်းမာရေးကိုထိခိုက်နိုင်သည်။	နီးစပ်ရာရွာများမှ ပြည်သူများ	- ရပ်ရွာကျန်းမာရေး၏ သက်ရောက်မှုများကို စောစီးစွာဖော်ထုတ်နိုင်ရန်အတွက် ဒေသခံအာဏာပိုင်များ ဒေသခံများအကြားဆက်လက်ဖြစ်ပွားနေသောရပ်ရွာလူထုနှင့် ထိတွေ့ဆက်ဆံမှုကိုလွယ်ကူချောမွေ့စေရန် ယန္တရား တစ်ခုတည်ဆောက်ခြင်း။ - ဆေးလိပ်နှင့် မူးယစ်ဆေးဝါးကင်းမဲ့ဇုန် သတ်မှတ်ခြင်း။
		(ဂ) ကိုဗစ်19 ကြောင့် ဒေသခံပြည်သူအပေါ် သက်ရောက်မှု	ဒေသခံပြည်သူ	- ရထားဘူတာရုံနှင့် ရထားအတွင်းမဝင်ခင် ကိုယ်အပူချိန်တိုင်းခြင်း။ - ဆပ်ပြာနှင့်ရေကိုအသုံးပြု၍ မကြာခဏလက်ဆေးခြင်း။ - ပါးစပ်နှာခေါင်းစည်းတပ်ဆင်ခြင်း။
	သုံးစွဲမှုကြောင့် သက်ရောက်မှုများ	**(က) လျှပ်စစ်သုံးစွဲမှု**	ဒေသခံပြည်သူ	- အသုံးမပြုသောလျှပ်စစ်ပစ္စည်းများအားပိတ်ထားခြင်း။ - LED မီးများနှင့် ဝပ်အားနည်းသောမီးများအသုံးပြုခြင်း။
		(ခ) ရေသုံးစွဲမှု	ဒေသခံပြည်သူ	- ရေမလိုသောအိမ်သာများအားအဆင်ပြေသလိုသုံးစွဲခြင်း။ - ရေချွေတာမှုအတွက် အသိပညာဖြန့်ဝေခြင်း အစီအစဉ်များ။
လုပ်ငန်းဖျက်သိမ်းကာလ				
ကွန်ကရစ်၊ သံမဏိကိုယ်	**လေထုပတ်ဝန်းကျင်အပေါ်**	(က) ဖုန်မှုန့်ထုတ်လွှတ်မှု	ရထားလမ်းတစ်လျှောက်ရှိ ဒေသခံပြည်သူများ	- ဖုန်မှုန့်လျော့ချရေးအတွက် ရေဖြန်းခြင်း။

ထည်များနှင့် စက်ပစ္စည်းများ ဖယ်ရှားခြင်း	**သက်ရောက်မှု**	(ခ) ဓာတ်ငွေ့ထုတ်လွှတ်မှု	ရထားလမ်းတစ်လျှောက်ရှိ ဒေသခံပြည်သူများ	- အင်ဂျင်ကောင်းသောစက်များနှင့် ဆာလဖာပါဝင်မှုနည်းသောလောင်စာများကိုအသုံးပြုရန်။
		(ဂ) ဆူညံသံ	ရထားလမ်းတစ်လျှောက်ရှိ ဒေသခံပြည်သူများ	- ညဘက်အလုပ်လုပ်ခြင်းကိုရှောင်ကြဉ်ရန်။
	မြေပေါ်ရေအပေါ် သက်ရောက်မှု	- ကွန်ကရစ်တုံးများ၊ သံမဏိအပိုင်းအစများနှင့် စွန့်ပစ်ပစ္စည်းများကို သေချာမစွန့်ပစ်ခြင်းကြောင့် မြေပေါ်ရေထိခိုက်မှု	အနီးစပ်ဆုံးမြစ်နှင့်ရေထု	- ကန်များနှင့် ပိုက်လိုင်းအတွင်းကျန်ရှိနေသော လောင်စာများအားလုံးကိုထုတ်ရန်။ ထုတ်လွှတ်လိုက်သောဆီများသည် နီးစပ်ရာရေထုသို့ တိုက်ရိုက်မဝင်စေရန် ဂရုပြုဆောင်ရွက်ရမည်။ - လုပ်ငန်းခွင်မှ ရေဆိုးမြောင်းများကို oil and grease separator များနှင့် ချိတ်ဆက်ထားရန်။ - သစ်ပင်များပြန်လည်စိုက်ပျိုးပေးရန်။
	မြေဆီလွှာနှင့် မြေအောက်ရေအပေါ် သက်ရောက်မှု	- ကွန်ကရစ်၊ သံမဏိအပိုင်းအစ၊ သတ္တုအပိုင်းအစများစသည့် စွန့်ပစ်ပစ္စည်းများကိုသေချာစွာ မစွန့်ပစ်ခြင်း။	မြေဆီလွှာညစ်ညမ်းခြင်း	- MCDC ၏ စည်းမျဉ်းများနှင့် အညီအမှီက်များစွန့်ပစ်ရန်။ - သစ်ပင်များ ပြန်လည်စိုက်ပျိုးပေးရန်။
	လူမှုစီးပွားရေးအပေါ် သက်ရောက်မှု	(က) ဒေသခံပြည်သူများ အလုပ်အကိုင်ဆုံးရှုံးခြင်းနှင့် အစိုးရဝင်ငွေ လျော့နည်းခြင်း	ဒေသခံလူထု	- ဝန်ထမ်းများအတွက် အခြားသော အသက်မွေးဝမ်းကျောင်း ခွင့်ပြုရန်။ - စီမံကိန်းရေးဆွဲသူသည် ၄င်းတို့၏ဝန်ထမ်းများ ဆန္ဒမပါသောအငြိမ်းစားယူရမှုအတွက် အခြားသောသင့်တော်သည့် အလုပ်များဖန်တီးပေးခြင်းခြင့် ကြိုတင် ပြင်ဆင်ထားရန်။

		(ခ)သယ်ယူပို့ဆောင်ရေးနှင့် ဒေသခံစီးပွားရေးနိမ့်ကျလာခြင်း	ဒေသခံလူထု	- ဖျက်သိမ်းခြင်းလုပ်ငန်းများ ဖြစ်ပေါ်လာပါက မြန်မာ့မီးရထားသည် မူဆယ်-မွန္လေးအမြန်ကားလမ်း ပြုပြင်ထိန်းသိမ်းရေးနှင့် အဆင့်မြှင့်တင်ရေးအတွက် တာဝန်ခံပေးခြင်း။

၁.၇။ထပ်ဆင့်တိုးပွားလာနိုင်သည့် ပတ်ဝန်းကျင်ထိခိုက်မှုများအကျဉ်းချုပ်

ဇယား - ထပ်ဆင့်တိုးပွားနိုင်သောပတ်ဝန်းကျင်ထိခိုက်မှုများအကျဉ်းချုပ်

လုပ်ငန်းများ	သက်ရောက်မှု	Receptor	လျော့ချရေးနည်းလမ်းများ
အကြိုဆောက်လုပ်ရေးကာလ			
လုပ်ငန်းခွင်ရှင်းလင်းရေး	ကျက်စားရာဒေသများဆုံးရှုံးခြင်း	အပင်နှင့် တိရစ္ဆာန်မျိုးစုံမျိုးကွဲများ	- အပင်ခုတ်ခြင်းကိုအနည်းဆုံးအထိလျော့ချရန်။ - ဖော်ထုတ်ပြီးသောစိုစွတ်ဒေသများသည် လက်ရှိအခြေအနေတိုးတက်မှုအတွင်း ဆက်လက်ထားရှိသင့်သည်။
ဆောက်လုပ်ရေးကာလ			
ဆောက်လုပ်ရေးလုပ်ငန်းများ	သစ်တောများပြုန်းတီးမှုကြောင့် ရာသီဥတုပြောင်းလဲခြင်း	ရထားလမ်းတစ်လျှောက် ပတ်ဝန်းကျင်	- စီမံကိန်းကြောင့် ထိခိုက်နိုင်သောသဘာဝကာဗွန်ကန်များကိုထိန်းသိမ်းခြင်း။ - သစ်တောခုတ်ထွင်ခြင်းများတတ်နိုင်သမျှ လျော့ချရန်။ - အပင်များအားရွေးချယ် ရှင်းလင်းခြင်းနှင့် ပြန်လည်စိုက်ပျိုးရေးနှင့် အစားထိုးစိုက်ပျိုးခြင်း။ - သစ်ပင်များဖယ်ရှားခြင်းအတွက် လိုအပ်သောခွင့်ပြုချက်များရရှိပြီးနောက် ဆောက်လုပ်ရေးလုပ်ငန်းများ၏ မည်သည့်လုပ်ငန်းမဆိုအာဏာပိုင်များထံ ကြိုတင်တင်ပြသင့်သည်။ - အလုပ်သမားများအားသဘာဝပတ်ဝန်းကျင် ထိန်းသိမ်းကာကွယ်ရေး အသိပညာများပေးခြင်း။ - ဆောက်လုပ်ရေးယာဉ်များမလိုအပ်ပဲဆိုင်းငံ့ထားခြင်းများကိုရှောင်ကြဉ်ခြင်း။
	မြေအသုံးချမှုပုံစံပြောင်းလဲခြင်း	ဒေသခံလူထု	- အဓိကအားဖြင့် စီမံကိန်းအတွင်း မြန်မာ့မီးရထားသို့ လယ်ယာမြေများရောင်းချခဲ့ရသောဒေသခံပြည်သူလူထုအားအလုပ်ခန့်ထားရန်။
	ရေရှားပါးမှု	ဒေသခံလူထု	- ရေရှည်တည်တံ့သောရေစီမံခန့်ခွဲမှု - ပြန်အသုံးပြုသောရေ

			- အသိပညာပေးအစီအစဉ်များ - မိုးရာသီတွင် မိုးရေသိုလှောင်နိုင်ရန်အတွက် ဆောက်လုပ်ရေးကာလကိုနောက်ကျမှစတင်ရန်။
လုပ်ငန်းလည်ပတ်ကာလ			
ရထားလမ်းတစ်လျှောက် ရထားများသွားလာခြင်း	အမြင်ပသာဒထိခိုက်မှု	ဒေသခံလူထု	- သစ်ပင်ပန်းမန်အစရှိသည်တို့ကိုစိုက်ပျိုးထားခြင်း။ - ရှုခင်းများစီမံခန့်ခွဲခြင်းနှင့် မြေနေရာများ ပြန်လည်ထူထောင်ခြင်း။
	လျှပ်စစ်သုံးစွဲမှုကြောင့် ထိခိုက်မှုများ	ဒေသခံလူထု	- ဒေသ၏ လျှပ်စစ်အသုံးကို မထိခိုက်သော လျှပ်စစ်မီး အရင်းအမြစ်ကိုလက်ရှိနှင့်အနာဂတ်တွင် အသုံးပြုခြင်း။ - နေရောင်ခြည်စွမ်းအင်နှင့် မီးစက်စသည့် အခြားလျှပ်စစ်ရင်းမြစ်များကိုအသုံးပြုခြင်း။
	တရားမဝင်ကုန်သွယ်မှု	ဒေသခံလူထု	- နိုင်ငံတွင်းမှ မထွက်ခွာမီစစ်ဆေးရေးဂိတ်တိုင်းတွင် သေချာစစ်ဆေးရန်။ - သက်ဆိုင်ရာအဖွဲ့အစည်းများနှင့် ပူးပေါင်းပါဝင်ရန်။
	ရေရှားပါးမှု	ဒေသခံလူထု	- ရေရှည်တည်တံ့သောရေစီမံခန့်ခွဲမှု - ပြန်အသုံးပြုသောရေ - အသိပညာပေးအစီအစဉ်များ

၁.၈။ပတ်ဝန်းကျင်ဆိုင်ရာစီမံခန့်ခွဲမှုနှင့် စောင့်ကြည့်လေ့လာရေးအစီအစဉ်

(က) ပတ်ဝန်းကျင်ဆိုင်ရာစီမံခန့်ခွဲမှု

ပတ်ဝန်းကျင်ဆိုင်ရာ စီမံခန့်ခွဲမှုအစီအစဉ်ကို စီမံကိန်း အကောင်အထည်ဖော်သည့် ကာလတစ်လျှောက်လုံးတွင် လုပ်ဆောင်ရမည်ဖြစ်ပြီး ဆောက်လုပ်ရေးနှင့် လုပ်ငန်းလည်ပတ်ရေး ကာလအတွင်း တာဝန်ဝတ္တရားများကို သတ်မှတ်ရမည်ဖြစ်ပါသည်။ ပတ်ဝန်းကျင်ဆိုင်ရာ ထိခိုက်သူများ၊ ထိခိုက်မှုများအားလျော့ချခြင်းအတွက် ဆောက်ရွက်မည့်လုပ်ငန်းအစီအစဉ်များ၊ အချိန်ဇယား၊ အကောင်အထည်ဖော်မည့် အဖွဲ့အစည်း သို့မဟုတ် တာဝန်ရှိအဖွဲ့အစည်း အစရှိသည့် ပါရာမီတာ များအားအောက်ဖော်ပြပါဇယားတွင်ဖော်ပြထားပါသည်။

ဇယား - ပတ်ဝန်းကျင်ဆိုင်ရာစီမံခန့်ခွဲမှုအစီအစဉ်အကျဉ်းချုပ်

ပတ်ဝန်းကျင်ဆိုင်ရာသက်ရောက်မှု	လျော့ချရေးအစီအမံများယူခြင်းသို့မဟုတ်အယူခံရခြင်း	သတ်မှတ်ချိန်	အကောင်အထည်ဖော်သော / တာဝန်ရှိသောအဖွဲ့အစည်း
ဒီဇိုင်းအဆင့်			
မြေယာရယူခြင်းနှင့်ပြန်လည်နေရာချထားခြင်း	အနည်းဆုံးလူများသို့မဟုတ်အိမ်ထောင်စုများနှင့်သဘာဝပတ်ဝန်းကျင်ထိခိုက်လွယ်သောနေရာများသို့ရွှေ့ပြောင်းခြင်းကိုရှောင်ရှားနိုင်ရန်အတွက်အဆိုပြုထားသောမီးရထားလမ်းညှိနှိုင်းမှုကိုမြေယာနှောင့်ယှက်မှုအနည်းဆုံးဖြစ်စေရန်ရွေးချယ်ခဲ့သည်	ဒီဇိုင်းအဆင့်အတွင်း	MR / စီမံကိန်းရေးဆွဲသူ
ယဉ်ကျေးမှုအမွေအနှစ်	ရထားလမ်းချိန်ညှိမှုဖြင့်ရှောင်ရှားခဲ့သည်	ဒီဇိုင်းအဆင့်အတွင်း	MR / စီမံကိန်းရေးဆွဲသူ
ရေအဖွဲ့အစည်းဆုံးရှုံးမှု	ရေအဖွဲ့အစည်းများကို ဖြတ်၍ရထားလမ်းများချိန်ညှိခြင်းကိုရှောင်ရှားရန်အထူးဂရုစိုက်သည်	ဒီဇိုင်းအဆင့်အတွင်း	MR / စီမံကိန်းရေးဆွဲသူ
ဆောက်လုပ်ရေးအဆင့်			
လေထုညစ်ညမ်းမှုနှင့်ဖုန်မှုန့်	ထုတ်လွှတ်မှုများကိုNEQG စံနှုန်းများနှင့်ကိုက်ညီစေရန်ယာဉ်များနှင့်စက်ပစ္စည်းများကိုပုံမှန်ထိန်းသိမ်းထားရမည်။	ဆောက်လုပ်ရေးတစ်လျှောက်လုံးစတင်ခြင်း	ကန်ထရိုက်တာ /

	ဖုန်မှုန့်များရှောင်ရှားရန်လိုအပ်သည့်နေရာများတွင်ဆောက်လုပ်ရေးကာလအတွင်းရေဖျန်းသင့်သည်။ ပစ္စည်းများပို့ဆောင်သောမော်တော်ယာဉ်များသည်ဝန်ကိုပိတ်ဆို့သောဖုန်မှုန့်များနှင့်ဖုန်မှုန့်များဖိတ်ကျခြင်းကို လျော့ချရန်ဖုံးအုပ်ထားသင့်သည်။	နှင့်ဆက်လက်လုပ်ဆောင်ခြင်း	ဆောက်လုပ်ရေး ဝန်ဆောင်မှုပေးသူ
ဆူညံမှု	လုပ်ငန်းခွင်နေရာများတွင်ဆူညံသံစံသတ်မှတ်ချက်ကို NEQG ဆူညံသံစံနှုန်းများအတိုင်းတင်းကြပ်စွာလိုက်နာရမည်။ ပြင်းထန်သောဆူညံသံအနီးအနားရှိအလုပ်သမားများသည်နားကြပ်များကိုဝတ်ဆင်ကြပြီးလုံခြုံရေးအချိန်ကိုကန့်သတ်ထားသင့်သည်။ ကျောင်းများနှင့်ဆေးရုံများအပါအဝင်တိတ်ဆိတ်ငြိမ်သက်သောနေရာများအတွက်ကောင်းမွန်သောအသံတိုင်းတာမှုပြုလုပ်လိမ့်မည်	ဆောက်လုပ်ရေးတစ်လျှောက်လုံးစတင်ခြင်းနှင့်ဆက်လက်လုပ်ဆောင်ခြင်း	ကန်ထရိုက်တာ / ဆောက်လုပ်ရေး ဝန်ဆောင်မှုပေးသူ
တုန်ခါမှု	ဆောင်းပါးစီမံကိန်း **EHS** လမ်းညွှန်လက်စွဲတွင် ဖော်ပြထားသည့်အတိုင်း အလုပ်နေရာများတွင်တုန်ခါမှုအတိုင်းအတာကိုသတ်မှတ်ချက်နှင့်လိုက်လျောညီထွေဖြစ်အောင်လုပ်ထားနိုင်သည့်အမြင့်ဆုံးအလျင်နှုန်းနှင့်ကိုက်ညီရမည်။	ဆောက်လုပ်ရေးတစ်လျှောက်လုံးစတင်ခြင်းနှင့်ဆက်လက်လုပ်ဆောင်ခြင်း	ကန်ထရိုက်တာ
မြေပေါ်ရေ			
စွန့်ပစ်ပစ္စည်းကနေညစ်ညမ်းမှု	စွန့်ပစ်ပစ္စည်းကနေညစ်ညမ်းမှု	စွန့်ပစ်ပစ္စည်းကနေညစ်ညမ်းမှု	ကန်ထရိုက်တာ/ ဆောက်လုပ်ရေး ဝန်ဆောင်မှုပေးသူ
မြေကြီးဖာထေးခြင်းကြောင့် ရေနုတ်မြောင်း၏ပိတ်ဆို့ခြင်း	မြေထုဖြည့်ဆည်းခြင်းသည်သဘာ ဝ ရေနုတ်မြောင်းစနစ်ကိုမပိတ်ဆို့ရန်သေချာ စေသည်		
ရေနံ၊ အမဲဆီ နှင့်အိမ်တွင်းစွန့်ပစ်ပစ္စည်းများ	မည်သည့်ရေနံနှင့်ချောဆီမဆိုယိုစိမ့်ခြင်းကိုရှောင်ရှားပါ။သင့်လျော်သောစွန့်ပစ်ပစ္စည်းစီမံခန့်ခွဲမှုစနစ်ကိုအသုံးပြုပါ		
မြေဆီလွှာနှင့်မြေအောက်ရေ			

မြေဆီလွှာညစ်ညမ်းမှုအလားအလာရှိသည်	သင့်လျော်သောစွန့်ပစ်ပစ္စည်းစီမံခန့်ခွဲမှုစနစ်	ဆောက်လုပ်ရေးကာလ	ကန်ထရိုက်တာ / ဆောက်လုပ်ရေးဝန်ဆောင်မှုပေးသူ
လောင်စာဆီနှင့်ချောဆီများယိုစိမ့်	ကွန်ကရစ်ကြမ်းပြင်သို့မဟုတ် အရည်စိမ့်မဝင်နိုင်သောအခံအပေါ်တွင်သိုလှောင်သည်။		
ဆောက်လုပ်ရေးအပျက်အစီးများနှင့်အိမ်တွင်းစွန့်ပစ်ပစ္စည်းများ	ဒေသခံ CDC ၏စည်းမျဉ်းစည်းကမ်းများအရအစိုင်အခဲစွန့်ပစ်မှုများ		
သစ်ပင်ပန်းမန်များနှင့်သတ္တဝါများ			
သစ်ပင်များနှင့် Avenue စိုက်ခင်းများဆုံးရှုံးမှု	သစ်ပင်များနှင့် Avenue စိုက်ခင်းများဆုံးရှုံးမှု	သစ်ပင်များနှင့် Avenue စိုက်ခင်းများဆုံးရှုံးမှု	ကန်ထရိုက်တာ
လူမှုရေး			
စီမံကိန်းထိခိုက်ခံရသည့်လူများ၏အသက်မွေးဝမ်းကျောင်းမှုအပြောင်းအလဲများနှင့်အတူအဆောက်အဦးများနှင့်အခြားပိုင်ဆိုင်မှုများကိုပြန်လည်နေရာချထားခြင်း	အသစ်ပြန်လည်နေရာချထားရေးအစီအစဉ်၏ရပိုင်ခွင့် matrix အတွက်အသက်မွေးဝမ်းကျောင်းပြန်လည်ထူထောင်ရေး၏လျော်ကြေးငွေနှင့်အကူအညီတွင်အသေးစိတ်ပါလိမ့်မည်	ဆောက်လုပ်ရေးကာလ	MR / စီမံကိန်းရေးဆွဲသူ
အဝင်လမ်းဆုံးရှုံးမှု	ယာယီဆက်သွယ်မှုကိုအပြန်အလှန်ဖလှယ်ခြင်းနှင့်အခြားလမ်းများပေါ်တွင်တည်ဆောက်ရမည်	ဆောက်လုပ်ရေးကာလ	ကန်ထရိုက်တာ
ယာဉ်ကြောပိတ်ဆို့မှုများ	ဆောက်လုပ်ရေးကာလအတွင်းယာဉ်ကြောပိတ်ဆို့မှုများရှိလျှင် သယ်ယူပို့ဆောင်ရေးနှင့်ယာဉ်ထိန်းရဲဌာန၏ညှိနှိုင်းဆောင်ရွက်မှုနှင့်အတူပိတ်ဆို့မှုကိုသက်သာစေရန်ဆောင်ရွက်သင့်သည်	ဆောက်လုပ်ရေးကာလ	ကန်ထရိုက်တာ / MR / စီမံကိန်းရေးဆွဲ

			သူ
ယာဉ်များ၊ လူများ၊ မွေးမြူရေး၊ ဆိုင်းဘုတ်များနှင့်ဘေးကင်းလုံခြုံရေး	ဘေးကင်းလုံခြုံမှုပညာရေးနှင့်ဒဏ်ငွေ။ ဆောက်လုပ်ရေးဇရိယာများအတွင်း လုံလောက်သော အသွားအလာ စီးဆင်းမှုကိုခွင့်ပြုသည်။ လုံခြုံရေးကြိုတင်ကာကွယ်ရေးအတွက်လုံလောက်သောဆိုင်းဘုတ်များ, အတားအဆီးများနှင့်အလံပုဂ္ဂိုလ်များစီစဉ်သည်။ ရေဒီယို၊ တီဗွီနှင့်သတင်းစာများမှတစ်ဆင့်စီမံကိန်းများ၏အတိုင်းအတာနှင့်အချိန်အပိုင်းအခြားနှင့်အဟန့်တားများသို့မဟုတ်ဝင်ရောက်ခွင့်ကိုကန့်သတ်မှုများဖြစ်စေသည့်ဆောက်လုပ်ရေးလုပ်ငန်းအချို့အားအများပြည်သူနှင့်ဆက်သွယ်သည်။	ဆောက်လုပ်ရေးကာလ	ကန်ထရိုက်တာ / ဆောက်လုပ်ရေး ဝန်ဆောင်မှုပေးသူ
ရေမှကူးစက်သော အင်းဆက်ပိုးကြောင့်ကူးစက်တတ် သောရောဂါများ တိုးပွား လာသည်။	ရပ်တန့်နေသောရေထုများမဖြစ်ပေါ်စေရန်ဆောက်လုပ်ရေးဇရိယာအားလုံးတွင်ကောင်းမွန်သောရေနုတ်မြောင်းရှိကြောင်းသေချာစေပါသည်။ ဆောက်လုပ်ရေးစခန်းများရှိလုံလောက်သောသန့်ရှင်းရေးနှင့်အမှိုက်များကိုစွန့်ပစ်ခြင်း။ အလုပ်သမားများကိုလုံလောက်သောကျန်းမာရေးစောင့်ရှောက်မှု ပေး၍ ထိခိုက်လွယ်သော အုပ်စုများနှင့်ဝေးကွာသောစခန်းများနေရာချထားပေးခြင်း	ဆောက်လုပ်ရေးကာလ	ကန်ထရိုက်တာ / MR / စီမံကိန်းရေးဆွဲသူ
စခန်းများသို့လှောင်ရုံများနှင့် သို့လှောင်ရာနေရာများ၏ တည်နေရာ	စခန်းသို့လှောင်ရုံများနှင့်သို့လှောင်ရာနေရာများ၏တည်နေရာစာချုပ်သတ်မှတ်ချက်များနှင့် အညီဖြစ်ရလိမ့်မည်	ဆောက်လုပ်ရေးကာလ	ကန်ထရိုက်တာ / စီမံကိန်းရေးဆွဲသူ
လုပ်ငန်းလည်ပတ်မှုအဆင့်			
ဆူညံသံနှင့်တုန်ခါမှု	သင့်လျော်သောအစီအမံများကို ခိုင်လုံသော နေရာများတွင် ထည့်သွင်းစဉ်းစားရပါမည်။ ဆူညံသံနှင့်တုန်ခါမှုညစ်ညမ်းမှု၏စည်းမျဉ်းများနှင့်၎င်း၏သက်ရောက်မှုများအကြောင်း အများပြည်သူများသို့ပညာပေးရလိမ့်မည်	လုပ်ငန်းကာလ	MR / စီမံကိန်းရေးဆွဲသူ

စွန့်ပစ်ပစ္စည်း			
ဘူတာရုံများနှင့် တွေ့နေကျခရီးသည်များဇရိယာများတွင်စည်ပင်သာယာအစိုင်အခဲစွန့်ပစ်ပစ္စည်းများထုတ်လုပ်ခြင်း	ရထားများနှင့်ဘူတာများတွင်စွန့်ပစ်ပစ္စည်းများကိုစုဆောင်းခြင်းနှင့်ခွဲထုတ်ခြင်း။ ဒေသဆိုင်ရာ CDC ၏ညွှန်ကြားချက်အရအမှိုက်များကိုသင့်လျော်စွာစွန့်ပစ်ခြင်း။	လုပ်ငန်းကာလ	MR / စီမံကိန်းရေးဆွဲသူ
မြေပေါ်ရေ			
ရေနံညစ်ညမ်းမှု	အထူးသဖြင့်သိုလှောင်ရုံဒေသများရှိစွန့်ပစ်ရေမထုတ်မီသန့်စင်သောဆီကိုသင့်လျော်သောကုသမှုကိုခံယူရမည်	လုပ်ငန်းကာလ	MR / စီမံကိန်းရေးဆွဲသူ
storm water ရေနုတ်မြောင်းစနစ်၏ပြုပြင်ထိန်းသိမ်းမှု	မြို့ပြရေနုတ်မြောင်းစနစ်များကိုလုံလောက်သော storm water စီးဆင်းမှုကို သေချာစေရန်အခါအားလျော်စွာစစ်ဆေးပြီး ရှင်းလင်းလိမ့်မည်	လုပ်ငန်းကာလ	
ကုသမှုအစီအစဉ်မှနောက်ဆုံးကုသထားသည့် စွန့်ထုတ်အရည်ကိုစွန့်ပစ်ခြင်း	နောက်ဆုံးစွန့်ပစ်ခြင်းအတွက်ရွေးချယ်စရာများကိုစစ်ဆေးပြီးလက်ခံထားသောရေထုများ၏သက်ရောက်မှုကိုအနည်းဆုံးဖြစ်စေရန်သင့်တော်သောစွန့်ပစ်ပစ္စည်းကိုသေချာစွာဆုံးဖြတ်ရမည်။ တတ်နိုင်သမျှသုညစွန့်ပစ်စည်းမျဉ်းစည်းကမ်းတွေကိုမွေးစားနိုင်ပါသည်	လုပ်ငန်းကာလ	MR / စီမံကိန်းရေးဆွဲသူ
လူမှုရေး			
ခရီးသည်နှင့်ဒေသခံပြည်သူများ၏ရထားလမ်းမတော်တဆမှုဖြစ်ခြင်း	ခရီးသည်များနှင့်ဒေသခံများအားမီးရထားလမ်းအတွက်တိကျသောယာဉ် ဘေးအန္တရာယ်လုံခြုံစေရန်အသိပညာပေးခြင်း	လုပ်ငန်းကာလ	MR / စီမံကိန်းရေးဆွဲသူ

ဇယား -ပတ်ဝန်းကျင်စောင့်ကြည့်လေ့လာခြင်းအစီအစဉ်

အမျိုးအစား	စောင့်ကြည့်မှတ်သားပေးရန်ကန့်သန့်ချက်များ	တည်နေရာ	တိုင်းတာမှုကြိမ်နှုန်းများ	တာဝန်ယူမှုများ
တည်ဆောက်ရေးအကြိုကာလနှင့်ကြိုတင်ပြင်ဆင်မှုကာလ				
လေထုအရည်အသွေး	၁။ဆိုဒ်ကင်းလှည့်ခြင်း ၂။နေထိုင်သူများထံမှလက်ခံရရှိသောတိုင်တန်းတင်ပြစာများလက်ခံခြင်း ၃။လိုအပ်ပါကလေထုအရည်အသွေးစစ်ဆေးခြင်း	ဆောက်လုပ်ရေးနေရာများ၏ကိုယ်စားလှယ်အချက်များ	၁။လစဉ် ၂။လက်ခံရှိသည့်မည်သည့်အချိန်မဆို ၃။လိုအပ်လျှင်	ကန်ထရိုက်တာ(MR/ စီမံကိန်း တည်ဆောက် သူက စီမံသည်)
ရေထုအရည်အသွေး	၁။ဆိုဒ်ကင်းလှည့်ခြင်း ၂။အမျိုးသားသဘာဝပတ်ဝန်းကျင်ဆိုင်ရာ(ထုတ်လွှတ်မှု)အရည်အသွေး NQEQ ကသတ်မှတ်ထားသောကန့်သတ်ချက်တွေကို စောင့်ကြည့်လေ့လာရေး	ဆောက်လုပ်ရေးအနီးဝန်းကျင်ရှိ ချောင်းစွယ်	၁။လစဉ်	ကန်ထရိုက်တာ (MR/ စီမံကိန်းတည်ဆောက် သူကစီမံသည်)
ဆူညံသံနှင့်တုံခါမှုများ	၁။ဆိုဒ်ကင်းလှည့်ခြင်း ၂။နေထိုင်သူများထံမှလက်ခံရရှိသောတိုင်တန်းတင်ပြစာများလက်ခံခြင်း ၃။ဆူညံသံနှင့်တုံခါမှုအဆင့်စောင့်ကြည့်လေ့လာခြင်းsensitive receptorsနှင့်လက်ခံရတိုင်ကြားစာများတွင်ပါဝင်လျှင်	ဆောက်လုပ်ရေးဆိုဒ်များ	၁။အပတ်စဉ် ၂။လက်ခံရှိသည့်မည်သည့်အချိန်မဆို ၃။လိုအပ်လျှင်	ကန်ထရိုက်တာ (MR/ စီမံကိန်းတည်ဆောက် သူကစီမံသည်)
သင်ပင်များခုတ်လဲခြင်း	၁။ခုတ်လဲရန်လိုအပ်မည့်သစ်ပင်များနှင့်မျိုးစိပ်အရေအတွက်အကိုစစ်ဆေးခြင်း ၂။အုပ်ချုပ်ရေးအာဏာပိုင်များ (MONREC)	ဆောက်လုပ်ရေးဆိုဒ်များ	၁။အပတ်စဉ်	ကန်ထရိုက်တာ (MR/ စီမံကိန်းတည်ဆောက်

	နှင့်ညှိနှိုင်းတိုင်ပင်ခြင်း			သူကစီမံသည်)
စွန့်ပစ်ပစ္စည်း	၁။ဆောက်လုပ်ရေးလုပ်ငန်းခွင်ဆိုဒ်ကင်းလှည့်ခြင်းနှင့်သန့်ရှင်းရေး ၂။စွန့်ပစ်ပစ္စည်းစွန့်ပစ်ခြင်းနည်းလမ်းများ	ဆောက်လုပ်ရေးဆိုဒ်များ	၁။လစဉ် ၂။လစဉ်	ကန်ထရိုက်တာ (MR/ စီမံကိန်းတည်ဆောက်သူကစီမံသည်)
အန္တရာယ်ရှိသောပစ္စည်းများနှင့်ရေနံ/ဆီစီမံခန့်ခွဲမှု	၁။အန္တရာယ်ရှိပစ္စည်းများကိုင်တွယ်မှုကိုဆိုင်ကင်းလှည့်၍စစ်ဆေးကြည့်ရှုခြင်း ၂။အလုပ်သမားများအတွက်အန္တရာယ်ရှိသောပစ္စည်းများကိုင်တွယ်မှုဆိုင်ရာသင်တန်းမှတ်တမ်းများ	ဆောက်လုပ်ရေးဆိုဒ်များ	၁။လစဉ် ၃။၃လတစ်ကြိမ်	ကန်ထရိုက်တာ (MR/ စီမံကိန်းတည်ဆောက်သူကစီမံသည်)
လူမှုပတ်ဝန်းကျင်ပြန်လည်နေရာချ ထားရေး	ARP အကောင်အထည်ဖော်တိုးတက်မှု	စီမံကိန်းဇရိယာနှင့်ပတ်ဝန်းကျင်	လစဉ်နှင့်၃လတစ်ကြိမ်	ကန်ထရိုက်တာ (MR/ စီမံကိန်းတည်ဆောက်သူကစီမံသည်)
လက်ရှိလူမှုရေးအခြေခံအဆောက်အအုံနှင့်ဝန်ဆောင်မှုများ	၁။တိုင်ကြားချက်များစုဆောင်းခြင်း ၂။လမ်းအသွားအလာအခြေနေကိုရုပ်ပိုင်းဆိုင်ရာလေ့လာခြင်း ၃။ယာဉ်ထိန်းရဲများနှင့်တွေ့ဆုံမေးမြန်းခြင်း	စီမံကိန်းဇရိယာနှင့်ပတ်ဝန်းကျင်	၁။လက်ခံရှိသည့်မည်သည့်အချိန်မဆို ၂။ဆောက်လုပ်နေစဉ်နေ့စဉ် ၃။လိုအပ်လျှင်	ကန်ထရိုက်တာ (MR/ စီမံကိန်းတည်ဆောက်သူကစီမံသည်)
စီမံကိန်းဆောက်လုပ်နေစဉ်အတွင်းအလုပ်သမားများ၏ကျန်းမာရေးနှင့်လုံခြုံရေးစောင့်ကြည့်ပေးခြင်း	လုပ်ငန်းခွင်ဒဏ်ရာရရှိမှုအတွက်ကျန်မာရေးမှတ်တမ်းများ	ကန်ထရိုက်တာမှညွှန်းဆိုသည့်ဆေးရုံ/ဆေးခန်း	လက်ခံရရှိမှုအပေါ်	ကန်ထရိုက်တာ (MR/ စီမံကိန်းတည်ဆောက်သူကစီမံသည်)

ယာဉ်တိုက်မှု	၁။ဆိုဒ်ကင်းလှည့်ခြင်း ၂။မတော်တဆင့်မှုများမှတ်တမ်း ၃။ဘေးကင်းလုံခြုံရေး၊အသိပညာပေးနှင့်အခြား ဆောင်ရွက်ချက်များမှတ်တမ်း	ဆောက်လုပ်ရေးဆိုဒ်များ	၁။အနည်းဆုံးလစဉ် ၂။လစဉ် ၃။လစဉ်	ကန်ထရိုက်တာ (MR/ စီမံကိန်းတည်ဆောက် သူကစီမံသည်)
လေထုအရည်အသွေး	ဆိုဒ်ကင်းလှည့်ခြင်း	ရထားလမ်းတစ်လျောက်	လစဉ်	MR/ စီမံကိန်း တည်ဆောက်သူ
ရေထုအရည်အသွေး	အမျိုးသားသဘာဝပတ်ဝန်းကျင်အရည်အသွေး (ထုတ်လွှတ်မှု) လမ်းညွှန်ချက် အတိုင်း သတ်မှတ်ချက်များကိုစောင့် ကြည့်ခြင်း	ပို့လွှတ်သည့်နေရာမှသိုလှောင်ရုံ အထိ	လုပ်ငန်းလည်ပတ်စဉ်ကာ လအပြီးနောက်ပထမ၂နှစ် အတွက်၆လတစ်ကြိမ်	MR/ စီမံကိန်း တည်ဆောက်သူ
ဆူညံသံနှင့်တုံခါမှု	ဆူညံသံနှင့်တုံခါမှုအဆင့်	ဒေသခံနေထိုင်သူများအနီးမှဖြတ်သွားဝေ သာရထားလမ်းဘူတာများကိုစောင့်ကြည့် လေ့လာခြင်း	၂၄နာရီစဉ်ဆက်မပြတ်စော ာင့်ကြည့်ခြင်း	MR/ စီမံကိန်း တည်ဆောက်သူ
မြေဆီလွှာညစ်ညမ်းမှု	၁။အလုပ်သမားနားနေဆောင်နှင့်ဘူတာရုံအနီး မြေဆီလွှာအရည်သွေးကိုစောင့်ကြည့်လေ့လာ ခြင်း	သိုလှောင်ရုံများနှင့်အလုပ်သမား နားနေဆောင်	၁။သုံးလတစ်ကြိမ် ၂။လိုအပ်လျှင်	MR/ စီမံကိန်းတည်ဆောက် သူ
စွန့်ပစ်ပစ္စည်း	၁။ဆောက်လုပ်ရေးလုပ်ငန်းခွင်ဆိုဒ်ကင်းလှည့်၍ဘူတာရုံ ၊ရထားလမ်းနှင့်ဆက်စပ်အဆောက်အအုံများကိုအမှိုက်စွ မ့်ပစ်မှုစစ်ဆေးခြင်း ၂။စွန့်ပစ်ပစ္စည်းစွန့်ပစ်ခြင်းနည်းလမ်းများ	ရထားဘူတာရုံများ၊သိုလှောင်ရုံနှင့်ဆက်စ ပ်အဆောက်အအုံများ	လုပ်ငန်းလည်ပတ်စဉ်ကာ လအပြီးနောက်ပထမ၂နှစ် အတွက်၆လတစ်ကြိမ်	MR/ စီမံကိန်း တည်ဆောက်သူ
အန္တရာယ်ရှိနှင့်အန္တရာယ် မရှိသော	၁။အန္တရာယ်ရှိပစ္စည်းများကိုင်တွယ်မှုသင်တန်း မှတ်တမ်း ၂။အန္တရာယ်ရှိပစ္စည်းများကိုင်တွယ်မှုနှင့်	စီမံကိန်းဧရိယာ	လုပ်ငန်းလည်ပတ်စဉ်ကာ လအပြီးနောက်ပထမ၃နှစ်	MR/ စီမံကိန်း တည်ဆောက်သူ

ပစ္စည်းများစီမံခန့်ခွဲမှု	သိမ်းဆည်းခြင်းမှတ်တမ်း		အတွက်ခုလတစ်ကြိမ်	
ယာဉ်မတော်တဆမှုများ	၁။မတော်တဆငှ့်မှုများမှတ်တမ်း ၂။ဘေးကင်းလုံခြုံရေး၊အသိပညာပေးနှင့်အခြား ဆောင်ရွက်ချက်များမှတ်တမ်း	MMR လိုင်းအနီးရှိ	၁။လစဉ် ၂။လုပ်ငန်းလည်ပတ်စဉ် ကာလအပြီးနောက်ပထမ ခုနှစ်အတွက်လစဉ်	MR/ စီမံကိန်း တည်ဆောက်သူ
ဖျက်သိမ်းအဆင့်				
လေထုအရည်အသွေး	၁။ဆိုဒ်ကင်းလှည့်ခြင်း ၂။အမျိုးသားသဘာဝပတ်ဝန်းကျင်ဆိုင်ရာ (ထုတ်လွှတ်မှု)အရည်အသွေး NQEQ ကသတ်မှတ်ထားသောကန့်သတ်ချက်တွေကို စောင့်ကြည့်လေ့လာရေး	ကိုယ်စားပြုဖျက်သိမ်းလုပ်ငန်းခွင်ဆိုဒ်များ	၁။လစဉ် ၂။လက်ခံရှိသည့်မည်သည့်အချိန်မဆို ၃။လိုအပ်လျှင်	ကန်ထရိုက်တာ (MR/ စီမံကိန်း တည်ဆောက်သူကစီမံသည်)
ရေထုအရည်အသွေး	၁။ဆိုဒ်ကင်းလှည့်ခြင်း ၂။အမျိုးသားသဘာဝပတ်ဝန်းကျင်ဆိုင်ရာ (ထုတ်လွှတ်မှု)အရည်အသွေး NQEQ ကသတ်မှတ်ထားသောကန့်သတ်ချက်တွေကို စောင့်ကြည့်လေ့လာရေး	ဖျက်သိမ်းဆိုဒ်နှင့်စီမံကိန်း၏အခြားဆက်စပ်ဇရိယာများ	၁။လစဉ် ၂။နှစ်နှစ်တစ်ကြိမ်	ကန်ထရိုက်တာ (MR/ စီမံကိန်း တည်ဆောက်သူကစီမံသည်)
ဆူညံသံ	၁။ဆိုဒ်ကင်းလှည့်ခြင်း ၂။ဒေသခံများမှတိုင်ကြားမှုရှိလျှင် ၃။တိုင်ကြားမှုရှိပါကဆူညံသံများနှင့်တုံ့ခံမှုများကို စောင့်ကြည့်လေ့လာပေးရန်	ဖျက်သိမ်းဆိုဒ်များ	၁။လစဉ်သို့မဟုတ်လိုအပ်တိုင်း	ကန်ထရိုက်တာ (MR/ စီမံကိန်း တည်ဆောက်သူကစီမံသည်)
မြေဆီလွှာညစ်ညမ်းမှု	၁။အမျိုးသားသဘာဝပတ်ဝန်းကျင်ဆိုင်ရာ (ထုတ်လွှတ်မှု)အရည်အသွေး NQEQ	ဖျက်သိမ်းဆိုဒ်များ	၁။လိုအပ်လျှင်လစဉ်	ကန်ထရိုက်တာ (MR/

	ကသတ်မှတ်ထားသောကန့်သတ်ချက်တွေကို စောင့်ကြည့်လေ့လာရေး ၂။ဖျက်သိမ်းဆိုဒ်များ၏အပျက်အစီးများစွန့်ပစ်မှု စောင့်ကြည့်ခြင်း ၃။အန္တရာယ်ရှိသောပစ္စည်းများနှင့်ရေနံစီမံခန့်ခွဲမှု အကောင်အထည်ဖော်မှု			စီမံကိန်းတည်ဆောက်သူကစီမံသည်)
လုပ်ငန်းခွင်ကျန်းမာရေးနှင့်လုံခြုံရေးအပါအဝင် လုပ်ငန်းအခြေအနေ	၁။လုပ်ငန်းခွင်မတော်တဆမှုများမှတ်တမ်း ၂။ OHS စီမံကိန်းအကောင်အထည်ဖော်မှုမှတ်တမ်း ၃။ဘေးကင်းလုံခြုံရေးအသိပညာပေးစည်းရုံးလှုံဆော်ရေးနှင့်အခြားဆောင်ရွက်ချက်များမှတ်တမ်း	ဖျက်သိမ်းဆိုဒ်များ	၁။လိုအပ်လျှင်လစဉ်	ကန်ထရိုက်တာ (MR/ စီမံကိန်းတည်ဆောက်သူကစီမံသည်)
ယာဉ်မတော်တဆမှုများ	၁။ဆိုဒ်ကင်းလှည့်ခြင်း ၂။ရထားလမ်းမတော်ဆမှုများမှတ်တမ်း ၃။MMRတစ်လျောက်အခြားမတော်တဆမှုများမှတ်တမ်း	ဖျက်သိမ်းဆိုဒ်များ	၁။လိုအပ်လျှင်လစဉ်	ကန်ထရိုက်တာ(MR/ စီမံကိန်းတည်ဆောက်သူကစီမံသည်)

၁.၉။လူထုပူးပေါင်းပါဝင်မှုရှိရေးလုပ်ဆောင်ထားရှိချက်များ

လူထုပူပေါင်းပါဝင်ခြင်းနှင့်တိုင်ပင်ဆွေးနွေးခြင်းအကျဉ်းချုပ်လုပ်ငန်းစဉ်တွင် လူနေရပ်ကွက်များ အတွင်းကွင်းဆင်းဆောင်ရွက်ခြင်း၊ အဓိက အုပ်စုများ နှင့်ဆွေးနွေးခြင်း နှင့် လူထုတွေ့ဆုံပွဲများ ပြုလုပ်ခြင်းတို့ပါဝင်သည်။ စီမံကိန်းအတွက် လူထုတွေ့ဆုံပွဲများပြုလုပ်ခြင်း ပြီးမြောက်ရန် စီမံကိန်းတစ်ခုလုံးအတွက် အနည်းဆုံးလူထုတွေ့ဆုံပွဲ ၁၉ ပွဲပြုလုပ်မည် ဖြစ်ပြီး ရှယ်ယာရှင်အစည်းအဝေး ၆ခု ပါဝင်မည်ဖြစ်သည်။

(က) လူနေရပ်ကွက်များအတွင်းကွင်းဆင်းဆောင်ရွက်ခြင်းနှင့် အဓိကအုပ်စုများနှင့် ဆွေးနွေးခြင်း

လူနေရပ်ကွက်များအတွင်းကွင်းဆင်းဆောင်ရွက်ခြင်းအတွက် ရှိရင်းစွဲလူမှုစီးပွားအခြေအနေများကိုဖော်ထုတ်ရန်နှင့် စီမံကိန်းနှင့် ပက်သက်၍ လူထု၏ စိတ်ခံစားမှု၊ သဘောထားများနှင့် ပြင်ဆင်ထားမှုအတိုင်းအတာကိုသိရှိနားလည်ရန် ရထားလမ်းတစ်လျှောက်ရှိ ၈၇ ရွာသို့ လိုက်လံကြည့်ရှုခဲ့သည်။ တိကျသောအချက်အလက်များရရှိရန် ရှိရင်းစွဲ အချက်အလက်များကို လူမှုရေးဆိုင်ရာကျွမ်းကျင်သူများ၊ လူမှုရေးအတိုင်ပင်ခံများ၊ ရပ်ရွာအာဏာပိုင်များနှင့် ဒေသခံလူထုတို့မှတဆင့် ကောက်ယူမည်ဖြစ်သည်။ ရပ်ရွာအတွင်းကွင်းဆင်းလေ့လာမှုများအတွင်း ဒေသခံလူထုမှ စီမံကိန်းနှင့် ပက်သက်၍ မျှော်လင့်ထားသောကောင်းကျိုးများနှင့် စိုးရိမ်ပူပန်နေသော အကြောင်းအရာအများစုမှာအောက်ပါအတိုင်းဖြစ်သည်။

- မြေအသုံးချမှုအတွက် ခွင့်ပြုချက်မရှိပါကလျော်ကြေးပေးရန်။
- စမ်းချောင်းများနှင့် သဘာဝရေပူစမ်းများပိတ်ဆို့ခြင်း။
- တောင်တန်းဒေသစိုက်ပျိုးရေးအပေါ် ထိခိုက်မည်ကိုစိုးရိမ်ခြင်း။

(ခ) လူထုတွေ့ဆုံပွဲများ ပြုလုပ်ခြင်း

လူထုတွေ့ဆုံပွဲများတွင်ဒေသခံအဓိကသက်ဆိုင်သူများ၊လွှတ်တော်ကိုယ်စားလှယ်များ၊ အစိုးရမဟုတ်သောအဖွဲ့အစည်းများ၊ သတင်းမီဒီယာများစသဖြင့် တတ်ရောက်ကြပြီး ၎င်းတို့မှ သိလိုသည်များကို မေးမြန်းကြပါသည်။လူထုတွေ့ဆုံပွဲနှင့် ပူးပေါင်းပါဝင်မှုတွင် ရှာဖွေ တွေ့ရှိချက်များကို အနှစ်ချုပ်ခြင်းဖြင့် အောက်ဖော်ပြပါများသည် အဆိုပြု တံတားနှင့် မြေအောက်မြောင်းများစီမံကိန်းနှင့် ပတ်သက်သောဆွေးနွေးမှုများမှ တွေ့ရှိလာသော လူထုစိုးရိမ်ပူပန်မှုများ ဖြစ်ပါသည်။

(က) ဒီဇိုင်းအဆင့်အတွက် တွေ့ရှိချက်များ

- ဆောက်လုပ်ရေးမတိုင်မီအခြားသောအထောက်အပံ့များ၏ အရှည်၊ အကျယ် နှင့် မြေအသုံးပြုမှု သတင်းအချက်အလက်များကိုတရားဝင်ကြေညာပေးရန်။
- ရထားလမ်း၏အကျယ်နှင့် မြေအသုံးချမှုအချက်အလက်များပွင့်လင်းမြင်သာမှုရှိစေရန်။
- စီမံကိန်းအကောင်အထည်ဖော်ခြင်းအတွက် တင်ဒါစနစ်။
- ဒေသခံပြည်သူများ၏ အလုပ်အကိုင်အခွင့်အလမ်းမူဝါဒ။
- စီမံကိန်းမစတင်မီနှောင့်နှေးကြန့်ကြာမှုမရှိပဲလျော်ကြေးများအားပေးအပ်ရန်။
- သဘာဝရေစီးကြောင်းစနစ်ပိတ်ဆို့မှုများမဖြစ်စေရန်။
- စိုက်ပျိုးမြေ၊ သစ်တောမြေနှင့် ရှေးဟောင်းသုတေသနမြေနေရာများပျက်စီးမှုနည်းပါးစေရန် မူဝါဒ၊
- စိုက်ပျိုးမြေ၊ သစ်တောမြေ၊ သမိုင်းဝင်နှင့် ရှေးဟောင်းသုတေသနမြေနေရာများ ထိခိုက်မှုနည်းစေရေးလုပ်ငန်းစဉ်။

- ပိုင်ရှင်၏ခွင့်ပြုချက် ရှိ/မဲ့ မြေယာအသုံးပြုမှုများအတွက် သင့်လျော်သောနစ်နာကြေးမူဝါဒ။

(ခ)ဆောက်လုပ်ရေးကာလအတွက် လူထုစိုးရိမ်ပူပန်မှုများ

- နိုင်ငံခြားနှင့် ပြောင်းရွှေ့အလုပ်သမားများအားထိန်းချုပ်ရန်။
- ဆောက်လုပ်ရေးမှထွက်ရှိလာသောမြေသားများအားလယ်ယာမြေများအနီးတွင် မစွန့်ပစ်ရန်။
- ရထားလမ်းအားသဘာဝအရင်းအမြစ်များ၏ အဝေးတွင် ထားရှိရန်။
- အများပြည်သူသုံးခုံကျော်တံတားဆောက်လုပ်ပေးရန်။
- စီမံကိန်းပြင်ပနေရာများတွင် သစ်ပင်ခုတ်ခြင်းများအားရှောင်ကြဉ်ရန်။
- သဘာဝရေစီးကြောင်းစနစ်နှင့် သဘာဝရေပူစမ်းပိတ်ဆို့မှုများမဖြစ်စေရန်။
- ကျေးရွာလမ်းများအားပိတ်ဆို့ခြင်းမရှိစေရန်။
- ရထားလမ်းတစ်လျှောက်ရှိတောရိုင်းတိရစ္ဆာန်များအားထိခိုက်မှုမရှိစေရန်။
- ရှားပါးသတ္တုများပါဝင်နေနိုင်သောမြေသားများအားအခြားနေရာသို့ ရွှေ့ပြောင်းခြင်းများမပြုလုပ်ရန်။
- ရထားလမ်းကြောင်းဆောက်လုပ်နေစဉ်ကာလအတွင်းလုပ်သားများနှင့် ဆောက်လုပ်ရေးပစ္စည်းများသယ်ယူပို့ဆောင်ရာတွင် ယာဉ်ကြောပိတ်ဆို့မှုများနည်းပါးစေရန်။

(ဂ) လုပ်ငန်းလည်ပတ်မှုကာလလူထုစိုးရိမ်ပူပန်မှုများ

- စီမံကိန်းအနီးအနားတွင် ရွှေ့ပြောင်းအလုပ်သမားများ အခြေချနေထိုင်ခြင်းကို တားဆီးပေးရန်။
- သစ်ပင်ပန်းမန်များဖယ်ရှားခြင်းအတွက် အစားထိုးအပင်များ ပြန်လည်စိုက်ပျိုးပေးခြင်း။
- ရထားလမ်းကြောင်းတစ်လျှောက်လုံးတွင် ဘေးအကာအရံထားရှိခြင်း။
- ရထားလမ်းဥမင်လိုဏ်ခေါင်းနှင့်သက်ဆိုင်သောဘေးကင်းလုံခြုံရေးသင်္ကေတများတပ်ဆင်ပေးခြင်း။
- မြန်မာဘာသာ၊ ရှမ်းဘာသာနှစ်မျိုးလုံးဖြင့် ရေးထားသောသတိပေး ဆိုင်းဘုတ်များထားရှိခြင်း။
- ရထားလမ်းဖွံ့ဖြိုးရေးကြောင့် စီးပွားရေးအခြေအနေများ လျော့နည်းသွားနိုင်သော မူဆယ်-မွန္တလေး အဝေးပြေးလမ်း၏ အနီးအနားနှင့်ဘေးပတ်လည်ရှိဒေသခံပြည်သူများအတွက် အလုပ်အကိုင်အခွင့်အလမ်းများဖန်တီးပေးနိုင်ရန်။
- ဒေသခံပြည်သူလူထုအတွက် သင့်လျော်သောရထားအသုံးပြုခ။
- လူကုန်ကူးမှုတားဆီးရေးမူဝါဒ။
- "Zero-Dollar Tourism" တားဆီးရေးမူဝါဒ။

၁.၁၀။ အနှစ်ချုပ်သုံးသပ်ချက်

ပတ်ဝန်းကျင်ထိခိုက်မှု လေ့လာဆန်းစစ်ခြင်း လုပ်ငန်းအရ ရထားလမ်းကြောင်းအတွက် အဓိကပတ်ဝန်းကျင် ထိခိုက်မှုမှာ မြေနေရာသိမ်းဆည်းမှု ဖြစ်သည်။ ဆောက်လုပ်ရေးကာလအတွင်း အခြားသောလူမှုရေးထိခိုက်မှုများမှာ မြေအသုံးချမှု၊ ဇီဝမျိုးစုံ မျိုးကွဲများ အပေါ်

သက်ရောက်မှု၊ သဘာဝရေစီးကြောင်းစနစ်နှင့် သဘာဝရေပူစမ်းများ ကျေးရွာလမ်းများ ပိတ်ဆို့မှု တို့ဖြစ်သည်။ လုပ်ငန်းလည်ပတ်ရေးကာလအတွင်း အဓိကပတ်ဝန်းကျင်ထိခိုက်မှုများမှာ ဆူညံသံ နှင့်တုန်ခါမှု ဖြစ်သည်။

အနှစ်ချုပ်အရ ပတ်ဝန်းကျင်နှင့် လူမှုရေးထိခိုက်မှုများအားလုံးသည် ဤအစီရင်ခံစာတွင် တင်ပြထားသည့် လျော့ချရေးနည်းလမ်းများဖြင့် လက်ခံနိုင်သည့် အဆင့်သို့ လျော့နည်းအောင် ပြုလုပ်နိုင်သည်။ ရထားလမ်းကြောင်း၏ပတ်ဝန်းကျင်နှင့် လူမှုရေးထိခိုက်မှုများ၏ သဘာဝအရ ဆောက်လုပ်ရေး ကာလအတွင်းရှိထိခိုက်မှုများသည် လုပ်ငန်းလည်ပတ်မှုကာလနှင့် လုပ်ငန်း ဖျက်သိမ်း ကာလထက်ပိုများမည်ဖြစ်သည်။ ထို့ကြောင့် စီမံကိန်းအဆိုပြုသူသည် ဆောက်လုပ်ရေး ကာလအပေါ် ပို၍အလေးအနက်ထားသင့်သည်။ မြေအသုံးချမှုအတွက်မူ ကျယ်ပြန့်သော Resettlement Action Plan (RAP) အပြင် သင့်တော်သောလျော်ကြေးနှင့် ပြန်လည်နေရာ ချထားရေးများ ပြုလုပ်ပေးရန်လိုအပ်သည်။

1.0. EXECUTIVE SUMMARY

1.1. Overview

The Memorandum of Understanding (MOU) on Feasibility Study for Muse-Mandalay Railway Project between Myanmar Railways (MR), the Ministry of Transport and Communications (MOTC) of the Republic of the Union of Myanmar and China Railway Eryuan Engineering Group Co. Limited (CREEC), China Railway Group Limited, the People's Republic of China signed on October 22, 2018. According to this MOU, CREEC will conduct Feasibility Study (FS) for the new railway line from Mandalay to Muse. Although the proposed project is merely in FS stage, EIA is required for the proposed railway project (railway alignment) in accordance with this Environmental Conservation Law (2012) and Environmental Impact Assessment Procedure, 2015. Ever Green Tech Environmental Services and Training Co., Ltd. were appointed to conduct Environmental Impact Assessment (EIA) for the feasibility study of the proposed railway alignment project.

1.2. Summary of Introduction

1.2.1. Project Proponent and the EIA Study Team

The followings are the brief of project proponent for the FS of Muse-Mandalay railway project.

Project Developer	
Project Developer	Myanmar Railways (MR) under the Ministry of Transport and Communications (MOTC)
Type of Project	Muse-Mandalay Railway Alignment
Project Location	Muse-Mandalay railway starts from Muse port of entry at the north, goes south to Mandalay
Contact Person	1.U Myo Win (General Manager) Upper Myanmar Administration (MR) Upper Myanmar Administration Department, Mandalay Station, Mandalay, Myanmar Tel : +95-2-35172 Fax : +95-2-35829 E-mail : myowingmupper@gmail.com
	2.U Phyo Htet Kyaw [Assistant General Manager (Planning)] Planning and Administration Department, (MR) Nay Pyi Taw Station Compound, Nay Pyi Taw, Myanmar Tel : +95-6777164(office)/+95-9-43124800(mobile) Fax : +95-67-77164

Below is the background information on Ever Green Tech Environmental Services and Training Co., Ltd., (Third party) who will conduct the EIA for the proposed project.

Ever Green Tech Environmental Services & Training Co., Ltd.	
Company Name	Ever Green Tech Environmental Services and Training Co., Ltd.
Company Registration Number	3344/2015-2016 (Ygn)
Transition Consultant Registration Number	0047
Contact Address	No.1/9, Baho Road, 16th quarter, Hlaing Township, Yangon
Telephone Number	09-5099230, 5099232
E-mail	green.evergreentech@gmail.com
Contact person	Dr. Kyaw Swar Tint Ph.D. (Mining) Principle Environmental and Social Consultant 11kyawswar@gmail.com 09-797111000

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1.2.2. Selected Consultants for Conducting EIA

The following are the selected consultants for impact assessment and report writing.

	No.	**Name**	**Degree**	**Responsibility**	**Area of Expertise**
Consultants	1	Dr. Kyaw Swar Tint	Ph.D. (Mining)	Key Consultant	(a) Air Pollution Control (b) Noise and Vibration (c) Socio-Economy (d) Environmental Management and Monitoring

	2	Mr. Min Aung	M.Sc. (Chemistry)	Key Consultant	(a) Water Pollution Control (b) Modelling of Water Quality (c) Soil and Ground Water Pollution Control
	3	Dr. Thein Tun	Ph.D. (Metallurgy)	Senior Consultant	(a) Risk Assessment and Hazard Management (b) Facilitation of Meeting (c) Occupational Safety and Health
	4	Dr. Myo Min Tun	Ph.D. (Metallurgy)	Senior Consultant	(a) Evaluation of Alternatives (b) Resources Utilization and Management (d) Waste Management
	5	Dr. Sao Hone Pha	Ph.D. (Electronics)	Consultant	Map, Google Earth, Remote Sensing and GIS
	6	Ms. Nandar Nwe	M.S. in EIA/EMS (YTU),	Consultant	Social Impact Assessment (Household Survey)
	7	Ms. Thazin Htwe	M.S. in EIA/EMS (YTU), Dip; in Applied Psychology (YU)	Consultant	Social Impact Assessment (Public Consultation and Stakeholder Engagement)
	8	Mr. Yaw Ma Nar	B.Sc. (Forestry); Dip in EIA/EMS	Field Coordinator	Baseline Study (Traffic and Secondary Data Collection)
	9	Mr. Moe Pyi Kyaw	B.Sc. (Forestry)	Surveyor	Baseline Study (Surface Water and Soil Quality)
	10	Dr. Wyne Nwe New Oo	Ph.D. (Boitech)	Consultant	Species Identification
	11	Dr. Nyunt Lwin	Ph.D. (Zoology)	Consultant	Fauna Diversity
	12	Dr. Nyo Nyo Lwin	Ph.D. (Botany)	Freeland Consultant	Flora Diversity

	13	Dr. Khon Aung	M.B.B.S. (Ygn)	Consultant	Health Impact Assessment
	14	Dr. Myo Min Nyunt	Ph.D. (Mining)	Consultant	Geotechnical Engineering
	15	Dr. Ohm Theik	Ph.D. (Mining)	Consultant	Geotechnical Engineering (Slope Stability)
	16	Dr. Tin Aung Myint	Ph.D. (Geology)	Consultant	Engineering Geology
	17	Dr. Win Swe	Ph.D. (Geography)	Consultant	Hydrology and Socio-economic
	18	Ms. May Thet Zaw	M.E. (Civil)	Consultant	Constructional Related Impact Assessment and Risk Assessment
	19	Ms. Nay Chi Win Maung	M.E. (Civil)	Consultant	Waste management
	20	U Aung Naing Tun	L.L.B; MBA	Consultant	Legal Requirement
Foreign Consultant	21	Mr. Cheng Liang shuang	M.Sc. (Conservation of Soil & Water)	Consultant	Water resources and high-speed railway design

1.2.3. Objectives of the EIA Study

The objectives of an EIA are to:

- Ensure that social and environmental considerations are explicitly addressed and incorporated into the development decision-making process;
- Anticipate and avoid, minimize or offset significantly adverse biophysical, social and other relevant impacts of proposed developments;
- Protect the productivity and capacity of natural systems and the ecological processes which maintain their functions; and
- Promote development that is sustainable and that optimizes resource use and management opportunities.

1.2.4. Scope of the EIA Study

The EIA Study for the proposed railway alignment will cover the construction and operation of new railway alignment from Muse to Mandalay. The total length of the main railway line is

409.960 km. The EIA study will cover the environmental, social and health impacts and respective mitigation and enhancement measures. But the study will not cover for political and economic issues.

1.3. Summary of Policy, Legal and Institutional Framework

1.3.1. Summary of Laws and Regulations Related to the Proposed Project

Myanmar has promulgated several laws and regulations concerning protection of the environment. The following table describes laws and regulations which are directly or indirectly associated with the proposed project. The law and regulations related to the proposed project will be classified as follow:

Table - Laws and Regulations Related to Workmen's Right, Occupational Safety and Health

Laws and Regulations	Year
The Labor Organization Rules, (No. 1,7 to 11)	2012
Second Amendment to the Labor Dispute Settlement Law (Law No.17)	2019
Labor Disputes settlement Act (Law No.5)	2014
Employment and Skill Development Law, (Law No. 5, 14, 30(a,b))	2013
The Leave and Holiday Act, 1951 (Law Amended July, 2014)	2014
Minimum Wages Law (Law No. 12, 13 (a to g)	2013
Payment of Wages Act (Law No. 3,4, 5, 14, 8 with 7,10)	2016
The Social Security Law (Law No. 11(a), 15(a), 18(b), 48, 49, 75)	2012
Law Amending the Workmen's Compensation Act	2005
Prevention and Control of Communicable Diseases Law (Law No. 3, 4, 9, 11)	1995
The Control of Smoking and Consumption of Tobacco Product Law (Law No. 9)	2006
The Prevention of Hazard from Chemical and Related Substances Rules (Law No. 8,15,16,17, 20, 22, 23, 27)	2013
Occupational safety and health Law (Pyidangsu Hluttaw Law No 8)	2019
Workmen's Compensation Act	2005
The Traditional Drug Law (Law No.7)	1996
Law Relating to Overseas Employment (Law No.3)	1999
Prevention from Danger of Chemical and associated Materials Law (Law No.28)	2013

Table - Laws and Regulations Related to Cultural and Heritage

Laws and Regulations	Year
The Protection of rights of National Race Law, (Law No. 5)	2015
Protection and Preservation of Cultural Heritage Regions Laws (Law No. 15, 16)	2019
The Protection and Preservation of Antique Objects Law (Law No. 12,15 20)	2015

The Protection and Preservation of Ancient Monuments Law (Law No. 12,15 20)	2015
Law on the preservation and protection of ancient buildings	2015
Law Protecting Ancient Objects (Law No.43)	2015
Law Concerning Religious Conversion (Law No.48)	2015

Table - Laws and Regulations Related to Communities' Development, Health and Safety

Laws and Regulations	**Year**
Village Regional Development Law (Law No. 39)	2019
Law Regarding Population Control & Health (Law No. 28)	2015
Law of protection of farmer rights and enhancement of their benefits (Law No 32)	2013
Vacant, Fallow, Virgin Land Management Law (Law No. 4(d), 5(d),7)	2012
Second Amendment of the Law on the Development of Border Areas and National Races (Law No. 44)	2015
The Law Relating to Private Health Care Services (Law No.5)	2007
Public Health Law (Law No. 3, 5)	1972

Table - Laws and Regulations Related to Transportation and Communication

Laws and Regulations	**Year**
Automobile Law Pyidaungsu Hluttaw Law No. 55/2015	2015
Railway Transportation Service Law (Section 28 to 39, 42 and 43)	2016
The Highways Law (Law No.24)	2015
Law Amending Highway Act (Law No 33)	2014
Road Carriers Law(No 3)	2016
The bridges Law (Law No 16)	2019
Multi-Model Transport Law (Law No 3)	2014
The Law Amending the Embankment Act (Law No.2)	1998
Law Amending the Law on the Utilization of Roads and Bridges (Law No.25)	2014

Table - Laws and Regulations Related to Land Acquisition

Laws and Regulations	**Year**
Vacant, Fallow, Virgin Land Management Law (Law No. 4(d), 5(d),7)	2012
Land Acquisition, Resettlement and rehabilitation Law (Section 39,41,42,46,54(b and c),58)	2019
Farm Land Law	2012
Farmland Act (Law No.11)	2012
National Land Use Policy	2016

Table - Other Relative Laws and Regulations for the Proposed Project

Laws and Regulations	Year
Myanmar Mining Law (Law No. 13)	2018
Law Amending the electronic transactions law (Law No 6)	2014
Telecommunication Law (Law No 31)	2013
Natural Disaster Management Law (No 21)	2013
Constitution of the Republic of the Union of Myanmar (Articles 24,45,349,359)	2008
Law on standardization (Law No.28)	2014
Environmental Conservation Law (Law No.7(o), 14,15,24,25,29)	2012
Environmental Conservation Rules (Rule 55, 69 (a), (b))	2014
EIA Procedures (Article 102 to 110, 113, 115, 117)	2015
National Environmental Quality (Emission) Guidelines (Section 2.1.9)	2015
Law Amending the Factories Act 1951 (Pyidaungsu Hluttaw Law No. 12/2016)	2016
Private Industrial Enterprise Law	1990
The Myanmar Insurance Law (Law No. 15, 16)	1993
Myanmar Fire Force Law, (Law No. 25)	2015
The Electricity Law	2014
The Electricity Rule	2015
Myanmar Petroleum and Petroleum Products Law (No. 9(a)∈,10∈,11)	2017
The Export and Import Law (Section 6,7)	2012
The Myanmar Engineering Council Law (Law No. 20,24,25,31(a), 37)	2013
Patent Law	2019
Pesticide Law Pyidaungsu Hluttaw Law No. 14/2016	2016
Forest Law	1992
Protection of Biodiversity and Protected Area Law	2018
Conservation of Water Resources and Rivers Law (Law No. 8, 11(a), 13, 19, 24(b), 30)	2006
Conservation of Water Resources and Rivers Rules	2013
The Freshwater Fisheries Law (Law No. 36,40,41)	1991
Animal Health and Development Law (Law No.17)	2010
The Fertilizer Law (Law No.7)	2002

1.3.2. Summary of International Agreements and Conventions

In addition to the domestic laws listed above, Myanmar is also a signatory to the following international conventions, and these may have relevance to the proposed survey activities. Refer to the following Table.

Table - International Agreements and Conventions Relevant to the Proposed Project

International Agreements and Conventions	Status
Declaration of the United Nations Conference on the Human Environment	1972
Vienna Convention for the Protection of the Ozone Layer, 1985	1998
Montreal Protocol on Substances that Deplete the Ozone Layer, 1989	1993
Basel Convention, 1989	2015
United Nations Framework Convention on Climate Change (UNFCCC), New York, 1992 and Kyoto Protocol 1997	1995 and 2005
Convention on Biological Diversity, Rio de Janeiro, 1992	1994
Asia Least Cost Greenhouse Gas Abatement Strategy (1998 ALGAS)	1998
United Nations Agenda 21	1997
Relevant ILO Conventions in force in Myanmar • C1 Hours of Work • Unemployment Convention • C14 Weekly Rest • C17 Workmen's Compensation (Accidents) • Workmen's Compensation (Occupational Diseases) Convention • C19 Equality of Treatment (Accident Compensation) • C26 Minimum Wage Fixing Machinery • C29 Forced Labour Convention • C42 Workmen's Compensation (Occupational Diseases) Revised 1934 • C52 Holidays with Pay • C63-Convention concerning Statistics of Wages and Hour of Work • C87- Freedom of Association and Protection of the Right to Organise Convention • C182- Worst Forms of Child Labour Convention	
International Environmental Law (IEL)	2017

1.3.3. Summary of Statement of Commitments

The developer has to commit to comply with the followings:

a) We, Myanmar Railway (MR) commit to follow the environmental commitments, mitigation measures, management plans illustrated in the EIA report. We also commit to follow the Environmental Conservation Laws 2012, the Environmental Conservation Rules 2015 that stated in EIA.

b) Comply with the commitments of the environmental and socio-economic development revealed in the Environmental Impact Assessment report.

c) Acknowledge and comply the laws, regulations and guidelines associated with the project, included in the report.

d) Comply and proceed the alternative methods, mitigation measures and monitoring plans included in the report for the reduction of the negative environmental impacts; and take responsibility for the environmental impacts due to non-compliance of the commitment.

1.3.4. Summary of Sustainability Policy

Project developer's sustainability model is "To operate in a sustainable manner means to create value for stakeholders, and to use resources so that the needs of future generations will not be compromised, respecting people, the environment and the society as a whole."

1.3.5. Summary of Project's Environmental, Social and Health Policies

The main policy and commitment of project developer can be identified in the following points:

- the protection of public safety, the health and safety of the workforce and the local communities
- the protection and promotion of human rights, the economic and social development of local communities;
- the protection of the environment and the conservation of biodiversity and ecosystems;
- the continuous improvement of the quality of the processes, services and products of our activities and operations;
- the compliance with Myanmar laws, regulations and industrial standards regarding the environment, health, safety and hygiene at work in all of our operations
- visible and active leadership that promotes HSE excellence, which engages and motivates employees and contractors alike to succeed
- setting objectives and targets for measuring and improving HSE performance in line with Company activities and strategic objectives
- manage HSE in order to achieve our objective of incident free operations
- implementing sustainable development principles in our activities
- seek and achieve continuous improvement in our processes, consistent with our strategic objectives and priorities, by adopting the most advanced systems for environmental protection and energy efficiency.

1.4. Summary of Project Description

The following will be the summary of project description.

1.4.1. Project Area and Location

The proposed project will cover the alignment of the high-speed railway that starts from Muse port of entry at the north, goes south to Mandalay. Muse-Mandalay Railway (MMR) connects with China's railway network at the north, and links up with Myanmar existing meter-gauge railway by a break of gauge at Mandalay. The railway will also pass through or near the big township such as Kuit Kai, Thein Ni, Lashio, Thipaw, Kyauk Mae, Pyin Oo Lwin and Mandalay. The total length of the main railway line is 409.960 km. The project alignment of proposed railway line is shown as follow:

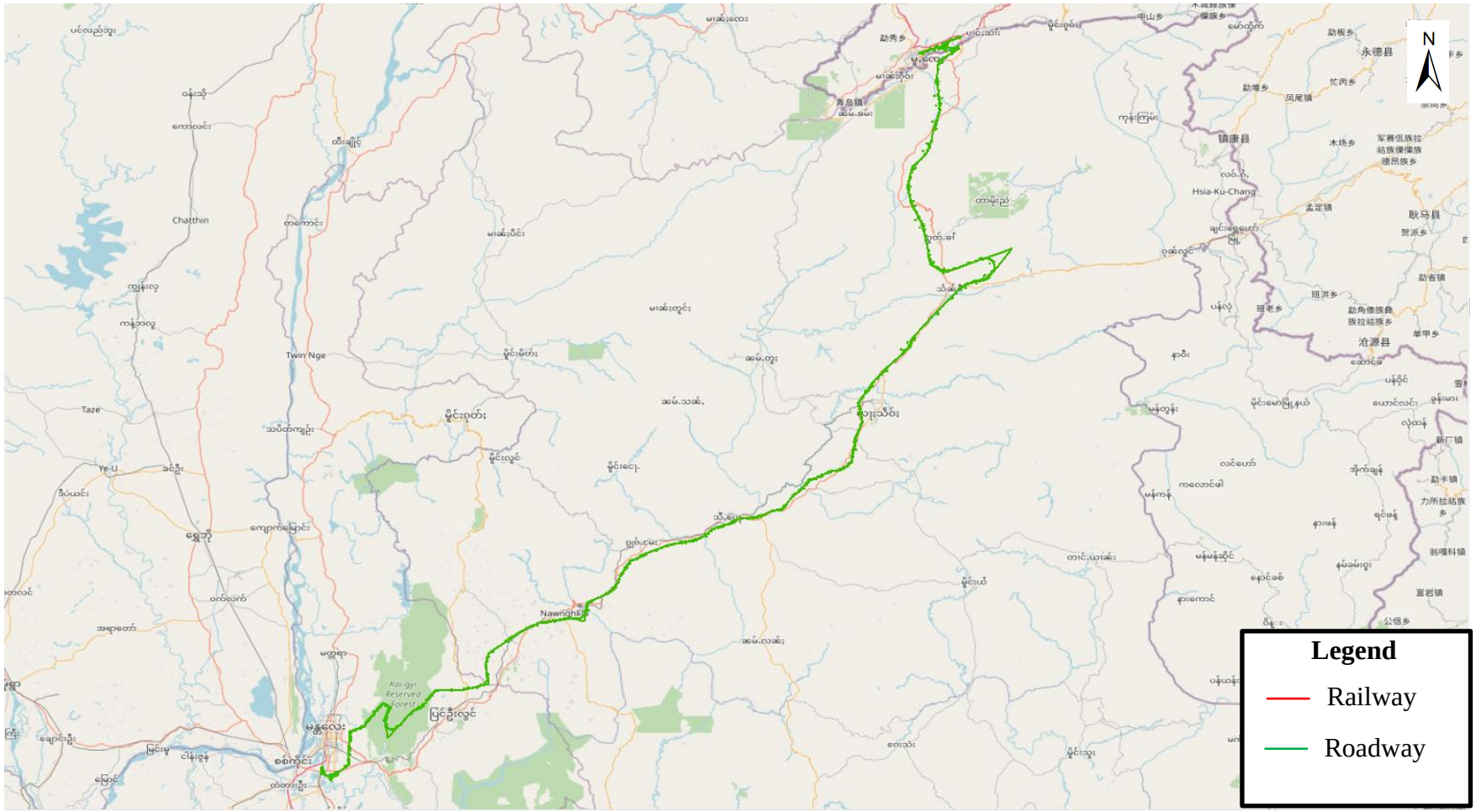


Figure - Proposed Muse-Mandalay Railway Line

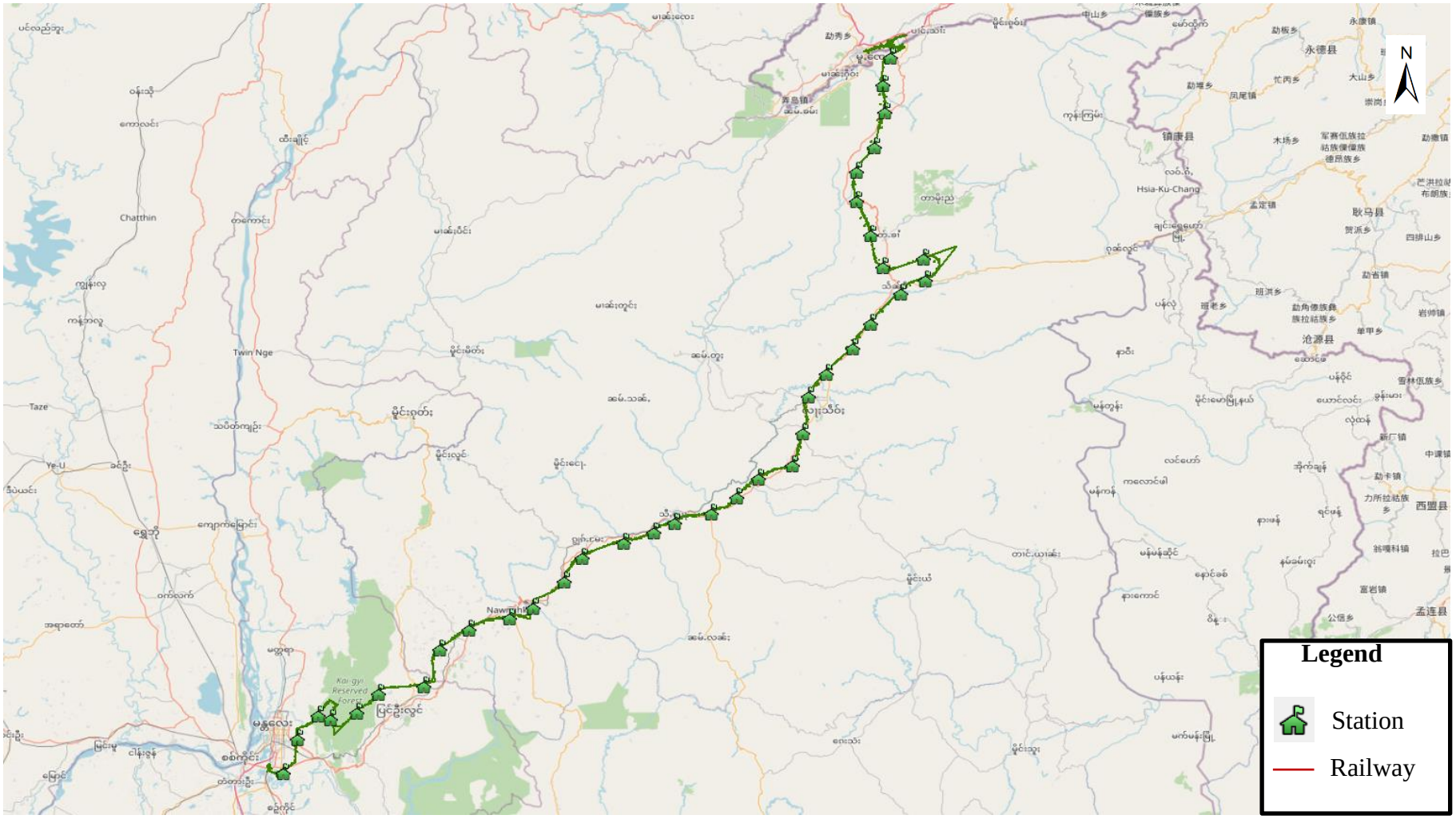


Figure - Stations along the Proposed Muse-Mandalay

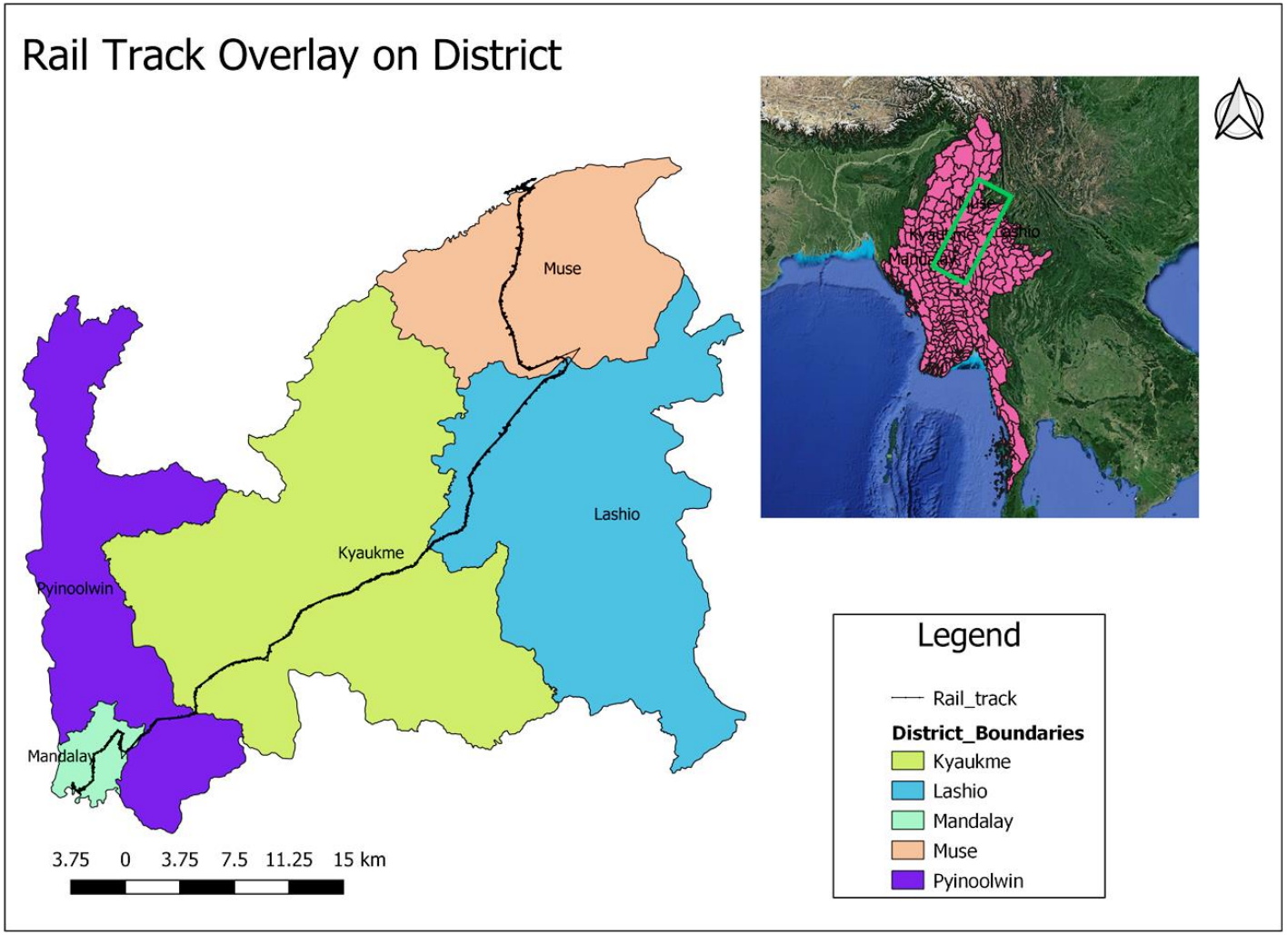


Figure - Districts that will be Passed by Muse-Mandalay Railway Alignment

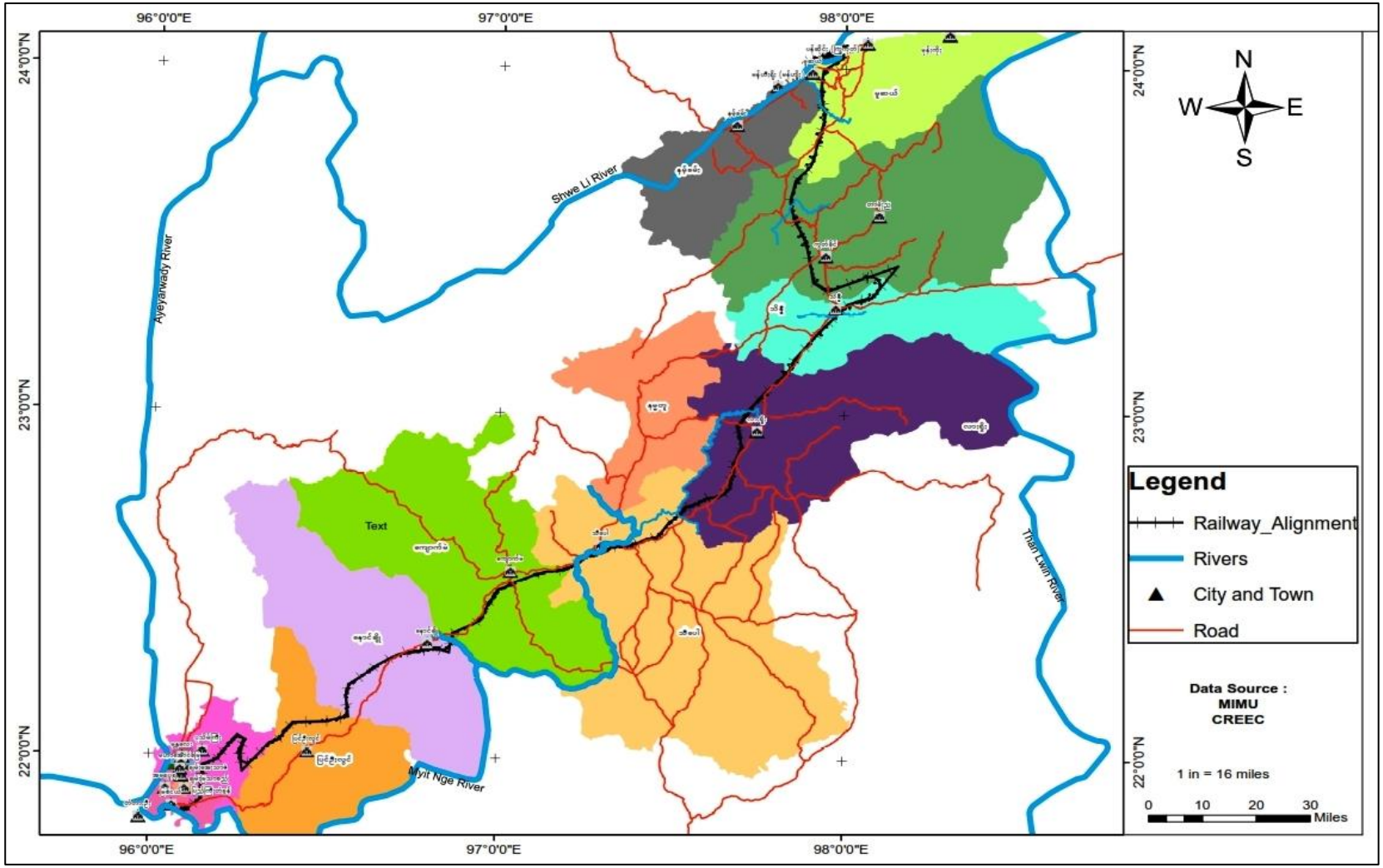


Figure - Townships that will be Passed by Muse-Mandalay Railway Alignment

1.4.2. Main Technical Specifications of the Railway Line

The main technical specifications are as follow:

Item	Standard
Railway grade	Grade Ⅰ
Rail gauge	1435mm
Number of mainlines	Single line (reserve condition of doubling line)
Ruling gradient (‰)	12‰，push grade24‰
Minimum curve radius(m)	General section 2000m, difficult section 1600m
Design running speed of passenger trains(km/h)	160km/h
Type of traction	Electric traction
Type of locomotive	Electrical 6-axis vehicle
Tractive tonnage (t)	3000t
Effective length of arrival-departure track (m)	650, reserve 850
Type of blocking	Semi-automatic blocking

1.4.3. Main Components in Railway Line

The following are main components that include in the railway project.

No.	Components	Quantity	Total Length
1.	Total Railway Line	1 No.	409.960 km
2.	Nos. of bridges along the railway	124 Nos.	69.309 km
3.	Nos. of tunnels along the railway	60 Nos.	221.469 km
4.	Nos. of stations along the railway	36 Nos.	4 km

1.4.4. Auxiliary Project Components

The meter-gauge railway link from Mandalay South to Myitnge is 4.170 km long, without bridge and tunnel works, and Myitnge Station is to be renovated.

1.4.5. Land Use

The land use for main line of Muse-Mandalay Railway is 37,320,512m^2, including 25,951,997m^2 permanent land use and 11,368,515m^2 temporary land uses. Land use for the meter-gauge connecting line from Mandalay South to Myitnge is 292,909m^2 including 189,699m^2 permanent land use and 103,210m^2 temporary land use.

1.4.5. Land Use Classes within 500m beside the Railway Alignment

According to the GIS study, the land use classes within 500m beside the railway alignment are as follow:

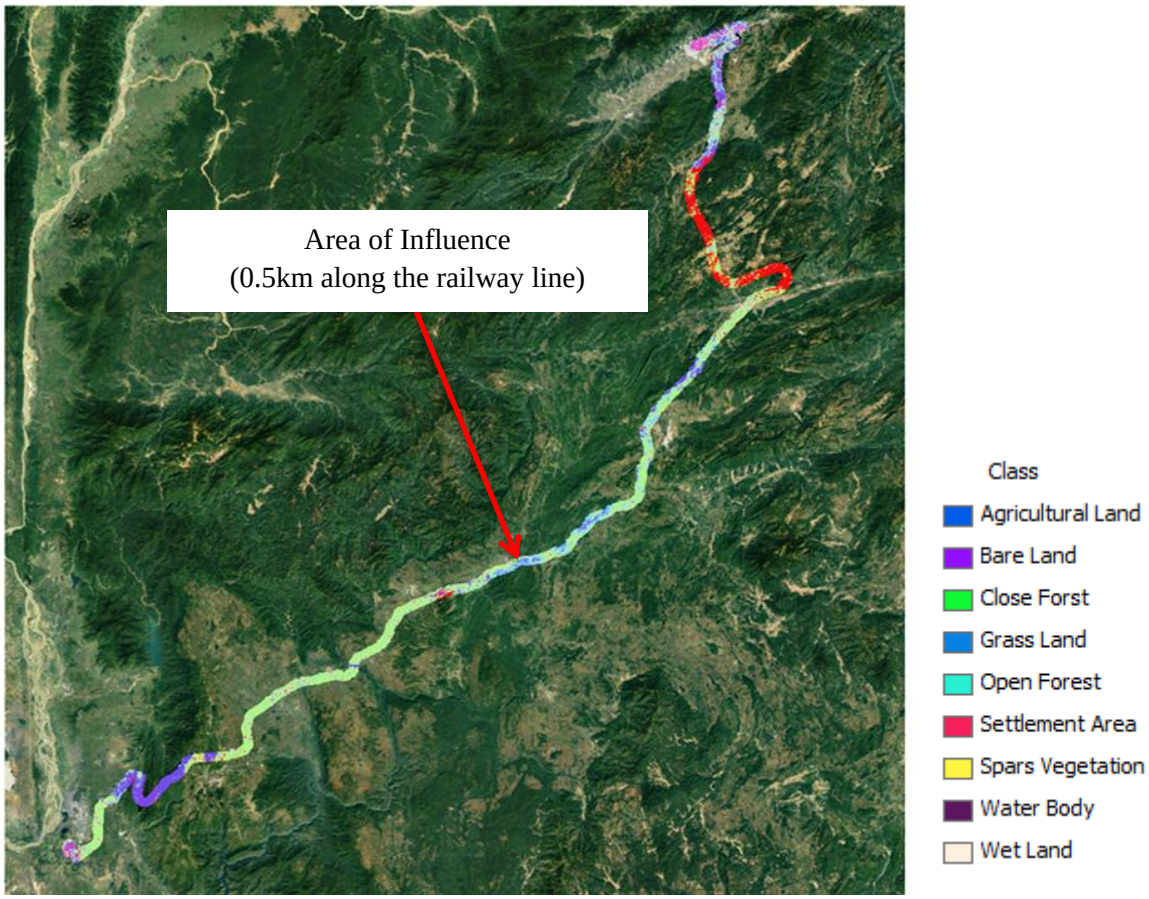


Figure – Land Use Land Cover (LULC) Classes of Railway Alignment

No	Class	Area (Km^2)	Area (Km^2)	Area (Percentage)
1	Agricultural Land	218.9486	416.0773	52.622097
2	Bare Land	4.9292		1.184684
3	Open Forest	91.777		22.057680
4	Close Forest	44.8061		10.768696
5	Settlement	23.622		5.677310
6	Water Body	1.5959		0.383799
7	Wet Land	1.1969		0.287663
8	Grass Land	0.02		0.004807
9	Sparse Vegetation	29.1806		7.013264

According to this table, the most land use types are agricultural land (52%), forest area (32%), settlement area (5%) and vegetation area (7%). The rest are water body (0.3%), bare and grass land (1.1%) and wet land (0.2%).

1.4.6. Summary of Process Description

The common construction of a new railway is mainly divided into the following steps:

(a) Pre-Construction Activities

There are some preparative works before railway track construction. It includes:

- Site clearance
- Subgrade
- Subgrade drainage
- Materials preparation

(b) Construction Activities

The construction activities will include the construction of roadbed, reinforcing steel bar and sleeper laying, track panel frame assembling, upper layer reinforcing steel bar binding and template installation, roadbed slab concrete pouring and track panel frame detachment.

(c) Operation and Maintenance

The operational activities of the alignment include the maintenance of the railway alignment.

1.4.7. Sewage Treatment and Disposal Scheme

Domestic sewage is discharged into septic reservoir and oily sewage in the turnaround depot is settled in oil separation sedimentation reservoir and then both of then flow into the integrated membrane bio-Reactor (MBR) sewage treatment equipment.

1.4.8. Road

Road works are mainly divided into station-accessing road work and temporary accessing road work. Combination of permanent and temporary roads is considered at temporary accessing road.

1.4.9. Implementation Schedule

The schedule of implementation will be about 5 years after the starting date. So, the railway stations will also be finished within 5 years.

1.4.10. Workforce

For construction phase the project will use engineers, skillful workers and general workers a total number of 375. For operation period, the project will use permanent workers of 264.

1.4.11. Summary of Alternative Analysis

Alternative analysis has been considered as an integral part of EIA process, which involves examination of alternative ways of achieving the objectives of the proposed project. The aim of alternative analysis is to arrive at a development option, which maximizes the benefits while minimizing the unwanted impacts. Alternative analysis is also a form of mitigation measures.

The alternative analysis for Mandalay-Muse was conducted into the following points (a) "no project" alternative and (b) alternative analysis for alignment.

(a) The "No Action" Alternative

From Environmental Perspective

This alternative avoids the implementation of Muse-Mandalay Railway. If this project is not implemented, no environmental and social impacts will occur. According to the impact

assessment, all of the environmental impacts related to the proposed railway project can be minimized with proper mitigation measures to acceptable level. So, the No Project Alternative is not flexible from the environmental point of view.

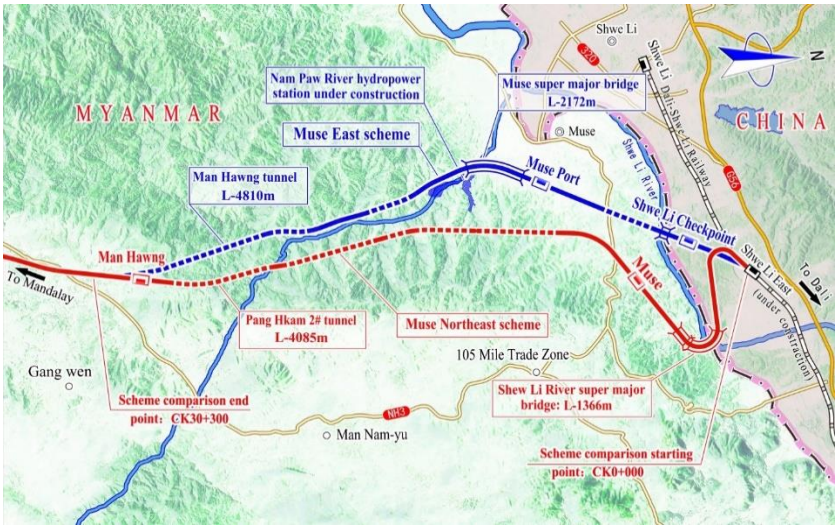
From Socio-economic Perspective

The proposed project will have a huge land use and will cause land acquisition and resettlement. However, the backward productivity and inconvenient traffic environment along the route will hinder the economic development of Mandalay, Shan State and even Myanmar, making the people along the route still living in poverty and unable to promote social progress. The foregone benefits of this option will include loss of foreign capital investment, loss of transportation development in the regions, loss of employment opportunities for local people, loss of infrastructure development, loss of increased business opportunities for local services, loss of skill development and improved services and of community development potential among other benefits of the project. Constructing Muse-Mandalay Railway can improve traffic conditions, lower transport costs and promote personnel exchanges which will add vitality into the national economy, and improve people's livelihood and boost social development & stability.

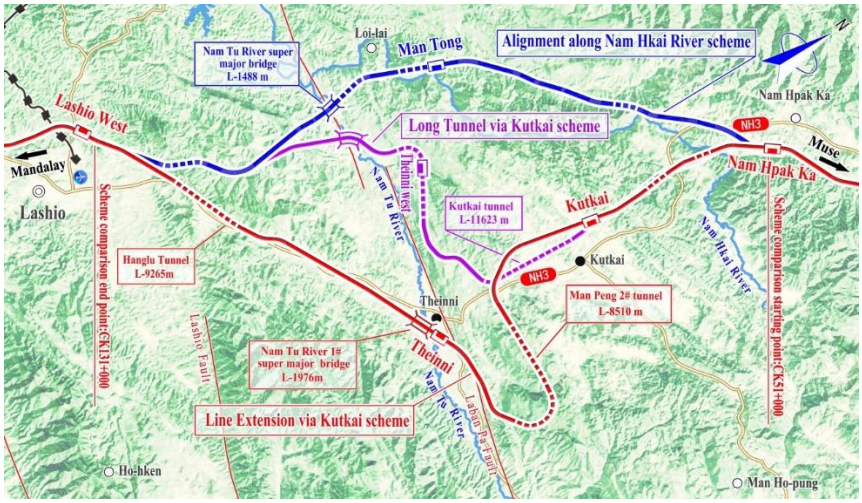
In Myanmar, transportation is still difficult due to the lack of alternative ways expect for road way in many regions. High speed rail way system will be beneficial for improvement of transportation system in Myanmar. So, "no-project" option represents a lost opportunity for Myanmar and cannot be accepted in the present condition if the developer can resolve politically aware and social issues related to the proposed project. For land use, it will have to conduct comprehensive RAP for proper land acquisition and resettlement.

(b) Alternative Analysis for Alignment

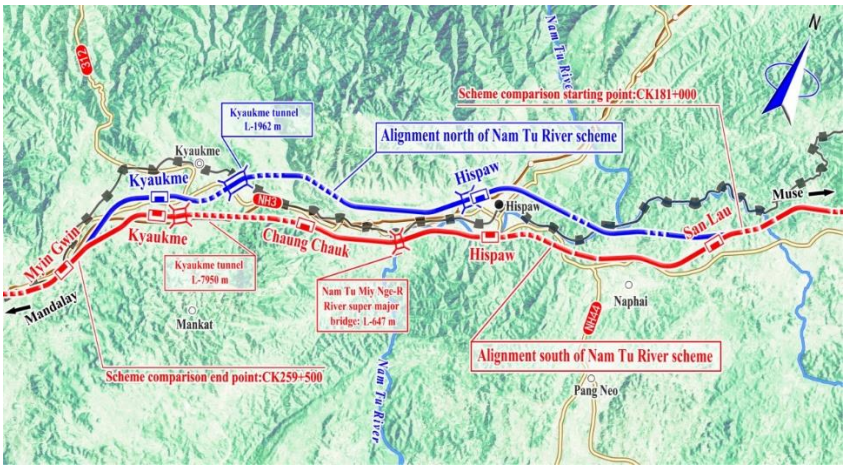
The alternative analysis for alignment was made section by section such as (i) Shweli East-Man Hawng Section, (ii) Nam Hpak Ka-Lashio West section, (iii) San lau-Myin Gwin section, (iv) Myin Gwin-Om Ma Ka section, and (v) Om ma ka-Mandalay East Section. All of the alternative selection of alignment will be based on technical, economic, and environmental perspective respectively.



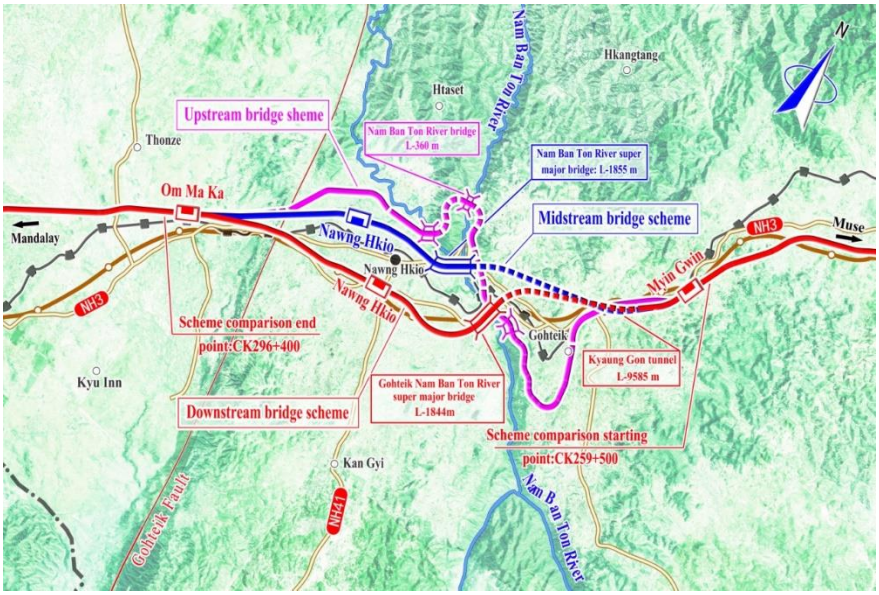
Schematic Map for Alignment Scheme of Shweli East-Man Hawng Section



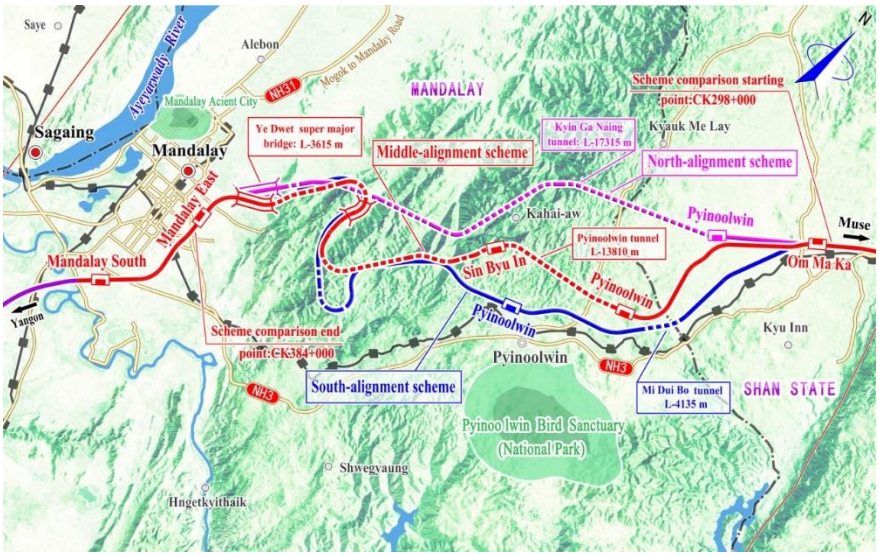
Schematic Map for alignment scheme of Nam Hpak Ka-Lashio West Section



Schematic Map of the alignment scheme of San lau-Myin Gwin Section



Schematic Map for the alignment scheme of Myin Gwin-Om Ma Ka section

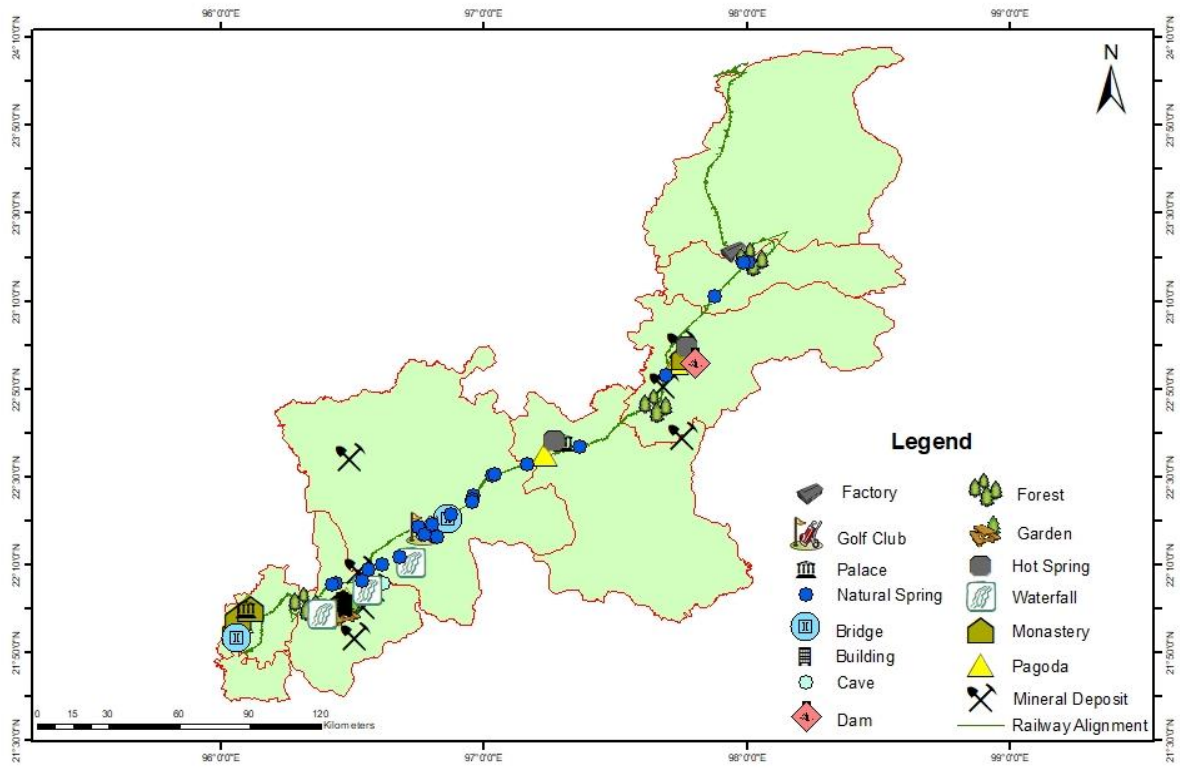


Schematic Map for the alignment scheme of Om ma ka–Mandalay section

1.5. Summary of Description of the Environment

1.5.1. Environmentally Sensitive Areas

There will be large area of agricultural lands, forest area, biodiversity abundance area, and natural springs along the railway alignment. All of these areas can be considered as environmental sensitive areas.



According to the above figure of map overlay method, most of the environmentally sensitive areas around the stations are residential areas (villages), natural springs, rivers and canals, factory, quarry, Nawng Hkio Golf Club, agricultural lands and forest areas including Kai Gyi Reserved Forest.

1.5.2. Military Areas

There are military areas in Nam Hpak Ka, Lashio, Pyin Oo Lwin and other places along the route.

1.5.3. Industrial and Mining Enterprises

There are small quarries along the line.

1.5.4. Geotechnical Characteristics

The geotechnical characteristics along the Muse-Mandalay Railway are:

i. Karst
ii. Landslide and Talus
iii. Unstable Rocks and Rock-Fall
iv. Bedding

v. Seismic Liquefaction
vi. Soft Soil and Mollisol
vii. Expansive Soil
viii. Expansive Rock
ix. High Ground Stress

1.5.5. Mineral Deposits

According to the existing geological records and possible structural trends, there would be lead-zinc-silver, antimony, gold that could be expected in it. Coal and phosphorous deposits might also be found as well. Some deposits are a little far from the proposed railway line. Why mentioned here is that mineral deposits are trending approximately N-S direction and those could be probably found during construction of the line such as tunneling, bridge, station and railway line etc.,. For example, although Phayaung taung gold is far from the construction, gold occurrences are sporadically found along the western margin of Shan scarp, trending N-S direction. For Yadanatheingi lead-zinc-silver deposit, similar deposits and occurrences could be estimated in Pyin Oo Lwin, Naungcho and Kyaume as regional structural trending passing in these areas. Similarly, deposits at Bawdwin mine and Mohochaung mine, they might also be extended more or less into Hsipaw, Lasho, Kutkai and Nam Hpatkar areas.

1.5.6. Mining Areas

There wiilbe Mohochuane Mine (Pb,Zn), Bawdwin Mine (Pb, Zn), Sintaung (Coal), Nanma (Coal), Yadanatheingi (Pb, Zn), Naungthakaw (Fe), Pauktaw (Fe), Inya (Fe), Kyadwinye Iron Mine (Fe), Aniskan (Ba) and Phayauntaung (Au) Mine arond the Muse-Mandalay Railway line. However, all of the mining areas are far from the impact zone of the railway alignment for FS stage.

1.5.7. Air Quality and Noise Level

Air quality and noise level along the Muse-Mandalay Railway is relatively good due to the less development of industrialization and the main source will be noise from vehicle movement.

1.5.8. Vibration Measurement

Vibration levels were measured at points along the proposed Muse-Mandalay Railway. The measurements are taken in places which are Pyin Oo Lwin-Oak Pho Village (Monastery), Naung Cho- Shwe Pyi Nyunt Village, Goke Hteik, Hsipaw (near Baw Gyo Pagoda), Beyond

Hsipaw (San Laung), Lashio, Hseni, Nam Hpat Kar and Muse. All of the vibration levels are within the acceptable level.

1.5.9. Water Quality

Water samples are collected all of the rivers along the Muse-Mandalay Railway and tested in Public Health Department. According to the testing results all of the surface water are suitable for domestic use.

1.5.10. Dams and Hydropower

There are also several dams especially constructed on Myitnge river and Shweli river for hydropower demand and cultivation purposes. On Nam Tu-Myitnge river, Yeywa Dam has completed. Namtu Dam and upper Yeywa dam are still under construction and Middle Yeywa dam and Deedoke dam are planned to be constructed. On Shwe Li river Shwe Li I hydropower project is already finished and Shwe Li II and III is also under construction. There are many natural lakes, ponds, waterfalls, springs and small reservoirs found around or along the line and local people get used to them for agricultural and domestic utilization in the area.

1.5.11. Occurrence and Distribution of Groundwater

Groundwater along the line occurs as four types; 1. Pore-water in loosely cemented soil and younger rock, 2. Bedrock fissure water in clastic and crystalline rocks, 3. Karst water in carbonate rocks and 4. geothermal water from the earth.

The major aquifers of Myanmar range from Precambrian to Recent age and vary from coastal and north-south trending tectonically controlled basins. The major groundwater recharge is from monsoonal rainfall, which extends from June to September, ranges up to 3050 mm in the deltaic area, 3810 mm in the north, ~2000 mm in the eastern mountainous region, and only 760 mm in the central dry zone. The largest aquifer is the Irrawaddy river basin, which like the IGBM basin is the most prolific aquifer, however, much of the aquifers of the basin have been identified to have groundwater enriched with As. The other aquifers are in the Thanlwin, the Chindwin, and the Sittaung rivers.

1.5.12. Soil Quality

Soil samples are collected near the tunnel and bridge construction sites and all of the sample will be tested in Department of Agricultural, Yangon. According to the testing results, all soil samples are suitable for agricultural purpose.

1.5.13. Socio-economic

The proposed line mostly passes through mostly in Shan State and partly in Mandalay Regions. These two regions have different socio-economic conditions. Mandalay region is urban area and the living standard is relatively high. But the socio-economic conditions in Shan State where the railway alignment will pass is dominated by agriculture and underdeveloped.

1.5.14. Cultural and Heritage

The nearest cultural relics will be Gokhteik Bridge and Baw Kyo Pagoda with the distance of 980 m and 1079.05 m away horizontally respectively from the proposed alignment.

1.5.15. Temples and Pagodas

According to the GIS study, there will have no famous temples and pagoda within the affected area of the railway construction. However, the railway may pass near some mountain pagoda as there are a lot of temples and pagodas distributed along the route.

1.6. Summary of Potential Environmental Impacts and Mitigation Measures

The key potential environmental impact due to the railway alignment, railway stations and possible mitigation measures are as follow:

Table - Summary of Potential Environmental Impacts and Mitigation Measures

Category	Item	Expected Environmental and Social Impacts and Sources of Impacts	Receptors	Mitigation Measures
PRE-CONSTRUCTION				
Site Clearing and Earth Working	**Impacts on air environment**	(a) Fugitive dust generation - Fugitive dust generation due to dozers and trucks for site clearing and ground levelling	Local residents in nearest villages, Local residents near along the hauling road, Flora diversity along the hauling road	- Water will be sprayed at construction site and along the construction road - Water will be sprayed by using handheld spray
		(b) Vehicular emissions - Vehicular emissions from the operation of vehicles and machineries	Ambient Air Quality	- Plan to reduce in loading and unloading time and idle time during working hours - Avoid local traffic time - Use machineries, vehicles and generator with good engine conditions and use low sulphur content fuel, - Regular maintenance of machineries, vehicles and generator
		(c) Increase in noise - Noise from heavy machineries and vehicles	Local residents in nearest villages	- Limit working at night and avoid the operation of noisy equipment and machineries at night if it is necessary to make operation at night - Arrange construction activities reasonably, especially at night - Regular maintenance of machineries
	Impacts on surface water environment	(a) Liquid wastes - Temporary water pollution due to earth working activities - Sedimentation of surface drainage networks - Improper handling of fuel oil and lubricants	Surface water quality	- Training workers on appropriate handling of chemicals and fuels - Store and handling as per MSDS - Use temporary septic tanks and other waste water facilities - Sedimentation pond with suitable drainage system around the dumping sites

		(b) Solid wastes - Unsuitable soil materials from site clearing activities - Domestic solid wastes	Surface water quality	- Reduce, reuse and recycle of domestic wastes - Limit unnecessary earthworks - Prevent over-excavation - Working in a small area at a point of time
	Impacts on soil environment	- Domestic wastes from pre-construction workers - Biomass site clearing and tree cutting - Earth soil from earth cutting activities	Soil contamination and ground water quality	- Dispose according to the rules and regulations of CDC - Solid waste management plan
	Impacts on biodiversity environment	(a) Impacts on flora diversity Tree cutting alongside the railway and for the construction of stations	Flora diversity	- Avoid cutting of road side plants and fence plants
		(b) Impacts on fauna diversity Affect the feeding, breeding and movement of wildlife due to Increase in noise	Fauna diversity	- Sound proof measurement shall be constructed surrounding the construction sites as needed - Borrow pit will be away from fauna diversity abundance area
	Impact on human environment	***Impacts on socio-economic environment*** (a) Positive socio-economic impact - At least 3000 workers for local employment	Local people	- Policy to use local people as much as possible
		(b) Negative socio-economic impact (i) Visual Impacts Visual pollutants like waste from site clearance and from the tree cutting alongside of railway	Local community	- Efficient and timely removal of all demolition and construction waste as per requirement
		(ii) Land acquisition and involuntary resettlement - Land use and involuntary resettlement will affect socio-economic situation of local people	Local residents near the railway line	- Compensation for affected structures and standing crops and assistance of livelihood restoration as per RAP. - Appropriate measures for relocated vendors - Avoid agricultural land, historiological places, archeological places, forest area and ecologically sensitive area as much as

		- Resettlement or/and relocation of buildings and other assets, involving some changes - Loss of income opportunity of some PAPs due to resettlement and shop owners, vendors or farmers to be affected by construction works		possible, reasonable compensation for land use as per compensation program in RAP
CONSTRUCTION PHASE				
Construction activities	**Impact on air environment**	(a) Fugitive dust generation - Dust emission from on-site vehicles and construction activities - Particulate matter from transportation of construction materials and demolition waste, and traffic movement on unpaved road	Local residents in nearest villages, Local residents near along the hauling road	- Use covers or control equipment on material handling sources - Properly enclosing the site through use of appropriate hoarding and screening - Covering excavated soils and demolition wastes with impervious sheeting - Applying water as a dust suppressant as needed
		(b) Gaseous emissions Gaseous emissions from the operation of generator, concrete mixer and vehicles	Ambient Air Quality	- Schedule for the transportation of personnel and materials to avoid periods of peak flow - Improve maintenance - Reduce duration of traffic interference and reduce from traffic delay - Avoid periods of peak flow - Regular equipment maintenance
		(c) Increased in Noise Level - Noise generation from earth moving and excavation equipment, generators, concrete mixer	Local residents in nearest villages	- Limit operation of heavy machinery at night - Choosing inherently quiet equipment with mufflers - Installing warning signs in areas of high noise levels - Keeping equipment speed as low as possible - Scheduling noisy activities during the morning hours
	Impacts on surface water environment	(a) Construction debris - Waste materials such as pallets, packing crates, steel structures off-cuts and waste concretes - Drainage and seepage from construction waste dumping site - Unsuitable soil material from foundation preparation	Surface water quality	- Minimize the time of exposure of any waste and erodible land exposed to stormwater runoff - Minimize land clearing activities to those of required work areas - Using sediment controls, with special care taken during the rainy season - Paving roads wherever possible.

		(b) Oil and grease - Leakage of fuel oil from transportation of construction materials - Lubricants and grease from construction machineries	Surface water quality	- Restore work areas as soon as possible once any construction is complete. - Avoid construction works during the rainy season. - Avoid any leakage of oil and lubricant from vehicles and machineries used in construction phase.
		(c) Domestic wastes from construction workers - Domestic waste generation from construction workforce - Improper waste disposal from establishment of labor camps	Surface water quality	- Waste water channels from the site should be connected to septic tank - Vegetation of bare areas after the construction state, and - Compact soil as soon as building foundations are formed to prevent erosion, especially during the wet season.
	Impacts on soil and ground water environment	- Accidental spills of fuel oil and lubricants due to improper handling or storage of equipment - Wastewater from repair shops and washing places - Construction debris and domestic wastes from construction workers - Soil contamination and ground water pollution from improper disposal of solid wastes - Seepage from construction waste dump site	Soil contamination	- Use generated materials for reclamation purposes whenever applicable on site - Minimize construction wastes through careful planning - Label all chemical wastes and store in corrosion and resistant containers - Identify collection sites and schedule for the removal of construction wastes to minimize odor and pest infestation - Sedimentation pond with suitable drainage system around the dumping sites
		Impacts on Soil Quality due to Hazardous Wastes - Oil-based paints are consisted of VOC, so these paint cans can be hazardous to the environment if they are not properly disposed. - The lead-based paints for the steel structure for the construction of the stations	Soil contamination	- Where possible, substitute water-based paint for oil-based paints; - Never discharge any oil-based paint or residuals down the drain - Disposal of hazardous wastes should be made according to the rules and regulations of CDC
	Impacts on biodiversity environment	(a) Impact on flora diversity - Clearing away trees and natural vegetation	Flora diversity	- Determine and construct the appropriate number, spacing, and location of crossing structures based on species-specific information. - Monitor structures for obstructions, such as detritus or silt blockages, that impede movement - Manage human activity near crossing structures, with use of measures such as fencing and signage.

		(b) Impact on fauna diversity - Hazards to the habitats of birds and butterflies due to clearing away trees - Disturbance to the aril and wild animals due to noise from construction activities	Fauna diversity	- Construct multiple and varying crossing structures at a wildlife crossing point to provide connectivity for species likely to use a given area. - Routes outside existing transportation corridors could be designed with alternative pathways or under crossings to maintain wildlife migratory paths or corridors.
	Impacts on human environment	Positive socio-economic impact (i) Job Creation Nearly 500 employment opportunities for local people	Local residents near the railway line	- Unskilled and semi-skilled job opportunities will be offered to the local communities as much as possible - The developer will encourage construction sub-contractor to use local labor force as part of tender requirement
		(ii) Skill development for local people Local people hired by the proposed project would remain in communities with skills acquired during project construction	Local residents near the railway line	- Training programs will be implemented prior to and during the construction phase
		(iii) Potential to growth of local economy and business - There will be benefit for local economy if the required food and consumer goods for construction workers are bought from nearest villages	Local residents near the railway line	- Any food and consumer goods that can be bought in nearest villages should be preferred as first priority - The project developer should encourage construction contractors and sub-contractors to stimulate the emergence of local small business as part of tender requirement
		Negative socio-economic impacts (i) Traffic congestion - Road traffic congestion in surrounding area during construction period	Local residents near the railway line	- Arrange construction hauling reasonably, especially during local traffic time. - Use alternative road that will not pressure on public road.
		(ii) Livelihood and economic activity - Disruption of livelihood and economic activities of business located along the route - Impact on people whose livelihood is linked with existing modes of transportation	Local people alongside the railway line	- Payment for loss of business (temporary or permanent), loss of livelihood, loss of wages - Provision of compensation to the Project Affected Parties (PAPs) using the compensation - Continual liaising with the PAPs will be undertaken to decide on the site-specific mitigation measures. - Consultation with people whose livelihood depend on modes of transportation that may be affected by the project. They will be included in the development of the traffic management plan.

		(iii) Blockage of drainage - Blockage of drainage system, natural spring and village road due to land filling - Increase potential to flood in nearest agricultural lands	Local people	- Alternative water way will prepare - Utilize drainage facilities to discharge the harvested water
		(iv) Conflicts between communities - Conflict between non-Shan communities and Shan ethnic - A higher frequency of incidents of name-calling, spitting, hostile attitudes, damage to property and racially motivated violence against them	Local community near the railway line	- Use local people as much as possible - Limit night out for foreign workers - Limit the use of foreign workers - When making an agreement contract with contractors and subcontractors, it must include the fact that they have to use local workers as much as possible.
		(v) Impacts associated with social services - Increase in temporary pressure on existing infrastructure - Increase in pressure on local food consumption	Local community near the railway road	- Own health care facilities will be supported to workers - Appoint local construction workers
		(vi) Increase in crime and security An inflow of skilled migrant construction workers and their dependents from other areas may increase in social pathologies and crime	Local community near the railway road	- The impact can be mitigated by the use of local labour force as much as possible - Construction site should be fenced and all of the construction workers should not be allowed going out at night
		(vii) Impact to tradition of Shan - The influx of people due to the operation of railway will have impact on traditional of Shan	Local community in Shan region	- Gallery of custom of Shan should be constructed during the construction of Railway - The developer should encourage the visitors to know about the custom and behaviors of local people (Customs of Shan)
		(viii) Impacts due to population influx - The risk of social conflicts, risks of spread of communicable diseases, health and safety risks, waste generation and sewage and increased pressure on resources, are all expected to increase	Local community near the railway alignment	- Equal opportunities for employment will be created to ensure that the local female population also has access to these opportunities. - Raise awareness amongst construction workers about local traditions and practices

		(ix) Public road damage The transportation of workers and construction materials can damage the damage to the public road	Local community	- Repair the roads as soon as possible if the public roads are damaged by the construction activities - Use public roads as per resistance of roads if unavoidable
		(x) Controversy with EAOs The proposed project can be in the vicinity of territory of Ethnic Armed Organizations	Construction workers and local people	- Have transparency in every development of the project. - Inform the EAOs before any development of the project. - Discuss and negotiate with EAOs if any conflicts occur.
		Impacts on archaeology and cultural heritage - Disturb, damage or destroy features or buried remains of cultural heritage interest - Potential to cause direct permanent and irreversible effects on the cultural heritage due to construction activities	Cultural and Religious custom near the construction site	- Programme for archaeological works designed to identify, characterize and record buried archaeological remains - Avoid the archaeological site that will be pointed out by heritage advisors, and an archaeological evaluation
		Potential health impacts (a) Increase infection of air-borne diseases An influx of construction workers can lead to the spread of air-borne diseases	Community health	- Providing medical check for workers who are susceptible infection of air-borne diseases
		(b) Fugitive dust emission - Dust will expose the construction workers and some local people in nearest villages to bronchial and other respiratory tract diseases	Local people	- Wetting of roads by water spraying - Seeding storage mound surfaces as soon as is practicable - Spraying exposed surfaces of mounds regularly - Restricting vehicle speeds - Watering roadways
		(c) Increase infection of water borne diseases - Loose soil from earthworks may be washed into river - Potential surface water pollution can emanate from waste products generated by construction activities entering the surface drainage	Construction workers and community health	- Avoid construction time during rainy seasons - Construction debris will be disposed at suitable location that does not impact on local nearest rivers - All areas of fuel storage will be banned to prevent hydrocarbon pollution of surface water

		(d) Potential to increase infections from mosquito - Stagnant pools of water during the construction phase will cause bleeding zone for mosquitoes - Potential to cause infections from mosquitoes especially in rainy season	Construction workers and community health	- Avoid construction time in rainy seasons as much as possible - Ensure that there are no stagnant pools of water during the construction phase - Proper temporary or permanent drainage system will be compensated
		(e) Increase risk of sexually transmitted infections - The improved economic status of the area and the influx of new migrant workers, living away from their families can lead to an increased risk of sexually transmitted infections	Construction workers and community health	- MR will provide information and education about safe sex and implement HIV control program for migrant construction workers
		(f) Health impact related to increase in noise level - Hearing loss and impairment are known to occur as a result of exposure to acute, high decibel noise - Noise annoyance can lead to stress related impacts on health	Construction workers and local people near the railway line	- Reduce speed limits for trucks in the project area to reduce noise level - Avoid working at night
		(g) Increased in traffic Increase in public unease will lead to increasing in traffic volumes to and from the site	Local community	- Arrange construction hauling reasonably, especially during local traffic time and at night - Use alternative transportation ways where feasible
		Visual impacts - Visual pollutants like construction materials and equipment impact on their visualization - Visual intrusions arise from the inevitable presence of construction equipment, materials, transport vehicles, and piles of soil and debris	Local community	- Enclose the construction camp sites with non-transparent fencing to minimize the visual impacts on nearby areas - Site housekeeping to keep project area clean and limit visual intrusion - Efficient and timely removal of all demolition and construction wastes as per requirements

	Impacts of utility consumption	(a) Water consumption - Impact on local water usage due to the water used for construction process and for domestic workers	Local community	- Water can be taken from surface water sources or underground sources where the sources are available - Consider residents' opinion and make agreements or contracts with the head of the village if spring water or underground water are the water sources of villages - Awareness campaign to disseminate knowledge on strategies and technologies that can be used for water conservation
		(b) Use of topsoil If the topsoil is taken from the nearby land like agricultural and farm land, there would be an impact on the environment and the local people	Nearby land	- Compensation should be made with the land owner
		(c) Use of gravel If gravels are made from the own stone crusher, there would be an impact on the environment	Local community	- The first-grade gravel for the subgrade should be bought from the local agent. - Making the subgrade gravels by the use of the stone crushers should be avoided.
		(d) Fuel consumption - The different forms of energy are used for different purposes in the construction process. - Electricity cannot be directly used from existing power lines since the construction process takes place where there is no electricity and generators will be mainly used as the source of energy	Local community	- Use construction machines efficiently. - Train workers to gain the knowledge of energy conservation. - Learn the efficient construction site management.
OPERATION PHASE				
Travelling of Trains along the railway	**Impact on air environment**	(h) Impacts on air environment due to gaseous emissions - Gaseous emissions from vehicles and food stalls from the stations	Ambient air	- Use vehicles with good engine and low Sulphur content fuel - Regular maintenance of machineries if generators are used for electricity - Install gas exhaust

		(ii) Impact of Noise - Noise and vibration due to the travelling of high-speed trains	Local residents near the railway line	- Sound proof measurements will be taking near the public area - Sound and vibration will be controlled by wheel maintenance, vehicle maintenance and elastic solution
		(iii) Impacts of vibration - Vibration will adversely affect the residential areas, schools and hospitals	Local residents near the railway line	- If buildings on both side of the railway are obviously affected by railway vibration and residents complain about railway vibration, the reasons should be found out in time and wheel-grinding and low-vibration rolling stock should be adopted to reduce the impact of railway vibration
	Impact on surface water environment	(i) Oil and grease from depots - Oil and grease from the depots and maintenance of activities	Surface water environment	- Purification system for the type of waste water produced from Depot shall be provided - Oil absorption mats shall be provided to remove oils from waste water
		(ii) Domestic wastes from stations - Domestic wastes from stations include domestic wastes from both operating staff and the passengers coming to the stations.	Local community	- Proper disposal of wastes according to the CDC's instruction - Domestic effluent will be collected and contained in septic tanks
	Impact on soil and ground water environment	- Leakage of oil and grease, hazardous chemicals from the train maintenance and in depots	Local residents near the railway line	- Proper handling and storage according to their MSDS to control leakage of oil and grease
	Impact on biodiversity environment	- Direct mortality of protected species from site activity, especially vehicle movements - Disturbance to plants and animals - especially bats - in areas surrounding the site from artificial lighting - The potential for disturbance to retained habitats and species, their resting and breeding places remains	Flora and fauna diversity	- Rail would be completely covered - Sound barrier at the sensitive flora diversity area and landside cover in the fauna diversity areas

	Impact on human environment	Positive socio-economic impact (i) Improvement in livelihood and economic - Presence of the stations will also attract future commercial development around the area - The direct employment opportunities would be increased for the local people.	Local community	- Monitoring of the implementation of the resettlement action plan will be conducted - For PAPs whose livelihood had been affected during construction stage, monitoring of the implementation of the RAP will be conducted
		(ii) Improvement in tourism sector - Increase in the number of travelers especially Chinese from Yunnan	Local community and government	- Support the development of responsible tourism in Myanmar - Raise tourist awareness about how to avoid negative impacts of tourism
		(iii) Benefits to national economy - The project operation will contribute to government revenues in terms of taxes paid to the government	National government	- Efficient and transparent tax collection mechanisms will be introduced and strengthened
		(iv) Benefits to local economy - Increase in economy of the community near the stations - Transportation services to and from the nearest villages and towns are improved	Local community	- Consider formulation of specific strategies to link project development with local community
		(v) Increase in transportation sector - Increase in transportation for goods transportation - GHC emission reduces since gaseous emissions from the train is much less than that of train	Local community	- Consider the road networks of villages and towns with the railway stations - Enhance by adjusting allocation of CSR budget and giving priority for CSR activities relevant to community immediate needs each year after discussion with representatives from local authorities, CBOs, and NGOs
		Negative socio-economic impacts (i) Increase in Human Trafficking - Since transportation becomes easy, the rate of human trafficking would increase	Local community	- Corporation with human trafficking team in every trip to Mandalay to Muse Permanent Immigration Inspection Team

		(ii) Increase in trade off drugs The rate of trading off drugs would increase especially in Shan state	Local community	- Government should redouble its drug control and anti-corruption efforts - At the community level, the government should focus more on education and harm reduction
		(iii) Impact to tradition of Shan -Chinese from Yunnan can enter in large number and this influx can have impact on Shan tradition	Local community in Shan State	- Gallery of custom of Shan should be constructed - The railway station design should be considered with the tradition of Shan - Shan foods should be promoted at the stations
		(iv) Economic displacement along Muse-Mandalay express road The businesses along the Muse-Mandalay express road like the food stalls are disturbed by the implementation of Muse-Mandalay railway	Local business along Muse-Mandalay express road	- Negotiation with the local community near Muse-Mandalay express road to make a plan to do business near stations like food stalls
		(v) Accidents on railway alignment The accidents at railway alignment can occur when the human passes the railway alignment and hit by the train.	Local residents along the railway alignment	- Fence should be made along the railway alignment - Barrier gate should be positioned in the place where village roads cross the railway alignment - Good lighting system should be provided especially where the railway alignment passes the village road
		(vi) Social tension The nearby villages do not get electricity all the time while the railway lighting is always on during the night	Local community	- Consider distributing electricity also for local people before starting the project if possible. - Provide solar panel to local people
		Impact on archaeology and cultural heritage - Impact on cultural and religious in Mandalay and Shan regions due to population influx - Impact on buried archeological site	Local community	- Participation of cultural and religious festival in Mandalay and Shan Regions - Awareness to foreigners to respect local custom - Avoid the archaeological site that will be pointed out by heritage advisors, and an archaeological evaluation

		Health impacts (a) Increase risk of sexually transmitted infections - Risk of sexually transmitted infections such as HIV/AIDS because of the population influx	Local community	- Premedical examination for workers will be conducted, followed by routine medical examination during the works and a final post medical examination - MR will review sexually transmitted infection clinic access and education to reduce spread of sexually transmitted infections within the community.
		(b) Community wellness - Social pathologies and crimes including increased substance abuse, drugs, thief, crime, and human trafficking can impact on the mental health of people in nearest villages	Local people in nearest villages	- Establish a mechanism to facilitate on-going community engagement between the local authorities and local residents for early identification of impacts on community wellness. - Implement smoking and drug free zone.
		(c) Health impact on community due to Covid-19 Since the transportation becomes, the number of visitors would increase which can be the carrier of the Covid-19 viruses	Local community	- Measure temperature before entering to the stations and also on the train; - Wash hands with soap and water very often; - Wear masks
	Impacts of Utility Consumption	(a) Electricity consumption The electricity will be used up for lighting along the railway alignment and for the stations	Local community	- Implementing good housekeeping measures such as turning off equipment such as fans, and lights when not in use - Use LED lights and/or lower wattage lamps - Using more efficient equipment
		(b) Water Consumption The water usage in operation phase is from the use of operating staff and the passengers coming to the station	Local community	- Dry type urinals will be used selectively - Awareness campaign to distribute knowledge on strategies and technologies that can be used for water conservation
DECOMMISSIONING PHASE				
Removing the concrete and steel structure, and equipment	**Impacts on air environment**	(a) Fugitive dust generation - Fugitive dust emission from site clearing, ground leveling and earth filling	Local residents along the railway line	- Spray water for dust control,

		(b) Gaseous emissions - Gaseous emission from the operation of dozer, trucks and generator used	Local residents along the railway line	- Use machineries with good engine with low sulphur content fuel for gaseous emission
		(c) Noise - Increasing in noise levels from the operation of heavy machineries used for demolition of concrete and steel structures	Local residents along the railway line	- Avoid working at night for noise control
	Impact on surface water environment	- Improper disposal of decommissioning debris such as concrete blocks, steel pieces and drainage from solid waste dump	Nearest rivers and water body	- Pump all of the remaining fuel oil inside the tanks and pipe lines. Care have to be taken the remaining oil are not disposed to nearest water bodies directly. - Waste water channels from the site should be connected to oil and grease separator during decommissioning to prevent wastewater from entering the nearest water bodies. - Vegetation of bare areas after the decommission activities.
	Impacts on soil and ground water environment	- Improper disposal of solid wastes such as concrete, steel structures, cabling, scrap metal, etc.	Soil contamination	- Dispose wastes according to the rules and regulations of MCDC. - Vegetation of bare areas after the decommission activities.
	Impacts on socio-economic environment	(i) Loss of jobs for local people and revenues for the government Loss of jobs for local people indirect employment depending on the operation of proposed and of associated services for tourism	Local people	- Allow local people to source alternative livelihood. - Project developer will prepare their employees for forced retirement by providing applicable jobs at other oil stations under the same developer, if feasible.
		(ii) Decline in transportation sector and local business Local people depending on it can be faced with difficulties in transportation	Local people	- If the decommissioning is happened, MR should be responsible for the maintenance and upgrade of Muse-Mandalay Express Road - MR should operate the railway alignment with proper maintenance

1.7. Summary for Cumulative Impacts

Cumulative impacts will be summarized as follow:

Table – Summary of Cumulative Impacts

Activity	Impact	Receptor	Mitigation Measures
PRE-CONSTRUCTION PHASE			
Site Clearing Activities	Loss of Habitat	Flora and Fauna diversity	- Clearing of vegetation should be kept to a minimum. - Wetland habitats identified should be retained within the development footprint in its current state.
CONSTRUCTION PHASE			
Construction Activities	Climate Change due to deforestation	Vicinities along the railway alignment	- Protect natural carbon sinks that could be endangered by the project, such as peat soils, woodlands, wetland areas and etc. - Clearing of vegetation should be kept to a minimum, keeping the width and length of the earth works to a minimum and the floodplain / wetlands habitats identified should be retained within the development footprint in its current state. - Ensure there is selective clearing of the vegetation this allows future re-growth and regeneration. - There should be initiated prior to the commencement of any construction once the required permits are in place and submitted to the authority for the removal of trees - Training of construction workers to raise awareness of environmental protection requirements - Avoid unnecessary idling of construction vehicles
	Alternation of Land Used Pattern	Local communities	- Employ local people, especially people who sold their farmlands to MR, in the proposed project.
	Water scarcity	Local communities	- Sustainable water management : improving water infrastructure must be a priority - Reclaimed water : Rainwater harvesting and recycled wastewater also allows reducing scarcity and easing pressures on groundwater - Awareness and education : Employees must be educated about water scarcity and must be trained to get knowledge on how to save water as much as possible. - Construction period should be started in the late rainy season in order to be able to store rainwater in storage tanks throughout the whole rainy season.
OPERATION PHASE			
	Visual impact	Local communities	- Install natural visual barriers such as vegetation. - Landscape management and site restoration

Travelling of trains along the railway	Impacts due to electricity consumption	Local communities	- Use the source of electricity that does not pressure on local use in the current and future. - Use alternative source of energy such as solar power station or generators
	Water scarcity	Local communities	- Sustainable water management - Reclaimed water (rainwater harvesting and recycled wastewater) - Awareness and education
	Illegal trading	Local community	- Proper inspection at every gate before going out of the country - Cooperate with respective organizations

1.8. Summary of Environmental Management and Monitoring Plan

(a) Environmental Management Action Plan

Environmental management action plan will be carried out throughout all project implementation phases and the responsibilities for construction and operation phases. Environmental impact; mitigation measures taken or to be taken; time frame and implementing /responsible organization parameters are presented in the following tables.

Table – Summary of Environmental Management Action Plan

Environmental Impact	Mitigation Measures Taken or To Be Taken	Time Frame	Implementing / Responsible Organization
DESIGN PHASE			
Land acquisition and resettlement	The proposed railway alignment was selected to minimize the land disturbance to avoid displacement of people or households and environmentally sensitive areas in least.	During Design stage	MR / Project Developer
Cultural Heritage	Avoided by adjustment of railway alignment	During Design stage	MR / Service Provider
Loss of Water Bodies	Utmost care taken to avoid railway alignment crossing water bodies	During Design stage	MR / Project Developer
CONSTRUCTION PHASE			
Air Pollution & Dust	Vehicles and machinery are to be regularly maintained so that emissions conform to NEQG Standards. Water should be sprayed during construction phase, wherever it is required to avoid dust. Vehicles delivering materials should be covered to reduce spills and dust blowing off the load.	Beginning with and continuing throughout construction	Contractor / Construction services provider
Noise	Noise standard at processing sites, will be strictly enforced as per NEQG noise standards. Workers in vicinity of strong noise will wear earplugs and their working time should be limited as a safety measure. Sound proof measurement will be taken for silence zones including schools and hospitals.	Beginning and throughout construction	Contractor / Construction services provider
Vibration	The vibration level limits at work sites adjacent to the alignment shall conform to the permitted values of peak velocity as given in article project EHS guidelines Manual	Beginning and through construction	Contractor / Construction services provider
Surface Water			
Contamination from Wastes	All justifiable measures will be taken to prevent the wastewater produced in construction from entering directly into river and irrigation system	Throughout construction period	Contractor / Construction services provider

Blockage of drainage due to earth filling	Earth filling will ensure not to block natural drainage system		
Oil and Grease & Domestic Wastes	Avoid any leakage of oil and lubricant Use proper waste management system		
Soil and Ground Water			
Potential to soil contamination	Proper waste management system	Throughout construction period	Contractor / Construction services provider
Leakage of fuel oil and lubricants	Store over concrete floor or impermeable pad		
Construction debris and domestic Wastes	Solid wastes according to the rules and regulations of local CDC.		
Flora And Fauna			
Loss of trees and Avenue Plantation	Areas of tree plantation cleared will be replaced according to Compensatory afforestation Policy under the Forest Law.	After completion of construction activities	Contractor / Construction services provider MR / Project Developer
Social			
Resettlement or/and relocation of buildings and other assets, involving some changes in livelihood of project affected peoples	Compensation and assistance of livelihood restoration that will be elaborated in the entitlement matrix of updated Abbreviated Resettlement Plan	During construction	MR / Project Developer
Loss of Access	Temporary access should be built at the interchange and other roads.	During construction	
Traffic jams and congestion	If there are traffic jams during construction, measures should be taken to relieve the congestion with the co-ordination of transportation and traffic police department	During construction	Contractor / Construction services provider MR / Project Developer
Safety with vehicles, people and livestock and signage	Safety education and fines. Allow for adequate traffic flow around construction areas Provide adequate signage, barriers and flag persons for safety precautions. Communicate to the public through radio, TV & newspaper announcements regarding the scope and timeframe of projects, as well as certain construction activities causing disruptions or access restrictions	During construction	Contractor / Construction services provider

Increase in disease Water-borne, Insect-borne, Communicable diseases	Make certain that there is good drainage at all construction areas, to avoid creation of stagnant water bodies. Provide adequate sanitation and waste disposal at construction camps. Provide adequate health care for workers and locate camps away from vulnerable groups	During construction At start-up Throughout construction	Contractor / Construction services provider MR / Project Developer
Location of camps depots and storage areas	Location of camps depots and storage areas shall be as per the contract specifications.	Throughout construction	Contractor / Construction services provider MR / Project Developer
OPERATION PHASE			
Noise and Vibration	Suitable measures should be considered where warranted. The public shall be educated about the regulations of noise and vibration pollution and its implications.	During operation	MR / Project Developer
Waste			
Generation of municipal solid waste in stations and common passenger areas	Collection and separation of waste in the trains and stations Proper disposal of waste according to local CDC's instruction	During operation	MR / Project Developer
Surface Water			
Oil pollution	Suitable treatment shall be taken for treatment oil before discharging the wastewater especially in depot areas	During operation	MR / Project Developer
Maintenance of Storm Water Drainage system	The urban drainage systems will be periodically checked and cleared so as to ensure adequate storm water flow.	During operation	MR / Project Developer
Disposal of final treated effluent from treatment plan	Options for final disposal shall be studied and the suitable disposal route shall be decided carefully to minimize the impact of receiving bodies. As far as possible zero discharge rules may be adopted.	During operation	MR / Project Developer
Social			
Railway accidents of passengers and local people	Enlightening passengers and local residents about traffic safety specific to railways	During operation	MR / Project Developer

Table - Summary of Environmental Monitoring Plan

Category	Parameters to be monitored	Locations	Frequency of measurements	Responsibilities
During Pre-Construction / Preparation Phase				
Air quality	1) Site patrol 2) Checking received complaints from residents 3) Monitoring of air quality, if needed	Representative point(s) of construction site(s)	1) Monthly 2) Whenever received 3) When needed	Contractor (managed by MR or Project Developer)
Water quality	1) Site patrol 2) Monitoring of parameters stipulated by National Environmental Quality (Emission) Guideline	Creeks nearby construction site(s)	1) Monthly	Contractor (managed by MR or Project Developer)
Noise and vibration	1) Site patrol 2) Received complaints from residents 3) Monitoring the noise and vibration level, if required considering received complaints and sensitive receptors etc.	Construction site(s)	1) Monthly 2) Whenever received 3) When needed	Contractor (managed by MR or Project Developer)
Cutting of trees	1) Check of species and number of trees that need be cut 2) Prior consultation with administrative authorities in charge of (MONREC)	Construction site(s)	1) Weekly	Contractor (managed by MR or Project Developer)
Waste	1) Site patrol and housekeeping at construction site 2) Checking waste-disposal method	Construction site(s)	1) Monthly 2) Monthly	Contractor (managed by MR or Project Developer)
Hazardous materials and oil management	1) Site patrol to check a condition of handling or storing hazardous materials 2) Record of training on handling hazardous materials for workers	Construction site(s)	1) Monthly 2) Quarterly	Contractor (managed by MR or Project Developer)
Social environment related to resettlement	Progress of implementation of RAP	Project area and surrounding	Monthly and quarterly	Contractor (managed by MR or Project Developer)

Existing social infrastructure and services	1) Collection of complaints 2) Physical observation of road traffic condition 3)Interviewing/discussing with Traffic Police	Construction site(s) and surroundings	1) Whenever received 2) Every day of construction period 3) When necessary	Contractor (managed by MR or Project Developer)
Monitoring health and safety of the workers during the construction of the project components	Health records about occupational injuries	Clinic / hospital referred by the contractor	on received case	Contractor (managed by MR or Project Developer)
Traffic accident	1) Site patrol 2) Record of accidents 3) Record of safety-awareness campaign and other measures	Construction site(s)	1) Monthly at minimum 2) Monthly 3) Monthly	Contractor (managed by MR or Project Developer)
Operation Phase				
Air quality	Site patrol	Along the Railway Line	Monthly	MR, Project Developer
Water quality	Monitoring of parameters stipulated by National Environmental Quality (Emission) Guideline	Discharged point from depots	Every six months for the first 2 years after starting of the operation stage	MR or Project Developer
Noise and Vibration	Noise and vibration level	Monitoring stations at every place where the railway pass near the local residents	24 hours continuous monitoring for each frequency	MR or Project Developer
Soil contamination	1) Monitoring of soil quality near the stations and labour dormitory	Depots and labour dormitory	1) Quarterly 2) When needed	MR or Project Developer
Waste	1) Site patrol to check the waste management in stations, railcars and other related facilities 2) Check of waste-disposal method	Railway stations, depots and other related facilities	Every three months for the first 2 years after starting of the operation stage	MR or Project Developer
Management of the hazardous and non-hazardous materials	1) Record of training on handling hazardous materials for workers 2) Record and condition of handling or storing hazardous materials	Project area	Quarterly for the first 3 years after starting of the operation stage	MR or Project Developer

Traffic accidents	1) Records of accidents 2) Record of safety-awareness campaign and other measures	Around the MMR Line area	1) Monthly 2) Every for the first 3 years after starting of the operation stage	MR or Project Developer
Decommissioning Phase				
Air quality	1) Site patrol 2) Monitoring of parameters stipulated by NEQ(Emission) Guideline	Representative point of decommissioning work site(s)	1) Monthly 2) Whenever received 3) When needed	Contractor (managed by MR or Project Developer)
Water quality	1) Site patrol 2) Monitoring of parameters stipulated by NEQ(Emission) Guideline	Discharged point from decommissioning work site(s) and other project- related area	1) Monthly 2) Biannually	Contractor (managed by MR or Project Developer)
Noise	1) Site patrol 2) Whenever Received complaints from residents 3) Monitoring of noise and vibration level, if required considering received complaints	Decommissioning work site(s)	1) Monthly or whenever necessary	Contractor (managed by MR or Project Developer)
Soil contamination	1) Monitoring of soil parameters at waste disposal site stipulated by NEQ(Emission) Guideline 2) Monitoring of waste disposal site of decommissioning debris 2) Implementation of hazardous materials and oil management	Decommissioning work site(s)	1) Monthly or if needed	Contractor (managed by MR or Project Developer)
Working condition including occupational health and safety	1) Record of workplace accident 2) Record of implementation of OHS Plan 3) Record of safety-awareness campaign and other measures	Decommissioning work site(s)	1) Weekly or if needed	Contractor (managed by MR or Project Developer)
Traffic accidents	1) Site patrol 2) Record of railway accidents 3) Record of other accidents along the MMR	Decommissioning work site(s)	1) Weekly of if needed	Contractor (managed by MR or Project Developer)

1.9. Summary of Public Consultation and Participation

Public consultation will be made by household survey, focus group discussion and public consultation meetings. In fulfillment of the public consultation for the project, at least 19 public meetings for the whole project including six stakeholder meetings for scoping reports in total will be held so far.

(a) Household Survey and Focus Group Discussion

For household survey, 87 villages along the railway were conducted to evaluate primary socio-economic conditions of the project area and to understand the mood, perceptions and extent of preparedness of the people towards the proposed project. To get the accurate data, primary data collection will be conducted by social specialist, social consultants, local authorities and local people. During household survey, the most important positive outcomes from the project expected by the local people and most of their concerns about proposed project are as follow:

- Worry to land confiscation;
- Compensation to land use if they don't have permit to land right (land grant);
- the blockage of streams and natural springs;
- blockage of village road;
- job opportunities;
- Impact on agricultural land;
- Impact on natural water resource; and
- Damage on the terrace farm.

(b) Public Consultation Meetings (PCMs)

In public consultation meeting that was organized with participation of local stakeholders, parliament members, NGO and mass media, etc. are attended and asked questions that they want to know. By summarizing all of the findings from public consultation and participation process, the following are the most public concerns come out from public consultation and participation process related to the proposed bridges and culverts project.

Summary of Key Findings from Public Consultation and Participation Process

The followings are the summary of key findings from public consultation process such as household survey, consultation with key informers and public consultation meetings.

(a) Key Pubic Concerns for Design Stage (Before Construction Phase)

Key Public Concerns during PCMs
1. Declare the length, width and land use of other facilities to public before any construction;
2. Declare the width of the railway line and land use of other facilities openly;
3. Tender system for every project implementation works;
4. Policy to ensure job opportunities to local people;
5. Make sure compensation before any development the project without any delay.
6. Policy to avoid blockage of natural drainage system;
7. Policy to less damage to agricultural land, forest area and archaeological places;
8. Procedure to less damage to agricultural land, forest area, historiological and archaeological places;
9. Policy to proper compensation to land use with or without official permit for land ownership;
10. Make sure compensation before the project without delay;
11. Proper compensation to land use with or without ground grant;
12. Not to use the require electricity for rails in local source.
13. Not to produce the electricity for railway in Myanmar;
14. Not to reduce the water catchment area due to railway line (in Pyin Oo Lwin) region;
15. Not to limit the village area by the railway line;
16. Not to damage to buried archeological places due to excavation;
17. Not to separate the agricultural lands by the railway;
18. Construct railway stations not only for passengers but also for goods;

(b) Key Public Concerns during Construction Phase (Within Construction Phase)

Key Public Concerns during PCMs
1. Control foreign and migrant workers;
2. Not to dispose soil material from construction near the agricultural lands;
3. Not to damage to uncover natural resources; (keep away alignment from natural resources existing area);
4. Construct flyover when meet the public road;
5. Not to take soil material for land filling at another place;
6. Avoid tree cutting outside of the project area;
7. Avoid blockage of natural drainage system and natural spring;
8. Avoid blockage of village road;
9. Less damage to wildlife along the railway line;
10. Not to make crushing plant for road stones and chipping for railway construction without permission. Not to construct quarry mine site without permission from government;
11. Not to dispose soil material from construction near the agricultural lands;
12. Increase in traffic congestion and road damage during transportation of workers and construction material during railway construction;

(c) Key Public Concerns during Operation Phase (After Construction Phase)

Key Public Concerns during PCMs
1. Prevent the settlement of migrant workers near the project sites
2. Replanting trees as compensation for tree cutting;
3. Cover with side wall along the whole railway;
4. Safety sign along the railway line.
5. Notice board along the railway road in both Myanmar Language and Shan Language.
6. Create job opportunities for local people at Muse-Mandalay Railway road where the economic conditions can be reduced due to the development of railway line;
7. Reasonable railway fee that can be affordable to local people;
8. Policy to prevent human trafficking;
9. Policy to prevent zero-dollar tourism;

1.10. Conclusions

According to the EIA study, the most public concerns is land acquisition of the railway. The other most important environmental impact during construction phase will be impact on biodiversity, blockage of natural drainage system, village road, parting of agricultural land, flood and damage to natural spring. The most important environmental impacts during operation phase will be noise & vibration.

As for conclusion, all of the environmental and social impacts can be mitigated to proper mitigation measures to acceptable level described in this report. According to the nature of the environmental and social impacts for railway construction, the impact due to construction phase will have high impact than operation phase. So, the developer should have high attention for construction phase. For the land use, it is necessary to prepare comprehensive Resettlement Action Plan (RAP) and for proper compensation for land use and resettlement.

2.0 INTRODUCTION

2.1. Presentation of the Project Proponent

Myanma Railways (MR) and China Railway Eryuan Engineering Group Co., Ltd (CREEC) signed the Memorandum of Understanding (MOU) on Feasibility Study (FS) for Muse-Mandalay Railway Project, on October 22, 2018. According to this MOC, CREEC will conduct FS for Muse-Mandalay Railway alignment. So, it is necessary to conduct EIA for the railway alignment.

2.2. Brief of the Project Proponent

The followings are the brief of project proponent for the FS of Muse-Mandalay railway project.

Project Developer	
Project Developer	Myanma Railways (MR) under the Ministry of Transport and Communications (MOTC)
Type of Project	Muse-Mandalay Railway Alignment
Project Location	Muse-Mandalay railway starts from Muse port of entry at the north, goes south to Mandalay
Contact Person	1.U Myo Win (General Manager) Upper Myanmar Administration (MR) Upper Myanmar Administration Department, Mandalay Station, Mandalay, Myanmar Tel：+95-2-35172 Fax：+95-2-35829 E-mail：myowingmupper@gmail.com
	2.U Phyo Htet Kyaw [Assistant General Manager (Planning)] Planning and Administration Department, (MR) Nay Pyi Taw Station Compound, Nay Pyi Taw, Myanmar Tel：+95-6777164(office)/+95-9-43124800(mobile) Fax：+95-67-77164

2.3. Brief of the EIA Service Provider

Below is the background information on Ever Green Tech Environmental Services and Training Co., Ltd., (Third party) who will conduct the EIA.

Ever Green Tech Environmental Services & Training Co., Ltd.	
Company Name	Ever Green Tech Environmental Services and Training Co., Ltd.
Company Registration Number	3344/2015-2016 (Ygn)
Transition Consultant Registration Number	0047
Contact Address	No.1/9, Baho Road, 16th quarter, Hlaing Township, Yangon
Telephone Number	09-5099230, 5099232
E-mail	green.evergreentech@gmail.com
Contact person	Dr. Kyaw Swar Tint Ph.D. (Mining) Principle Environmental and Social Consultant 11kyawswar@gmail.com 09-797111000

2.4. Selected Consultants for Conducting EIA

The following are the selected consultants for impact assessment and report writing.

	No	**Name**	**Degree**	**Responsibility**	**Area of Expertise**
Our Consultants	1	Dr. Kyaw Swar Tint	Ph.D. (Mining)	Key Consultant	(a) Air Pollution Control (b) Noise and Vibration (c) Socio-Economy (d) Environmental Management and Monitoring
	2	Mr. Min Aung	M.Sc. (Chemistry)	Key Consultant	(a) Water Pollution Control (b) Modelling of Water Quality (c) Soil and Ground Water Pollution Control

	3	Dr. Thein Tun	Ph.D. (Metallurgy)	Senior Consultant	(a) Risk Assessment and Hazard Management (b) Facilitation of Meeting (c) Occupational Safety and Health
	4	Dr. Myo Min Tun	Ph.D. (Metallurgy)	Senior Consultant	(a) Evaluation of Alternatives (b) Resources Utilization and Management (d) Waste Management
	5	Dr. Sao Hone Pha	Ph.D. (Electronics)	Consultant	Map, Google Earth, Remote Sensing and GIS
	6	Dr. Aung Lay Tin	Ph.D. (Mining)	Human Resources Environmental Services Co., Ltd.	Environmental Baseline Study (Ambient Air Quality and Noise Level)
	7	Ms. Nandar Nwe	M.S. in EIA/EMS (YTU),	Consultant	Social Impact Assessment (Household Survey)
	8	Ms. Thazin Htwe	M.S. in EIA/EMS (YTU), Dip; in Applied Psychology (YU)	Consultant	Social Impact Assessment (Public Consultation and Stakeholder Engagement)
	9	Mr. Yaw Ma Nar	B.Sc. (Forestry); Dip in EIA/EMS	Field Coordinator	Baseline Study (Traffic and Secondary Data Collection)
	10	Mr. Moe Pyi Kyaw	B.Sc. (Forestry)	Surveyor	Baseline Study (Surface Water and Soil Quality)
	11	Dr. Wyne Nwe New Oo	Ph.D. (Boitech)	Consultant	Species Identification
	12	Dr. Nyunt Lwin	Ph.D. (Zoology)	Consultant	Fauna Diversity
	13	Dr. Nyo Nyo Lwin	Ph.D. (Botany)	Freeland Consultant	Flora Diversity
	14	Dr. Khon Aung	M.B.B.S. (Ygn)	Consultant	Health Impact Assessment
	15	Dr. Myo Min Nyunt	Ph.D. (Mining)	Consultant	Geotechnical Engineering
	16	Dr. Ohm Theik	Ph.D. (Mining)	Consultant	Geotechnical Engineering (Slope Stability)

	17	Dr. Tin Aung Myint	Ph.D. (Geology)	Consultant	Engineering Geology
	18	Dr. Win Swe	Ph.D. (Geography)	Consultant	Hydrology and Socio-economic
	19	Ms. May Thet Zaw	M.E. (Civil)	Consultant	Constructional Related Impact Assessment and Risk Assessment
	20	Ms. Nay Chi Win Maung	M.E. (Civil)	Consultant	Waste management
	21	U Aung Naing Tun	L.L.B; MBA	Consultant	Legal Requirememt
Foreign Consultant	22	Mr. Cheng Liang shuang	M.Sc. (Conservation of Soil & Water)	Consultant	Water resources and high speed railway design

2.5. Scope of the EIA Study

This EIA study for the proposed railway alignment will cover FS for the following:

(1) Main line from China-Myanmar borders to Mandalay totals 409.960 km; and
(2) The meter-gauge connection line (of 4.170km) goes from Mandalay South to Myit Nge.

The EIA study will cover all of the environmental and social impacts related to the proposed project. However, the study will not cover for political and economic issues. Based on the impact assessment, the EIA study for the proposed railway project will be focused on

(i) Impacts on air environment (air quality, noise & vibration)
(ii) Impacts on surface water environment;
(iii) Impacts on soil and ground water environment;
(iv) Impacts on biodiversity environment; and
(v) Impacts on human environment (socio-economic, visual, health, utilities, cultural and heritage.).

2.6. The Need of EIA

An EIA and EMP are required for environmentally approvals from Environmental Conservation Department (ECD, Nay Pyi Daw) and Environmental Conservation Department (ECDs, Mandalay and Shan Region). The Environmental Conservation Department under Ministry of Natural Resources and Environmental Conservation is the lead authority for this

EIA process and the development needs to be authorized by this department in accordance with this Environmental Conservation Law (2012). Although the proposed project is FS stage, the environmental impacts associated with the proposed project require investigation in compliance with this Environmental Conservation Law (2012) and the EIA (Environmental Impact Assessment) procedures (2015).

2.7. Purpose and Objectives of the EIA Study

The Environmental Conservation Department under Ministry of Natural Resources and Environmental Conservation is the lead authority for this EIA process and the development needs to be authorized by this Department in accordance with this Environmental Conservation Law (2012). The environmental impacts associated with the proposed project require investigation in compliance with the EIA (Environmental Impact Assessment) procedures (2015). The main purpose of an EIA is to provide the relevant authorities with sufficient information on the proposed activities to allow them to make an informed decision on whether or not the EIA should be authorised. This EIA will be conducted according to Environmental Impact Assessment Procedures, 2015. The objectives of an EIA are to:

- Ensure that social and environmental considerations are explicitly addressed and incorporated into the development decision-making process;
- Anticipate and avoid, minimize or offset significantly adverse biophysical, social and other relevant impacts of proposed developments;
- Protect the productivity and capacity of natural systems and the ecological processes which maintain their functions; and
- Promote development that is sustainable and that optimizes resource use and management opportunities.

An EIA functions as a planning tool which helps determine the social, economic and Environmental impacts of a proposed project through Public Participation (PP) and independent specialist assessment. Through the EIA, potential negative and positive impacts are identified and recommendations are made for reducing or avoiding negative impacts, and enhancing positive impacts.

The findings of an EIA are transferred into clear and measurable objectives that must be achieved during construction, operation and decommissioning of a proposed project. These objectives, and plans for achieving them, are captured in an Environmental Management Plan

(EMP). The EMP is a public document and typically becomes a component of the project financing terms and conditions should the project go ahead.

The basic guiding principles of the EIA are:

- To inform decision-makers and result in appropriate levels of Environmental protection and community well-being;
- To provide timely information and outputs which assist with design and engineering modifications that reduce negative impacts;
- To identify any significant Environmental effects and key issues (i.e. the matters that must be taken into account when making decisions) and apply the necessary mitigation measures;
- To provide opportunities to inform and involve Interested and Affected Parties (I&APs), incorporating their inputs and concerns explicitly into the documentation and decision-making;
- To allow opportunities for participation by the authorities involved;
- To ensure that the EGT EIA Team has implemented appropriate methodologies and experts from the relevant disciplines, and to ensure the team has assessed potential interrelationships between the biophysical, social and economic issues; and
- To provide, as far as possible, an objective, rigorous and balanced assessment of the issues.

2.8. About the EIA and EMP Report

EIA is a formal process used to predict how the proposed project will affect natural resources such as water, air, land, socio-economic and wildlife. It is desirable to ensure that the development options under consideration are sustainable. It also aims to make recommendations for the mitigation of the potential negative impacts and enhancement of the positive ones.

EMP is a site-specific plan developed to ensure that the project is implemented in an environmental sustainable manner where all contractors and subcontractors, including consultants, understand the potential environmental impacts arising from the proposed project and take appropriate actions to properly manage that risk. EMP also ensures the project

implementation is carried out in accordance with the design by taking appropriate mitigation actions to reduce adverse environmental impacts during its life cycle.

The EIA and EMP reports will contain:

(a) the present status of air, noise, water, land, biological, socio-economic and health components of the environment;

(b) identification and evaluation of positive and negative impacts due to the development of the project;

(c) proposed pollution control measures, environmental management plan (EMP) to be adopted for mitigation of adverse impacts;

(d) measures for the improvement of the community around the area, and

(e) post-project environmental quality monitoring programme.

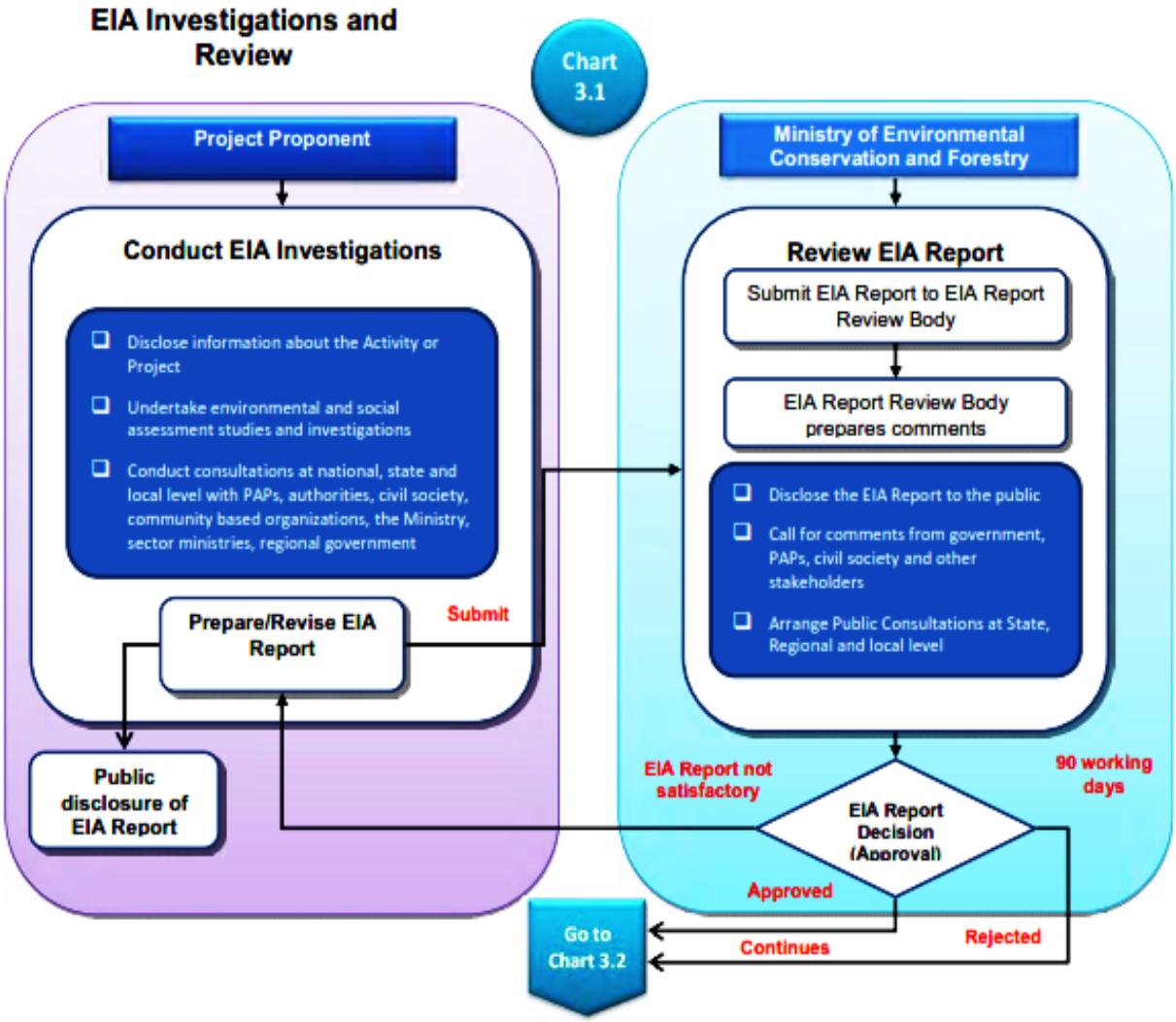
In making impact assessment, Green Tech ESIA Team mostly referred to the pollution limits set by Myanmar National Emission Guidelines, USEPA, OSHA and WHO.

3.0. POLICY, LEGAL AND INSTITUTIONAL FRAMEWORK

This chapter sets out the relevant legal and policy context in Myanmar and documents the environmental and social standards with which the proposed project has to comply with, as well as the international standards that the project will follow.

3.1. National Requirements

The EIA has been undertaken in accordance with the Myanmar Environmental Impact Assessment Procedure which was promulgated on December 29th, 2015, and provides legislation for environmental and social governance of economic development in Myanmar, under the Environmental Conservation Law 2012 and Environmental Conservation Rules 2014 of the National Environmental Policy for Myanmar 1994. An overview of the process (from the Myanmar EIA Procedure, 2015) is shown in Figure 3.1.



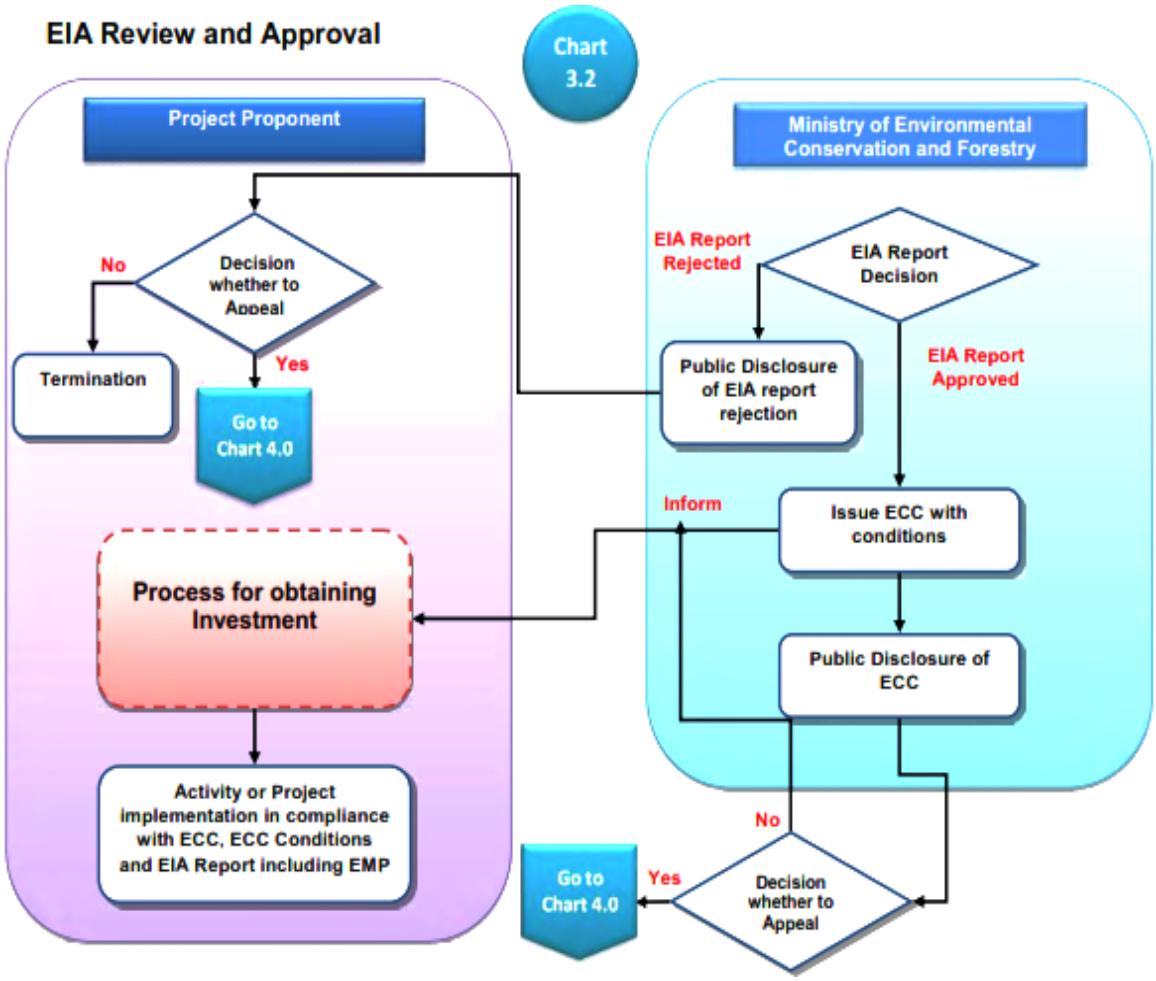


Figure 3.1 - EIA Review and Approval Process

3.2. Laws and Regulations Related to the Proposed Railway Project

Myanmar has promulgated several laws and regulations concerning protection of the environment. The following table describes laws and regulations which are directly or indirectly associated with the proposed project.

Table 3.1 - Laws and Regulations Related to Workmen's Right, Occupational Safety and Health

Laws and Regulations	Year	Purposes
The Labor Organization Rules, (No. 1,7 to 11)	2012	▪ This Law was enacted, to protect the rights of the workers, to have good relations among the workers or between the employer and the worker, and to enable to form and carry out the labour organizations systematically and independently
Second Amendment to the Labor Dispute Settlement Law (Law No.17)	2019	▪ The Pyidaungsu Hluttaw hereby had enacted this Law for safeguarding the right of workers or having good relationship between employer and workers and making peaceful workplace.
Labor Disputes settlement Act (Law No.5)	2014	▪ Concerning the safety, health and welfare of the employees ▪ Recreation of the employees, at or away from place of work ▪ Related personnel problems, including any individual grievance which the Works Committee may decide to consider ▪ Provision of the best means for utilizing the ideas and suggestions of the employees and encouragement of them to put forward ideas and suggestions ▪ Any matter affecting the industry concerned which it shall decide to take into its consideration
Employment and Skill Development Law, (Law No. 5, 14, 30(a,b))	2013	▪ To facilitate employment which is appropriate to the age and ability of the job seeker ▪ To help workers obtain employment and to provide stability of employment and skills development for employees ▪ To help employers obtain appropriate employees
The Leave and Holiday Act, 1951 (Law Amended July, 2014)	2014	▪ To allow worker for leave and holiday allowances, religious or social activities with earn allowance, and benefits for Health allowances. ▪ Concerned workers: Daily wage workers/ temporary workers/permanent workers.
Minimum Wages Law (Law No. 12, 13 (a to g)	2013	This Law was enacted to meet with the essential needs of the workers, and their families, who are working at the commercial, production and service, agricultural and livestock breeding businesses and with the purpose of increasing the capacity of the workers and for the development of competitiveness,
Payment of Wages Act (Law No. 3,4, 5, 14, 8 with 7,10)	2016	(a) Pay in local currency or foreign currency recognized by the Central Bank of Myanmar. This may be in cash, check or deposit into the bank account of Employee. (b) Moreover, pay can be in the means of… (1) Totally in cash OR half the cash and half in things set according to the local price to those employees working in trade, manufacturing and service sectors. (2) Totally in cash OR half the cash and half in things set as local price according to local traditions or common agreement to those working in agriculture and livestock sectors. But, this must be for the sake of the employees and their families. And, it also must be reasonable/fair.

		(3) An employee will receive the payment for 60 days when he/she is in Alternative Civil Service.
The Social Security Law (Law No. 11(a), 15(a), 18(b), 48, 49, 75)	2012	▪ The employers and workers will co-ordinate with the Social Security Board or insurance agency in respect of keeping plans for safety and health in order to prevent employment injury, contracting disease and decease owing to occupation and in addition to safety and educational work of the workers and accident at the establishment.
Law Amending the Workmen's Compensation Act	2005	▪ To protect personal injury caused to a workman by accident arising out of and in the course of his employment and to compensate in accordance with the provisions of Workman Compensation Act
Prevention and Control of Communicable Diseases Law (Law No. 3, 4, 9, 11)	1995	To prevent the outbreak of Communicable Diseases, by implementing following project activities; (a) immunization of children by injection or orally; (b) immunization of those who have attained majority, by injection or orally, when necessary; (c) carrying out health educative activities relating to Communicable Disease.
The Control of Smoking and Consumption of Tobacco Product Law (Law No. 9)	2006	▪ To convince the public that health can be adversely affected due to smoking and consumption of tobacco product and to cause refraining from the use of the same; ▪ To protect from the danger which affects public health adversely by creating tobacco smoke-free environment; ▪ To obtain a healthy living style of the public including child and youth by preventing the habit of smoking and consumption of tobacco product;
The Prevention of Hazard from Chemical and Related Substances Rules (Law No. 8,15,16,17, 20, 22, 23, 27)	2013	▪ Performing the sticking pictogram for being least the health impacts and accident injuries in the occupational area according to the prescribed standards and norms of the Globally Harmonized System GHS); ▪ Making the necessary arrangements to be safety of the occupational area and issuing orders and directives for preventing and decreasing the accident; ▪ Laying down the proliferation plans on knowledge, and safety of chemical and related substances to administrators, license holders, public and workers; ▪ Cooperating with local and foreign governmental departments, organizations and non-governmental organizations in respect of safety management for chemicals hazard.
Occupational safety and health Law (Pyidangsu Hluttaw Law No 8)	2019	▪ The purpose to effectively implement measures related to safety and health at every industry, prevent by the workplace accidents and occupational diseases and set occupational safety and health standards.
Workmen's Compensation Act	2005	▪ To protect personal injury caused to a workman by accident arising out of and in the course of his employment and to compensate in accordance with the provisions of Workman Compensation Act
The Traditional Drug Law (Law No.7)	1996	▪ To promote and develop traditional medicine and traditional drugs; ▪ To enable the public to consume genuine quality, safe and

		efficacious traditional drugs; ▪ To register traditional drugs systematically; ▪ To control and regulate systematically the manufacture of traditional drugs.
Law Relating to Overseas Employment (Law No.3)	1999	▪ To enable the beneficial and systematic utilization of human resources of the State for building a modern and developed State; ▪ To enable those seeking overseas employment to get employment opportunities and to secure such employment systematically; ▪ To ensure that there is no loss of the rights and privileges of workers and that they receive the rights they are entitled to; ▪ To enable the systematic utilization within the country of the knowledge experience and skills gained abroad, according to the type of overseas employment undertaken,
Prevention from Danger of Chemical and associated Materials Law (Law No.28)	2013	▪ To prevent from damaging the environmental resources and from endangering the lively creatures due to the chemical and associated materials; ▪ To control systematically for the safety in carrying out in accord with the approval for chemical and associated materials business; ▪ To carry out the data information acquiring system and to widely do the educating and research works in order to utilize the chemical and associated materials systematically; ▪ To carry out continuous development for worksite safety, health and environmental conservation.
Prevention from Danger of Chemical and associated Materials Law (Law No 28)	2013	▪ To prevent from damaging the environmental resources and from endangering the lively creatures due to the chemical and associated materials ▪ To control systematically for the safety in carrying out in accord with the approval for chemical and associated materials business ▪ To carry out the data information acquiring system and to widely do the educating and research works in order to utilize the chemical and associated materials systematically ▪ To carry out continuous development for worksite safety, health and environmental conservation.

Table 3.2 - Laws and Regulations Related to Cultural and Heritage

Laws and Regulations	Year	Purposes
The Protection of rights of National Race Law, (Law No. 5)	2015	▪ Consists of four bills, as submitted to the legislature; Buddhist Women ' s Special Marriage Bill, Religious Conversion Bill, Monogamy Bill and Population Control Bill.
Protection and Preservation of Cultural Heritage Regions Laws (Law No. 15, 16)	2019	▪ To implement the protection and preservation policy with respect to perpetuation of cultural heritage that has existed for many years; to protect and preserve the cultural heritage regions and the cultural heritage.

The Protection and Preservation of Antique Objects Law (Law No. 12,15 20)	2015	▪ To implement the policy of protection and preservation for the perpetuation of antique objects; ▪ To protect and preserve antique objects so as not to deteriorate due to natural disaster or man-made destruction; ▪ To uplift hereditary pride and to cause dynamism of patriotic spirit by protection and preservation of antique objectives; ▪ To have public awareness of the high value of antique objectives; ▪ To carry out in respect of protection and preservation of antique monuments in conformity with the International Convention and Regional Agreement ratified by the State.
The Protection and Preservation of Ancient Monuments Law (Law No. 12,15 20)	2015	▪ To implement the policy of protection and preservation for the perpetuation of ancient monuments; ▪ To protect and preserve ancient monuments so as not to deteriorate due to natural disaster or man-made destruction; ▪ To uplift hereditary pride and to cause dynamism of patriotic spirit by protecting and preserving ancient monuments; ▪ To have public awareness of the high value of ancient monuments; ▪ To protect and preserve ancient monuments from destruction; ▪ To search and maintain ancient monuments; ▪ To carry out in respect of protection and preservation of ancient monuments in conformity with the International Convention and Regional Agreement ratified by the State.
Law on the preservation and protection of ancient buildings	2015	▪ To implement the policy of protection and preservation for the perpetuation of ancient monuments ▪ To protect and preserve ancient monuments so as not to deteriorate due to natural disaster or man-made destruction ▪ To uplift hereditary pride and to cause dynamism of patriotic spirit by protecting and preserving ancient monuments ▪ To have public awareness of the high value of ancient monuments ▪ To protect and preserve ancient monuments from destruction ▪ To search and maintain ancient monuments ▪ To carry out in respect of protection and preservation of ancient monuments in conformity with the International Convention and Regional Agreement ratified by the State.
Law Protecting Ancient Objects (Law No.43)	2015	▪ To implement the policy of protection and preservation for the perpetuation of antique objects ▪ To protect and preserve antique objects so as not to deteriorate due to natural disaster or man-made destruction ▪ To uplift hereditary pride and to cause dynamism of patriotic spirit by protection and preservation of antique objects ▪ To have public awareness of the high value of antique objects To carryout in respect of protection and preservation of antique objects in conformity with the International Convention and Regional Agreement ratified by the State.

Law Concerning Religious Conversion (Law No.48)	2015	▪ To move freely from own religion to another religion, from one religion to atheism, from atheism to one religion

Table 3.3 - Laws and Regulations Related to Natural Environment

Laws and Regulations	Year	Purposes
Pesticide Law Pyidaungsu Hluttaw Law No. 14/2016	2016	▪ To direct the Myanmar Agriculture Service to analyze and test pesticides or any active ingredient received as samples as to conformity with the content of ingredient as claimed on the label; and to undertake bio-efficacy trials on crops for determining effectiveness in practical use.
Forest Law	1992	▪ To implement forest policy and environmental conservation policy, to promote public cooperation in implementing these policies, to develop the economy of the State, to prevent destruction of forest and biodiversity, to carry out conservation of natural forests and establishment of forest plantations and to contribute towards the fuel requirement of the country.
Protection of Biodiversity and Protected Area Law	2018	▪ To protect wildlife, wild plants and conserve natural areas, to contribute towards works of natural scientific research, and to establish zoological gardens and botanical gardens.
Conservation of Water Resources and Rivers Law (Law No. 8, 11(a), 13, 19, 24(b), 30)	2006	▪ To conserve and protect the water resources and rivers system for beneficial utilization by the public; to prevent environmental impact.
Conservation of Water Resources and Rivers Rules	2013	▪ To conserve and protect the water resources and rivers system for beneficial utilization by the public; to prevent environmental impact.
The Freshwater Fisheries Law (Law No. 36,40,41)	1991	▪ To further develop the fisheries; ▪ To prevent the extinction of fish; ▪ To safeguard and prevent the destruction of freshwater fisheries waters; ▪ To obtain duties and fees payable to the State; ▪ To manage the fisheries and to take action in accordance with the Law.
Animal Health and Development Law (Law No.17)	2010	▪ To carry out animal health and development work and promote livestock development; ▪ To prevent outbreak of contagious disease in animals and to control the outbreak systematically when occurs; ▪ To inspect imported animal, animal product and animal feed; ▪ To issue recommendation certificate concerning animal, animal product and animal feed for export; ▪ To protect animals by law from being ill-treated.
The Fertilizer Law (Law No.7)	2002	▪ To enable supporting the development of agricultural sector which is the basic economy of the State; ▪ To enable supervision and control the fertilizer business systematically;

		▪ To enable growers to use fertilizer of quality in conformity with the specifications; ▪ To support the conservation of soil and environment by utilizing suitable fertilizer; ▪ To enable carrying out of educative and research works extensively for the systematic utilization of fertilizer by the agriculturalist; ▪ To cooperate with government departments and organizations, international organizations and local and foreign non-governmental organizations regarding fertilizer business.

Table 3.4 - Laws and Regulations Related to Transportation and Communication

Laws and Regulations	Year	Purposes
Automobile Law Pyidaungsu Hluttaw Law No. 55/2015	2015	▪ For the safe driving of motor vehicles in public areas through registration according to official rules and regulations. ▪ To provide driving licenses for driving particular types of motorized vehicles after qualification checks. ▪ For the easy flow of road users and for the protection against road risks and vehicle perils. ▪ To avoid traffic congestion and to use high technology transportation systems efficiently in order to implement protection against road risks and vehicle perils. ▪ To reduce environmental pollution caused by motor vehicles.
Railway Transportation Service Law (Section 28 to 39, 42 and 43)	2016	▪ To be safe environment for construction site ▪ To attain required land use pemissions validly
The Highways Law (Law No.24)	2015	▪ To cause easier communication and transportation among states and divisions by constructing the highways and to strengthen national solidarity and friendship and to cause all-round development in all regions and areas in economic and social sectors, ▪ To give support in implementing the duty for security and convenience in road and communication and quickness in flow of commodities; and to supervise systematically in respect of traffic and use of highways. ▪ To give support in the modernization and development of the State by constructing highways within the State or by constructing highways which connect with neighboring countries; ▪ To carry out systematically the works of extension, repair and maintenance for durability of highways;
Law Amending Highway Act (Law No 33)	2014	▪ Generally the prevention of obstruction to traffic and of annoyance, danger or injury to the public
Road Carriers Law (No 3)	2016	▪ Systematic supervision for the development of road transport drugs in the country

		▪ The economic medicine of the country; Social medicine coordinate and coordinate the needs of private transport agents to improve the management and transportation of medicines and transportation. ▪ Road transport drugs are required by law for systematic medicine and developmental medicine; Rules and regulations can be enacted, ▪ Coordinate with relevant departments and organizations for the environmental impact of road transport in the transport sector ▪ To prevant car vehicle accident and road accidents, coordinate with relevant agencies and organizations.
The bridges Law (Law No 16)	2019	▪ To systematically supervise, supervise and charge bridges on the construction of new bridges, construction of new bridges, upgrades, extensions, inspections of bridges ▪ To ensure the safety and security of the users of the bridge and to be able to continuously carry out matters related to the maintenance and strength of the bridge ▪ Safe and secure use of the bridge will speed up the flow of passengers and goods, improve transportation costs, improve the socio-economic life of citizens and raise living standards ▪ To accelerate the development of the country by constructing, upgrading, expanding, inspecting, repairing and maintaining the bridge for its longevity
Multi-Model Transport Law (Law No 3)	2014	▪ To implement the provisions contained in international convention and promises contained in regional agreement related to the multimodal transport ▪ To facilitate the orderly expansion of international trade through regional and international integration among the multimodel transport operators ▪ To stimulate the development of smooth, economic and efficient multimodal transport services adequate to the requirements of international trade ▪ To perform orderly operation by the multimodel transport operators in accord with the terms and conditions by making a registration under this law ▪ To create a balance of interests between users and carriers of multimodal transport services ▪ To maintain a smooth, swift and efficient transport by reducing problems of transit in taking steps to engage arrangements.
The Law Amending the Embankment Act (Law No.2)	1998	▪ Prohibitions on damaging or trespassing on embankments; or constructing and maintaining embankments without prior permission

Law Amending the Law on the Utilization of Roads and Bridges (Law No.25)	2014	▪ to promote traffic convenience and contribute to the development of the national economy by prescribing matters concerning the construction, upgrading, maintenance, management, etc. of roads and bridges.

Table 3.5 - Laws and Regulations Related to Communities' Development, Health and Safety

Laws and Regulations	Year	Purposes
Village Regional Development Law (Law No. 39)	2019	▪ To narrow the gap between urban social status and rural social status. ▪ To ensure the continuity of the development of rural areas and the social development of the rural population. ▪ To maximize the efficiency of human resources and finances that can be achieved in rural development activities, including the participation of the people ▪ To improve the lives of people living in rural areas and be able to create civil society protection network for the risk of disaster ▪ Highlight the role of local people in advancing the development of rural areas ▪ To be able to work in harmony with the environment in order to promote the development of rural areas ▪ To ensure that people in rural areas have access to personal hygiene and home pollution prevention activities by working together with the relevant government departments, government agencies, and non-governmental organizations
Law Regarding Population Control & Health (Law No. 28)	2015	▪ To improve living standards while alleviating poverty in the country; ▪ To ensure sufficient quality healthcare; and ▪ To develop maternal and child health
Law of protection of farmer rights and enhancement of their benefits (Law No 32)	2013	▪ To support farmers by providing suitable loans and assistance for investment ▪ To manage for providing technology, input and production facility to farmers smoothly to improve production; ▪ To assist farmers for getting reasonable price and market in selling agricultural ▪ produces; ▪ To protect the rights of farmers possessing small plot and to enhance their benefits ▪ effectively; ▪ To provide aids as much as possible for loss and damage caused by any natural disaster
Vacant, Fallow, Virgin Land Management Law (Law No. 4(d), 5(d),7)	2012	The Central Committee may allow the businesses applied for the right to cultivate or utilize vacant, fallow and virgin lands for making foreign investment with the approval of the Myanmar Investment Commission. The Central Committee may, when the investors granted under the foreign investment law or organization consisting of the

		investors granted under the foreign investment law, apply for obtaining the right to cultivate or utilize the vacant, fallow and virgin lands, permit after scrutiny only the businesses which are unable to be carried out by the citizens.
Land Acquisition, Resettlement and rehabilitation Law (Section 39,41,42,46,54(b and c),58)	2019	▪ In this law, it is stipulated that the government holds rights to take over land provided that compensation is made to the original land owner. No private ownership of land is permitted ▪ To prevent potential impacts on environmental and social sectors due to land use for projects
Second Amendment of the Law on the Development of Border Areas and National Races (Law No. 44)	2015	▪ To develop the economic and social works and roads and communications of the national races at the border areas, in accordance with the aims which are non-disintegration of the Union, non-disintegration of the national solidarity and perpetuation of the sovereignty of the State; ▪ To strengthen the amity among the national races; ▪ To eradicate totally the cultivation of poppy plants by establishing economic enterprises; ▪ To preserve and maintain the security, prevalence of law and order and regional, peace and tranquility of the border areas.
The Law Relating to Private Health Care Services ***(Law No.5)***	2007	▪ Develop private health care services in accordance with the national health policy; ▪ To participate and carry out systematically by private health care services in the national health care system as an integral part; ▪ To enable utilizing effectively the resources of private sector in providing health care to the public; ▪ To enable the public to choose as desired in fulfilling their needs for health by establishing private health care services; To enable provision of quality service at fair cost and to take responsibility.
Public Health Law (Law No. 3, 5)	1972	To promote and safeguard public health and to take necessary measures in respect of environmental health.

Table 3.6 - Laws and Regulations Related to Land Acquisition

Laws and Regulations	Year	Purposes
Vacant, Fallow, Virgin Land Management Law (Law No. 4(d), 5(d),7)	2012	The Central Committee may allow the businesses applied for the right to cultivate or utilize vacant, fallow and virgin lands for making foreign investment with the approval of the Myanmar Investment Commission. The Central Committee may, when the investors granted under the foreign investment law or organization consisting of the investors granted under the foreign investment law, apply for obtaining the right to cultivate or utilize the vacant, fallow and virgin lands, permit after scrutiny only the businesses which are unable to be carried out by the citizens.
Land Acquisition, Resettlement and rehabilitation Law (Section	2019	▪ In this law, it is stipulated that the government holds rights to take over land provided that compensation is made to the original land owner. No private ownership of land is permitted

39,41,42,46,54(b and c),58)		▪ To prevent potential impacts on environmental and social sectors due to land use for projects
Farm Land Law	2012	▪ Establish a system of land registration for farmers including provision of land use certificates (LUCs) that create rights to sell, exchange, access credit, inherit and lease the land. Government retains the power to revoke the LUCs if any of the conditions of use are not complied with in full.
Farmland Act (Law No.11)	2012	▪ To minimize the impact Federal programs have on the unnecessary and irreversible conversion of farmland to nonagricultural uses ▪ To assure that to the extent possible federal programs are administered to be compatible with state, local units of government, and private programs and policies to protect farmland
National Land Use Policy	2016	▪ NLUP sets out principles and objectives for land governance reform (including involuntary resettlement) to guide the preparation of a future Land Law. While generally aspirational in nature, it does call for formation of a National Land Use Council as well as State and District Land Use Committees to commence implementing the objectives of the policy. In relation to involuntary resettlement, the NLUP specifically calls for comprehensive mitigation measures covering resettlement and livelihood restoration; special attention to the needs of landless, women and ethnic minorities; comprehensive consultation and participatory planning; and effective grievance redress procedures. It is unclear what the current status of the NLUP is with respect to other existing instruments and to what extent the provisions of the NLUP will be applied.

Table 3.7 - Other Relative Laws and Regulations for Proposed Project

Laws and Regulations	Year	Purposes
Myanmar Mining Law (Law No. 13)	2018	▪ To improve living standards while alleviating poverty in the country; ▪ To carry out for the development of conservation, utilization and research works of mineral resources; ▪ To protect the environmental conservation works that may have detrimental effects due to mining operation.
Law Amending the electronic transactions law (Law No 6)	2014	▪ To support with electronic transactions technology in building a modern, developed nation ▪ To obtain more opportunities for all-round development of sectors including human resources, economic, social and educational sector by electronic transactions technologies ▪ To recognize the authenticity and integrity of electronic record and electronic data message and give legal protection thereof in matters of internal and external transactions, making use of computer network ▪ To enable transmitting, receiving and storing local and foreign information simultaneously, making use of electronic transactions technologies

		▪ To enable communicating and co-operating effectively and speedily with international organizations, regional organizations, foreign countries, local and foreign government departments and organizations, private organizations and persons, making use of computer network.
Telecommunication Law (Law No 31)	2013	▪ To enable to support the modernization and development of the nation with telecommunications technology ▪ To enable to bring out Telecommunications Services that will be able to provide high quality and worthy services to the users by allowing fair and transparent competitions from domestic and abroad in the telecommunications sector which is developing ▪ To enable to give more opportunities to the general public to use Telecommunications Service by expanding the Telecommunications Network in the entire country along with the telecommunications technology which is developing ▪ To enable to protect the Telecommunications Service providers and users in accord with law ▪ To enable to supervise Telecommunications Service, Network Facilities and Telecommunications Equipments which require license for national peace and tranquility and for public security.
Natural Disaster Mangement Law (No 21)	2013	▪ To implement natural disaster management programmes systematically and expeditiously in order to reduce disaster risks; ▪ To form the National Committee and Local Bodies in order to implement natural disaster management programmes systematically and expeditiously ▪ To coordinate with national and international government departments and organizations, social organizations, other nongovernment organizations or international organizations and regional organizations in carrying out natural disaster management activities ▪ To conserve and restore the environment affected by natural disasters ▪ To provide health, education, social and livelihood programmes in order to bring about better living conditions for victims.
Constitution of the Republic of the Union of Myanmar (Articles 24,45,349,359)	2008	- To conserve the natural environment, - To prevent and upgrade the rights and lives of the workers
Law on standardization (Law No.28)	2014	▪ To enable to determine Myanmar Standards; ▪ To enable to support export promotion by enhancing quality of production organizations and their products, production processes and services; ▪ To enable to protect the consumers and users by guaranteeing imports and products are not lower than prescribed standard, and safe from health hazards; ▪ To enable to support protection of environment related to products, production processes and services from impact, and conservation of natural resources;

		▪ To enable to protect manufacturing, distributing and importing the disqualified goods which do not meet the prescribed standard and those which are not safe and endangered to the environment; ▪ To support on establishing the ASEAN Free Trade Area and to enable to reduce technical barriers to trade. ▪ To facilitate technological transfer and innovation by using the standards for the development of national economic and social activities in accordance with the national development programs.
Environmental Conservation Law (Law No.7(o), 14,15,24,25,29)	2012	- To enable to implement the Myanmar National Environmental Policy; - To enable to lay down the basic principles and give guidance for systematic integration of the matters of environmental conservation in the sustainable development process;
Environmental Conservation Rules (Rule 55, 69 (a), (b))	2014	- To implement correctly according to the environmental management plan
EIA Procedures (Article 102 to 110, 113, 115, 117)	2015	- To develop the environmental impacts and to draw the environmental management plan;
National Environmental Quality (Emission) Guidelines (Section 2.1.9)	2015	These national Environmental Quality (Emission) Guidelines (hereafter referred to as Guidelines) provide the basis for regulation and control of noise and vibration, air emissions, and liquid discharges from various sources in order to prevent pollution for purposes of protection of human and ecosystem health.
Law Amending the Factories Act 1951 (Pyidaungsu Hluttaw Law No. 12/2016)	2016	To make effective arrangements in every factory for disposal of waste and effluent, and matters on health, cleanliness and precaution against danger.
Private Industrial Enterprise Law	1990	To narrow down the gap between rural development and urban development by the development and improvement of industrial enterprises; to avoid or reduce the use of technical know-how which cause environmental pollution; to cause the use of energy in the most economical manner.
The Myanmar Insurance Law (Law No. 15, 16)	1993	(a) to overcome financial difficulties by effecting mutual agreement of insurance against social and economic losses which the people may encounter, due to common perils; (b) to promote the habit of savings individually by effecting life assurance, thus contributing to the accumulation of resources of the State; (c) to win the trust and confidence of the people in the insurance system by providing effective insurance safeguards which may become necessary in view of the social and economic developments.
Myanmar Fire Force Law, (Law No. 25)	2015	▪ To take precautionary and preventive measure and loss of state own property, private property, cultural heritage and the lives and property of public due to fire and other natural disasters ▪ To organize fire brigade systemically and to train the fire brigade ▪ To prevent from fire and to conduct release work when fire disaster, natural disaster, epidemic disease or any kind of certain danger occurs

		▪ To educate, organize an inside extensively so as to achieve public corporation ▪ To participate if in need for national security, peace for the citizens and law and order
The Electricity Law	2014	Projects into "small" (up to 10 MW), "medium" (between 10 MW to 30 MW) and large (upwards of 30 MW); the states and regions can issue permits for small and medium power plants. In case these plants are not connected to the national grid, the Union Government Ministry is not the primary authority involved. The authorities have a legal right to use land for the purpose of power plants under the Electricity Law, and have the right to expand and maintain their facilities.
The Electricity Rule	2015	▪ Operation, maintenance and expansion of distribution systems in accordance with all applicable law and regulatory requirements, ▪ compliance with all applicable distribution codes and performance standards approved and issued by the Ministry and all environmental requirements, ▪ the distribution systems are safe, secure and operate reliably and economically.
Myanmar Petroleum and Petroleum Products Law (No. 9(a)€,10€,11)	2017	▪ To carry out the petroleum and petroleum product businesses activities systematically in accordance with the provisions of the law, stipulated standards, procedures and conditions; ▪ To enable the petroleum and petroleum product business activities to carry out safely without environmental impact; ▪ To establish free and fair competition in carrying out petroleum and petroleum product business activities; ▪ To secure energy requirement and energy security of the Union;
The Export and Import Law (Section 6,7)		• To enable to implement the economic principles of the State successfully. • To enable to lay down the policies relating to export and import that supports the development of the State. • To cause the policies relating to export and import of the State and activities are to be in conformity with the international trade standards. • To cause to be streamlined and speedy in carrying out the matters relating to export and import.
The Myanmar Engineering Council Law (Law No. 20,24,25, 31(a), 37)	2013	▪ To uphold and upgrade the dignity, ethics and quality of the Myanmar citizen engineers, graduate technicians and technicians who are practicing engineering works; ▪ To explore using engineering technology and information technology combined the good methods, research and development activities by which the natural resources and human resources of the State may be beneficially applied with least impact environment; ▪ To carry out guidance and supervision, and to take necessary actions for fulfillment of the requirements of stipulated technical standard, proper method, free from danger, keeping ethic and being dutiful in the fields of engineering and technology education, researches and services; ▪ To service engineering and technology related functions and duties beneficial for the State assigned by the relevant Ministry and relevant organizations.

Patent Law	2019	▪ To protect the rights and interests of the patentee and the inventor in accordance with this Law; ▪ To develop Myanmar ' s manufacturing by promoting technological innovations and distribution and transfer of technological knowledge; ▪ To establish a mutually-beneficial relationship between the inventors and users of inventions in order to promote technical know-how and socio-economic development; ▪ To help balance the rights and obligations of the inventors and users of inventions; ▪ To prevent the patentee or right holder from abusing patent rights and monopolizing trade.

3.3. National and International Guidelines for Proposed Railway Project

EIA assessment was undertaken in accordance with Myanmar's National Environmental Quality (Emission) (NEQ) Guidelines which were promulgated on December 29th, 2015 and provide the basis for regulation and control of various environmental parameters, including noise, air emissions, and effluent discharges. Moreover, beside the national guidelines, international guidelines and standards are referred to the impact assessment as follow:

(a) World Health Organization Guidelines (WHO);
(b) National Ambient Air Quality Standard (NAAQS), USEPA;
(c) IFC Guidelines for Waste Management Facilities, 2007;
(d) IFC Guidelines for Water and Sanitation, 2007; and
(e) IFC Guidelines for Occupational, Health and Safety, 2007.

3.4. National Environmental Quality (Emissions) Guideline for Proposed Project

(a) Air Quality

General guideline values for air emissions are described in current NEQG and the project shall apply theses guideline values for air quality parameters such as SO_2, NO_2, particulate matters (PM_{10} and $PM_{2.5}$).

Parameter	**Averaging Period**	**Guideline Value μg/m3**
Nitrogen dioxide	1-year 1-hour	40 200
Ozone	8-hour daily maximum	100
Particulate matter PM_{10} [a]	1-year 24-hour	20 50

Particulate matter $PM_{2.5}$ [b]	1-year	10
	24-hour	25
Sulfur dioxide	24-hour	20
	10-minute	500

[a] Particulate matter 10 micrometers or less in diameter

[b] Particulate matter 2.5 micrometers or less in diameter

(b) Water Quality

This guideline applies to activities typically conducted by rail infrastructure operators dedicated to passenger and freight transportation, including rail operations, covering construction and maintenance of rail infrastructure as well as operation of rolling stock, such as locomotives and railcars; and locomotive maintenance facilities, including engine services, and other mechanical repair and maintenance of locomotives and railcars. Process effluents from railway maintenance facilities involving metals machining, cleaning, and plating and finishing processes, including painting, should comply with the following levels applicable to treated effluent.

Table 3.8 - Effluent Levels for Railways

Parameter	Unit	Guideline Value
Aluminum	mg/l	3
Ammonia	mg/l	10 20 (electroplating)
Arsenic	mg/l	0.1
Cadmium	mg/l	0.1
Chemical oxygen demand	mg/l	250
Chromium (hexavalent)	mg/l	0.1
Chromium (total)	mg/l	0.5
Copper	mg/l	0.5
Cyanides (free)	mg/l	0.2
Cyanides (total)	mg/l	1
Fluorides	mg/l	20
Iron	mg/l	3
Lead	mg/l	0.2
Mercury	mg/l	0.01
Nickel	mg/l	0.5
Oil and grease	mg/l	10
pH	S.U.[a]	6-9
Phenols	mg/l	0.5
Silver	mg/l	0.2
Sulfide	mg/l	1

Temperature increase	°	<3[b]
Tin	mg/l	2
Total nitrogen	mg/l	15
Total phosphorus	mg/l	5
Total suspended solids	mg/l	50 25 (electroplating)
Volatile organic halogens	mg/l	0.1
Zinc	mg/l	2

(c) Noise

Noise prevention and mitigation measures should be taken by all projects where predicted or measured noise impacts from a project facility or operation exceed the applicable noise level guideline at the most sensitive point of reception.

In NEQG, the noise level is set as shown in Table below and noise prevention and mitigation measures should be taken by all projects where the predicted or measured noise impacts from a project facility or operation exceed the applicable noise level guideline at the most sensitive point of reception. Noise impact should not exceed the levels shown below, or result in a maximum increase in background levels of three decibels at the nearest offsite receptor location. According to the NEQG that has been prescribed by Ministry of Environmental Conservation and Forestry on 29th December, 2015, under Chapter 1 (General Provision), Section 1, sub- section 1.3 mentioned the following requirement for noise levels.

Table 3.9 - Noise Level set in NEQG

Receptor	One Hour LAeq (dBA)	
	Daytime (7:00-22:00) (10:00-22:00 for public holidays)	Night Time (22:00-7:00) (22:00-10:00 for public holidays)
Residential, institutional, educational	55	45
Industrial, commercial	70	70

Source: NEQG (December 2015)

3.5. International Agreements and Conventions

In addition to the domestic laws listed above, Myanmar is also a signatory to the following international conventions, and these may have relevance to the proposed survey activities. Refer to the following Table.

Table 3.10 - International Agreements and Conventions Relevant to the Proposed Project

International Agreements and Conventions	Status	Purposes
Vienna Convention for the Protection of the Ozone Layer, 1985	1998	Aims at the protection of the ozone layer, including requirements for limiting the production and use of ozone depleting substances.
Montreal Protocol on Substances that Deplete the Ozone Layer, 1989	1993	Aims at the protection of the ozone layer, including requirements for limiting the production and use of ozone depleting substances.
Basel Convention, 1989	2015	The Convention regulates the transboundary movements of hazardous wastes and provides obligations to its parties to ensure that such wastes are managed and disposed of in an environmentally sound manner.
United Nations Framework Convention on Climate Change (UNFCCC), New York, 1992 and Kyoto Protocol 1997	1995 and 2005	Provide a framework for intergovernmental efforts to tackle climate change. Recognises that the climate system is a shared resource whose stability can be affected by industrial and other emissions of carbon dioxide and other greenhouse gases.
Convention on Biological Diversity, Rio de Janeiro, 1992	1994	Aims to promote national policies for the conservation of wild flora, fauna and habitat that needs to be included in planning policies. The three main goals are: (1) the conservation of the biological diversity; (2) the sustainable use of its components; (3) fair and equitable sharing of the benefits.
Asia Least Cost Greenhouse Gas Abatement Strategy (1998 ALGAS)	1998	Develop national and regional capacity for preparation of GHG inventories. Assist in identifying GHG abatement options and preparation of a portfolio of abatement projects for each country.
United Nations Agenda 21	1997	Building on the National Environment Policy of Myanmar, takes into account principles contained in the Global Agenda 21. Myanmar Agenda 21 also aims at strengthening and promoting systematic environmental management in the country.
Relevant ILO Conventions in force in Myanmar • C1 Hours of Work • C14 Weekly Rest • C17 Workmen's Compensation (Accidents) • C19 Equality of Treatment (Accident Compensation) • C26 Minimum Wage Fixing Machinery • C29 Forced Labour Convention • C42 Workmen's Compensation (Occupational Diseases) Revised 1934 • C52 Holidays with Pay		Sets out legal instruments drawn up by the ILO's constituents (governments, employers and workers) and setting out basic principles and rights for workers.

3.6. Penalties and other Administrative Punishment

The developer must know the penalties and other administrative punishment granted as Appendix in EIA Procedures, 2015 in Myanmar as follow:

No	Non-Compliance	Penalties	Specific Administrative Punishment of the Ministry
1.	Failure or delay in timely submission of reports within Period prescribed by Ministry	100 to 500 US$ or equivalent Myanmar Kyat + 10-25 US$/ day unit cured or equivalent Myanmar Kyat	-Issue Enforcement Notice
2.	Obstruction or interference with an official in the course of their duties	250 to 5,000 US$ or equivalent Myanmar Kyat	-Issue Enforcement Notice -Criminal prosecution
3.	Failure to provide information to the Ministry or any representative	1,000 to 5,000 US$ or equivalent Myanmar Kyat	-Suspension of Approval of EMP, EMP-CP, EMP-OP in whole or in part
4.	Failure to provide information to the Ministry Inspector or any representative when requested in regard to inspection and monitoring	250 to 5,000 US$ or equivalent Myanmar Kyat	- Issue Enforcement Notice
5.	Undertaking or allowing any preparatory or other construction works without the prior approval by the Ministry of a reserved EMP or EMP-CP	1,000 to 5,000 US$ or equivalent Myanmar Kyat +50 to 500 US$/ day until cured or equivalent Myanmar Kyat	-Criminal prosecution
6.	Operating/implementing without a permit, or approval by the Ministry of an EMP or EMP-Op	1,000 to 5,000 US$ or equivalent Myanmar Kyat +50 to 500 US$/ day unit cured or equivalent Myanmar Kyat	- Criminal prosecution
7.	Non-compliance with an Enforcement Notice or Suspension Notice issued by the Ministry	2,000 to 10,000 US$ or equivalent Myanmar Kyat +100-500 US$/day unit cured or equivalent Myanmar Kyat	-Suspension of Approval of EMP, EMP-CP or EMP-OP in whole or in part -Revocation of Approval of EMP, EMP-CP or EMP-OP in whole or in part
8.	Failure to notify to the Ministry of any knowledge of any event of an imminent of Environmental damage	1,000 to 5,000 US$ or equivalent Myanmar Kyat	- Issue Enforcement Notice - Suspension of Approval of EMP, EMP-CP or EMP-OP in whole or in part -Revocation of Approval of EMP, EMP-CP or EMP-OP in whole or in part
9.	Failure to take reasonable steps to prevent an imminent thread of damage to the Environment, social, human health, livelihoods, or property, where application based on the EMP, EMP-CP or EMP-OP	2,500 to 10,000 US$ or equivalent Myanmar Kyat	-Issue Enforcement Notice - Suspension of Approval of EMP, EMP-CP or EMP-OP in whole or in part -Revocation of Approval of EMP, EMP-CP or EMP-OP in whole or in part

10.	Non-compliance with conditions in ‘the ECC and allowable Emission Limit Values	1,000 to 10,000 US$ or equivalent Myanmar Kyat	-Issue Enforcement Notice - Suspension of Approval of EMP, EMP-CP or EMP-OP in whole or in part -Revocation of Approval of EMP, EMP-CP or EMP-OP in whole or in part
11.	Failure to take pay compensation amounts required in respected in respect of social impacts	1,000 to 10,000 US$ or equivalent Myanmar Kyat	-Issue Enforcement Notice - Suspension of Approval of EMP, EMP-CP or EMP-OP in whole or in part -Revocation of Approval of EMP, EMP-CP or EMP-OP in whole or in part
12.	Failure to fully restore social conditions upon resettlement	1,000 to 10,000 US$ or equivalent Myanmar Kyat	-Issue Enforcement Notice - Suspension of Approval of EMP, EMP-CP or EMP-OP in whole or in part -Revocation of Approval of EMP, EMP-CP or EMP-OP in whole or in part

Notes:

1. All penalty amounts set forth in this Annex are denominated in United States Dollars (US$) and are subject to annual inflation adjustment.
2. Abbreviations are as follows;

   EMP = Environmental Management Plan
   EMP-CP = Environmental Management Plan – Construction Phase
   EMP-OP = Environmental Management Plan –Operational Phase

3.7. Sustainability Policy

Project developer’s sustainability model is “To operate in a sustainable manner means to create value for stakeholders, and to use resources so that the needs of future generations will not be compromised, respecting people, the environment and the society as a whole.” Green Tech adheres to a sustainability policy, which is composed of the following principles:

1. *Stakeholder relations* – “Engaging stakeholders and involving them in company’s business are both prerequisites for sustainability and for the construction of reciprocal value.”
2. *Human Rights* – “The respect of Human Rights represents the basis for an inclusive growth of societies, of the territories and, consequently, of the companies that work there.”
3. *Relations with communities and contribution to local development* – “Dialogue, the respect of local communities, the evaluation of impacts are all preconditions for an effective cooperation, targeted at creating territorial value.”

4. *Climate strategy* – "To satisfy the world's energy demand, by containing, at the same time, emissions of gases that have an impact on climatic change, is one of the greatest challenges of modern society."

3.8. Project's Environmental, Social and Health Policies

The main policy and commitment of project developer can be identified in the following points:

1. the protection of public safety, the health and safety of the workforce and the local communities
2. the protection and promotion of human rights, the economic and social development of local communities;
3. the protection of the environment and the conservation of biodiversity and ecosystems;
4. the continuous improvement of the quality of the processes, services and products of our activities and operations;
5. the compliance with Myanmar laws, regulations and industrial standards regarding the environment, health, safety and hygiene at work in all of our operations
6. visible and active leadership that promotes HSE excellence, which engages and motivates employees and contractors alike to succeed
7. setting objectives and targets for measuring and improving HSE performance in line with Company activities and strategic objectives
8. manage HSE in order to achieve our objective of incident free operations
9. implementing sustainable development principles in our activities
10. seek and achieve continuous improvement in our processes, consistent with our strategic objectives and priorities, by adopting the most advanced systems for environmental protection and energy efficiency
11. creating a culture in which the employees, Contractors and Visitors share these commitments and understand that working safely is a condition of employment.

3.9. Statement of Commitments

The followings are the commitments of the project developer and environmental assessment practitioner.

3.9.1 Commitments of Project Developer

The project developer will have to comply with the followings:

a) Comply with the commitments of the environmental and socio-economic development revealed in the Environmental Impact Assessment report.
b) Acknowledge and comply the laws, regulations and guidelines associated with the project, included in the report.
c) Comply and proceed the alternative methods, mitigation measures and monitoring plans included in the report for the reduction of the negative environmental impacts; and take responsibility for the environmental impacts due to non-compliance of the commitment.
d) Give priorities for the occupational health and safety of the workers.
e) Utilize the exact amount of fund as stated in proposed expenditure for cooperate social responsibility funds.
f) Take responsibility for all of the works and absence of the contractors, sub-contractors, officers and representatives of the company in operating the processes.
g) Take responsibility to support after discussion for the impacted people to ensure for their stable livelihood not lower than before the project; and resettlement and rehabilitate the impacted local people, government organizations and other related people and organizations.
h) Take responsibility to compensate, support, resettle and rehabilitate the effected people to ensure for their stable livelihood not lower than before the project after discussion with the relevant local authorities, related organizations and local people.

(Signature)

Name -

Occupation –

3.9.2. Commitments of the Environmental Assessment Practitioner

The EIA report was written by Ever Green Tech Environmental Services and Training Co., and EIAs in this report were designed by the following criteria;

(a) The designed EIA complied with the National Constitution, Environmental Conservation Law, EIA Procedures, and National Environmental Quality Guideline.

(b) This EIA also complied with the existing or future Labor laws, Occupational Health and Safety Laws, Rules and Procedures.

(c) These environmental impact protection procedures are designed of incident avoiding, mitigation and replacing for the project proponent who commits to follow the environmental impact protection procedure.

(d) This environmental management report is systematically designed not only for environmental impact protection procedures and occupational safety and health but also emergency management planning and social welfare programs.

(e) All facts including in this report are systematically surveyed without bias. As a third party, we commit and take full responsibility for all facts in this report.

(Signature)

Name -

Occupation -

4.0 PROJECT DESCRIPTION AND ALTERNATIVE SELECTION

4.1. Project Background

As part of the governments national transport strategy Ministry of Transport and Communication (MOTC) intends to improve transport capacities of the country by constructing the railway between Muse to Mandalay. The line starts from Muse Port in the north and ends at the Mandalay, in the south, connecting important cities and towns like Muse, Lashio, Kyaukme, Pyinoolwin and the central area. The total length of the main line is 409.960km and the railway is provided with 36 new stations, consisting of 1 border station, 9 intermediate stations, 1 passenger junction station, 1 freight junction station and 24 passing stations (including 12 stations to be reserved in initial stage and built in near future). Myanma Railways (MR) and China Railway Eryuan Engineering Group Co., Ltd (CREEC) signed the Memorandum of Understanding (MOU) on Feasibility Study (FS) for Muse-Mandalay Railway Project, on October 22, 2018. According to this MOC, CREEC will conduct FS for Muse-Mandalay Railway alignment.

4.2. Project Overview

Muse-Mandalay Railway is located in Shan State and Mandalay Region. The line starts from Muse Port of entry in the north and ends at Mandalay, the second largest city, in the south, connecting important northern cities and towns like Muse, Lashio, Kyaukme, Pyinoolwin and the central area. The total length of the main line is 409.960km. Meanwhile, a meter-gauge connecting line of 4.17km long from Mandalay South-Myitnge will be constructed to connect Muse-Mandalay railway with existing meter-gauge railway network in Myanmar.

4.3. Implementation Time Schedule

The schedule of implementation will be about 5 years after the starting date. So, the railway stations will also be finished within 5 years.

4.4. Description of the Project

4.4.1. Main Technical Standards

Table 4.1 - Main Railway Technical Standards

Item	Standard
Railway grade	Grade Ⅰ
Rail gauge	1435mm
Number of mainlines	Single line (reserve condition of doubling line)
Ruling gradient (‰)	12‰，push grade24‰
Minimum curve radius(m)	General section 2000m, difficult section 1600m
Design running speed of passenger	160km/h
Type of traction	Electric traction
Type of locomotive	Electrical 6-axis vehicle
Tractive tonnage (t)	3000t
Effective length of arrival-departure track (m)	650, reserve 850
Type of blocking	Semi-automatic blocking

4.4.2. Project Location

Muse-Mandalay Railway is located in Shan State and Mandalay Region. The line starts from Muse Port of entry in the north and ends at Mandalay, the second largest city, in the south, connecting important northern cities and towns like Muse, Lashio, Kyaukme, Pyinoolwin and the central area. The total length of the main line is 409.960km. Meanwhile, a meter-gauge connecting line of 4.17km long from Mandalay South-Myitnge will be constructed to connect Muse-Mandalay railway with existing meter-gauge railway network in Myanmar.

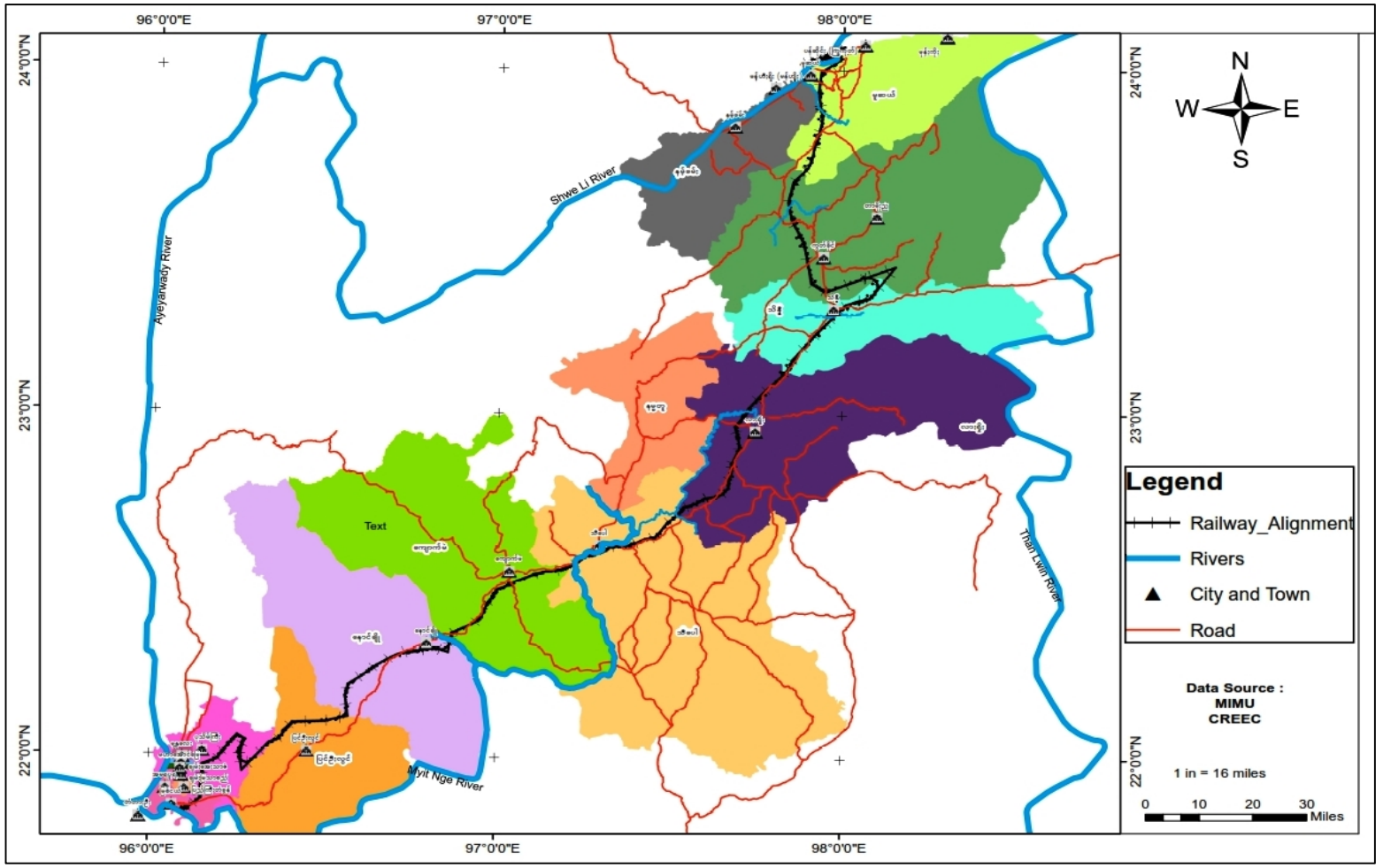


Figure 4.1 - Proposed Muse-Mandalay Railway Line in Map

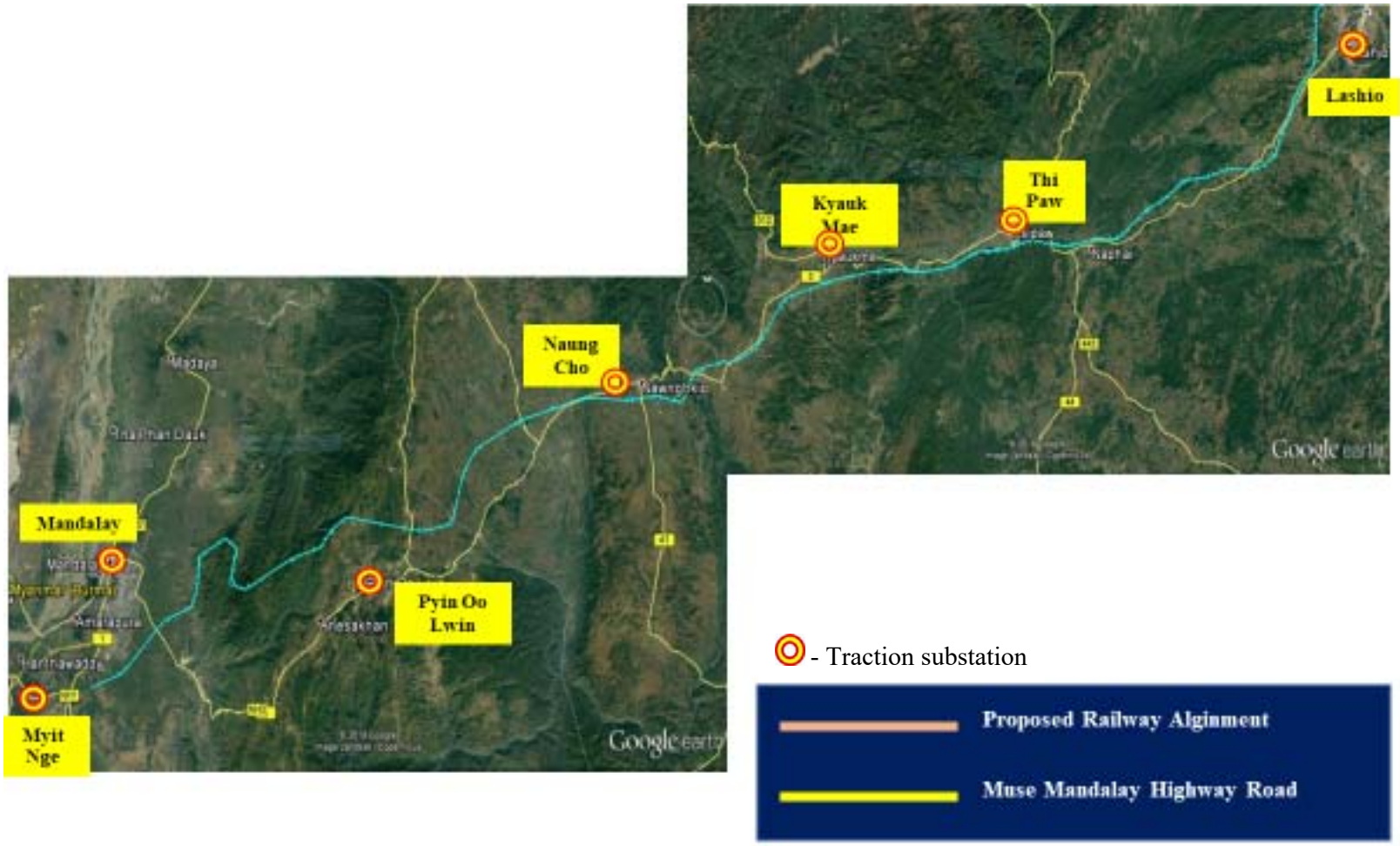


Figure 4.2 - Proposed Muse-Mandalay Railway Line in Google Earth (Mandalay to Lashio)

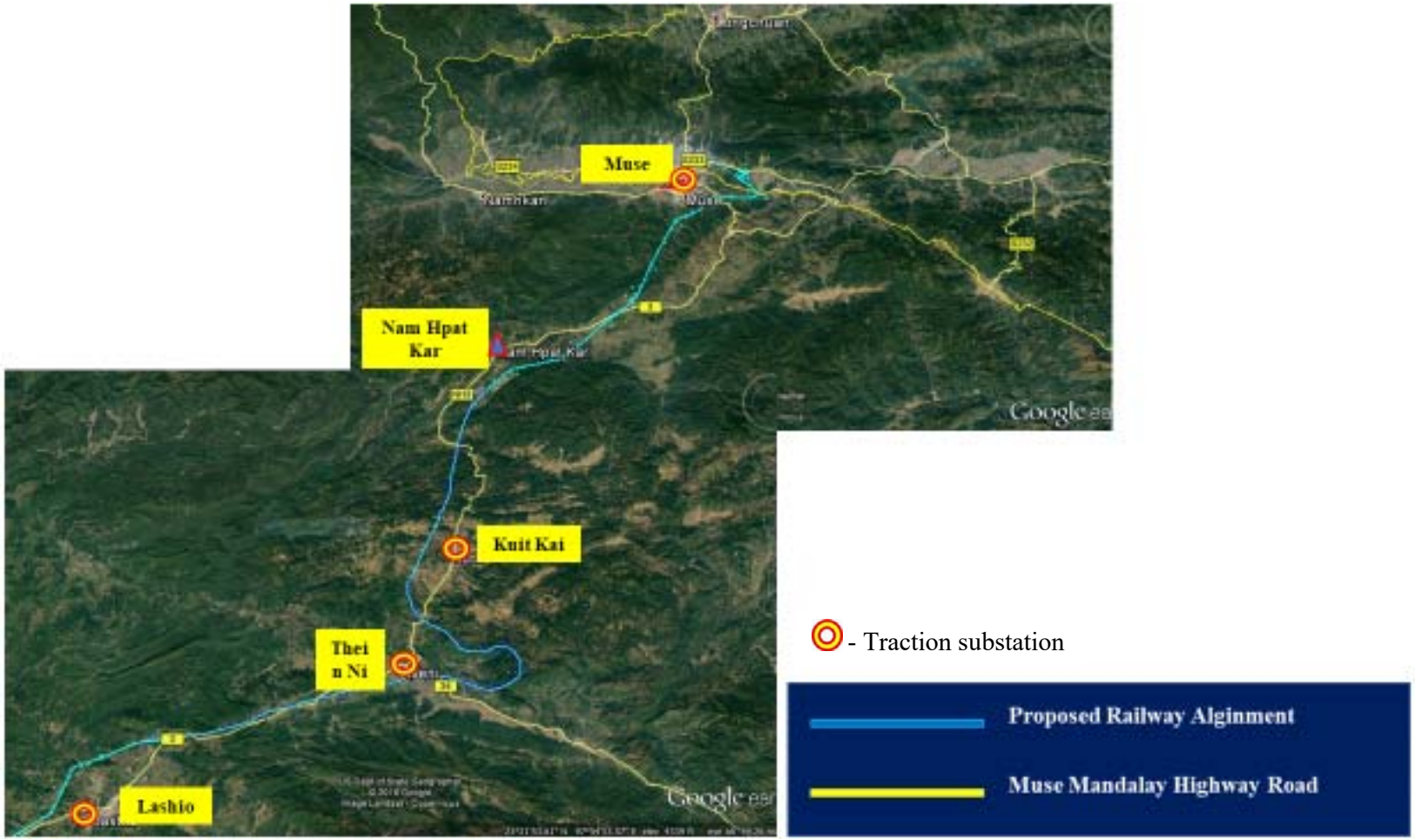


Figure 4.3 - Proposed Muse-Mandalay Railway Line (Lashio to Muse)

4.4.3. Main Technical Standards of Adjacent Railways

The north end of the railway is connected to Dali-Shweli Railway of China, and the railways adjacent to Dali-Shweli Railway include Guangtong-Dali Railway and Dali-Lijiang Railway. The main technical standards are listed in the following Table.

Table 4.2 - Main Technical Standards of Adjacent Railways

Alignment / Item			Railway Grade	Number of main lines	Ruling grade	Minimum radius of curve	Traction type	Locomotive Type	Traction tonnage	Effective length of arrival and departure track	Block type
Meter-gauge railways in Myanmar	Yangon-Mandalay	Existing		Single track	5‰	291	Diesel	DHL	1200/910	450 m	Train staff block
	Mandalay-Myitkyina	Existing		Single track	16.7‰	146	Diesel	DHL	700/257	450 m	Train staff block
	Mandalay-Lashio	Existing		Single track	40‰	103	Diesel	DHL	360/180	350-450 m	Train staff block
Standard gauge railways in China	Kunming-Guangtong	Existing	Grade Ⅰ	Single track	6‰, pusher grade 12‰	Normal 600m, difficult 400m	Electrical	SS_3	Dual loco. 3800t	850m	Automatic
		Existing	Grade Ⅰ	Double track	6‰, pusher grade 13‰	Normal 3,500m, difficult 2,800m	Electrical	SS_{3B}	Dual loco. 4000t	880m	Automatic
	Guangtong-Dali	Existing	Grade Ⅱ	Single track	12‰, pusher grade 23‰	350m	Diesel, reserve conditions for electrical traction	DF_{4B}	Single loco. 1000t, dual loco. 2000t	650m, reserve conditions for 850m	Semi-automatic
		Existing	Grade Ⅰ	Double track	6‰, pusher grade 13‰	Normal 3,500m, difficult 2,800m	Electrical	SS_{3B}	Dual loco. 4000t	850m	Automatic
	Dali-Shweli	Under construction	Grade Ⅰ	Single track	12‰, pusher grade 24‰	Normal 1,200m, difficult 800m	Electrical	HX_D3B	Dual loco. 3000t	650m Reserve 850m conditions	Automatic station block
	Dali-Lijiang	Existing	Grade Ⅰ	Single track	12‰	Normal 1,200m, difficult 800m	Electrical	SS_{3B}	Dual loco. 3000t	650m, reserve conditions for 850m	Automatic station block
	Dali-Lincang	Under construction	Grade Ⅰ	Single track	12‰, pusher grade 24‰	Normal 2,000m, difficult 1,600m	Electrical	HX_D3B	Dual loco. 3000t	650m, reserve conditions for 850m	Automatic station block

4.4.4. Land Use

The land use for main line of Muse-Mandalay Railway is 37,320,512m^2, including 25,951,997m^2 permanent land use and 11,368,515m^2 temporary land uses. Land use for the

meter-gauge connecting line from Mandalay South to Myitnge is 292,909m^2 including 189,699m^2 permanent land use and 103,210m^2 temporary land use.

Estimated house demolition is about 122,300m^2 and land acquisition is 26,141,700m^2. Subgrade earthwork: the total amount of filling and excavation is 64.51 million m^2, and the support masonry is 591,500 m^2. 819 culverts is 31272.18 horizontal linear meter in total. Track laying for main line is 409.72 km and for siding is 120.82km, and 347 turnouts are to be installed. Building is 292,300 m^2.

Land along the line is divided into three categories: new acquisition for permanent use, the existing land for permanent useful, and land for temporary use, and classified into nine subclasses: dry land, vegetable field, orchard, pond, economic forest, wood, homestead and wasteland. The quantities and indicators of land use are shown in the table below.

Table 4.3- Land Quantity Summary and Indicators

Land use item		Land use quantity (m²)			Land use specifications (m²/km)		
		New land use	Temporary land use	Sub-total	New land use	Temporary land use	Sub-total
Total for main line from Muse to Mandalay South	Section subgrade	9262532	2793158	12055690	68025	20513	88538
	Including land use of other disciplines	25951997	11368515	37320512	63304	27731	91035
Total for Muse-Mandalay South	Section subgrade	9425986	2893158	12319144	67168	20616	87784
	Including land use of other disciplines	26141696	11471725	37613421	63124	27701	90825

Source: CREEC (2019)

4.4.5. Land Use Land Cover (LULC) Classes of Railway Alignment

(a) The Land Use Map of Townships along the Railway Line

The LULC maps of the proposed railway alignment by GIS Method will be described as follow.

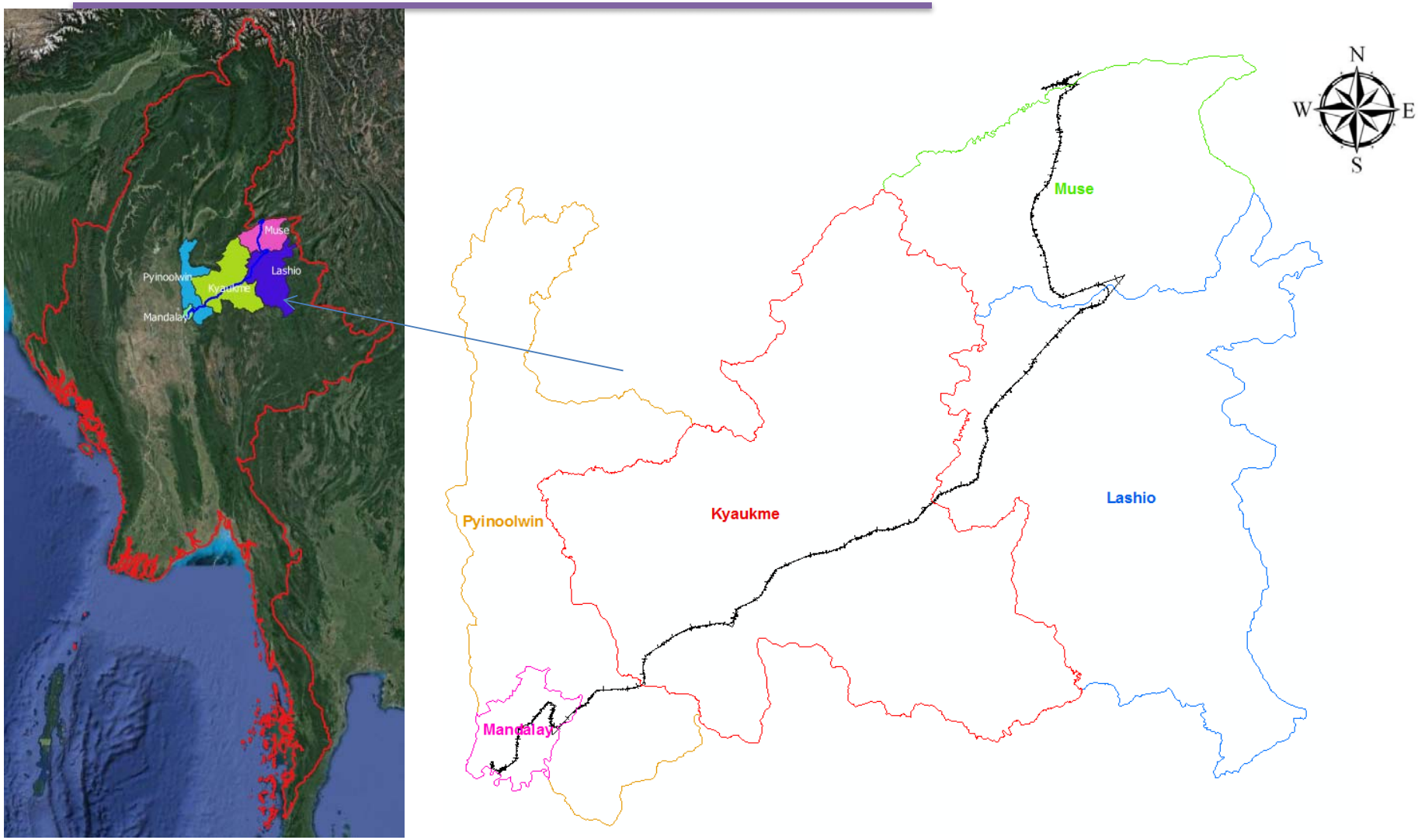


Figure 4.4 - Districts that the Railway will Pass through or Cross Nearby

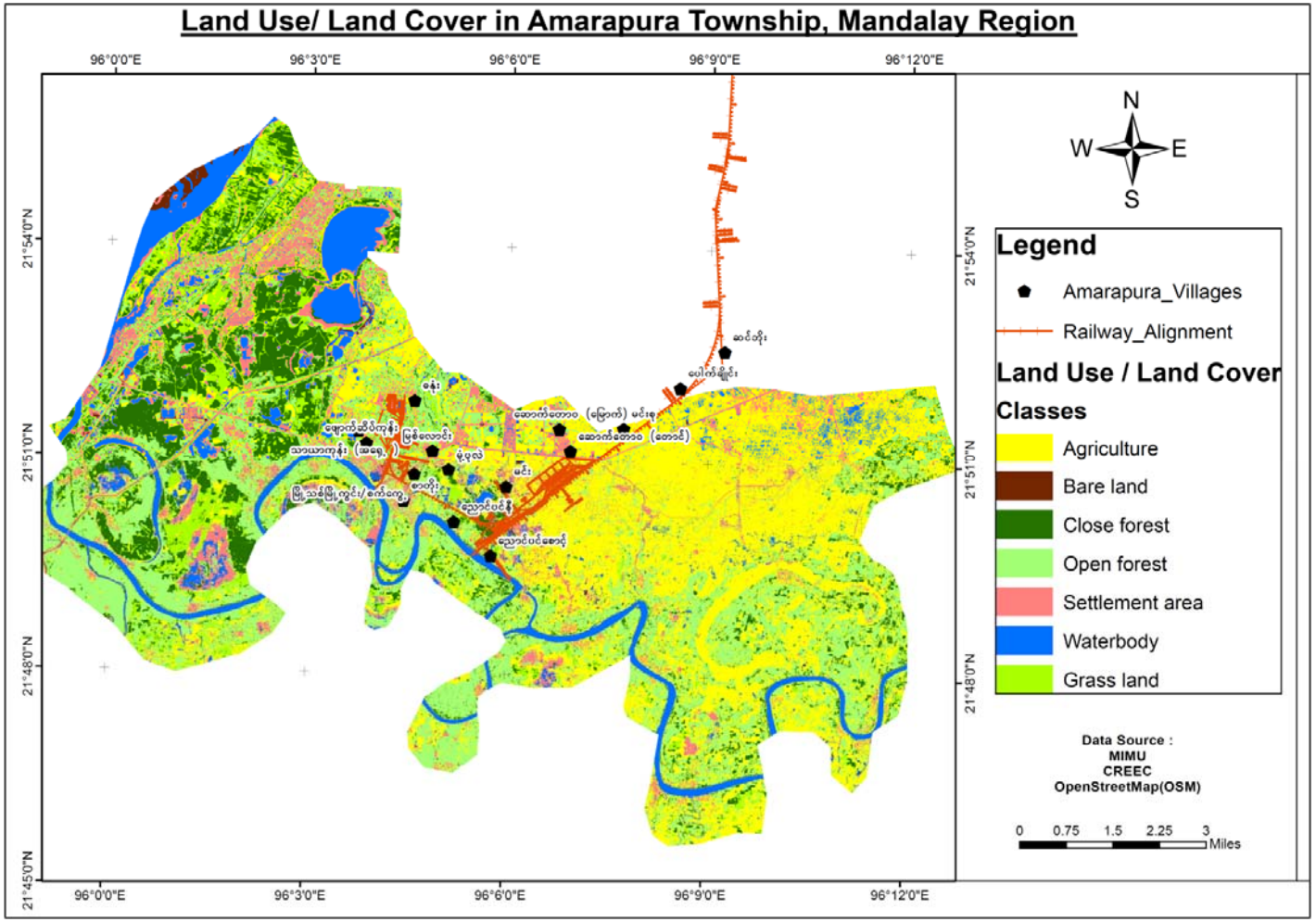


Figure 4.5 - Land Use Map of Amarapura Township (Source: EGT EIA Team, 2019)

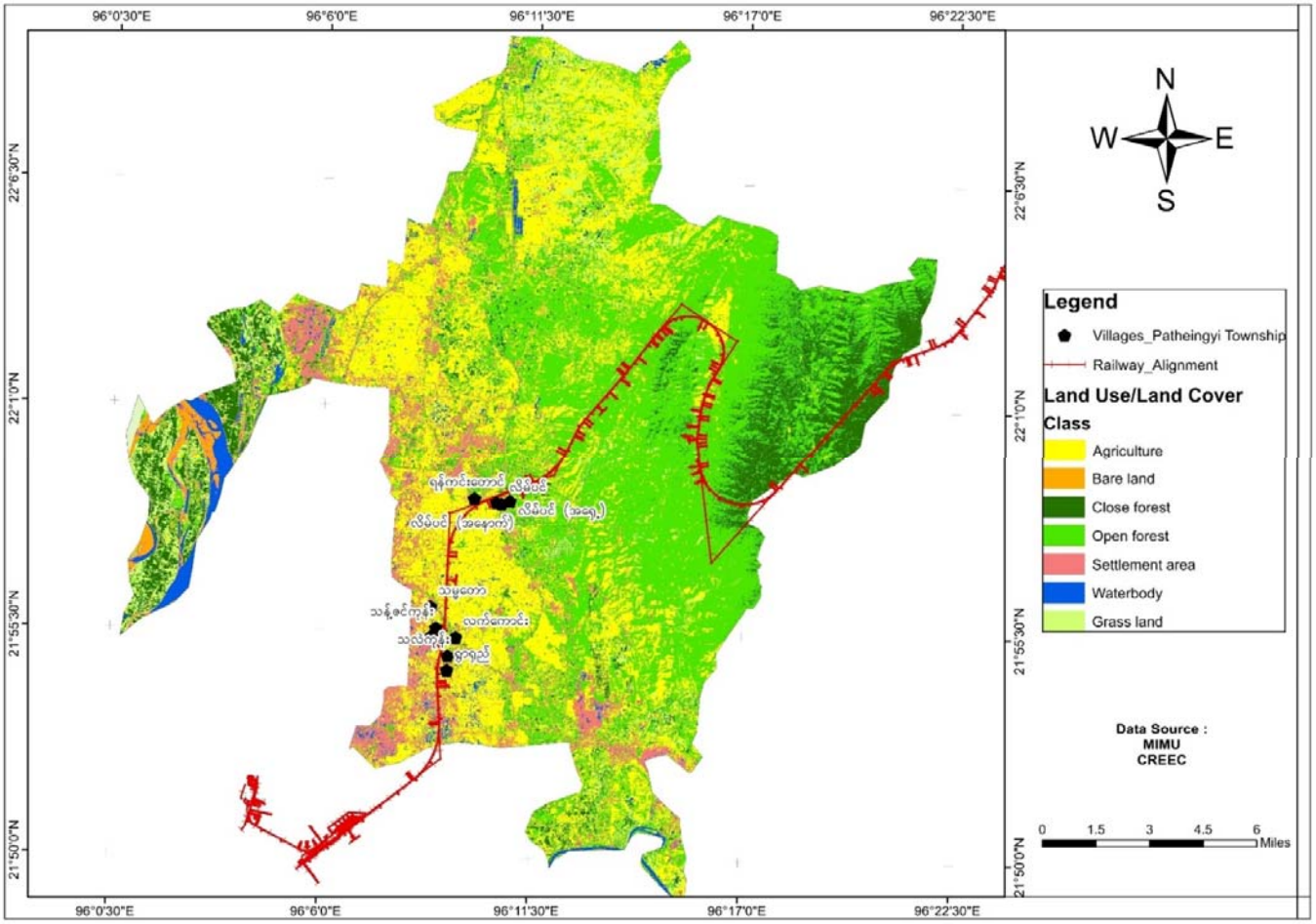


Figure 4.6 - Land Use Map of Patheingyi Township (Source: EGT EIA Team, 2019)

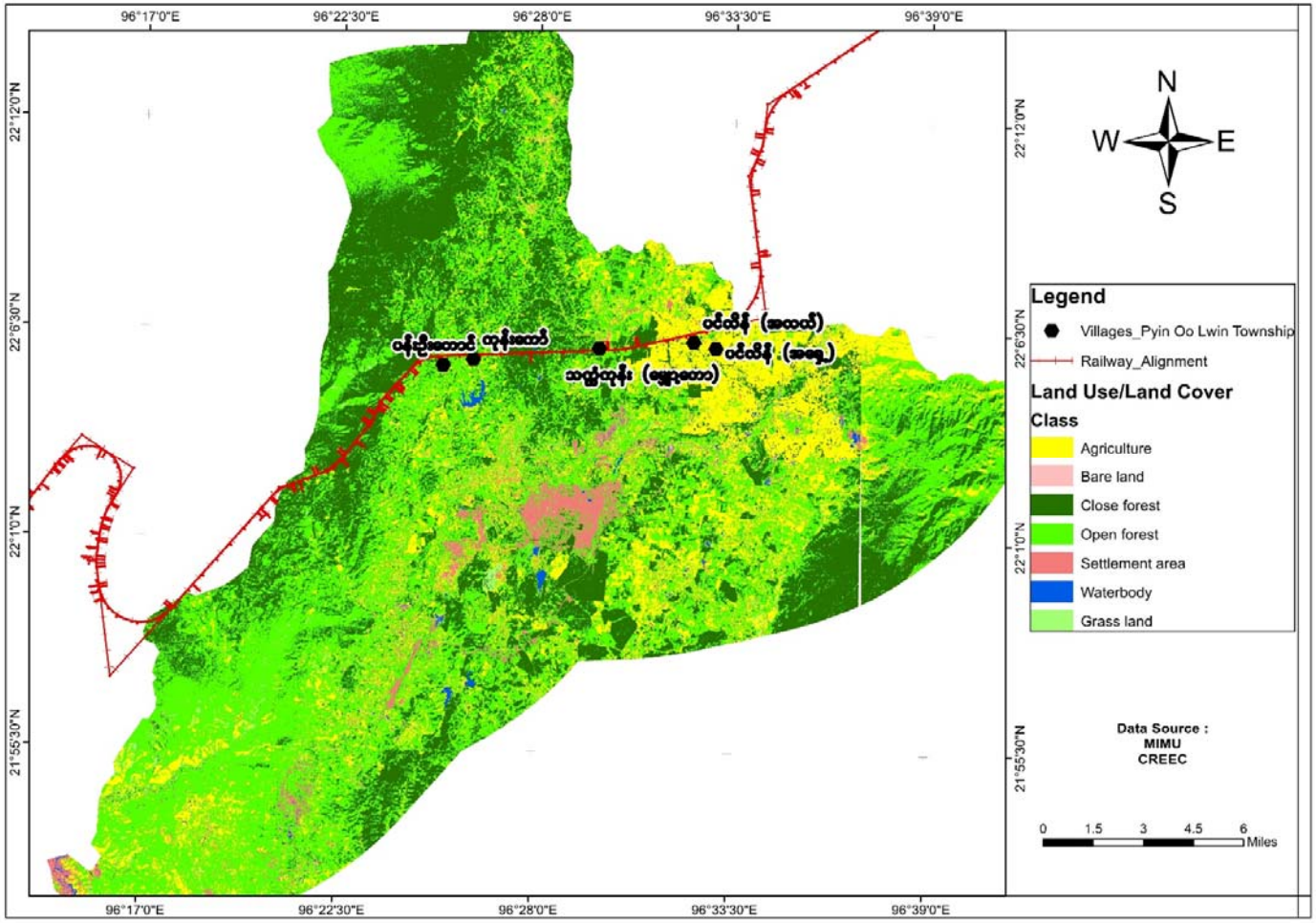


Figure 4.7 - Land Use Map of Pyin-Oo-Lwin Township (Source: EGT EIA Team, 2019)

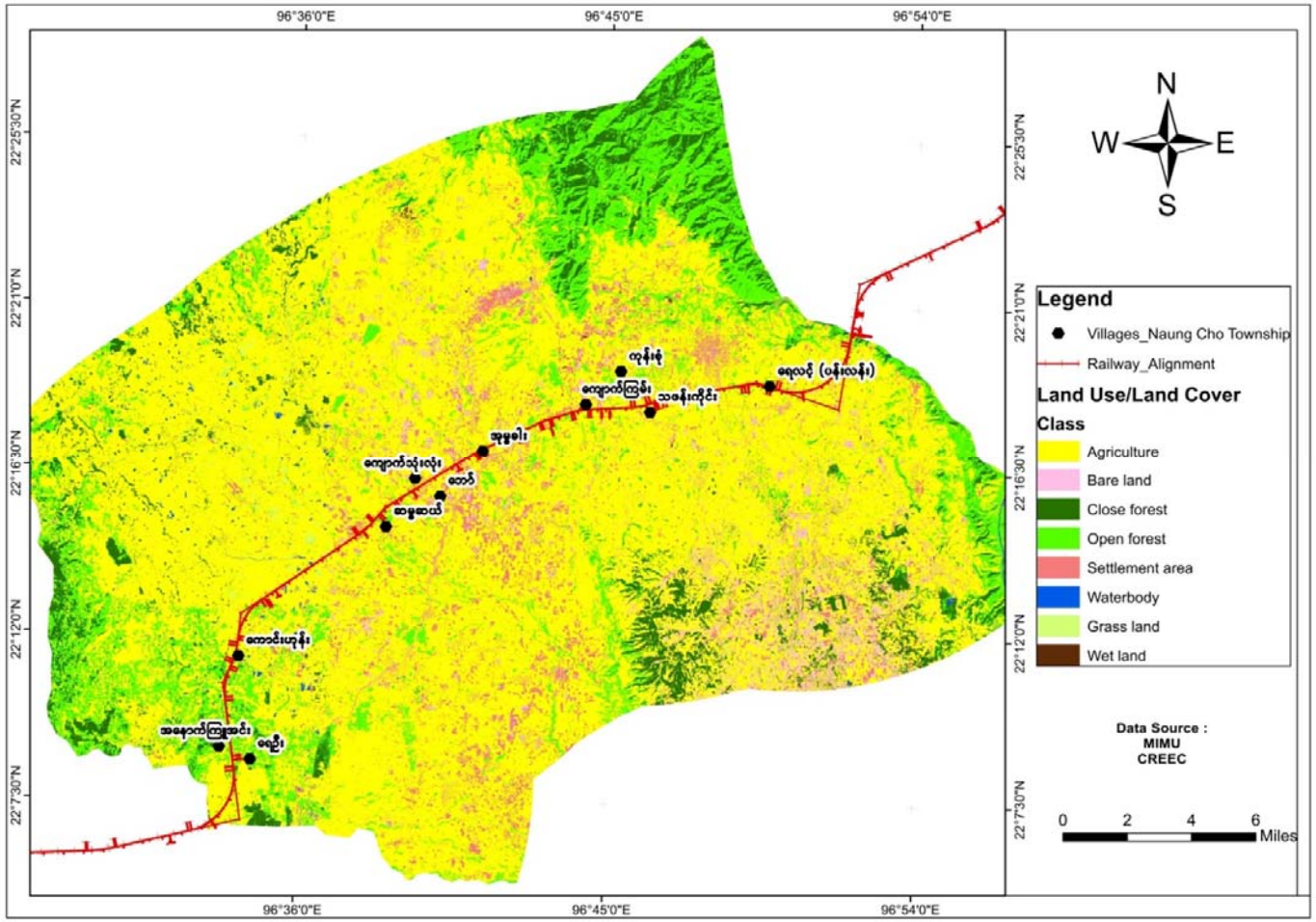


Figure 4.8 - Land Use Map of Naung Cho Township (Source: EGT EIA Team, 2019)

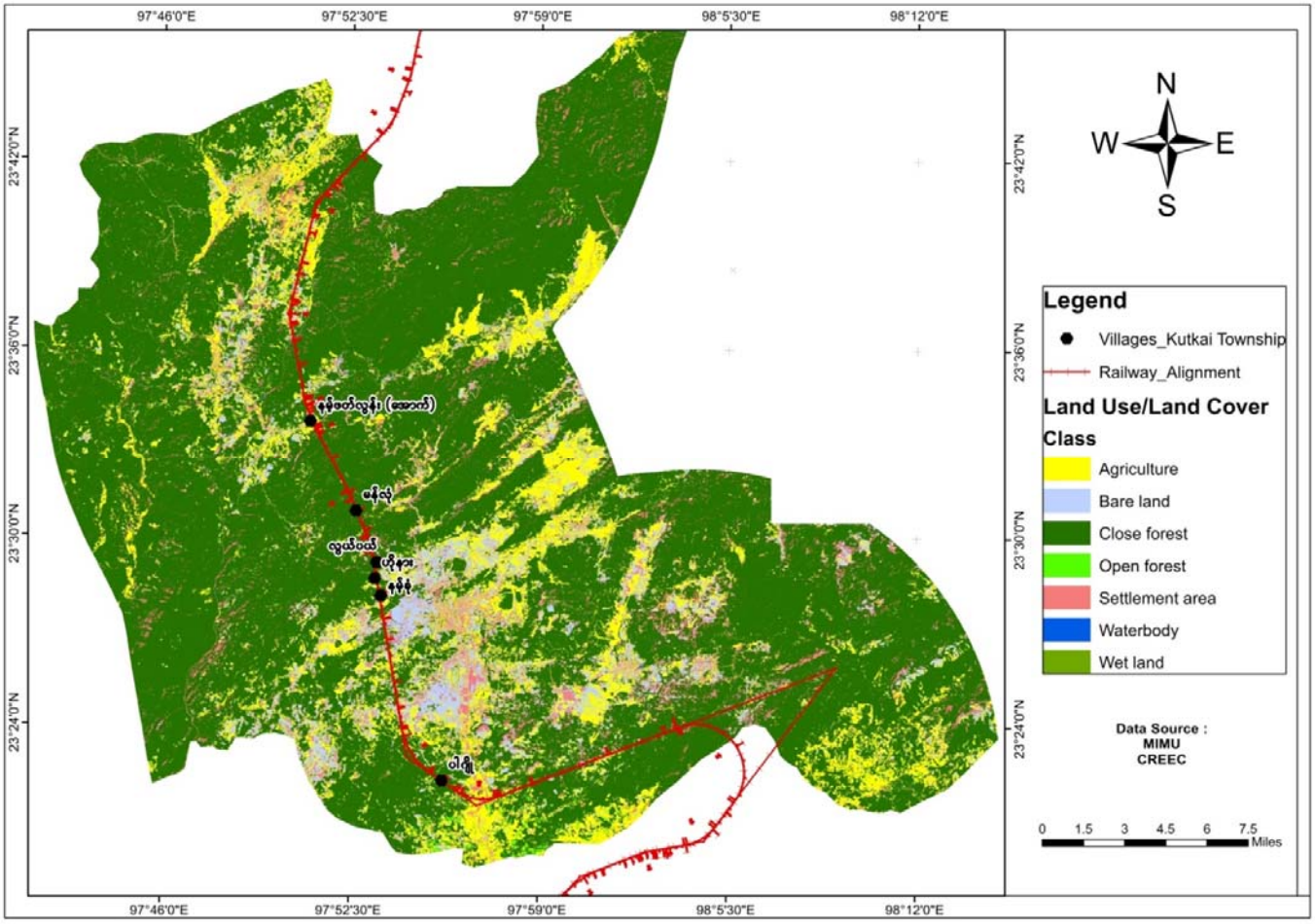


Figure 4.9- Land Use Map of Kutkai Township (Source: EGT EIA Team, 2019)

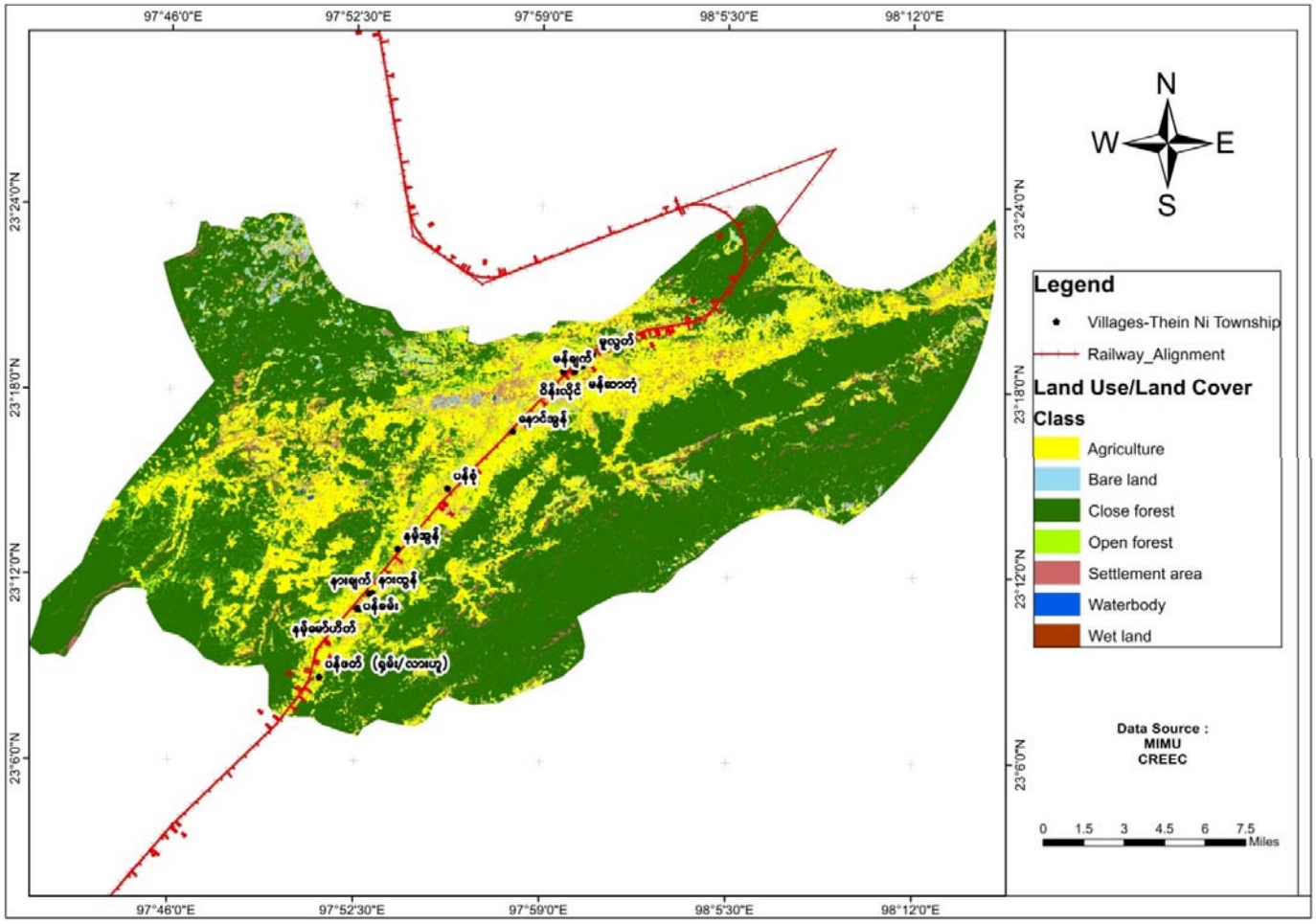


Figure 4.10- Land Use Map of Thein Ni Township (Source: EGT EIA Team, 2019)

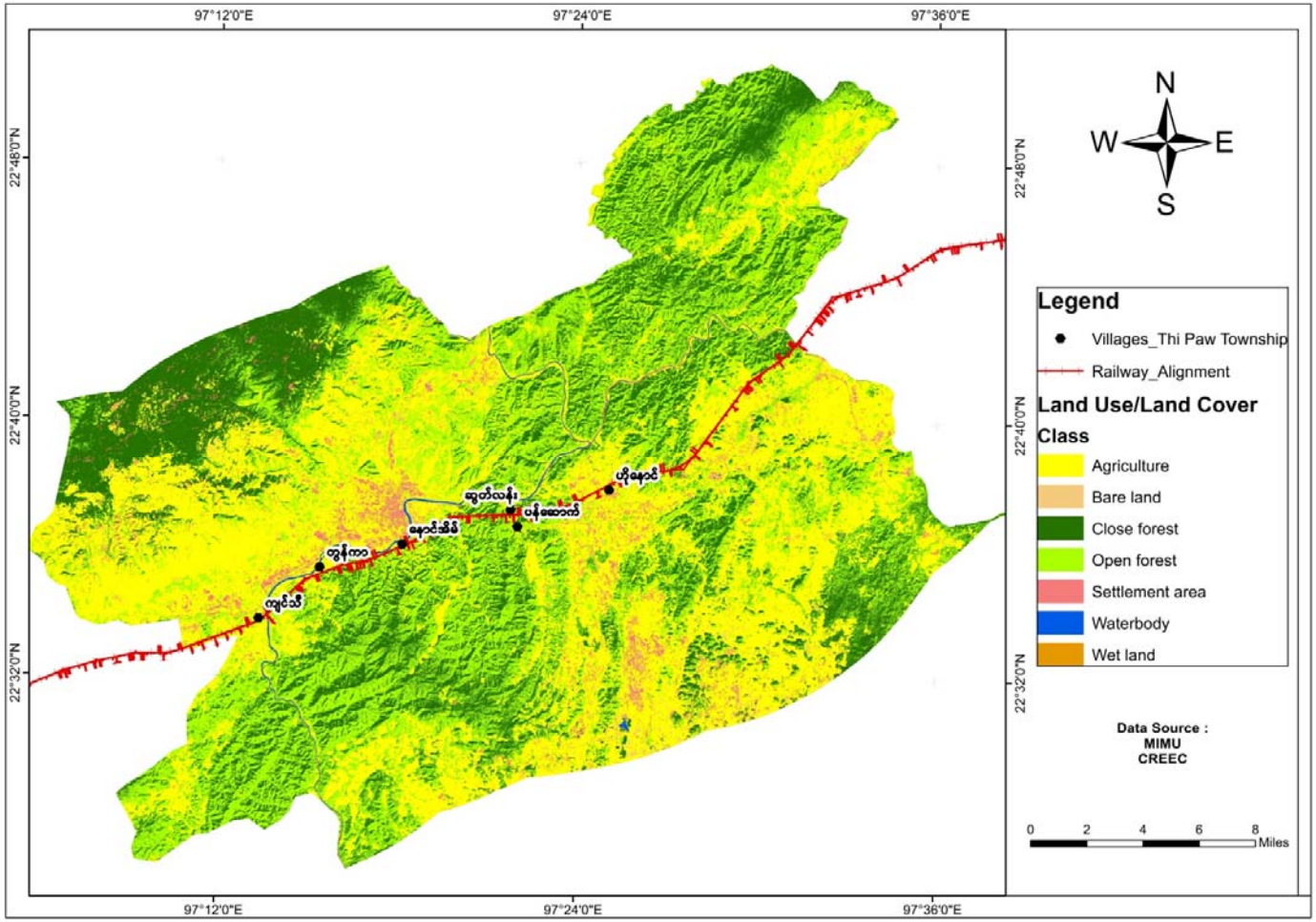


Figure 4.11 - Land Use Map of Thi Paw Township (Source: EGT EIA Team, 2019)

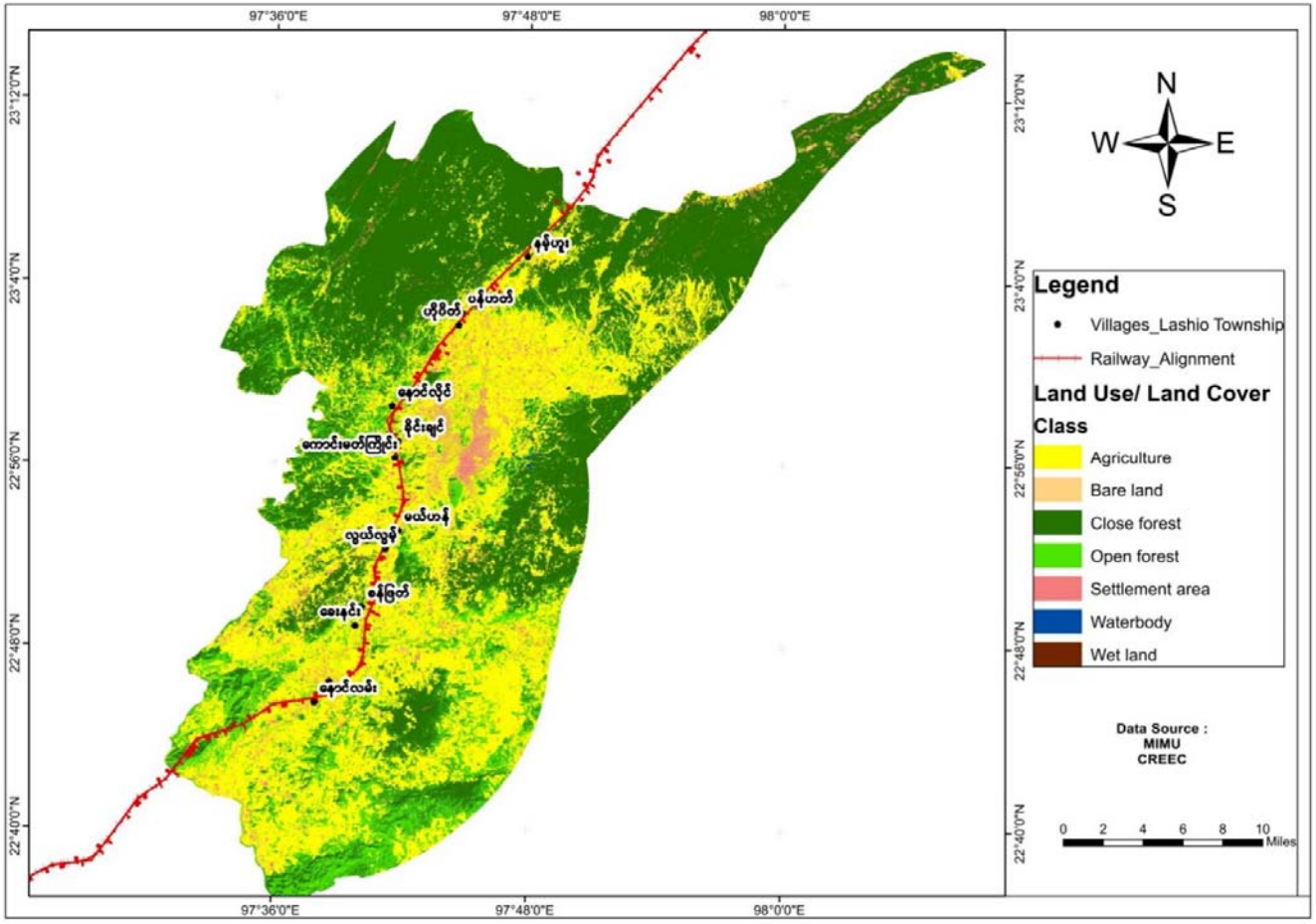


Figure 4.12- Land Use Map of Lashio Township (Source: EGT EIA Team, 2019)

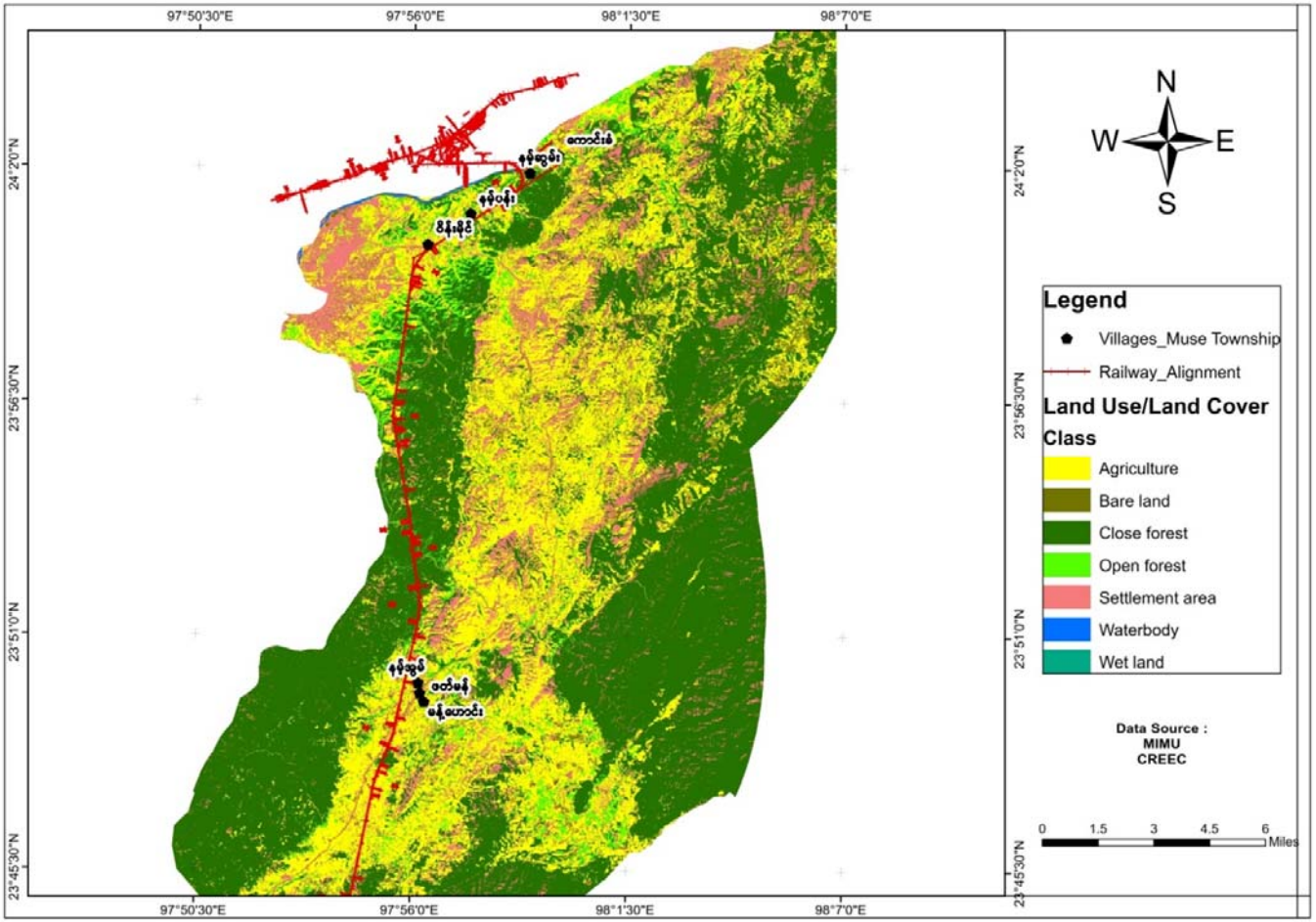
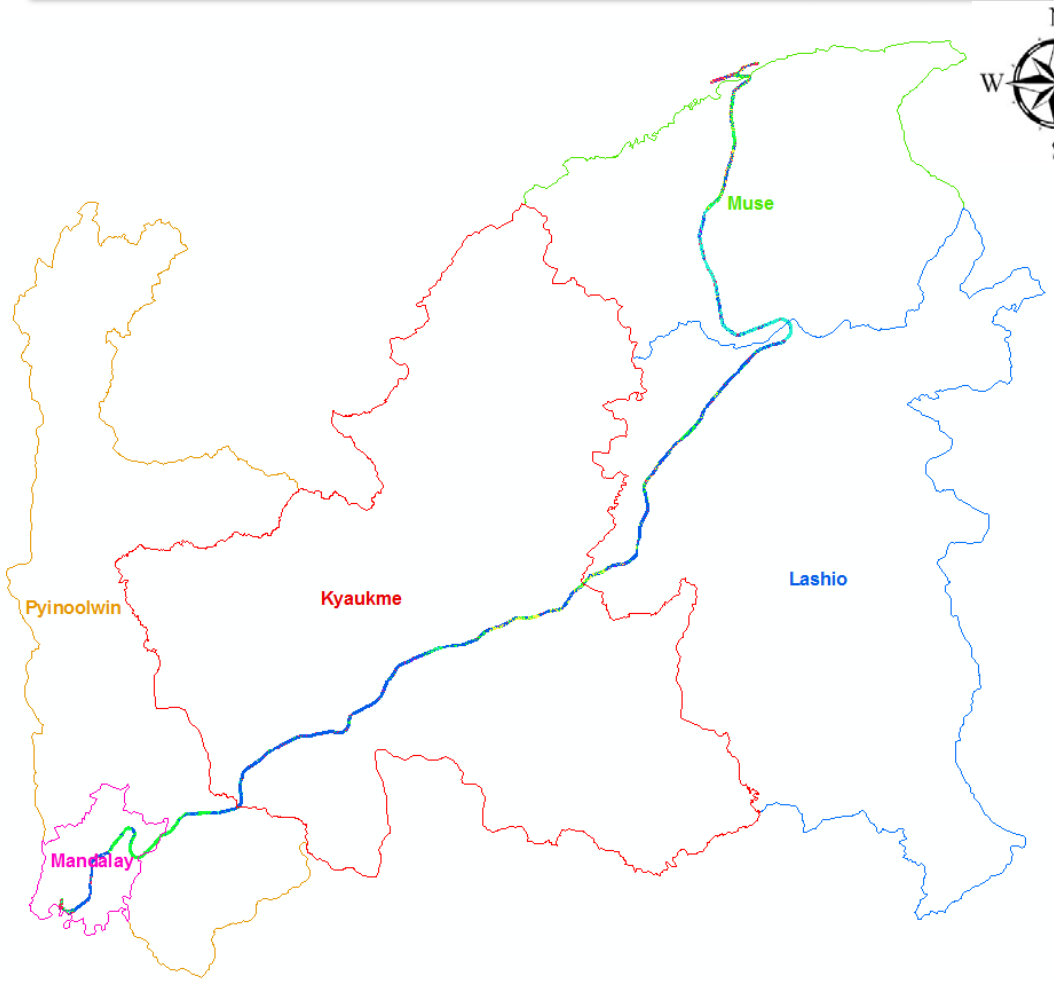


Figure 4.13- Land Use Map of Muse Township (Source: EGT EIA Team, 2019)

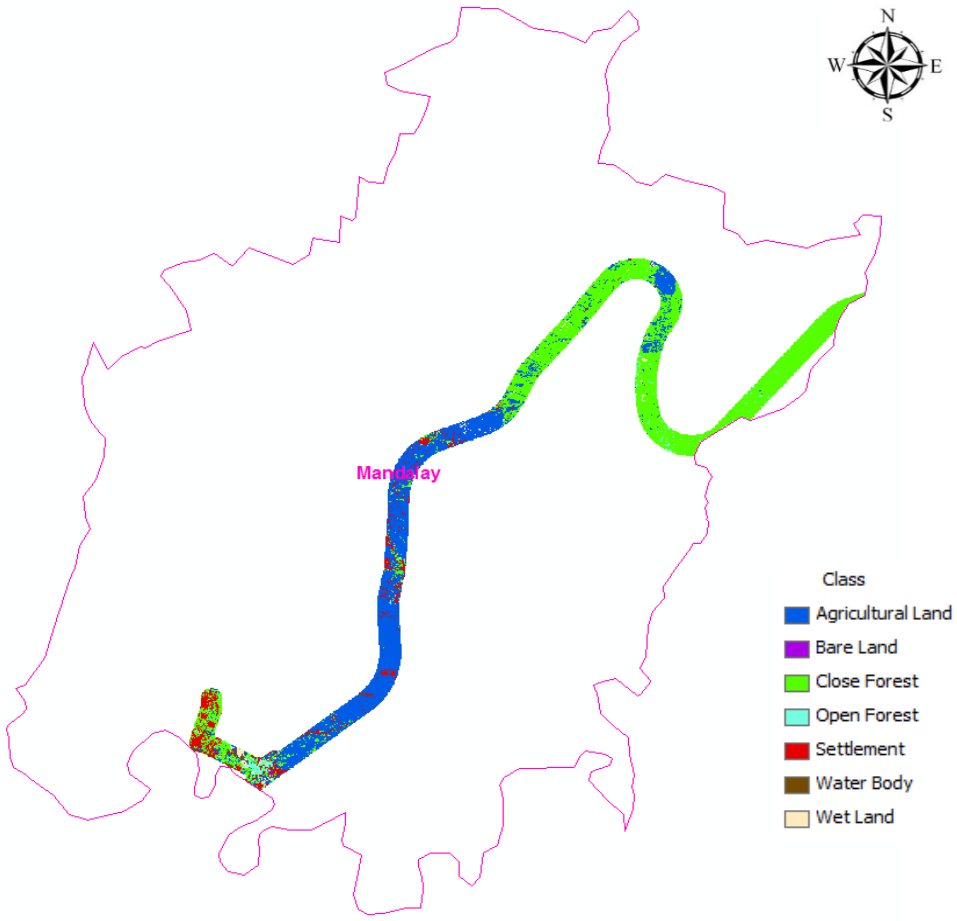


Class
- Agricultural Land
- Bare Land
- Close Forst
- Grass Land
- Open Forest
- Settlement Area
- Spars Vegetation
- Water Body
- Wet Land

No	Class	Area (Km²)	Area (Km²)	Area (Percentage)
1	Agricultural Land	218.9486	416.0773	52.622097
2	Bare Land	4.9292		1.184684
3	Open Forest	91.777		22.057680
4	Close Forest	44.8061		10.768696
5	Settlement	23.622		5.677310
6	Water Body	1.5959		0.383799
7	Wet Land	1.1969		0.287663
8	Grass Land	0.02		0.004807
9	Sparse Vegetation	29.1806		7.013264

Figure 4.14- Land Use Map for Mandalay, Kyaukme, Lashio, and Muse District (0.5 km Buffer from the center line of Rail Track)

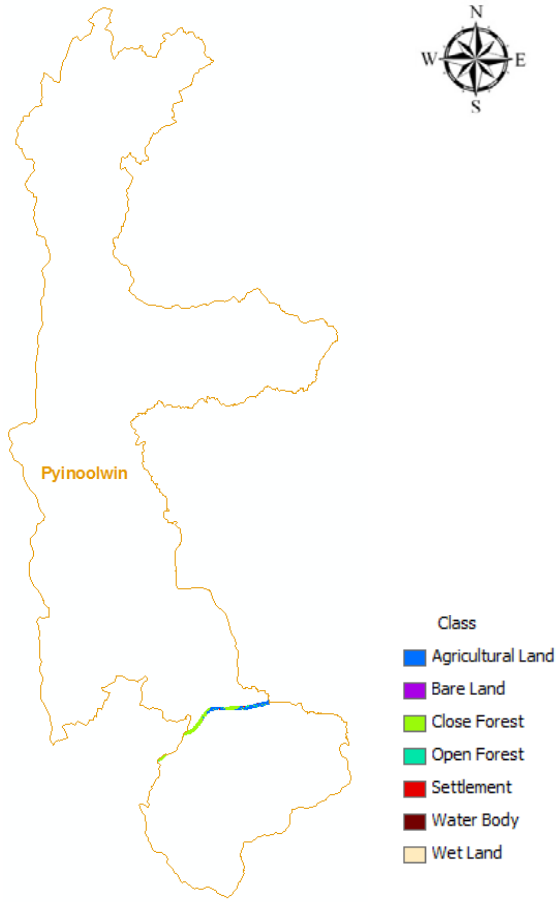
Mandalay



Land Use and Land Cover Classes
(Mandalay)
(0.5 Km Buffer from the center line of Rail Track)

No.	Class	Area (Km²)	Area (Km²)	Aera (Percentage)
1	Agricultural Land	22.6825	57.378	39.531702
2	Bare Land	0.0189		0.032939
3	Close Forest	1.3017		2.26864
4	Open Forest	28.0213		48.836314
5	Settlement	4.0577		7.071874
6	Water Body	0.484		0.843529
7	Wet Land	0.8119		1.415002

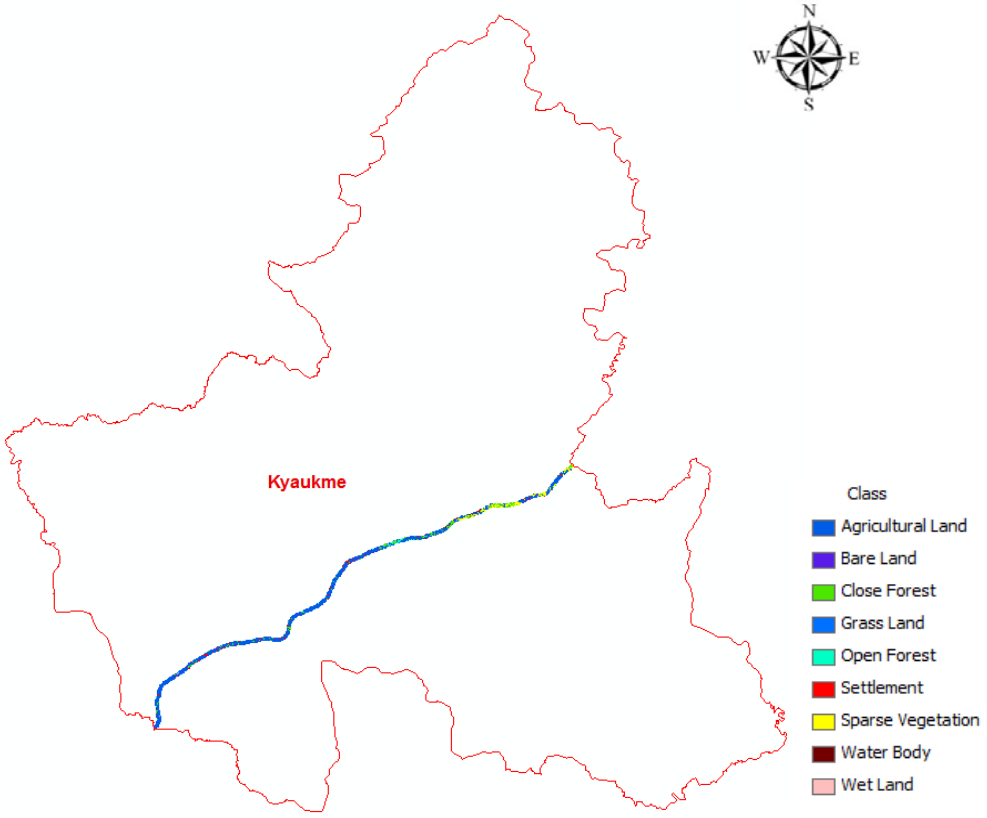
Pyin Oo Lwin



Land Use and Land Cover Classes (Pyinoolwin)
(0.5 Km Buffer from the center line of Rail Track)

No.	Class	Area (Km²)	Area (Km²)	Aera (Percentage)
1	Agricultural Land	10.7549	26.3511	40.813856
2	Bare Land	0.1014		0.384804
3	Close Forest	1.5038		5.706783
4	Open Forest	13.5042		51.247197
5	Settlement	0.3132		1.188565
6	Water Body	0.0683		0.259192
7	Wet Land	0.1053		0.399604

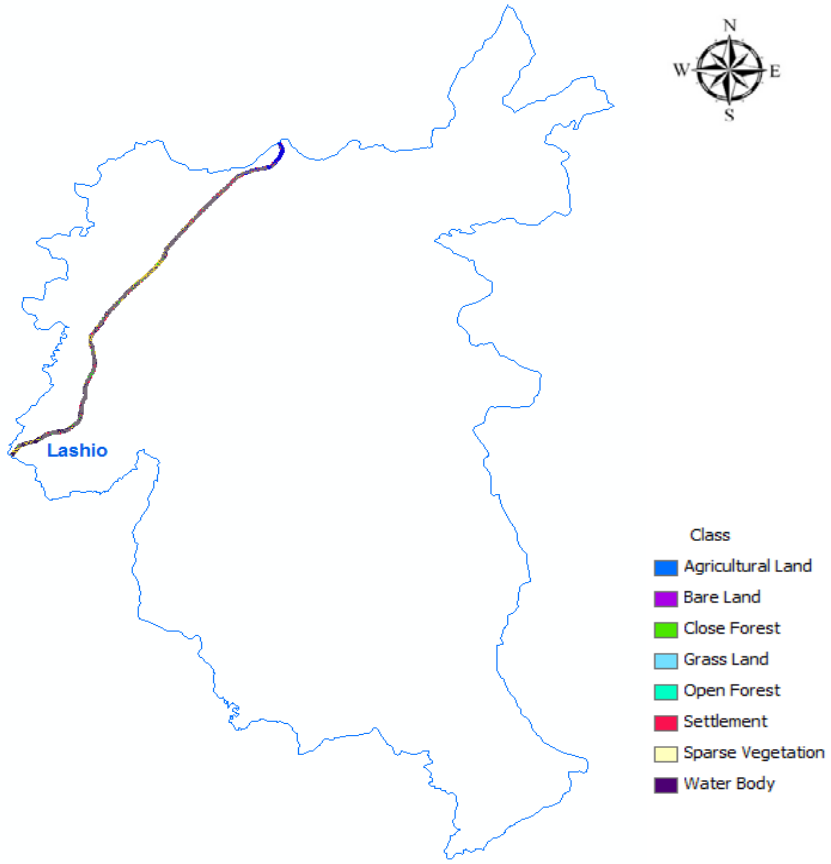
Kyaukme District (Hsipaw, Kyaukme, Nawng Hkio)



Land Use and Land Cover Classes (Kyaukme)
(0.5 Km Buffer from the center line of Rail Track)

No.	Class	Area (Km²)	Area (Km²)	Aera (Percentage)
1	Agricultural Land	91.9455	129.2438	71.14113
2	Bare Land	1.7473		1.351941
3	Open Forest	2.7178		2.102847
4	Close Forest	14.355		11.106916
5	Settlement	6.1426		4.752723
6	Water Body	0.8569		0.663011
7	Wet Land	0.2797		0.216413
8	Grass Land	0.0144		0.011142
9	Sparse Vegetation	11.1846		8.653877

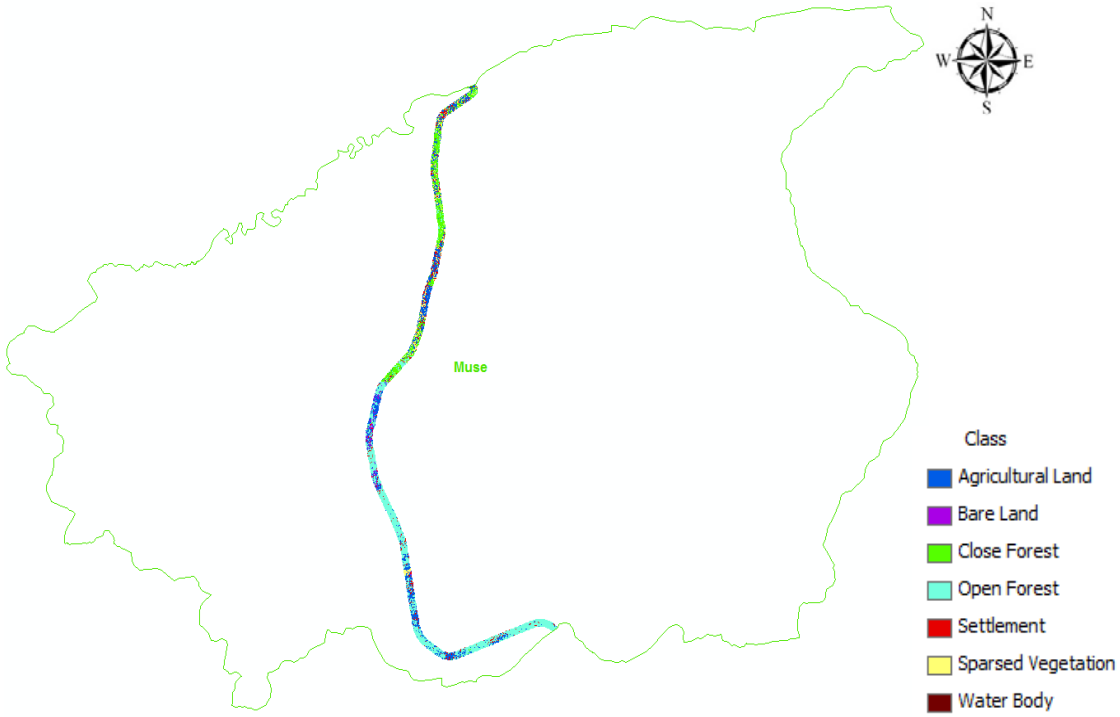
Lashio District (Theinni, Lashio)



Land Use and Land Cover Classes (Lashio)
(0.5 Km Buffer from the center line of Rail Track)

No.	Class	Area (Km²)	Area (Km²)	Aera (Percentage)
1	Agricultural Land	68.4583	104.2603	65.660947
2	Bare Land	1.1145		1.068959
3	Open Forest	7.5834		7.273526
4	Close Forest	11.8144		11.331638
5	Settlement	5.2443		5.030007
6	Water Body	0.0796		0.076347
7	Grass Land	0.0056		0.005371
8	Sparse Vegetation	9.9602		9.553205

Muse District (Muse, Kutkai, Nam Hpak Ka)

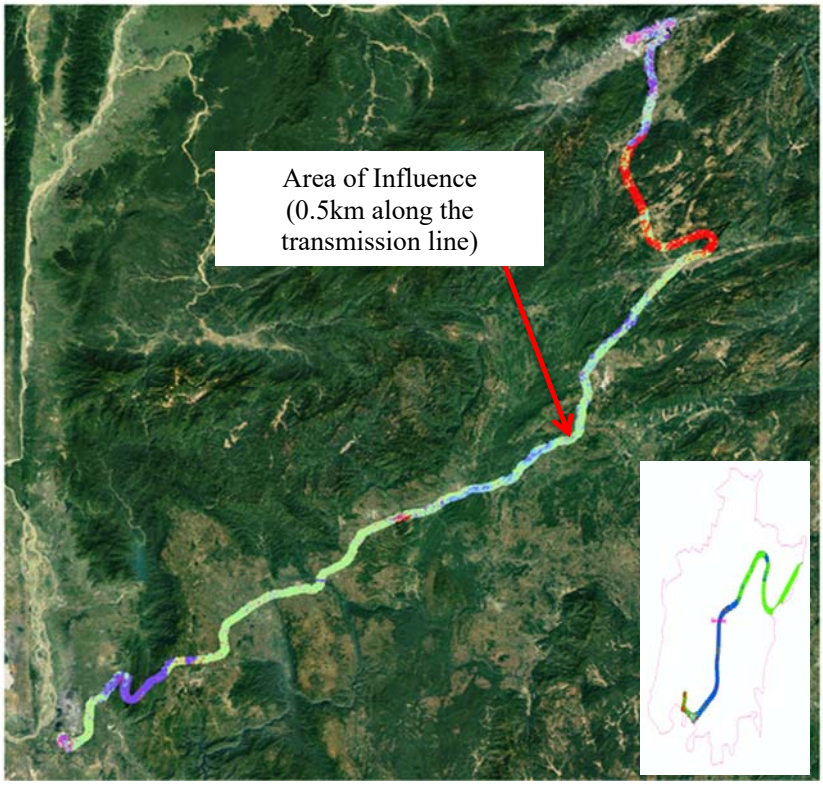


Land Use and Land Cover Classes (Muse)
(0.5 Km Buffer from the center line of Rail Track)

No.	Class	Area (Km²)	Area (Km²)	Aera (Percentage)
1	Agricultural Land	25.1074	98.8441	25.40101
2	Bare Land	1.9471		1.96987
3	Open Forest	39.9503		40.417486
4	Close Forest	15.8312		16.016333
5	Settlement	7.8642		7.956165
6	Water Body	0.1081		0.109364
7	Sparse Vegetation	8.0358		8.129772

(b) Area Calculation of LULC

Area calculation of classified LULC classes are based on buffer width 0.5 km around rail track centerline. According to the above land use classification by using GIS study, the land use types are as follow:



No	Class	Area (Km^2)	Area (Km^2)	Area (Percentage)
1	Agricultural Land	218.9486	416.0773	52.622097
2	Bare Land	4.9292		1.184684
3	Open Forest	91.777		22.057680
4	Close Forest	44.8061		10.768696
5	Settlement	23.622		5.677310
6	Water Body	1.5959		0.383799
7	Wet Land	1.1969		0.287663
8	Grass Land	0.02		0.004807
9	Sparse Vegetation	29.1806		7.013264

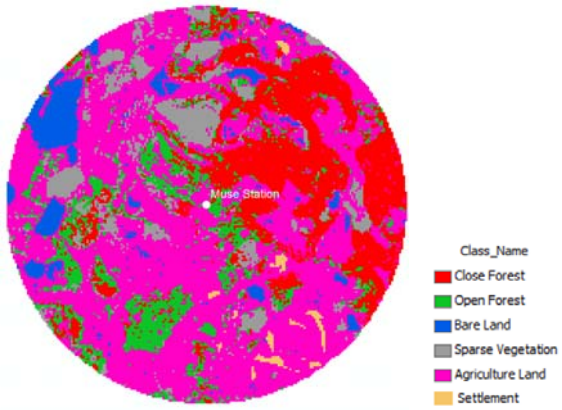
According to this table, the most land use types are agricultural land (52%), forest area (32%), settlement area (5%) and vegetation area (7%). The rest are water body (0.3%), bare and grass land (1.1%) and wet land (0.2%).

4.4.6. Land Use Land Cover (LULC) Classes of Railway Stations

The followings are the LULC classes of railway stations.

No.	Stations	No.	Stations
1	Muse Station	19	San Lau Station
2	Pang Kham Station	20	Kong Tha Station
3	Man Hawng Station	21	Hsipaw Station
4	Na Hpai Station	22	Hsipaw South Station
5	Nan Hpak Ka Station	23	Chaung Chauk Station
6	Pangnin Station	24	Kyaukme Station
7	Kutkai Station	25	Myin Gwin Station
8	Mang Peng Station	26	Namban Ton River Station
9	Nawng Yen Station	27	Nawng Hkio Station
10	Laban Pa Station	28	Om Maka Station
11	Theinni Station	29	Gangaw Station
12	Sam Lou Station	30	Pyinoolwin Station
13	Hang Lu Station	31	Sin Byu In Station
14	Lashio North Station	32	Sakangyi Station
15	Lashio West Station	33	Taung Kyun Station
16	Mehan Station	34	Tok Hka Taung Station
17	Nam Un Station	35	Mandalay East Station
18	Sint Eng Station	36	Mandalay South Station

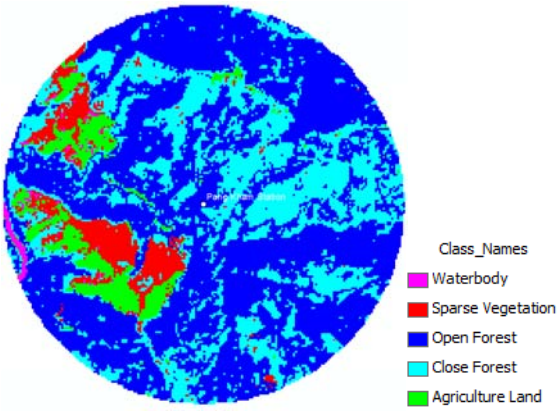
1_Muse Station



Area of LULC Classes (1Km Buffer Around Muse Station)

Classes	Area (Km²)	Area (%)
Close Forest	0.6594	20.69163
Open Forest	0.359	11.26523
Bare Land	0.1673	5.249787
Sparse Vegetation	0.3069	9.630362
Agriculture Land	1.65	51.77614
Settlement	0.044196	1.386847

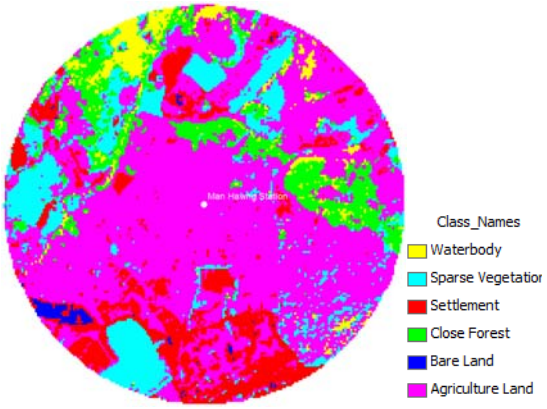
2_Pang Kham Station



Area of LULC Classes (1Km Buffer Around Pang Kham Station)

Classes	Area (Km²)	Area (%)
Waterbody	0.0252	0.795053
Sparse Vegetation	0.195	6.152196
Open Forest	1.7987	56.748486
Close Forest	0.9708	30.62847
Agriculture Land	0.1799	5.675795

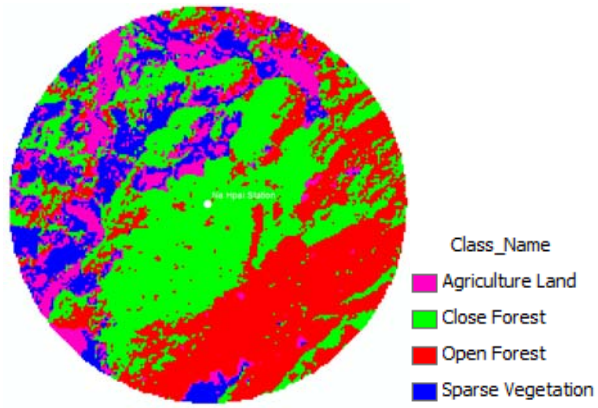
3_Man Hawng Station



Area of LULC Classes (1Km Buffer Around Man Hawng Station)

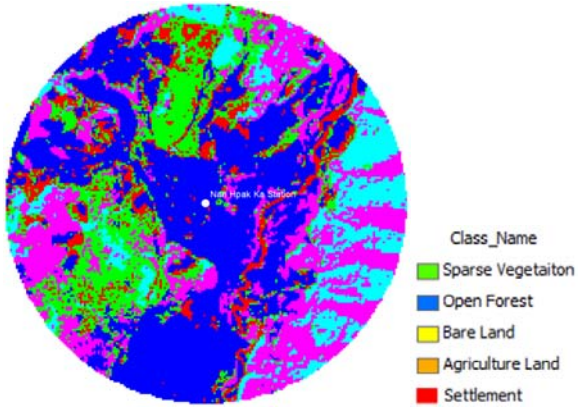
Classes	Area (Km²)	Area (%)
Agriculture Land	1.807	57.039141
Bare Land	0.0239	0.754419
Close Forest	0.3235	10.21149
Settlement	0.4246	13.402778
Waterbody	0.1386	4.375
Sparse Vegetation	0.4504	14.217172

4_Na Hpai Station



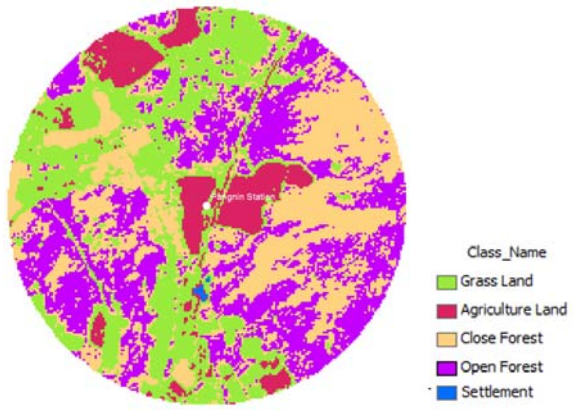
Area of LULC Classes (1Km Buffer Around Na Hpai Station)		
Classes	**Area (Km²)**	**Area (%)**
Agriculture Land	0.4381	13.824987
Open Forest	1.0705	33.781438
Close Forest	1.2454	39.300704
Sparse Vegetation	0.4149	13.092871

5_Nan Hpak Ka Station



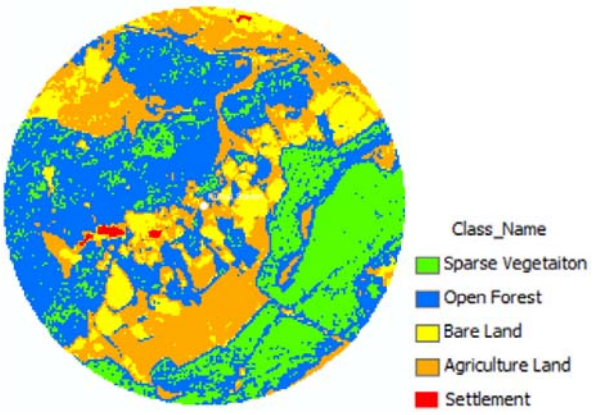
Area of LULC Classes (1Km Buffer Around Nan Hpak Ka Station)		
Classes	**Area (Km²)**	**Area (%)**
Water Body	0.2979	9.392143
Bare Land	0.5408	17.050255
Agriculture Land	1.1528	36.345293
Close Forest	0.4044	12.749858
Open Forest	0.7759	24.46245

6_Pangnin Station



Area of LULC Classes (1Km Buffer Around Pangnin Station)		
Classes	**Area (Km²)**	**Area (%)**
Grass Land	0.8628	27.18465
Agriculture Land	0.2912	9.174977
Close Forest	1.0924	34.41877
Open Forest	0.921	29.01838
Settlement	0.00645	0.203223

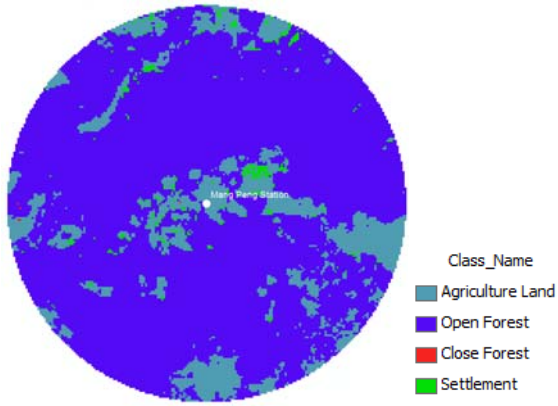
7_Kutkai Station



Area of LULC Classes (1Km Buffer Around Kutkai Station)

Classes	Area (Km^2)	Area (%)
Sparse Vegetation	0.6904	21.73886
Open Forest	1.316	41.43733
Bare Land	0.3641	11.46454
Agriculture Land	0.7943	25.01039
Settlement	0.01108	0.34888

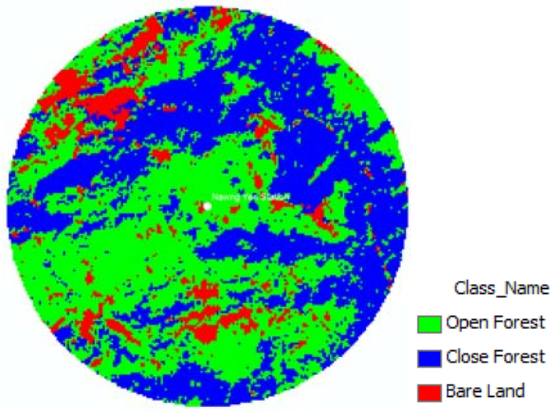
8_Mang Peng Station



Area of LULC Classes (1Km Buffer Around Mang Peng Station)

Classes	Area (Km^2)	Area (%)
Agriculture Land	0.4926	15.679908
Open Forest	2.6067	82.973644
Close Forest	0.0005	0.015915
Settlement	0.0418	1.330532

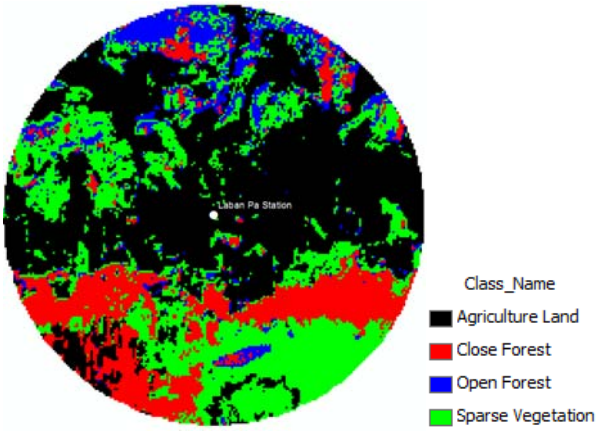
9_Nawng Yen Station



Area of LULC Classes (1Km Buffer Around Nawng Yen Station)

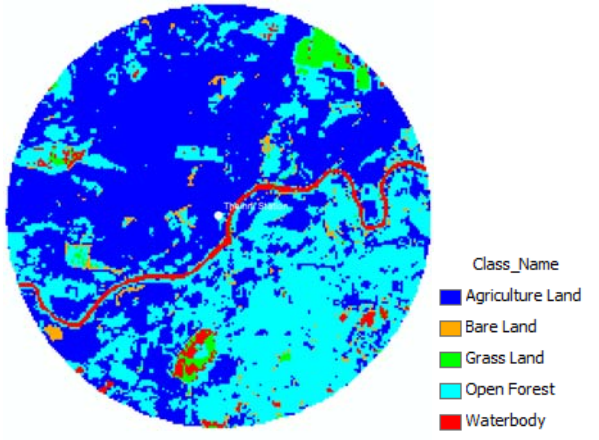
Classes	Area (Km^2)	Area (%)
Open Forest	1.5333	48.361457
Close Forest	1.3272	41.860905
Bare Land	0.31	9.777638

10_Laban Pa Station



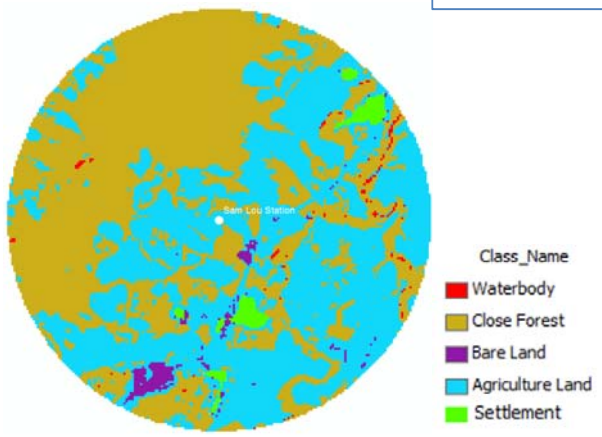
Area of LULC Classes (1Km Buffer Around Laban Pa Station)		
Classes	**Area (Km²)**	**Area (%)**
Agriculture Land	1.5259	48.141721
Close Forest	0.5064	15.976779
Sparse Vegetation	0.874	27.574457
Open Forest	0.2633	8.307042

11_Theinni Station



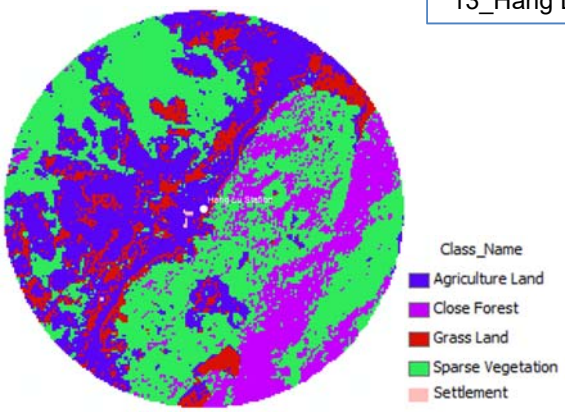
Area of LULC Classes (1Km Buffer Around Theinni Station)		
Classes	**Area (Km²)**	**Area (%)**
Bare Land	0.0624	1.968454
Waterbody	0.0907	2.861199
Grass Land	0.0727	2.293375
Agriculture Land	1.3986	44.119874
Open Forest	1.5456	48.757098

12_Sam Lou Station



Area of LULC Classes (1Km Buffer Around Sam Lou Station)		
Classes	**Area (Km²)**	**Area (%)**
Waterbody	0.0139	0.43685
Close Forest	1.6029	50.3773
Bare Land	0.0409	1.285451
Agriculture Land	1.4633	45.99023
Settlement	0.060727	1.909727

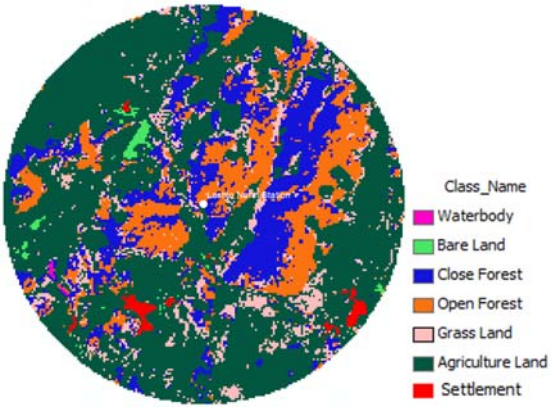
13_Hang Lu Station



Area of LULC Classes (1Km Buffer Around Hang Lu Station)

Classes	Area (Km^2)	Area (%)
Close Forest	0.5448	17.16724
Sparse Vegetation	1.3352	42.07359
Grass Land	0.3308	10.42386
Agriculture Land	0.9579	30.18446
Settlement	0.004787	0.150844

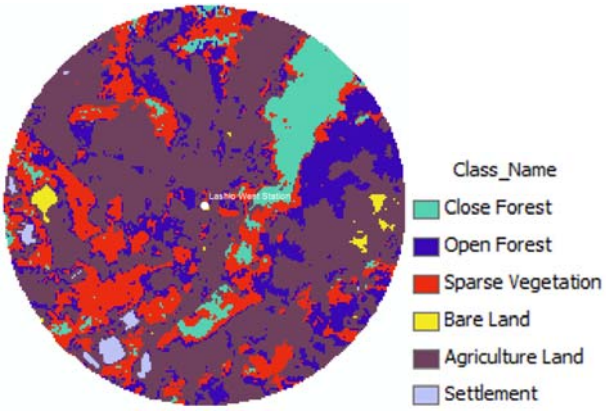
14_Lashio North Station



Area of LULC Classes (1Km Buffer Around Lashio North Station)

Classes	Area (Km^2)	Area (%)
Waterbody	0.0025	0.07855
Bare Land	0.0226	0.710093
Close Forest	0.5466	17.17421
Open Forest	0.4624	14.52864
Grass Land	0.2836	8.910729
Agriculture Land	1.8192	57.15938
Settlement	0.04578	1.43841

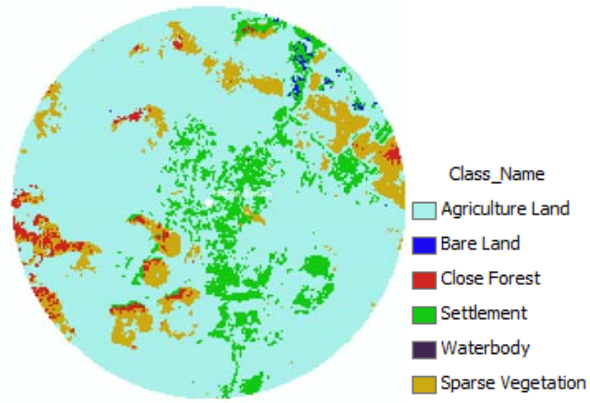
15_Lashio West Station



Area of LULC Classes (1Km Buffer Around Lashio West Station)

Classes	Area (Km^2)	Area (%)
Close Forest	0.2558	8.042169
Open Forest	0.609	19.14652
Sparse Vegetation	0.6327	19.89164
Bare Land	0.0249	0.782838
Agriculture Aland	1.613	50.71157
Settlement	0.045334	1.425269

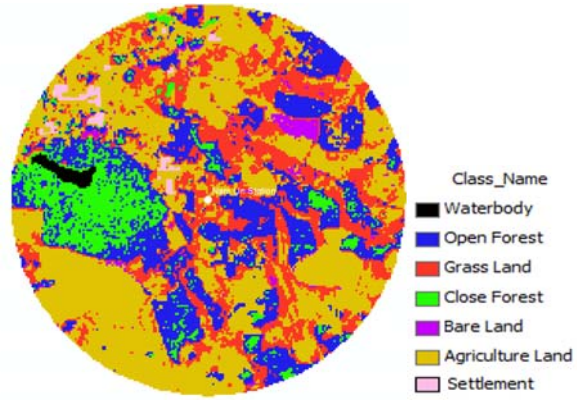
16_Mehan Station



Area of LULC Classes (1Km Buffer Around Mehan Station)

Classes	Area (Km^2)	Area (%)
Agriculture Land	2.4314	77.423258
Bare Land	0.009	0.286588
Close Forest	0.0611	1.945612
Settlement	0.3353	10.676984
Waterbody	0.0001	0.003184
Sparse Vegetation	0.3035	9.664374

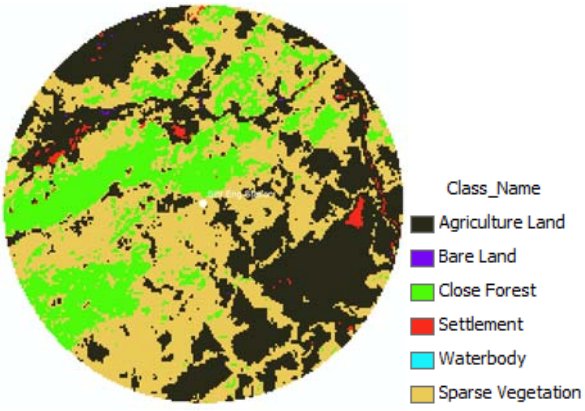
17_Nam Un Station



Area of LULC Classes (1Km Buffer Around Nam Un Station)

Classes	Area (Km^2)	Area (%)
Waterbody	0.0215	0.676121
Close Forest	0.2902	9.126059
Open Forest	0.7098	22.32142
Bare Land	0.0493	1.550361
Grass Land	0.723	22.73653
Agriculture Land	1.3555	42.62706
Settlement	0.030605	0.96245

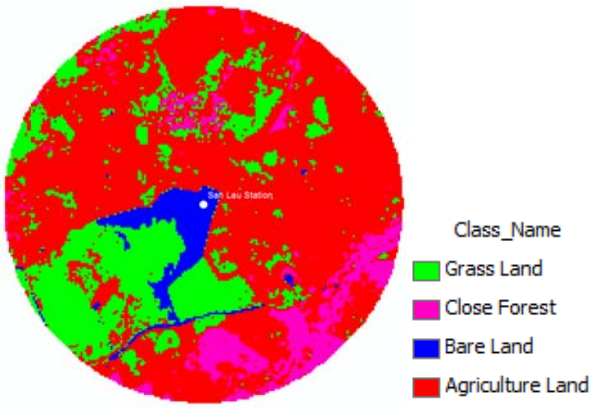
18_Sint Eng Station



Area of LULC Classes (1Km Buffer Around Sint Eng Station)

Classes	Area (Km^2)	Area (%)
Agriculture Land	1.1278	35.894335
Bare Land	0.002	0.063654
Close Forest	0.6088	19.376194
Settlement	0.0283	0.9007
Waterbody	0.0001	0.003183
Sparse Vegetation	1.375	43.761935

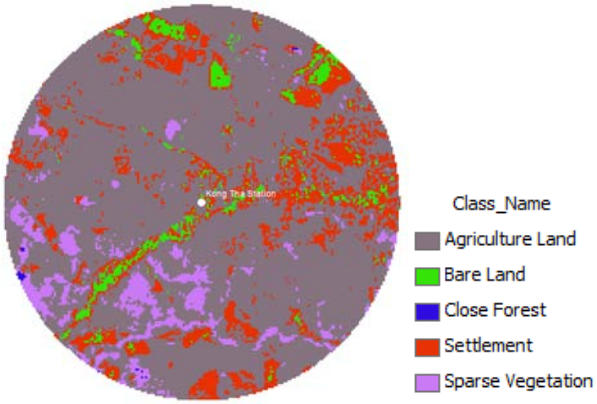
19_San Lau Station



Area of LULC Classes (1Km Buffer Around San Lau Station)

Classes	Area (Km^2)	Area (%)
Grass Land	0.7052	22.257993
Close Forest	0.2711	8.556639
Bare Land	0.1393	4.39668
Agriculture Land	2.0527	64.788688

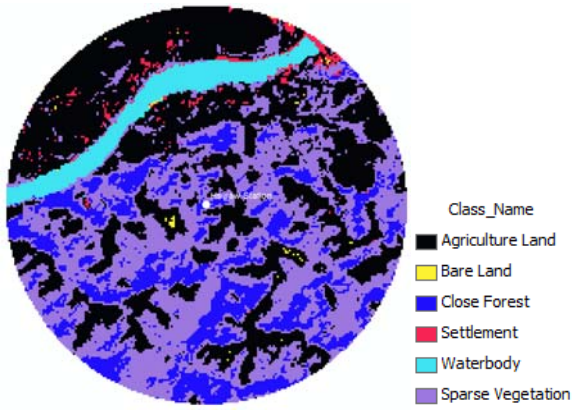
20_Kong Tha Station



Area of LULC Classes (1Km Buffer Around Kong Tha Station)

Classes	Area (Km^2)	Area (%)
Agriculture Land	2.3335	74.289262
Bare Land	0.103	3.279106
Close Forest	0.0026	0.082774
Settlement	0.4867	15.494572
Sparse Vegetation	0.2153	6.854287

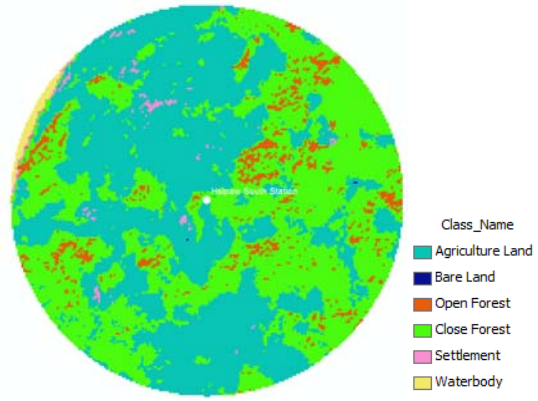
21_Hsipaw Station



Area of LULC Classes (1Km Buffer Around Hsipaw Station)

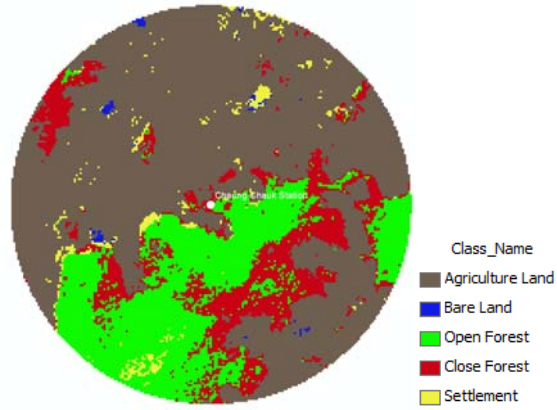
Classes	Area (Km^2)	Area (%)
Agriculture Land	1.2541	39.914067
Bare Land	0.0051	0.162317
Close Forest	0.5035	16.024825
Settlement	0.0428	1.36219
Waterbody	0.1753	5.579249
Sparse Vegetation	1.1612	36.957352

22_Hsipaw South Station



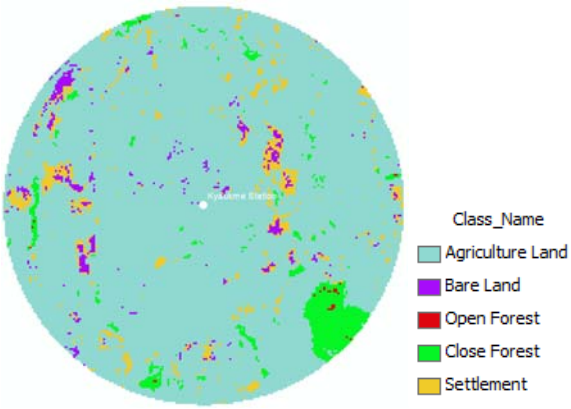
Area of LULC Classes (1Km Buffer Around Hsipaw South Station)		
Classes	**Area (Km²)**	**Area (%)**
Agriculture Land	1.5213	48.438246
Bare Land	0.0003	0.009552
Open Forest	0.1452	4.623173
Close Forest	1.4269	45.432547
Settlement	0.0258	0.821473
Waterbody	0.0212	0.675009

23_Chaung Chauk Station



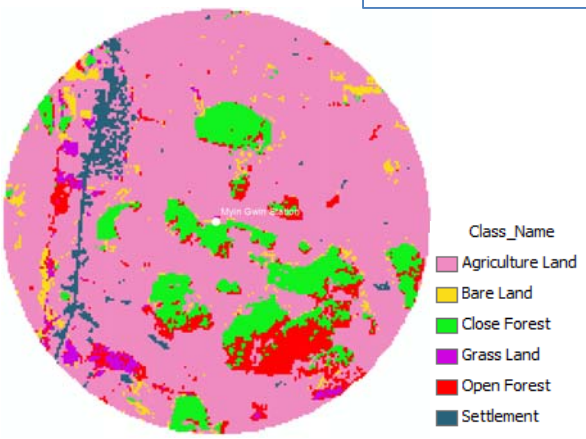
Area of LULC Classes (1Km Buffer Around Chaung Chauk Station)		
Classes	**Area (Km²)**	**Area (%)**
Agriculture Land	1.9211	61.152316
Bare Land	0.0121	0.385166
Open Forest	0.6939	22.088174
Close Forest	0.4474	14.241604
Settlement	0.067	2.132739

24_Kyaukme Station



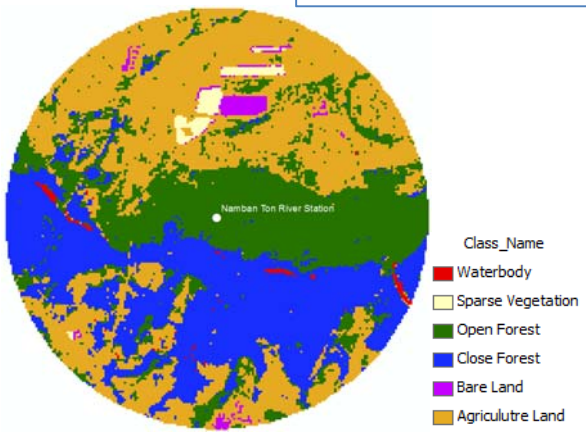
Area of LULC Classes (1Km Buffer Around Kyaukme Station)		
Classes	**Area (Km²)**	**Area (%)**
Agriculture Land	2.7971	89.054093
Bare Land	0.0615	1.958038
Open Forest	0.0029	0.09233
Close Forest	0.1319	4.199433
Settlement	0.1475	4.696106

25_Myin Gwin Station



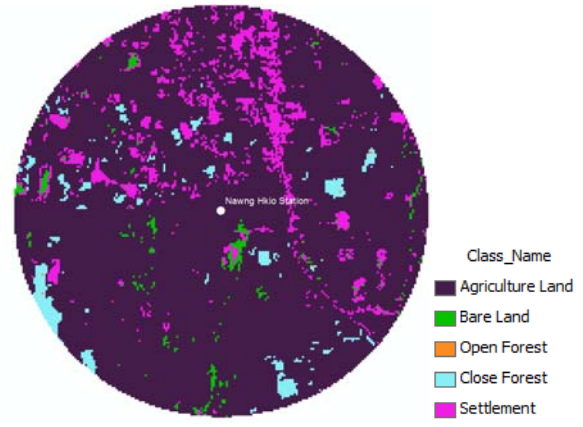
Area of LULC Classes (1Km Buffer Around Myin Gwin Station)		
Classes	**Area (Km^2)**	**Area (%)**
Agriculture Land	**2.3324**	**73.600505**
Bare Land	**0.0947**	**2.988324**
Close Forest	**0.3512**	**11.08236**
Grass Land	**0.0503**	**1.587251**
Open Forest	**0.2383**	**7.519722**
Settlement	**0.1021**	**3.221837**

26_Namban Ton River Station



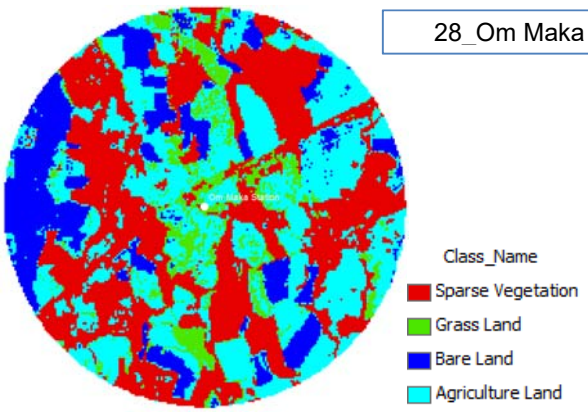
Area of LULC Classes (1Km Buffer Around Namban Ton River Station)		
Classes	**Area (Km^2)**	**Area (%)**
Waterbody	**0.0158**	**0.498627**
Sparse Vegetarian	**0.0408**	**1.287594**
Open Forest	**0.8546**	**26.970051**
Close Forest	**0.9152**	**28.882507**
Bare Land	**0.041**	**1.293906**
Agriculture Land	**1.3013**	**41.067315**

27_Nawng Hkio Station



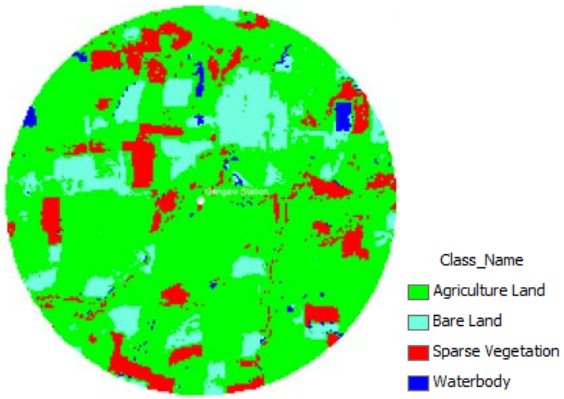
Area of LULC Classes (1Km Buffer Around Nawng Hkio Station)		
Classes	**Area (Km^2)**	**Area (%)**
Agriculture Land	**49.27101**	**87.628538**
Bare Land	**0.0429**	**1.365764**
Open Forest	**0.0007**	**0.022285**
Close Forest	**0.0915**	**2.912992**
Settlement	**0.2535**	**8.070421**

28_Om Maka Station



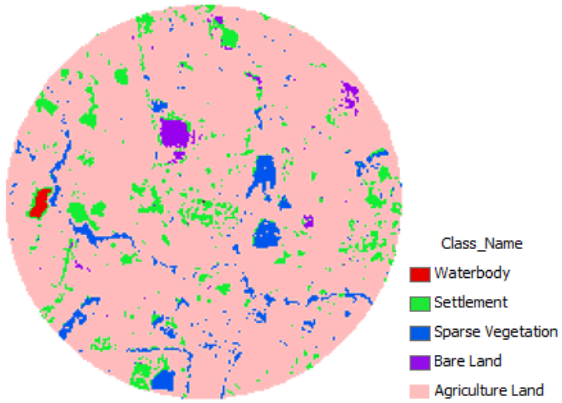
Area of LULC Classes (1Km Buffer Around Om Maka Station)		
Classes	**Area (Km²)**	**Area (%)**
Sparse Vegetation	**1.241**	**39.174216**
Grass Land	**0.2716**	**8.573503**
Bare Land	**0.5028**	**15.871713**
Agriculture Land	**1.1525**	**36.380568**

29_Gangaw Station



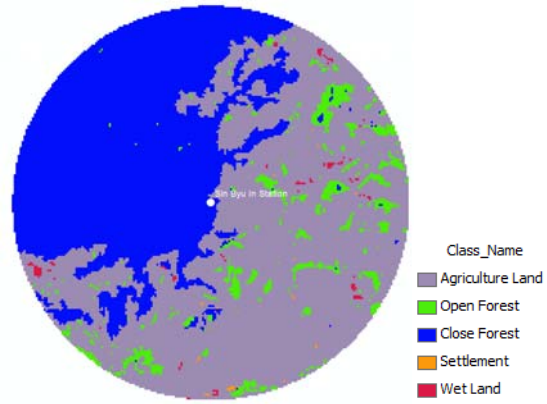
Area of LULC Classes (1Km Buffer Around Gangaw Station)		
Classes	**Area (Km²)**	**Area (%)**
Agriculture Land	**2.3052**	**72.716949**
Bare Land	**0.456**	**14.384404**
Sparse Vegetation	**0.3647**	**11.504369**
Waterbody	**0.0442**	**1.394278**

30_Pyinoolwin Station



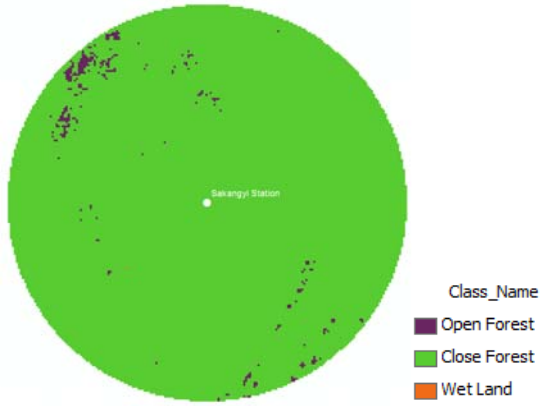
Area of LULC Classes (1Km Buffer Around Pyinoolwin Station)		
Classes	**Area (Km²)**	**Area (%)**
Waterbody	**0.0085**	**0.268181**
Settlement	**0.2236**	**7.05474**
Sparse Vegetation	**0.1385**	**4.369774**
Bare Land	**0.0387**	**1.221013**
Agriculture Land	**2.7602**	**87.086291**

31_Sin Byu In Station



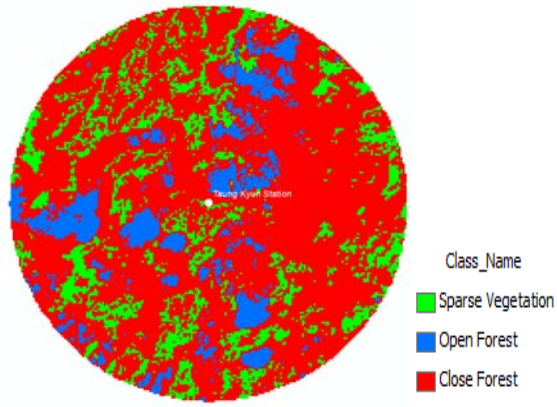
Area of LULC Classes (1Km Buffer Around Sin Byu In Station)		
Classes	**Area (Km²)**	**Area (%)**
Agriculture Land	**1.6817**	**53.536865**
Open Forest	**0.1589**	**5.058576**
Close Forest	**1.2844**	**40.888832**
Settlement	**0.003**	**0.095505**
Wet Land	**0.0132**	**0.420222**

32_Sakangyi Station



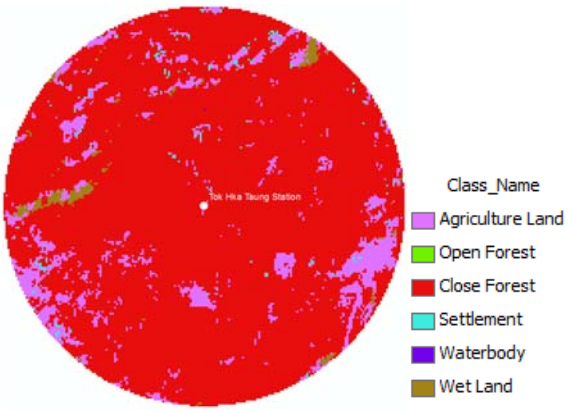
Area of LULC Classes (1Km Buffer Around Sakangyi Station)		
Classes	**Area (Km²)**	**Area (%)**
Open Forest	**0.0333**	**1.059565**
Close Forest	**3.1094**	**98.937253**
Wet Land	**0.0001**	**0.003182**

33_Taung Kyun Station



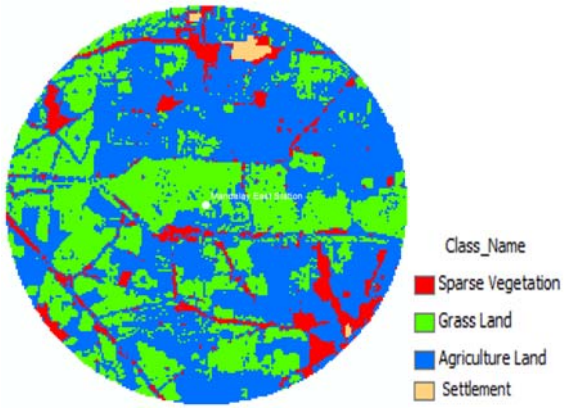
Area of LULC Classes (1Km Buffer Around Taung Kyun Station)		
Classes	**Area (Km²)**	**Area (%)**
Sparse Vegetation	**0.5436**	**17.167219**
Open Forest	**0.3191**	**10.077372**
Close Forest	**2.3038**	**72.755408**

34_Tok Hka Taung Station



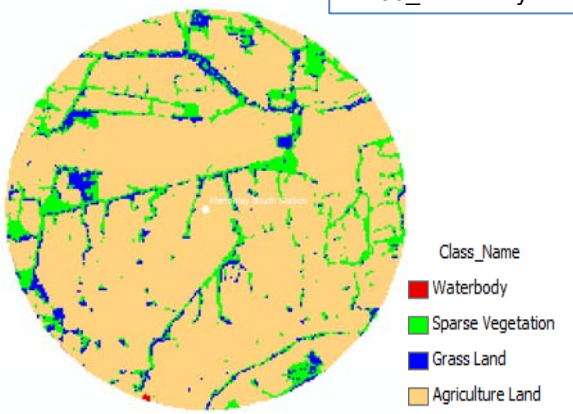
Area of LULC Classes (1Km Buffer Around Tok Hka Taung Station)		
Classes	**Area (Km^2)**	**Area (%)**
Agriculture Land	**0.2909**	**9.259908**
Open Forest	**0.0002**	**0.006366**
Close Forest	**2.7946**	**88.957504**
Settlement	**0.02**	**0.636639**
Waterbody	**0.0002**	**0.006366**
Wet Land	**0.0356**	**1.133217**

35_Mandalay East Station



Area of LULC Classes (1Km Buffer Around Mandalay East Station)		
Classes	**Area (Km^2)**	**Area (%)**
Sparse Vegetation	**0.2575**	**8.111567**
Grass Land	**1.1123**	**35.03882**
Agriculture Land	**1.7785**	**56.02494**
Settlement	**0.026179**	**0.824671**

36_Mandalay South Station



Area of LULC Classes (1Km Buffer Around Mandalay South Station)		
Classes	**Area (Km^2)**	**Area (%)**
Waterbody	**0.0011**	**0.034739**
Sparse Vegetation	**0.3859**	**12.186957**
Grass Land	**0.1531**	**4.834991**
Agriculture Land	**2.6264**	**82.943313**

According to above figures, the land use classes for railway stations can be found as close forest (21.1613%), open forest (14.4023%), bare land (2.7287%), sparse vegetation (9.5921%), agriculture land (45.1447%), settlement (2.1813%), water body (0.7520%), grassland (3.9945%), and wetland (0.0432%).

4.4.7. Project Description

The overall project for this railway project is shown in the following flow chart.

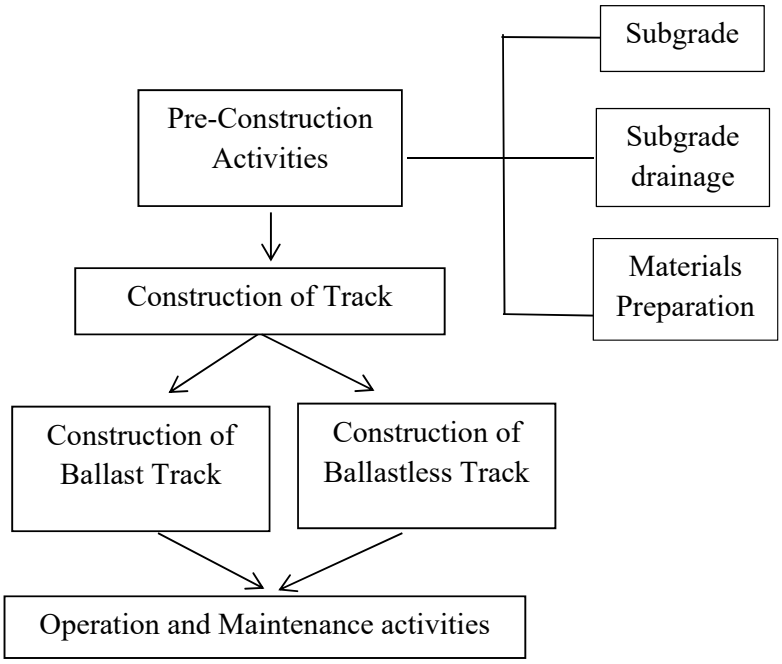


Figure 4.15 – Flow Chart of Processes in the Proposed Project

4.4.7.1. Pre-Construction Phase

There are some preparative works before railway track construction. It includes:

a) Site clearance
b) Subgrade
c) Subgrade drainage
d) Materials preparation

(a) Site Clearance for Railway Alignment

In the proposed project, the process of site clearance is generally undertaken as part of enable works, carried out to prepare a site for construction. It involves the clearing the site to allow

other remedial treatment or to take place demolition works before the actual construction works can begin. The site clearance is shown as below:

- Calculate the coordinates of cross-section center pillars of subgrade center line with an interval of 20m along straight section and 10m along curve section as per the construction drawings
- Calculate the width of cross-section site stripping with an interval of 20m along straight section and 10m along curve section as per height of filling and subgrade cross-section drawing.
- Generally, 20cm top soil remove from the site, sacrifice depth will change accordingly. Removed soil will transfer to dumping area.
- If the land type is garden land, farmland or grass land, top soil will be removed to store in a temporary place so as to replant trees.

Land type	Depth of top soil(cm)
garden land	30
farmland	40~50
Grassland	10~15

Figure - Example of Site Clearance along Railway Alignment

(b) Subgrade

The types of subgrade work sites are: deep road cutting, steep slope subgrade, bedding subgrade, high embankment, soft soil and soft soil subgrade, red clay, expansive soil subgrade, rock pile roadbed, landslide subgrade, riverfront subgrade, karst subgrade, sand

liquefied subgrade and dangerous rock fall subgrade, etc. Formation of subgrade involves ground leveling, remove other unwanted materials, and earth working activities to create space for the upper layer of the pavement.

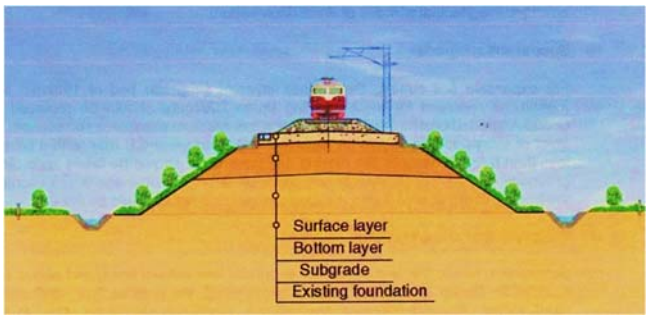


Figure - Filling Subgrade Standard Cross Section

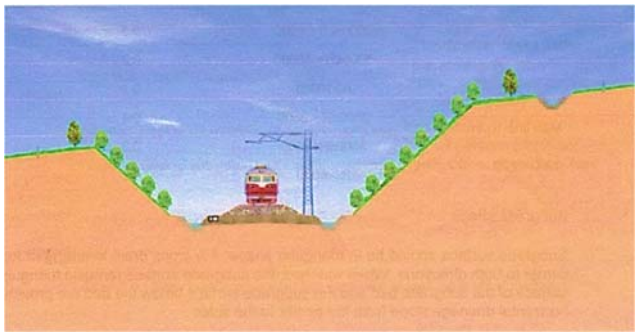


Figure - Cutting Subgrade Standard Cross Section

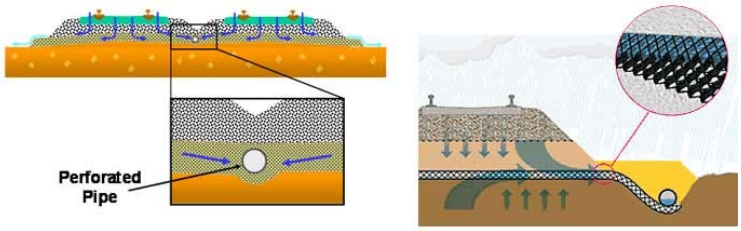
Muse-Mandalay Railway (including Mandalay South meter-gauge connecting line), sectional subgrade earthwork (cross section earthwork) is of 3484.0595×104m^3, with an average of 24.8269×104m 3 per km. The earthwork actually excavated/filled is of 3057.3657×104m^3, with an average of 21.7864×104m 3 per km. The total supporting structure masonry (including stations) is of 55.4791×104m^3, with an average of 0.2880×104m 3 per km. The total subgrade rock bolt (anchor cable) masonry is of 11.2132×104m^3, with an average of 0.0582×104m 3 per km. The total subgrade ancillary masonry is of 136.3741×104m^3, with an average of 0.7078×104m 3 per km. The total masonry of sectional subgrade retaining wall is of 14.4784×104m^3; with an average of 0.0751×104m^3 per km. Soft foundation reinforcement is of 837.2082×104m, with an average of 4.3455×104m. A total of 9,425,986m2 of land is to be acquired for sectional subgrade for permanent use, and 2,893,158m^2 for temporary use. The quantities of major subgrade works of subgrade and the indicators per kilometer are shown in the table.

Table: Main Engineering Quantity

Engineering Item \ Unit			Muse-Mandalay South Main line total		Muse-Mandalay South Whole line total (including Mandalay south meter-gauge connecting line)	
			Total amount	Subgrade per km	Total amount	Subgrade per km
Earthwork (10^4m^3)	Cross section earthwork	Cutting	2704.1688	19.8596	2704.734	19.2735
		Filling	708.5224	5.2034	779.3255	5.5534
		Total	3412.6912	25.0631	3484.0595	24.8269
	Earthwork actually excavated/filled		2986.5202	21.9333	3057.3657	21.7864
Masonry (10^4m^3)	Non-skid pile		30.4102	0.1613	30.4102	0.1578
	Retaining wall		25.0689	0.1330	25.0689	0.1301
	Slope protection		91.2604	0.4842	95.623	0.4963
	Rock bolt (anchor cable) frame beam		11.2132	0.0595	11.2132	0.0582
	Drainage system		40.1415	0.2130	40.7511	0.2115
	Retaining wall		14.4784	0.0768	14.4784	0.0751
	Total		212.5726	1.1278	217.5448	1.1292
Soft soil subgrade (10^4m^3)	CFG pile (m)		26.095	0.1384	26.095	0.1354
	Concrete mixing pile (m)		323.0336	1.7138	323.0336	1.6767
	Rotating spouting pile (m)		12.2663	0.0651	12.2663	0.0637
	Gravel pile (m)		413.0125	2.1912	475.8133	2.4697
	Plastic drainage board (m^2)		30.3042	0.1608	30.3042	0.1573
	Dynamic compaction (m^2)		5.0204	0.0266	5.0204	0.0261
	Impact rolling (m^2)		70.1981	0.3724	70.1981	0.3644
Land use (m^2)	New acquisition		9262532	68025	9425986	67168
	Temporary		2793158	20513	2893158	20616
	Total		12055690	88538	12319144	87784

(c) Subgrade drainage

The subgrade drainage is a system that is used to prevent the railway from water logging. The subgrade, road bed and slope of railway track are very easy to be washed by water. If the subgrade drainage measures are not proper, this will lead to the subgrade diseases. It is necessary to install drainage before laying the track. Specifically, it mainly adopts drainage pipes, carrier drains and attenuation ponds in some area.



Track Drainage

Source: (railway-fasteners.com)

(d) Materials preparation

The preparation of construction materials is another work before track laying. Ordinary materials include railway sleepers, steel rail, rail fasteners and some construction equipment. Preparation works primarily refer to check the complement and integrity of all materials.

4.4.7.2. Construction Phase

This line is mainly paved with ballast track, and tunnels with a length of 6 km or more use ballastless track and considered to be laid in the same time. The ballast track is 100m long, 60N, U75V non-bolt hot-rolled steel rails. The sleepers are 2.6m long III a type shoulder-stayed concrete sleepers, which are laid by 1667 pieces/km.

The ballastless track adopts elastic support block type ballastless track. The fasteners are elastic and non-separating fasteners, generally laid at 1667 pairs/km. The elastic support blocks are made of reinforced concrete support blocks and rubber boots. The rubber pad is composed of blocks under the block, and the track bed plate is C40 reinforced concrete structure.

(a) Ballasted Track

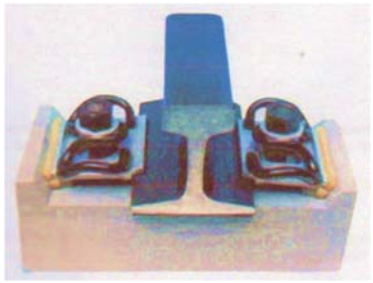
Trail

Rails are 60N, U75V bolt-hole-free hot rolled rails, with a fixed length of 100m. The continuously welded turnout rails on main line and the glued insulated rails are of the same material as the rails on the mainline. On the curves with radius ≤1200m, 60N, U75V bolt-hole-free heat-treated rails with a fixed length of 100m are adopted.

Sleepers and Fasteners

The sleepers are laid as 1667 pcs/km. The new type III concrete bridge are laid in the sections of ballasted bridge with guard rail and sections of shoulder retaining wall, and concrete turnout sleepers are laid in the turnout areas. Elastic strip type-II fasteners are adopted.

Type III Concrete sleepers with retaining shoulder



Elastic strip type II fasteners

Gravel Ballast

The ballasted bed of main line adopts Class I gravel ballast. The width of the top surface of single-track ballasted bed is 3.5m, the height of ballast shoulder pile is 15cm, and the gradient of pile ballast slope is 1:1.75. Ballast is used to fill the section between the ballast shoulder of bridge sections and the ballast-retaining wall, and the ballast is used to fill the section between the ballast shoulder of tunnel and the ballast-retaining wall. The top surface of the ballasted bed is level with that of the middle part of the sleeper in type-III concrete sleeper section; the top surface of the ballasted bed is 3cm lower than the sleeper's rail-bearing surface of laying turnout sleeper and bridge sleepers.

Structural height of ballasted track

The height of ballasted track structure is shown in the table below.

Foundation type	Rail height h_1	Thickness of rubber pad under rail h_2	Sleeper height h_3	Thickness of ballasted bed h_4	$H=\sum^{4}_{i=1} h_i$
Soil subgrade	176	10	230	300	716
Hard rock cutting	176	10	230	350	766
Bridge	176	10	210	≥350	≥746
Tunnel	176	10	230	350	766

For bridge-embankment and tunnel embankment joint sections, with different heights of track structures, the height differences of different foundation areas should be transitioned on the subgrade section, and the thicknesses of ballasted bed in different foundation areas should be transitioned within the range of 30m.

Construction Procedure for Ballastless Track

High-speed railway requires that track has high ride and high stability, therefore adopts solid concrete roadbed. The construction quality improving rail track is extremely important for the train safe of guarantee high-speed railway, comfortable, stable operation. Non-fragment orbit, due to features such as structure height is low, a little repair, good stability, good endurance, uniform elastic, has become the first-selected track structure of high-speed railway.

(1) Construction preparation

Construction Preparation will be done as mentioned above in Pre-Construction Activities.

(2) Roadbed section concrete supporting layer construction

First carry out an acceptance inspection to roadbed, roadbed just surface evenness is 20mm/4m, and elevation allowable variation is ± 20mm, then adopts slip form paver on subgrade bed top layer or adopts mould method of building to lay supporting layer.

(3) Bridge section base construction

- reinforcing bar processed is transported to job site, engineers and technicians orient the position of vertical, horizontal reinforcing bar in advance by designing requirement unwrapping wire on bridge floor, then reinforcing bar is laid in setting-out position, after reinforcing bar binding completes, under steel mesh reinforcement, concrete pad is installed;
- setting-out of shearing resistance limited impression is on Bridge Beam face;
- bridge base adopts C40 concrete, and adopts pumping method or concrete tank to carry out continuous uniform concreting building a segmentation, and concrete bed is wiped one's face smooth, and arranges transverse drainage slope;
- concreting, adopt and cover watering maintenance, concrete surface is fully moistening, and curing time is no less than 7d;

(4) Bridge section interlayer geotextile laying and limiting groove elastic cushion board installation

Intermediate layer geotextiles and mounting limit groove resilient sleeper-bearing is laid.

On bridge base He in limited impression, lay 4mm pp geo textiles, bridge base is all covered by geotextiles, in limited impression, lay resilient sleeper-bearing, resilient sleeper-bearing and limited impression either flush, adopts adhesive tape to be bonded and sealed;

(5) Roadbed slab working face cleaning, construction and paying-off

Substructure surface scum, dust and foreign material within the scope of road bed board are removed before railway roadbed concrete construction, engineers and technicians determine the position of sleeper sideline, template sideline, bottom transverse reinforcement and sleeper, and measure the absolute altitude of roadbed supporting surface surface, tunnel mat surface, bridge susceptor surface.

(6) Reinforcing steel bar and sleeper laying

In described step 2) roadbed location supporting layer lays road bed board bottom layer of the reinforcing steel after having constructed on the supporting layer in roadbed, location, tunnel, after step 4) bridge location geotextiles and limited impression surrounding resilient sleeper-bearing have been laid, in geotextiles, road bed board bottom layer of the reinforcing steel selvage line and reinforcement location control point is drawn according to road bed board reinforcement placement figure, and according to steel mesh reinforcement sideline and control point colligation road bed board bottom layer of the reinforcing steel.

(7) Track panel frame assembling and track panel rough adjustment

The section of track frame assembled is transported to job site, lays successively according to section of track rack position, make sleeper vertical with the rail on section of track frame.

(8) Upper-layer reinforcing steel bar binding and template installation

Colligation top reinforcement, installation of form.

(9) Track panel frame fine adjustment

Accurate adjustment section of track frame.

(10) Roadbed slab concrete pouring and concrete curing

- build before watering moistening basal plane, sleeper surface, use protective cover cover rail, fastener and sleeper surface;
- concrete is built from the mouth of building of an initiating terminal sleeper, move to next sleeper and build mouth after vibrating;
- concrete vibrating complete, finishing, floating concrete exposed surface

(11) Track panel frame detachment, transportation and part cleaning

dismounting section of track frame, transport and accessory are cleared up is for when road bed board concrete crushing strength is not less than 5MPa, first after order revolves ascending branch leg 1-2mm, unclamp rail clip, straddle truck or crane are sling section of track frame, enter next circulation construction.

4.4.7.3. Operation and Maintenance

The operational activities of the alignment include the maintenance of the railway alignment. Railway track is loaded with dynamic railway vehicles and always works in the exposed natural environment, which may cause abrasion, deformation, damage of relevant parts, change of geometry size etc. Therefore, with working hours increase, it is necessary to carry out regular maintenance in order to ensure the quality of railway track and the integrity of the equipment. In general, maintenance of railway track is to take periodic repairing, mainly including periodic updating, periodic comprehensive maintenance, regular inspection and key repairing of track. Below are the main types of maintenance:

(a) Rail Grinding

This consists of grinding machines travelling along the track with grinding stones, which are rotating stones or stones oscillating longitudinally, to abrade surface of rail. Rail grinding is conducted to correct rail corrugations, fatigue and metal flow and to re-profile the rail.

(b) Tamping

This is conducted to correct longitudinal profile, cross level and alignment of track. A number of sleepers at a time are lifted to the correct level with vibrating tamping tines inserted into the ballast.

(c) Ballast injection (stone blowing)

Ballast injection, or stone blowing, is conducted to correct longitudinal profile. The process introduces additional stones to the surface of the existing ballast bed, while leaving the stable compact ballast bed undisturbed.

(d) Sleeper replacement

In almost all types of sleeper defects, remedial action is not possible and the sleeper requires replacement. Defective sleepers can result in the rail losing the correct gauge, which can cause rolling stock derailments.

4.4.7.4. Decommissioning Phase

Although the proposed project is long-term project, decommissioning of the project would occur at the end of its lifespan. The goal of project decommissioning will be to remove the steel rail and steel structure as a whole and return the site to a condition as close to a pre-construction state as feasible. The physical removal of the structures and equipment will be the reversal of the construction process. All areas disturbed by the proposed project would be restored to pre-project conditions and/or to conditions acceptable to the CDC rule and regulations. During decommissioning phase, all concrete and steel structures and equipment would be dismantled and removed. The major activities that will be required for the decommissioning of the proposed project are:

(a) Concrete pile foundation removal;
(b) Concrete pier removal;
(c) Concrete structures (beam and bridge frame) removal,
(d) Steel beams and steel ropes removal
(e) Electrical supply system removal.

4.4.8. Station and Yard

There are 36 stations of the line including one port station, which mainly undertakes the work of reloading and transporting the import and export goods; 9 intermediate stations, mainly handling the arrival, dispatch and passing of trains, as well as passenger and cargo business. There are 24 passing stations, mainly for the arrival, dispatch and passing of trains; 1 passenger station, specializing in passenger transportation; 1 sectional station handling cargo business.

Table 4.4- List of New Stations along Muse-Mandalay Railway

S/N	Name	Nature of station	Note 1	Note 2	Note 3
1	Muse	Port of entry	Handle passenger & freight transport	/	Newly built
2	Pang hkam	Crossing station	To be closed when doubling the track	Delayed open	
3	Man Hawng	Crossing station	/	/	
4	Na Hpai	Crossing station	To be closed when doubling the track	Delayed open	
5	Nam Hpak Ka	Intermediate station	Only handle passenger transport	/	
6	Mong Yu	Crossing station	To be closed when doubling the track	Delayed open	
7	Kutkai	Intermediate station	Handle passenger & freight transport	/	
8	Man peng	Crossing station	/	/	
9	Nawng yen	Crossing station	To be closed when doubling the track	/	
10	Laban pa	Crossing station	To be closed when doubling the track	Delayed open	
11	Theinni	Intermediate station	Only handle passenger transport	/	
12	Sam lou	Crossing station	To be closed when doubling the track	Delayed open	
13	/	Crossing station	/	/	
14	Lashio North	Crossing station	To be closed when doubling the track	Delayed open	
15	Lashio West	Intermediate station	Handle passenger & freight transport	/	
16	MeLian	Crossing station	To be closed when doubling the track	/	
17	NaUng	Intermediate station	Only handle passenger transport	/	
18	Sint eng	Crossing station	To be closed when doubling the track	Delayed open	
19	SanLau	Crossing station			
20	KongTha	Crossing station	To be closed when doubling the track	Delayed open	
21	Hispaw	Intermediate station	Only handle passenger transport		
22	Hispaw south	Crossing station	Reserve condition for freight transport in the long term	Delayed open	
23	Chaung Chauk	Crossing station	To be closed when doubling the track	/	
24	Kyaukme	Intermediate station	Handle passenger & freight transport	/	
25	Myin Gwin	Crossing station	To be closed when doubling the track	/	
26	Nam ban ton River	Crossing station	To be closed when doubling the track	Delayed open	
27	Nawng Hki002o	Intermediate station	Handle passenger & freight transport	/	
28	/	Crossing station	To be closed when doubling the track	Delayed open	

29	Gan gaw	Crossing station	/	/	
30	Pyinoolwin	Intermediate station	Handle passenger & freight transport	/	
31	/	Crossing station	To be closed when doubling the track	/	
32	/	Crossing station	To be closed when doubling the track	Delayed open	
33	/	Crossing station		/	
34	/	Crossing station	To be closed when doubling the track	/	
35	Mandalay East	Passenger station	Only handle passenger transport	/	
36	Mandalay South	District station	Only handle freight transport	/	

In order to meet the demand of passenger & freight transport of the station and to serve the socio-economic development, station area supporting works will be done for 12 stations with both passenger & freight transport services, namely, Muse station, Nam Hpak Ka station, Kutkai station, Theinni station, Lashio west station, Nam un station, Hispaw station, Kyaukme station, Nawng Hkio station, Pyinoolwin station, Mandalay east station, and Mandalay south station.

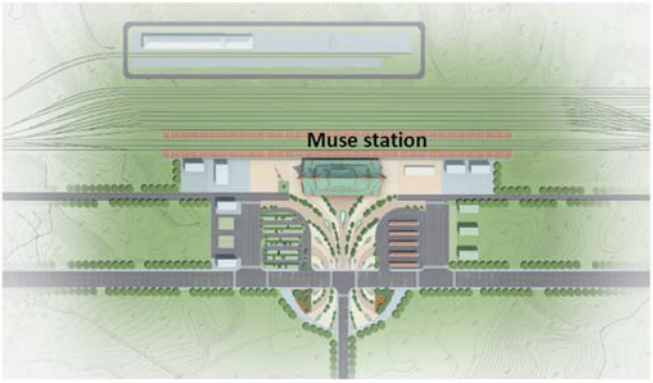


Figure – Plane layout of Muse Station

Figure – Plane layout of Nam Hpak Ka Station

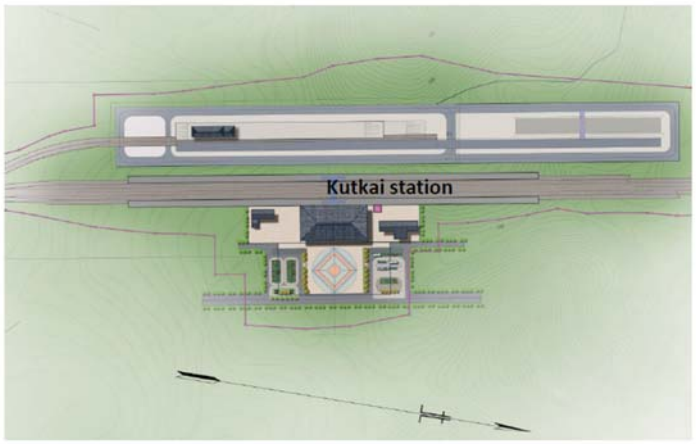


Figure – Plane layout of Kutkai Station

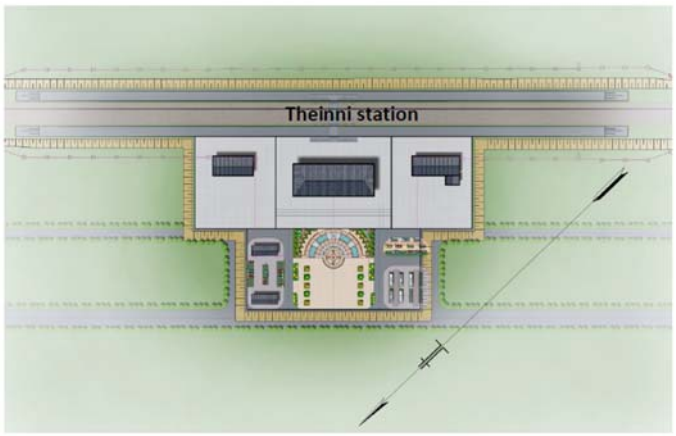


Figure – Plane layout of Theinni Station

Figure – Plane layout of Lashio West Station

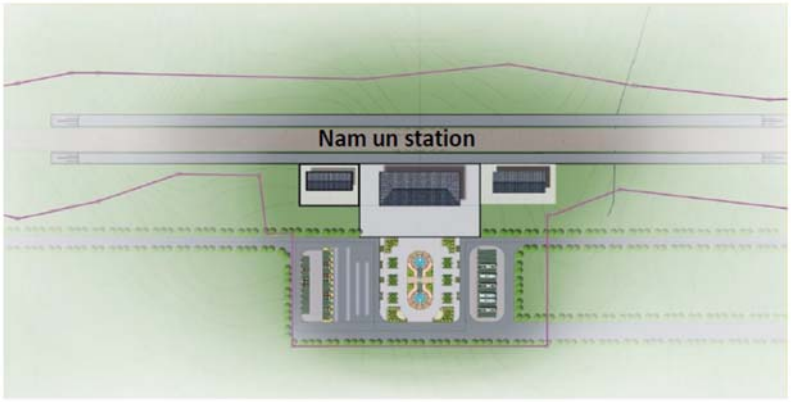


Figure – Plane layout of Nam Un Station

Figure – Plane layout of Thipaw Station

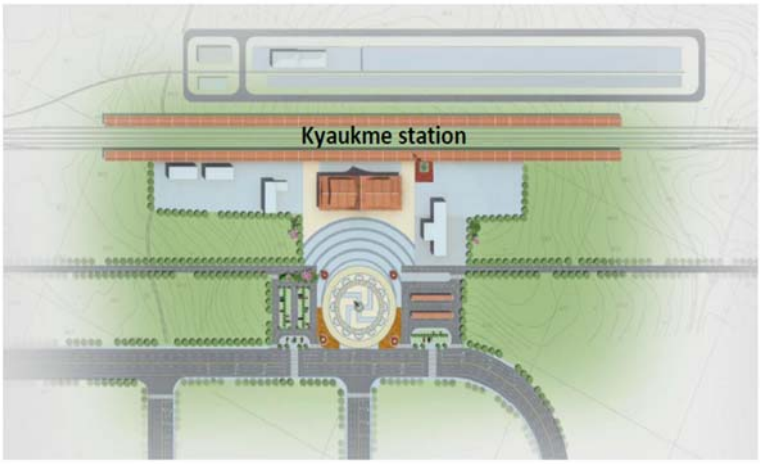


Figure – Plane layout of KyaukMe Station

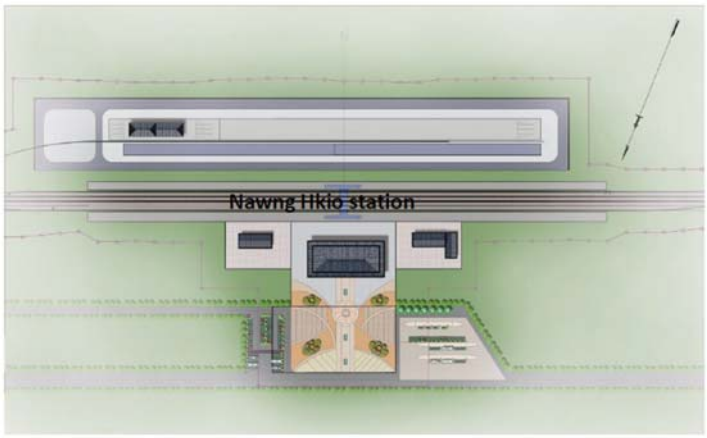


Figure – Plane layout of Nawng Hkio Station

Figure – Plane layout of Pyin Oo Lwin Station

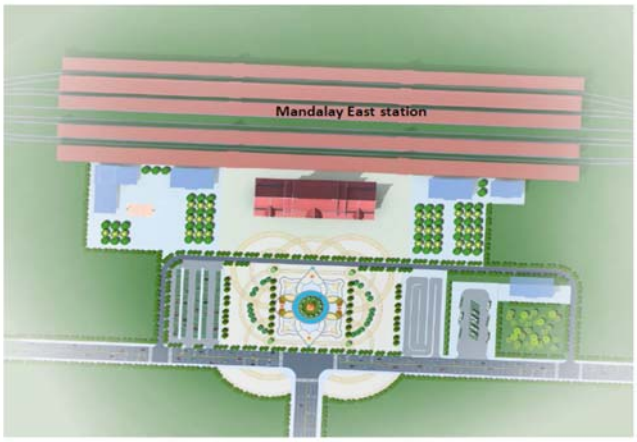


Figure – Plane layout of Mandalay East Station

4.4.9. Water Supply and Drainage

Water Supply Source

In addition to municipal water sources in Mandalay East, Mandalay South and Lashio, other stations are planning to use deep wells to obtain groundwater as water sources. The stations with daily water consumption ≥300m^3/d (excluding fire-fighting water consumption) will be designed as water supply station, with the stations with daily water consumption <300m^3/d (excluding fire-fighting water consumption) will be designed as household water supply station. The comprehensive living water consumption for railway staff is considered as 200L/(person-d), and the living water consumption for passengers is considered as 18L/(person-time).

Drainage System

In drainage system, soil pipelines are designed according to topography to make sure sewage flow by gravity to the treatment place. So, pipeline structures for drainage systems will be different based on topography of site locations. The following diagram shows the sample of pipeline structure and treatment tank of drainage system,. Pipeline Integrated MBR (Membrane Bio-Reactor) sewage treatment device is used in the treatment place. MBR can effectively remove nitrogen, phosphorus, dirty of the water.

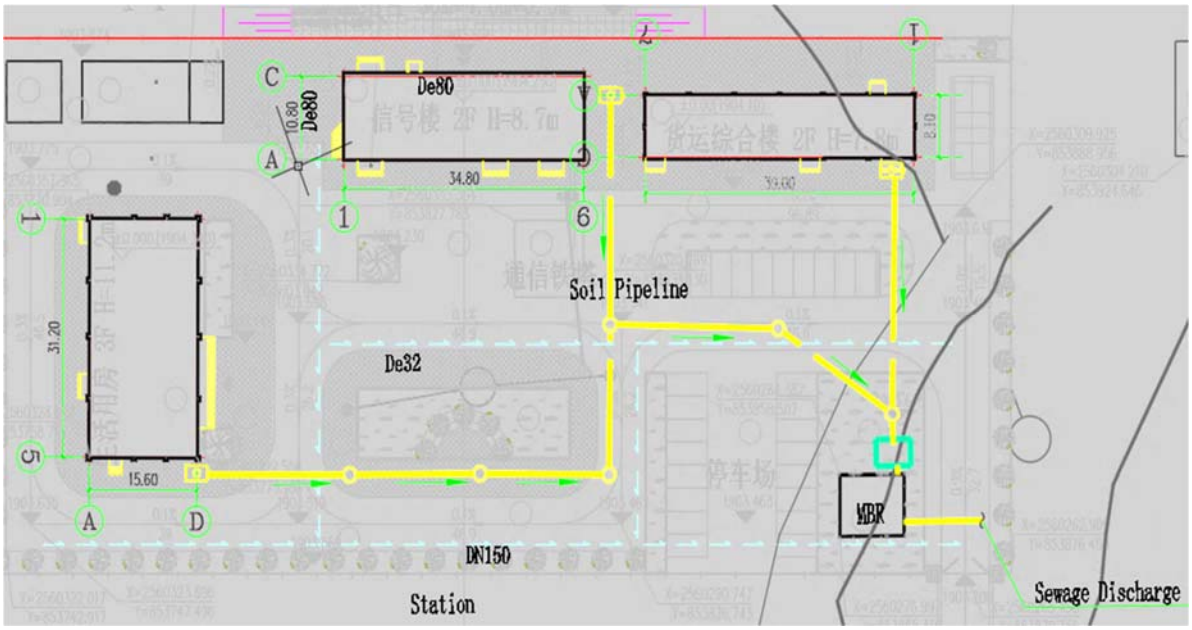


Figure 4.16 - Diagram for Drainage System

4.4.10. Sewage Treatment and Disposal Scheme

Domestic sewage is discharged into septic reservoir and oily sewage in the turnaround depot is settled in oil separation sedimentation reservoir and then both of then flow into the integrated membrane bio-Reactor (MBR) sewage treatment equipment. Sewage treatment processes are determined according to the requirements of the sewage composition, discharge volume and requirements of the receiving water body near the outlet, and should only be discharged after treated. The treatment technique should be unified to provide convenience for operation and maintenance. After treatment, they will be reused or discharged nearby. The oil-containing scum in the oil separation reservoir is got out manually and transported outside on a regular basis and handed over to the local sanitation department for centralized treatment. Sewage discharge for passenger trains will be taken into consideration. The sewage discharge adopts vacuum moveable sewage discharge vehicle.

Table 4.5- Effluents Levels after Treatment Process

S/N	Parameter	Effluent levels (After treatment process)
1	COD	50
2	BOD_5	10
3	SS	10
4	Oil and grease	1
5	Total Nitrogen	15
6	Ammonia	5
7	Total phosphorus	0.5
8	pH	6~9
9	Total coliform bacteria	10^3

4.4.11. Road

Road works are mainly divided into station-accessing road work and temporary accessing road work. Combination of permanent and temporary roads is considered at temporary accessing road.

4.4.12. Temporary Engineering

The temporary engineering includes several factories and yards for beam pre-casting, concrete mixing and track laying.

4.4.13. Plant and Equipment

An indicative list of plant and equipment that will typically be required during construction of the proposal is provided in table below.

Table 4.6- Indicative Construction Plant and Equipment

Description	Indicative plant and equipment
Rail track and signals	Track renewal plant Engineering trains carrying materials to and from site (pending availability of train paths which will be determined during detailed design) Tracked excavators Road Rail Vehicle excavators Dumpers Plain line tampers Stressing equipment Welding equipment Lifting equipment Lighting Generators Compactors
General	Road saws Pneumatic breakers All terrain teleloaders Jacking equipment Road surfacing equipment, including planers, pavers and rollers wheeled excavators Hydraulic breakers Dumpers Kerb lifters Core drills Concrete pumps Lighting and lighting towers Generators Cranes Road lorries Scaffolding and scaffold towers Road diversion and traffic management equipment Heavy duty hydraulic jacks

4.4.14. Firefighting Methods and Facilities

Muse, Mandalay East and Mandalay South stations;-

Outdoor fire hydrant system is to be set in these stations, for fire duration of 3 hours. Total fire water consumption is 756m^3 per time, among which 270m^3 per time is for outdoor

firefighting. The five stations of Nam Hpak Ka, Nawng yen, Lashio West, Hispaw and Sam biu in will use a high-pressure fire water supply system, with gravity water reservoir set up on the mountain near the station. The reservoir volume will be V= 200m^3, V=300m^3, V= 600m^3, V= 300m^3 and V= 200m^3 respectively. Outdoor fire hydrants are to be set in the railway station. Kutkai, Theinni, Nam um, Kyaukme, Nawng Hkio and Pyinoolwin use temporary high-pressure water supply system.

4.4.15. Related Disaster Monitoring System

Disaster monitoring system equipment will be installed on the proposed railway project.

(a) Rainfall monitoring system

The areas along this line are rich in rainfall, collapse, landslides and floods caused by continuous rainfall can damage roadbeds, bridges and other railway infrastructure. In order to monitor and release the rainfall information along the railway in real time and guarantee the safe operation of trains, a rainfall monitoring system is set up along the railway.

(b) Earthquake early-warning and monitoring system

The railway line is located in the high-intensity seismic region, and the seismic peak acceleration (g) is 0.2. In order to timely collect and release seismic information to guarantee the safe operation of trains, an earthquake early-warning and monitoring system is set up along the line.

4.4.16. Organization Structure for Project Implementation

The organization chart for the project is described in the following figure. The professionals and work crews for the project have not been selected for feasibility stage.

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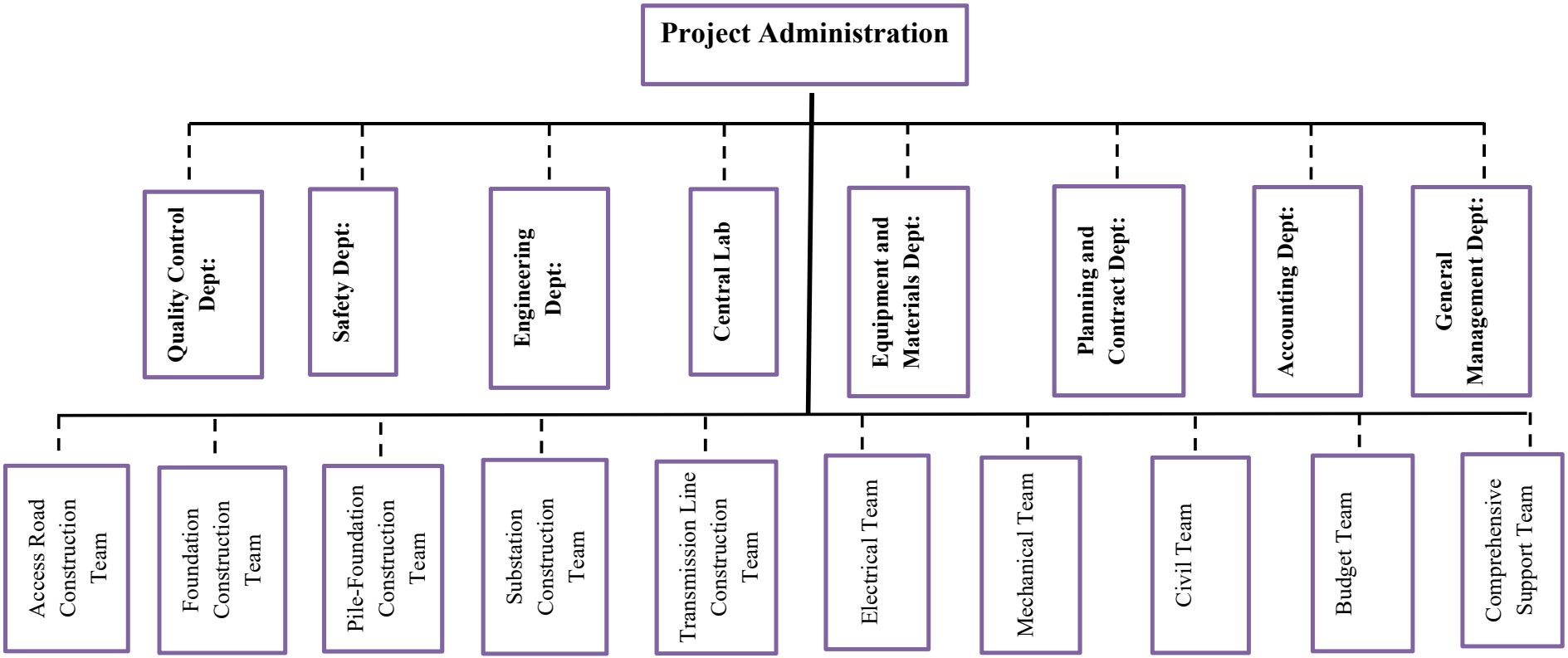


Figure 4.17– Organization Chart

4.4.17. Staffing

(a) Construction Period

For construction phase, the project will use engineers, skillful workers and general workers as follow:

No.	Types of Workers	Quantity	Duration
1.	Administration	30	Temporary during construction phase (at least five years)
2.	Engineers	20	Temporary during construction phase (at least one years)
3.	Skillful Workers	50	Temporary during construction phase (at least five years)
4.	Machine Operator	25	Temporary during construction phase (at least five years)
5.	General Workers	150	Temporary during construction phase (duration will depend on type of construction works)

(b) For Operation Period

The station operation staffing is as follows:

S/N	Station name	Station master	Station duty personnel	Passenger clerk	Freight clerk	Backup	Total
1	Muse	2	4	7	32	2	47
2	Man Hawng	1	4				5
3	Nam Hpak Ka	1	4	1			6
4	Kutkai	1	4	1	2		8
5	Manpeng	1	4				5
6	Nawngyen	1	4				5
7	Theinni	1	4	1			6
8	Hang Lu	1	4				5
9	Lashio West	1	4	4	3	1	13
10	Mehan	1	4				5
11	Nam Un	1	4	1			6

12	Sanlau	1	4				5
13	Hsipaw	1	4	2			7
14	Chaung Chauk	1	4				5
15	Kyaukme	1	4	1	2		8
16	Myin Gwin	1	4				5
17	Nawng Hkio	1	4	1	1		7
18	Gangaw	1	4				5
19	Pyin Oo Lwin	1	4	7	1	1	14
20	Sin Byu In	1	4				5
21	Taung Kyun	1	4				5
22	Tawma Pagoda	1	4				5
23	Mandalay East	2	4	34		2	42
24	Mandalay South	2	4		32	2	40
Total		27	96	60	73	8	264

4.5. Analysis of Alternatives

Alternative analysis has been considered as an integral part of EIA process, which involves examination of alternative ways of achieving the objectives of the proposed project. The aim of alternative analysis is to arrive at a development option, which maximizes the benefits while minimizing the unwanted impacts. Alternative analysis is also a form of mitigation measures.

The alternative analysis for Mandalay-Muse was conducted into the following points (a) "no project" alternative and (b) alternative analysis for alignment, and (c) alternative analysis for In each subcomponent many options were considered and these options were weighed from all considerations such as cost, environment, and ease of implementation.

4.5.1. The “No Action” Alternative

This alternative avoids the implementation of Muse-Mandalay Railway. In no project scenario case, there will be no impact on natural environment and local communities. But there will be positive impacts on residents’ life quality in “Project Scenario” case. So, it is necessary to considervfrom environmental and social perspectives as follow:

4.5.1.1. No Project Alternative from an Environmental Perspective

Although the development of the proposed project will have more or less environmental impacts, the levels of acceptability will be decided in conjunction with threshold criteria as shown in the following table.

Level of Acceptability	*Threshold Criteria for Potential Impacts*
Unacceptable	Exceeds legal or regulatory standard, e.g. water quality standard. Increases level of risk to public health. Extinction of biological species, loss of genetic diversity, rare or endangered species, critical habitat.
Normally Unacceptable	Conflict with policies or land-use plans. Loss of populations of commercial biological species. Large scale loss of productive capacity of renewable resources.
May be Acceptable with Mitigation	Avoidance of spread of biological disease, pests, feral animals or weeds. Some loss of threatened habitat.
Normally Acceptable	Some loss of populations and habitats of non-threatened species. Modification of landscape without downgrading special aesthetic values. Emissions demonstrably less than the carrying capacity of the receiving environment.

Source: Modified from Sippe (1999)

The "No Action" alternative will be considered according to the above table for the environmental perspective. According to the impact assessment results, all of the project's related environmental impacts can be mitigated to allowable levels with proper mitigation measures described in this report and so the proposed project can be considered as may be acceptable with mitigation.

4.5.1.2. No Project Alternative from a Socio-economic Perspective

A "no-project" option will mean that the status quo remains and all the social impacts related to the existence of the projects are not envisaged. This implies that if the project were not to proceed, none of the positive or negative impacts identified in this study will materialize. A no-project option will see all the anticipated project benefits not realized.

If this project is not implemented, no resettlement and environmental impacts will occur. However, the backward productivity and inconvenient traffic environment along the route will hinder the economic development of Mandalay, Shan State and even Myanmar, making the people along the route still living in poverty and unable to promote social progress. The "No Action" alternative is not a feasible alternative, as it would lead to loss of significant foreign direct investment as well as significant employment opportunities – the work force is currently estimated at 500 (on average) during the 5 years of construction, including some migrant workers and some local people. But this work force condition may change depending on the workforce requirement of the construction site condition and the worker readiness from the project developer, and so the job opportunity for local people is estimated as 250 people. The station operation staffing is 264 staffs at the stations for the operation period.

The foregone benefits of this option will include loss of foreign capital investment, loss of transportation development in the regions, loss of employment opportunities for local people, loss of infrastructure development, loss of increased business opportunities for local services, loss of skill development and improved services and of community development potential among other benefits of the project. Constructing Muse-Mandalay Railway can improve traffic conditions, lower transport costs and promote personnel exchanges which will add vitality into the national economy, and improve people's livelihood and boost social development & stability.

In Myanmar, transportation is still difficult due to the lack of alternative ways expect for road way in many region. High speed rail way system will be beneficial for improvement of transportation system in Myanmar. So, "no-project" option represents a lost opportunity for Myanmar and cannot be accepted in the present condition if the developer can solve the social affairs of land acquisition and resettlement.

4.5.2. Alternative Analysis for Alignment

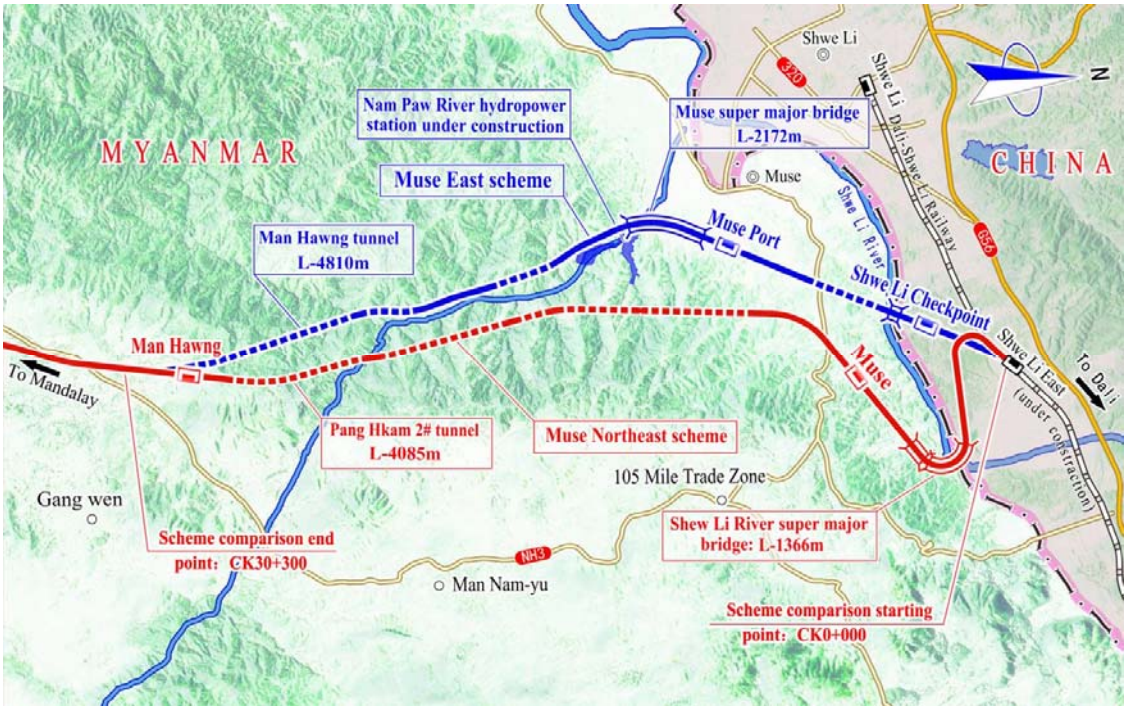
4.5.2.1. Alternative Analysis for Alignment based on Technical and Economic Considerations

Firstly, alternative analysis for alignment will be based on available technical and economic factors as follow:

Muse East Alignment: The alignment starts from Shweli East Station of Dali-Shweli Railway, runs towards southwest (Shweli Checkpoint Station set in China) and crosses

Shweli River before entering Myanmar in which a port station is set on east side of Muse. Then, the alignment passes over Nam Paw River and extends westward to the end point for comparison, i.e., Man Hawng Station. The line will be 26.25km long, with bridges and tunnels accounting for 59%.

Muse Northeast Alignment: The alignment starts from Shweli East Station of Dali-Shweli Railway, runs eastward (Shweli Checkpoint Station set in China) and crosses Shweli River by the Shweli Bridge before entering Myanmar and turning towards southwest (a port station set on northeast side of Muse). Then, the alignment passes under NH3 Highway and runs along Nam Paw River and extends eastward to the end point for comparison, i.e., Man Hawng Station. The line will be 30.48km long, with bridges and tunnels accounting for 66.6%.



Alternative 1

Alternative 2

Figure 4.18- Schematic Map for Alignment Scheme of Shweli East-Man Hawng Section

Comparison of the Preferred Alternatives by Engineering Quantity, Cost, Main Technical & Economic

The following tables are the engineering quantity, cost comparison of the schemes, and technical-economic comparison.

Table 4.7 - Comparison of Main Engineering Quantities and Costs for Shweli East-Man Hawng Section

Scope of comparison: CK0+000-CK30+300

Item		Unit	Muse Northeast scheme	Muse East scheme
			Quantity	Quantity
Construction length		km	30.480	26.25
Demolition and land acquisition	Demolition	m^2	8,689.4	34,757.7
	Road relocation	km	6.6	4.0
	Land for permanent use	10^4m^2	190.5	164.0
	Land for temporary use	10^4m^2	87.2	75.1

Table 4.8 - Main Technical-economic Comparison for Shweli East-Man Hawng Section

S/N	Item	Muse Northeast proposal	Muse East proposal
1	Site condition of Muse port station	It will be conducive to the transportation of goods between the 105 Mile Trade Zone and the Muse port station; the amount of demolition is small.	It will be conducive to the coordinated development of the station and Muse City; located on the edge of Muse City, the amount of demolition is large.
2	Geologic condition	The alignment will bypass Nam Paw River and pass in the form of tunnel; long routes will pass through Neogene (N)strata.	As multiple sections will be parallel to the Nam Paw River, there will be engineering geological problems such as embankment upon the slope, landslide and talus.
3	Length/radius of Shweli Super Major Bridge	1366m/700m	336m/straight line
4	Railway length/ ratio of bridges & tunnels	30.48km/58.7%	26.25km/60.2%
5	Cost of main works	507 million USD	470 million USD

Comparison of Geological Condition

The following table shows some technical consideration for alternative analysis based on geological conditions.

Table 4.9 - Comprehensive Comparisons of Geological Conditions for Shweli East-Man Hawng Section

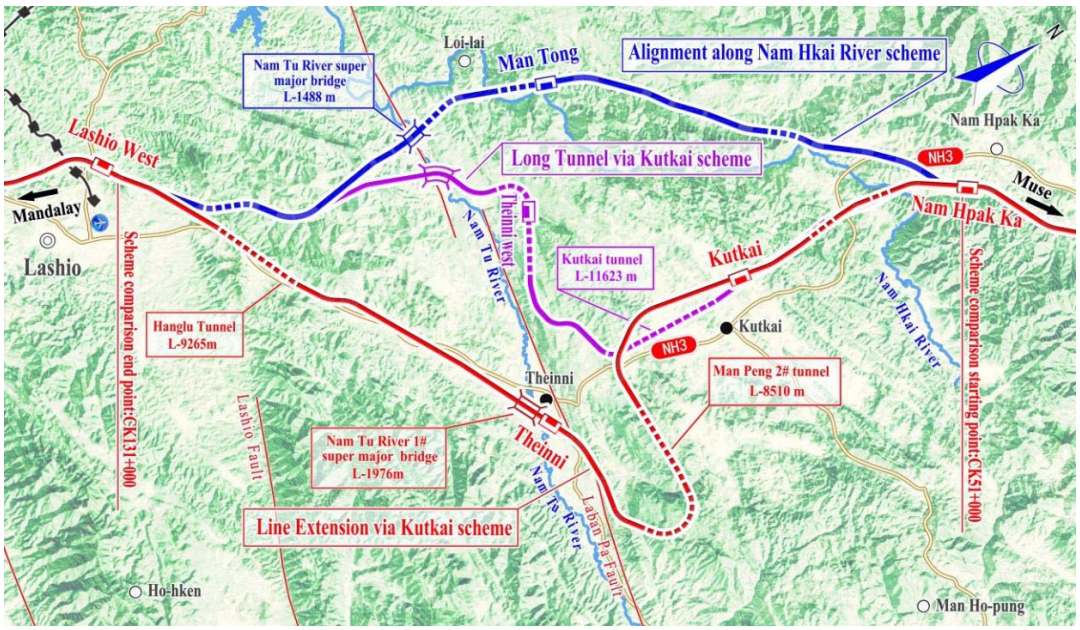
Engineering Geological Conditions	Muse Northeast Proposal	Muse East Proposal
Topography and Geomorphology	This section lies in the low mountainous areas on both side of Shweli River and the edge of Shweli Basin which are rich in ridges and hills. The small mileage end is characterized flat and open topography while the large mileage end enjoys undulating topography. The ground elevation is 760-950m, with a relative elevation difference of 20-200m. The overall surface is covered by thick overburdens, with little complete bedrock outcrops. The mountainous area is densely forested and rich in vegetation.	
Formation Lithology	The whole section goes through complex lithological structures. The surface is mainly composed of Quaternary eluvial silty clay, red clay and alluvial silty clay, and the bedrock is mainly upper Tertiary mudstones, Sinian-Cambrian argillaceous sandstone and dolomite.	The whole section goes through complex lithological structures. The surface is mainly composed of Quaternary eluvial clay, red clay and alluvial silty clay, and the bedrock is mainly upper Tertiary mudstones, Sinan-Cambrian argillaceous sandstone and dolomite. Mesozoic-Proterozonic intrusive granite is locally distributed.
Geological Structure	The survey area is located in the southeast of Longling-Shweli fault, with complex geological structure in general, developed with fold and fault structural features.	
Hydrogeology	This section passes over Shweli River, along which surface water system is developed. Groundwater is mainly Quaternary pore water and bedrock fissure water, and joint fissure is not developed. Mainly supplied by meteoric water and surface ditch water, the groundwater is not well developed and thus the groundwater level is low.	
Main Engineering Geological Problems	(1) The alignment passes through the upper Tertiary (N) mudstone stratum along the line, which is generally composed of weak swelling rocks with weak expansibility. The bedrock is poor in diagenesis and weak in strength. Especially, it is easy to soften and disintegrate when coming contact with water. Also, it is easy to be disturbed and greatly affected by water, belonging to extremely soft rock. The alignment should avoid the mountain slope made of expansive rocks and the joint zone of different geomorphic units, and should pass perpendicular to the ridge axis. The cutting slope should be provided with drainage measures, deformation joints should be reserved in tunnels, and supporting, waterproofing and drainage measures should be strengthened.	

Engineering Geological Conditions	Muse Northeast Proposal	Muse East Proposal
	(2) The trench section is covered with 2-8m thick soft soil and loose soft soil. (3) Some sections are covered by weak swelling silty clay, generally 2-10m in thickness. (4) Bedding and partial pressure of bedding are involved in the alignment. (5) The alignment passes through the upper Tertiary (N) strata which are coal-bearing, and the groundwater is erosive.	
Advantages	The alignment bypasses Nam Paw River and passes mainly in the form of tunnel.	The alignment is relatively straight.
Disadvantages	The sections of the alignment passing through the upper Tertiary (N) strata are long.	The fact that multiple lines are parallel to and closed to the Nam Paw River may lead to engineering geological problems such as a lot of slope subgrades, landslide and rock pile.
Evaluation of Engineering Geological Conditions	The engineering geological conditions are good.	The engineering geological conditions are poor.

As shown in the above table, geological conditions of the two schemes are similar. Because multiple sections of the Muse East scheme is parallel to the Nam Paw River, there will be engineering geological problems such as embankment upon the slope, landslide and talus. The alignment of the Muse Northeast scheme will bypass the river and pass mainly in the form of tunnel, but long routes will pass through upper Tertiary (N) strata. General speaking, the engineering geological condition of the Muse Northeast scheme is relatively better.

All in all, Muse Port Station in the Muse East scheme will be close to Muse City, which will be conducive to the coordinated development of Muse Port Station and Muse City. However, as new buildings are densely distributed in the station area, the amount of demolition will be large and the project implementation will be difficult and apt to cause adverse impact on the society; the demolition amount of the Muse Northeast scheme will be smaller, the project implementation and resettlement will be relatively simple. In addition, as the Muse Port Station will be located between Muse City and the 105 Mile Trade Zone, it will be conducive to the freight transportation between the 105 Mile Trade Zone and the Muse Port Station. Thus, the Muse Northeast scheme is recommended.

(2) Alignment scheme of Nam Hpak Ka-Lashio West section



Alternative 1

Alternative 2

Alternative 3

Figure 4.19 - Schematic Map for Alignment Scheme of Nam Hpak Ka-Lashio West Section

Scheme Description

Alignment along Nam Hkai River Scheme: The alignment starts at Nam Hpak Ka Station, travels along Nam Hkai River to Man Tong, crosses Nam Hkai River and Nam Tu River to Nam Pa Che, and then goes through Mu Long and finally ends at Lashio West Station. This scheme has a total length of 80km, with a bridge and tunnel ratio of 63.9%. Long tunnel via Kutkai scheme: The alignment starts at Nam Hpak Ka Station, runs along NH3 Highway to Kutkai, then falls down to Nam Pa Che along sufficient grade, passes through Mu Long and finally ends at Lashio West Station. This scheme has a total length of 90.996km, with a bridge & tunnel ratio of 63.6%. Line extension via Kutkai scheme: The alignment starts at Nam Hpak Ka Station, climbs along NH3 Highway up to Kutkai, then goes at the edge of the plateau platform with line extension and down to Theinni, and continues along NH3 Highway to the end point for comparison, i.e., Lashio West Station. This scheme has a total length of 113.144km, with a bridge & tunnel ratio of 58.8%.

Engineering Quantity, Cost, Technical & Economic Comparison

The following tables are the engineering quantity, cost comparison of the schemes, and technical-economic comparison.

Table 4.10 - Comparison of Main Engineering Quantities and Costs for Nam Hpak Ka-Lashio West Section

Scope of comparison: CK51+000-CK131+000

Item		Unit	Line extension via Kutkai scheme	Alignment along Nam Hkai River scheme	Long tunnel via Kutkai scheme
			Quantity	Quantity	Quantity
Construction length		km	113.144	80.000	90.996
Demolition and land acquisition	Demolition	m^2	36,035.0	20,383.3	20,866.5
	Road relocation	km	23.5	14.9	15.3
	Land for permanent use	10^4m^2	650.8	414.2	424.0
	Land for temporary use	10^4m^2	298.0	274.0	280.4

Table 4.11 - Main Technical-economic Comparison for Nam Hpak Ka-Lashio West Section

S/N	Item	Line extension via Kutkai scheme	Alignment along Nam Hkai River scheme	Long tunnel via Kutkai scheme
1	Economic center to be passed	Kutkai and Theinni	None	Kutkai
2	Impact on the groundwater of Kutkai City	No	No	Yes
3	Relationship between the alignment and Kunlong active fault	It will pass the active fault zone at a small angle in the form of simple bridges and subgrade and long sections will cross the soluble rock.	Short sections will cross the soluble rock, and it will pass the active fault zone at a large angle in the form of bridges and subgrade.	Long sections will cross the soluble rock, and it will pass the active fault zone at a small angle in the form of bridges and subgrade.

S/N	Item	Line extension via Kutkai scheme	Alignment along Nam Hkai River scheme	Long tunnel via Kutkai scheme
4	Long tunnel/ set	25,825m/3	5,500m/1	11,605m/1
5	Railway length/ratio of bridges and tunnels	113.144km/58.8%	80km/63.9%	90.996km/63.6%
6	Cost of main works	1.651 billion USD	1.214 billion USD	1.365 billion USD

Main Considerations for Alternative Analysis for Scheme of Nam Hpak Ka-Lashio West Section

Analyzed from promoting local economic development, as the alignment along Nam Hkai River will not pass Kutkai or Theinni, and the straight-line distance between the station and Kutkai will be 30km, the railway will have a poor promotion effect on local economic development; as the Long tunnel via Kutkai scheme will pass through Kutkai, it will have a better promotion effect on local economy; as the line extension via Kutkai scheme will pass through Kutkai and Theinni, it will have the best promotion effect on local economy.

Analyzed from impact on the groundwater in Kutkai City, the alignment along Nam Hkai River and the line extension via Kutkai scheme will not impact on the groundwater in Kutkai City, but the long tunnel via Kutkai scheme (with one-way slope long tunnel)will significantly impact the groundwater in Kutkai City, which will be highly likely to cause the water loss of Kutkai City and lead to major environmental problem.

Comparison of Geological Conditions

The following table shows some technical consideration for alternative analysis based on geological conditions.

Table - Comprehensive Comparisons of Engineering Geological Conditions for Nam Hpak Ka-Lashio West Section

Engineering geological conditions	Line extension via Kutkai scheme	Alignment along Nam Hkai River scheme	Long tunnel via Kutkai scheme
Topography and Geomorphology	The area belongs to Shan Plateau landform and is located at an altitude of 615-1450m, with a relative	The area belongs to Shan Plateau landform and is located at an altitude of 580-	The area belongs to Shan Plateau landform and is located at an altitude

Engineering geological conditions	Line extension via Kutkai scheme	Alignment along Nam Hkai River scheme	Long tunnel via Kutkai scheme
	elevation difference of 20-300m. the surface reliefs are large and incised valleys are developed. Affected by Kunlong fault, the elevation difference on both sides of the fault changes sharply. The alignment crosses the hilly area of Kutkai Plateau and the Theinni Basin which is of flat terrain.	1450m, with a relative elevation difference of 20-300m. The surface reliefs are large and incised valleys are developed. Affected by Kunlong fault, the elevation difference on both sides of the fault changes sharply. The alignment crosses the hilly area of Kutkai Plateau where the terrain undulates gently. Also, the alignment crosses Nam Hkai River valley.	of 570-1350m, with a relative elevation difference of 20-300m. The surface reliefs are large and incised valleys are developed. Affected by Kunlong fault, the elevation difference on both sides of the fault changes sharply. The alignment crosses a depopulated zone of about 40km as well as Nam Hkai River and Nam Tu River.
Formation Lithology	The whole section goes through complex lithological structures. The alignment mainly passes through strata composed of Jurassic (J) sandstone, mudstone, upper Paleozoic (Pz_2) limestone, dolomite limestone, dolomite, a small amount of Silurian (S) mudstone, and sandstone.	The whole section goes through complex lithological structures. The alignment passes through strata composed of Jurassic (J) sandstone, mudstone, upper Paleozoic (Pz_2) limestone, dolomite limestone, dolomite, a small amount of Triassic (T) shale, sandstone intercalated with limestone.	The whole section goes through complex lithological structures. The alignment mainly passes through strata composed of Jurassic (J) sandstone, mudstone, upper Paleozoic (Pz_2) limestone, dolomite limestone, dolomite, a small amount of Silurian (S) mudstone, and sandstone.
Geological Structure	Structural movements are intense in this area, leading to complicated geological structures and development of faults and fold structures. All the alignments go through Kunlong fractures which are branch fractures of regional Nanting River faults and Holocene active faults. The width of the fault zone ranges from tens of meters to hundreds of meters. A number of hot springs and erupting high-pressure gas springs emerge along the fault zone, leaving great influence on the project.		
Hydrogeology	Surface water is mainly from the Nam Tu River and its seasonal branches, which is non-erosive. Ground water is mainly pore water, bedrock fissure water and karst water. This area is moderately-strongly developed with karst and rich in karst water.		

Engineering geological conditions	Line extension via Kutkai scheme	Alignment along Nam Hkai River scheme	Long tunnel via Kutkai scheme
Main engineering geological problems	(1) All the alignments pass through strata composed of upper Paleozoic (Pz_2)limestone and dolomite, with karst moderately-strongly developed. The karst area is encountered with such engineering geological problems as tunnel gushing, mud rush and collapse while the karst subgrade and bridge sections are faced with the engineering geological problems such as karst collapse. (2) Seismic and active fracture zone: The neotectonic movements in the survey area are intensive and historical seismic activities are frequent. All the alignments pass through Kunlong fractures which are Holocene active faults. The width of the fault zone ranges from tens of meters to hundreds of meters. A number of hot springs and erupting high-pressure gas springs emerge along the fault zone, leaving great influence on the project. (3) The upper Paleozoic (Pz2)strata along the line are all covered with red clay which is generally weakly expansible and has certain influence on the project. (4) Bedding exists in some cuttings and tunnel side and front slopes. (5) Adverse geologies are developed along the line due to the intense tectonic movement and steep terrain, including landslide, slide, talus, dangerous rock and rockfalls.		
Advantages	The alignment passes through the active fault zone in the form of simple bridge (with a height of about 13m) and subgrade by a small angle, which is beneficial to the project.	(1) The section crossing soluble rocks is short, about 42.8km. There is only one 5.5km extremely long karst tunnel. (2) Some sections go along Nam Hkai River and the karst tunnels of these sections run along positions beneficial to karst water, leading to relatively low risk. (3) The alignment passes through the active fault zone in the form of bridge and subgrade by a large angle, forming an angle with the fault zone of about 75° .	The terrain is undulates slightly.
Disadvantages	(1) The section crossing soluble rocks is long, about 84.4km. There are 3	(1) The section crossing soluble rocks is long, about 61.3km. There are 2 extremely long	(1) The section crossing soluble rocks shows high risk in karst

Engineering geological conditions	Line extension via Kutkai scheme	Alignment along Nam Hkai River scheme	Long tunnel via Kutkai scheme
	extremely long karst tunnels with a length of over 5km, subjected to large risks in construction and karst water drainage. (2) The angle between the alignment and the active fault zone is about 35°, and the section closed to the fracture is 10km long approximately, leaving certain influence on the project. (3) The alignment crosses the Theinni Basin and may be subjected to sand liquefaction. (4) Construction of tunnels near the active fracture zone may suffer heat damage.	karst tunnels with a length of over 5km, one of which is 11.6km long, and adjacent to downtown Kutkai and whose body is located along the horizontal circulating zone of groundwater, subjected to large risks in construction and karst water drainage, threatening the safety of water supply in Kutkai City. (2) The alignment goes through the active fault zone in the form of bridge and subgrade by a small angle, forming an angle with the fault zone of about 30°. The bridge is about 30m high. About 20km-long section is closed to the active fault zone, the minimum distance between the two is about 1200m, which is not favorable to the project. (3) Construction of tunnels near the active fault zone may suffer heat damage.	tunnel construction and karst water drainage. (2) There are many contacts between soluble and insoluble rocks, which is adverse to the project. (3) The bridge crossing the active fault zone is about 37m high, which is relatively unfavorable. (4) Construction of tunnels near the active fault zone may suffer heat damage.
Evaluation of Engineering Geological Conditions	The engineering geological conditions are poor.	The engineering geological conditions are poor.	The engineering geological conditions are good.

As shown in the above table, the engineering geological conditions of the three schemes are similar, all affected by karst and active fracture zone. General speaking, the long tunnel scheme via Kutkai has the worst engineering geological conditions and the alignment along Nam Hkai River has the best engineering geological conditions.

In summary, the alignment along Nam Hkai River scheme has shortest alignment, lowest costs and relatively better engineering geological conditions, but it will not be conducive to driving local economic development. The long tunnel via Kutkai scheme has shorter alignment and lower cost, but the construction of long karst tunnels will be risky and have a great impact on the groundwater in Kutkai City. It is likely to cause groundwater loss in Kutkai City and induce environmental problems. The line extension via Kutkai scheme has the longest alignment and highest cost and the tunnel construction has some certain risks, but the railway will pass through the two economic centers of Kutkai and Theinni, it will better promote local economic development. The Ministry of Transport and Communications of Myanmar attaches great importance to the economic development of Kutkai area and hopes that the route will pass through Kutkai. Therefore, the line extension via Kutkai scheme is adopted in the study.

(3) Alignment scheme of San lau-Myin Gwin section

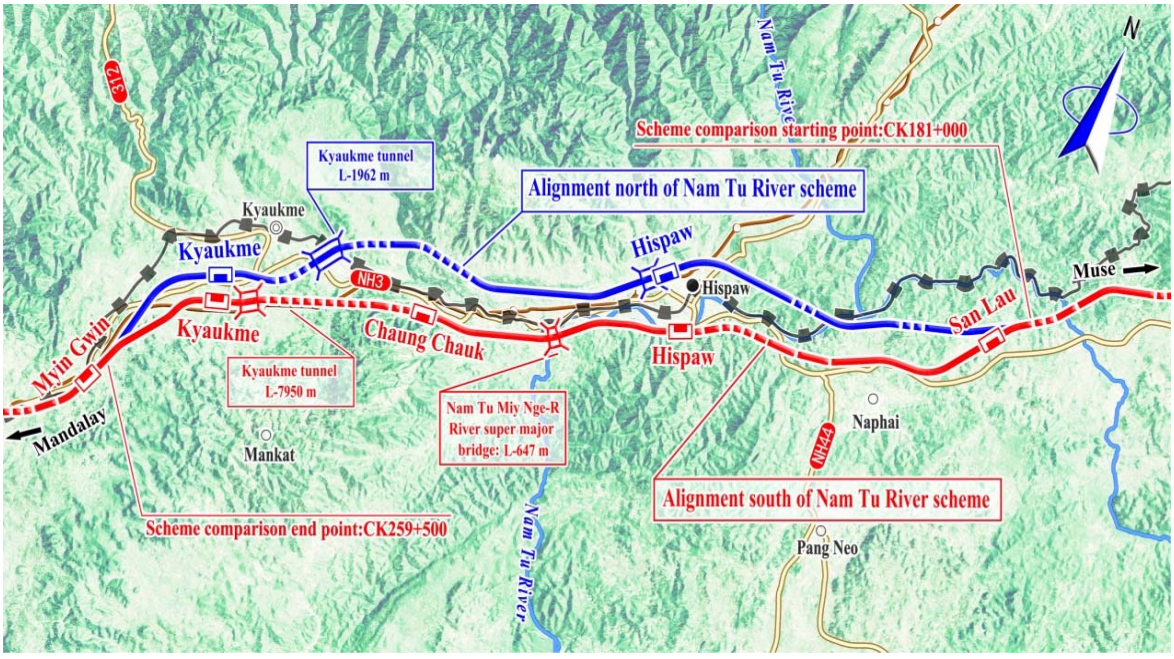


Figure 4.20 - Schematic Map of the Alignment Scheme of San Lau-Myin Gwin Section

Scheme Description

Alignment south of Nam Tu River scheme: The route starts from San lau Station, runs along NH3 Highway till Hispaw. Hispaw Station will be located on the south of the Nam Tu River. After crossing the Nam Tu River westwards, the route ascends to Kyaukme with sufficient grade, where Kyaukme Station is envisaged, before reaching the comparative terminal – Myin Gwin Station. This scheme has a total length of 64.866km, with a bridge & tunnel ratio of 50.8%.

Alignment north of Nam Tu Rive scheme: The route starts from San lau Station, crosses the Nam Tu River before reaching the northwest of Hispaw, where a station is envisaged, continues westwards and ascends to Kyaukme with sufficient grade, where a station is envisaged, and then reaching the comparative terminal – Myin Gwin Station. This scheme has a total length of 64.842km, with a bridge and tunnel ratio of 50.2%.

Engineering Quantity, Cost, Technical & Economic Comparison

See Table for the engineering quantity and cost comparison of the schemes, and see the next Table for their main technical-economic comparison.

Table 4.13 - Comparison of Main Engineering Quantities and Costs for San lau-Myin Gwin Section

Scope of comparison: CK181+000-CK259+500

Item		Unit	Alignment south of Nam Tu River	Alignment north of Nam Tu River
			Quantity	Quantity
Construction length		km	64.866	66.842
Demolition and land acquisition	Demolition	m^2	22,902.9	35,400.9
	Road relocation	km	14.9	18.5
	Land for permanent use	10^4m^2	371.7	383.1
	Land for temporary use	10^4m^2	170.2	175.4

Table 4.14 - Main Technical-economic Comparison for San lau-Myin Gwin Section

S/N	Item	Alignment south of Nam Tu River	Alignment north of Nam Tu River
1	Site condition	1. As the Hispaw Station is adjacent to the mountain on the south and the river in the north, its terrain condition is limited. 2. The terrain of Kyaukme Station is relatively open.	1. The terrain of Hispaw Station is relatively open. 2. The Kyaukme Station is closely adjacent to NH3 Highway, and its demolition amount is large.
2	Geological condition	They are generally similar in formation lithology and geological structure. Both shall take into account the existence of unfavorable geological phenomena and the development of special rocks or soils. There are risks of gushing, mud rush and collapse in karst areas where a tunnel is constructed, karst collapse in subgrade or bridge works and other engineering geological problems.	
3	Engineering condition	Key bridge / Nr.	647m/1	2,482m/2
		Long tunnel /Nr.	7,950/1	5050/1
4	Railway length/ratio of bridges and tunnels	64.866/50.8%	66.842/50.2%
5	Cost of main works	949 million USD	972 million USD

Analyzed from site condition of station, in the alignment south of Nam Tu River, as the Hispaw Station is adjacent to the mountain on the south and the river in the north, its terrain condition is limited. However, as the station is closely adjacent to the NH3 Highway Bridge, it will facilitate the travel of passengers. The terrain of Kyaukme Station is relatively open. In the alignment north of Nam Tu River, the terrain of Hispaw Station is relatively open; the Kyaukme Station is closely adjacent to NH3 Highway, and its demolition amount is large. Therefore, the station condition in the alignment south of Nam Tu River is relatively better.

Comparison of Geological Conditions

The following table shows some technical consideration for alternative analysis based on geological conditions.

Table 4.15 - Comprehensive Comparisons of Engineering Geological Conditions for San lau-Myin Gwin Section

Engineering geological conditions	Alignment south of Nam Tu River	Alignment north of Nam Tu River
Topography and Geomorphology	The planation surface of the Shan State Plateau is observed with erosive and corrosive low-mountain and hill-like landform features. This area is mostly 400-1000m in altitude. The top of the plateau surface is mostly gently undulated planation surface (from dozens to hundreds of meters), occasionally found with plateau basin units and development of locally deep-cut valleys.	
Formation lithology	The formation mainly consists of Quaternary eluvial, pluvial and alluvial soft-weak soil, slightly expansive soil and silty clay; the underlying bedrock consists of Jurassic (J)medium-sized sandstone, silty mudstone and mudstone, occasionally observed with mudstone, silty mudstone and seams as well as Upper Paleozoic (Pz_2) dolomite and dolomitic limestone.	
Geological structure	Structural movements are intense in this area, leading to complicated geological structures and development of faults.	
Hydrogeology	Surface water is mainly from the Nam Tu miy Nge River, the Nam hsim-c and its seasonal branches, which is non-erosive. Ground water is mainly pore water, bedrock fissure water and karst water. Hydro-geological conditions are complicated.	
Main engineering geological problems	(1) CK181+000-CK230+000 Section of the Line passes through areas where falls, collapses, rock taluses and landslides as well as other unfavorable geological phenomena are frequent, presenting certain risks for construction and operation. (2) Most of the areas passed by the Line are found with carbonatite. Weathered residual red clay is slightly expansive. Such clay in certain areas is strongly expansive. Soft and weak soil covers some low-lying and undulated areas, which may significantly impact the construction of subgrade. (3) Karst is moderately-intensively developed, possibly causing engineering geological problems including tunnel gushing, mud rush, collapse or collapse of karst in subgrade or bridge works.	(1) Most of the areas passed by the Line are found with carbonatite. Weathered residual red clay is slightly expansive. Such clay in certain areas is strongly expansive. Soft and weak soil covers the northern edge and certain low-lying and undulated areas of the Hispaw Basin, which may significantly impact the construction of subgrade. (2) Karst is moderately-intensively developed, possibly causing engineering geological problems including tunnel gushing, mud rush, collapse or collapse of karst in subgrade or bridge works.

Engineering geological conditions	Alignment south of Nam Tu River	Alignment north of Nam Tu River
Advantages	The mileage of the Line crossing river deposit is short, thus the problems of soft soil and sand liquefaction are minor.	The Line passes from the northern edge of the Hispaw Basin, where the terrain is flat and thus unfavorable geological phenomena due to gravity are minor.
Disadvantages	(1) There are risks of gushing, mud rush and collapse in karst areas where a tunnel is constructed. (2) Falls, collapses, rock taluses and landslides are frequent near the Line.	(1) There are large quantities of works of bridges crossing deep-cut river valleys. The mileage of the Line passing through the basin edge and river terraces is long, where expansive soil subgrade slopes are expected. (2) The mileage of the Line crossing the alluvial and pluvial layers of the basin is long, leading to major concerns for soft soil and sand liquefaction. (3) The mileage of the Line passing through karst areas is long. There are risks of gushing, mud rush and collapse in karst areas where a tunnel is constructed.
Evaluation of Engineering Geological Conditions	The engineering geological conditions are quite poor.	The engineering geological conditions are quite poor.

As shown in the above table, the two schemes are similar in topography and generally similar in formation lithology and geological structure. Both shall take into account the existence of unfavorable geological phenomena and the development of special rocks or soils. There are risks of gushing, mud rush and collapse in karst areas where a tunnel is constructed, karst collapse in subgrade or bridge works and other engineering geological problems. Therefore, the engineering conditions of the two schemes are equivalent.

In summary, the alignment south of Nam Tu River features shorter route, lower cost, simple construction process, convenient traffic and good construction conditions. Therefore, the alignment south of Nam Tu River is recommended in the study.

(4) Alignment Scheme of Myin Gwin-Om Ma Ka Section

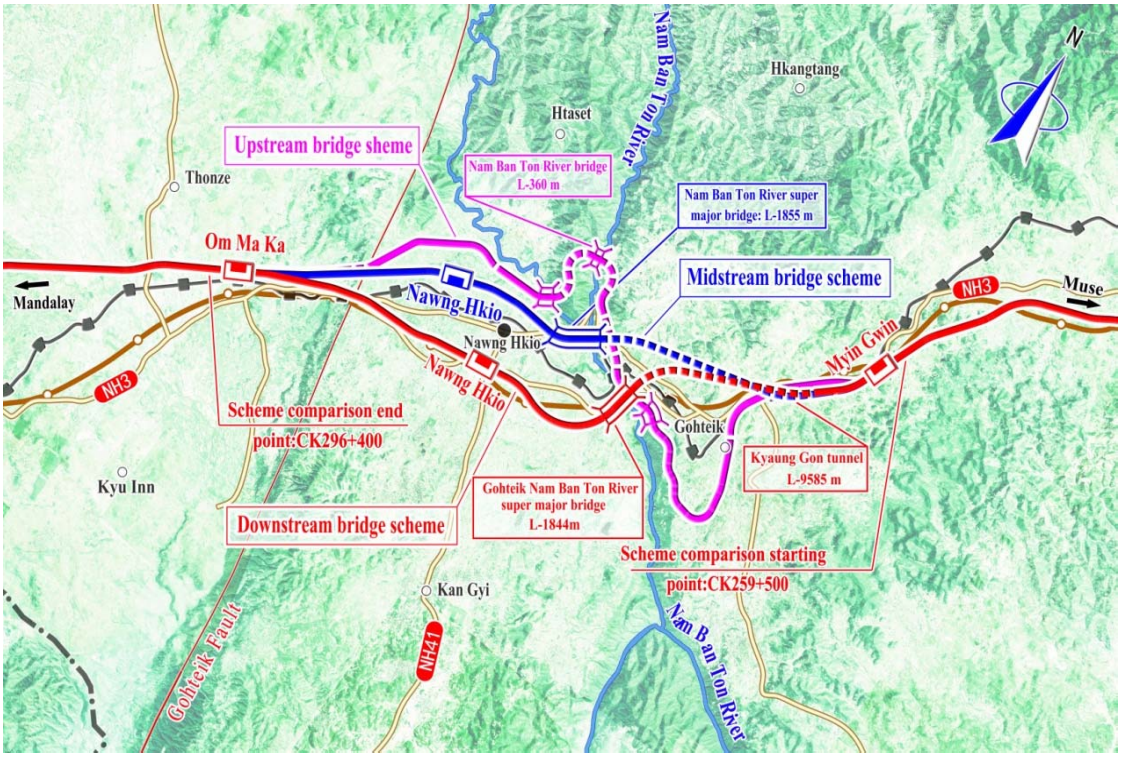


Figure 4.21 - Schematic Map for the Alignment Scheme of Myin Gwin-Om Ma Ka Section

Scheme Description

Upstream bridge scheme: The line leaves Myin Gwin Station, and travels along the NH3 Highway to Gohteik. In order to lower the height of the bridge crossing the Nam ban Ton River, the Myin Gwin – Nam ban Ton River section should be provided with line extension. As large radius cannot adapt to the terrain, the line extension with small radius will be used to reach the upstream of the Nam ban Ton River. A continuous steel-structure bridge with a main span of (68+128+68)m should be set to cross the Nam ban Ton River to the north side of the Nawng Hkio station, and finally arrives at the end of Om ma ka Station. The total length of the line is 51.28km, and the bridge & tunnel ratio is 44.1%.

Midstream bridge scheme: The line leaves Myin Gwin Station and runs westwards to Kyaung Gon Tunnel (L-11695m). The Nam Ban Ton River Super Major Bridge will be built at the line extension along NH3 Highway so that the line can cross the river, then it reaches Nawng

Hkio North, where a station is to be built, and finally arrives at Om Ma Ka Station. The total length of the line is 35.71km, and bridge and tunnel ratio is 55.2%.

Downstream bridge scheme: The Line leaves Myin Gwin Station, runs westwards to Kyaung Gon Tunnel (L-9565m) where it turns towards the southeast, crosses the Nam Ban Ton River by the Nam Ban Ton River Super Major Bridge which is built at approximately 900m downstream of Gohteik Meter-gauge Bridge, runs westwards, where a station will be built in the south of Nawng Hkio, and reaches Om Ma Ka Station. The total length of the line is 36.9km, and bridge and tunnel ratio is 55.9%.

Engineering Quantity, Cost, Technical & Economic Comparison

See table for the engineering quantity and cost comparison of the schemes, and see following table for their main technical-economic comparison.

Table 4.16 - Comparison of Main Engineering Quantities and Costs for Myin Gwin-Om Ma Ka Section

Scope of comparison: CK259+500-CK296+400

Item		Unit	Downstream bridge scheme	Midstream bridge scheme	Upstream bridge scheme
			Quantity	Quantity	Quantity
Construction length		km	36.900	35.71	51.28
Demolition and land acquisition	Demolition	m^2	10,536.8	9,225.0	10,326.1
	Road relocation	km	4.7	3.6	5.6
	Land for permanent use	10^4m^2	188.1	183.4	261.4
	Land for temporary use	10^4m^2	86.2	84.0	119.7

Table 4.17 - Main Technical-economic Comparison for Myin Gwin-Om Ma Ka Section

S/N	Item	Downstream bridge scheme	Midstream bridge scheme	Upstream bridge scheme
1	Design speed of passenger train	160km/h (conditions for 200km/h on double track reserved)	160km/h (conditions for 200km/h on double track reserved)	120km/h
2	Length/ height of Nam Ban Ton Bridge	1843.9m/178m	1855.3m/122m	360m/79m

S/N	Item	Downstream bridge scheme	Midstream bridge scheme	Upstream bridge scheme
3	Relationship with the fault	It will not cross the fault.	It will cross two faults where structures are developed and bank slope stability is poor.	It will cross two faults where structures are developed and bank slope stability is poor.
4	Length/Nr. of key tunnel	9585m/1	11695m/1	3495m/1
5	Railway length/ ration of bridges and tunnels	36.9km/ 56.2%	35.71km/ 54.2%	51.28km/46.1%
6	Cost of main works	681 million USD	720 million USD	728 million USD

Scheme Selection and Recommendation

Analyzed from target speed, both the downstream bridge scheme and the midstream bridge scheme can satisfy the 160km/h (conditions for 200km/h on double track reserved) standard, but the upstream bridge scheme requires a speed limit of 120km/h. Analyzed from bridge type and span arrangement, in the downstream bridge scheme, as both sides of the valley are steep slopes, the span of the full bridge is arranged as: 2(6×32+(1×48+2×36)m steel-concrete composite girders + (148+2×260+148m)steel-concrete double-layer combined rigid frame + 2×50m steel-concrete composite girders + 20×32). The two piers on the south are over 100m high.

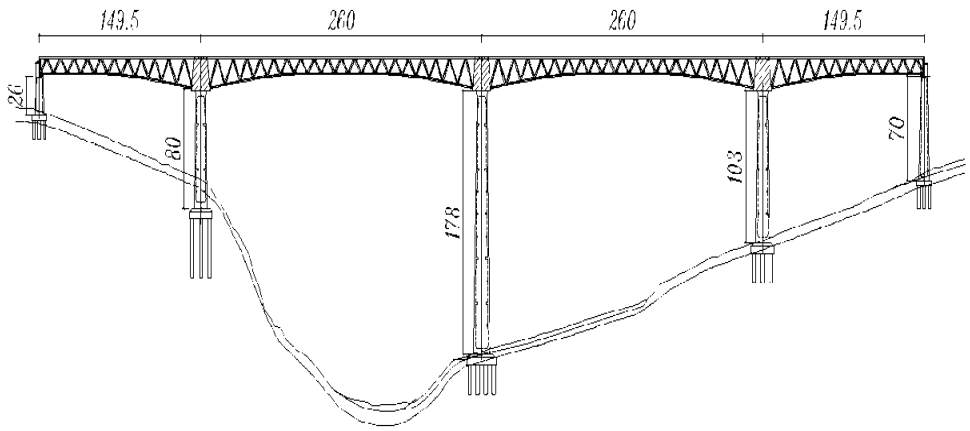


Figure 4.22 - Bridge Span Arrangement of the Downstream Bridge Proposal

In the midstream bridge scheme, the terrain is high in the north and low in the south. The span of the full bridge is: 2 (4×32m + (168+336+168)m continuous steel truss arched girder +5×144m continuous steel truss girder + 30×32m). The five piers on the south are over 100m high.

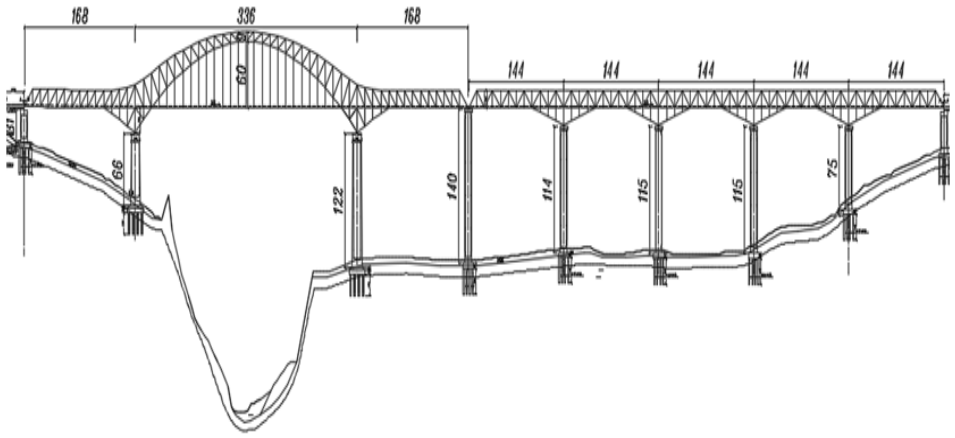


Figure 4.23 - Bridge Span Arrangement of the Midstream Bridge Proposal

In the upstream bridge scheme, as both sides of the valley are steep slopes, the span of the full bridge is arranged as: 2 (2×24m+ (68m+128m+68m) continuous steel structure +2×24m). None of the piers are over 100m high.

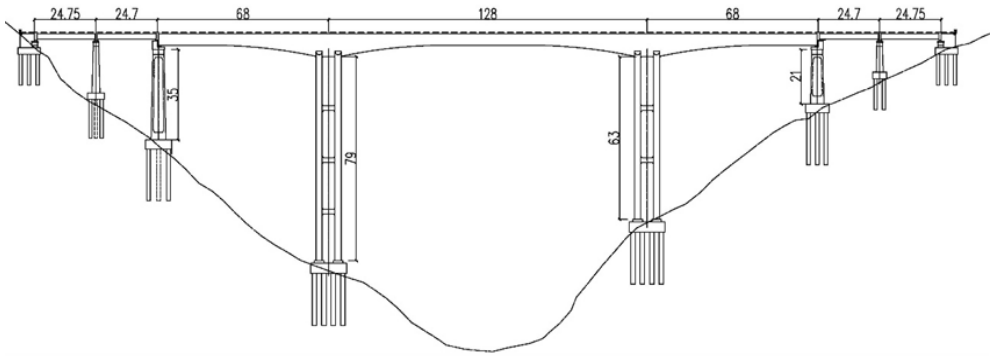


Figure 4.24 - Bridge Span Arrangement of the Upstream Bridge Proposal

Analyzed from bridge type and span arrangement, the downstream bridge scheme features larger main span and less high piers; the midstream bridge scheme features the longest main span and the most high piers; and the upstream bridge scheme features small main span and least high piers.

Comparison of Geological Conditions

Table 4.18 - Comparison of Geological Conditions for Myin Gwin-Om Ma Ka Section

Engineering geological conditions	Downstream bridge scheme	Midstream bridge scheme	Upstream bridge scheme
	The survey area belongs to Shan Plateau landform and is mostly located at an altitude of 400-810m and above. The top of the plateau surface is generally planation surface with relatively gentle relief, the surface relief is greater and incised valleys are developed.	The survey area belongs to Shan Plateau landform and is mostly located at an altitude of 450-900m and above. The top of the plateau surface is generally planation surface with relatively gentle relief, the surface relief is greater and incised valleys are developed.	The survey area belongs to Shan Plateau landform and is mostly located at an altitude of 500-900m and above. The top of the plateau surface with relatively gentle relief, the surface relief is greater and incised valleys are developed.
Formation lithology	The whole section is mainly composed of Quaternary red clay, and the underlying bedrock is Upper Paleozoic (Pz2) dolomite and dolomitic limestone.		The Section crosses formations mainly composed of Quaternary silty clay and red clay. The bedrock is siltstone, fine sandstone, silty mudstone, dolomitic limestone, limestone and argillaceous limestone, dolomite, and some slate, phyllite and schist.
Geological structure	In the survey area, the Gohteik fault is developed. The fault is thrust, and the strike is 340° -350° . The length of the fault in the area is 68km, which is the fault of the early and middle Pleistocene. No fault was observed near the bridge site area.	In the survey area, the Gohteik fault is developed. The fault is thrust, and the strike is 340° -350° . The length of the fault in the area is 68km, which is the fault of the early and middle Pleistocene. Two unidentified faults are developed near the bridge site.	In the survey area, the Gohteik fault is developed. The fault is thrust, and the strike is 340° -350° . The length of the fault in the area is 68km, and it is the fault of the early and middle Pleistocene. Two unidentified faults are developed near the bridge site.

Engineering geological conditions	Downstream bridge scheme	Midstream bridge scheme	Upstream bridge scheme
Hydrology	Underground water is mainly pore water and karst water. Local hydro-geological conditions are complicated.	Underground water is mainly pore water and karst water. Local hydro-geological conditions are complicated.	Underground water is mainly pore water, karst water and bedrock fissure water. Local hydro-geological conditions are complicated.
Main engineering geological problems	The Line passes through areas where karst, surrounding falling rocks and rock taluses are developed. Special rock or soil found along the line is expansive soil. Colluvial soil is slightly expansive which becomes soft with water and cracks when water is lost. The self-stability of local soil mass is poor.	(1) The Line passes through areas where karst, surrounding falling rocks and rock taluses are developed. Special rock or soil found along the line is expansive soil. Colluvial soil is slightly expansive which becomes soft with water and cracks when water is lost. The self-stability of local soil mass is poor. (2) The karst development is medium to strong, and there are engineering geological problems such as tunnel water inrush, mud burst, and collapse. There are engineering geological problems such as karst collapse in the subgrade and	Unfavorable geology such as unstable slopes, karst rocks and falling rocks are developed. The special geotechnical soil is expansive soil. It is a weak-medium expansive soil. It has easy water-softened and water-dried characteristics, and the soil has poor self-stability.

Engineering geological conditions	Downstream bridge scheme	Midstream bridge scheme	Upstream bridge scheme
		bridge sections. (3) The length of the tunnel is long, and the risk of karst and karst water is large. Larger caves may be encountered and is prone to water inrush and mud.	
Advantage	(1) Subgrade and bridge sections are short, and engineering geological problems such as karst collapse are few. (2) No structural traces are found in the bridge site area, and the stability of the bank slope is relatively good.	Subgrade and bridge sections are short, and engineering geological problems such as karst collapse are few.	(1) There are relatively fewer major works, and the construction risks of tunnel construction are relatively small. (2) The river valley cutting is relatively shallow, and the construction difficulty is easier than the latter two schemes.
Disadvantage	(1) There are relatively many major works, and the construction risks of tunnel works are relatively high. (2) The adverse geological conditions such as talus, karst, rockfall and landslide are relatively developed. (3) The valley is deep in cutting, the pier is high, and the construction is	(1) There are relatively many major works, and theconstruction risks of tunnel works are relatively high. (2) The adverse geological conditions such as talus, karst, rockfall and landslide are relatively developed. (3) The valley is deep in cutting, the pier is high, and the construction is difficult.	(1) Subgrades and bridges are long, and the lines are large. (2) The line crosses the fault twice, with complex lithology and complicated hydrogeology. The stability of the bank slope in the bridge area is poor.

Engineering geological conditions	Downstream bridge scheme	Midstream bridge scheme	Upstream bridge scheme
	difficult.	(4) The line crosses the fault twice, and the lithology is all dolomitic limestone. The surface water near the line is developed, the hydrogeology is relatively complicated, and the stability of the bank slope is poor.	
Evaluation of Engineering Geological Conditions	The engineering geological conditions are relatively good.	The engineering geological conditions are good.	The engineering geological conditions are poor.

It can be seen from the above table that the topography and landform of the three schemes are similar: the unfavorable geology and the special rock & soil are relatively developed, and the geological conditions of the three schemes are all relatively poor. But the upstream and midstream bridges would pass through two faults, where the structure is relatively developed, and the bank slope is not stable. The downstream bridge does not cross the fault, and the downstream geological conditions are relatively good.

In summary, the upstream bridge has the longest line length and a large investment. It needs to adopt a small-radius line extension based on the topography, and the design speed shall be limited to 120km/h. The midstream bridge has the shortest line length, but is limited by terrain, and has many high piers, so the cost is the largest; although the length of the downstream bridge is slightly longer than the midstream scheme, the cost is the smallest, so this study recommends the downstream bridge scheme.

(5) Alignment Plan of Om ma ka-Mandalay East Section

This section passes through two economic centers of Pyinoolwin (H=1100m)and Mandalay (H=80m). Due to the huge difference in elevation, the line needs to go down through line

extension. Choosing the appropriate location and elevation of the Pyinoolwin station to start the line extension becomes a key issue in this alignment plan.

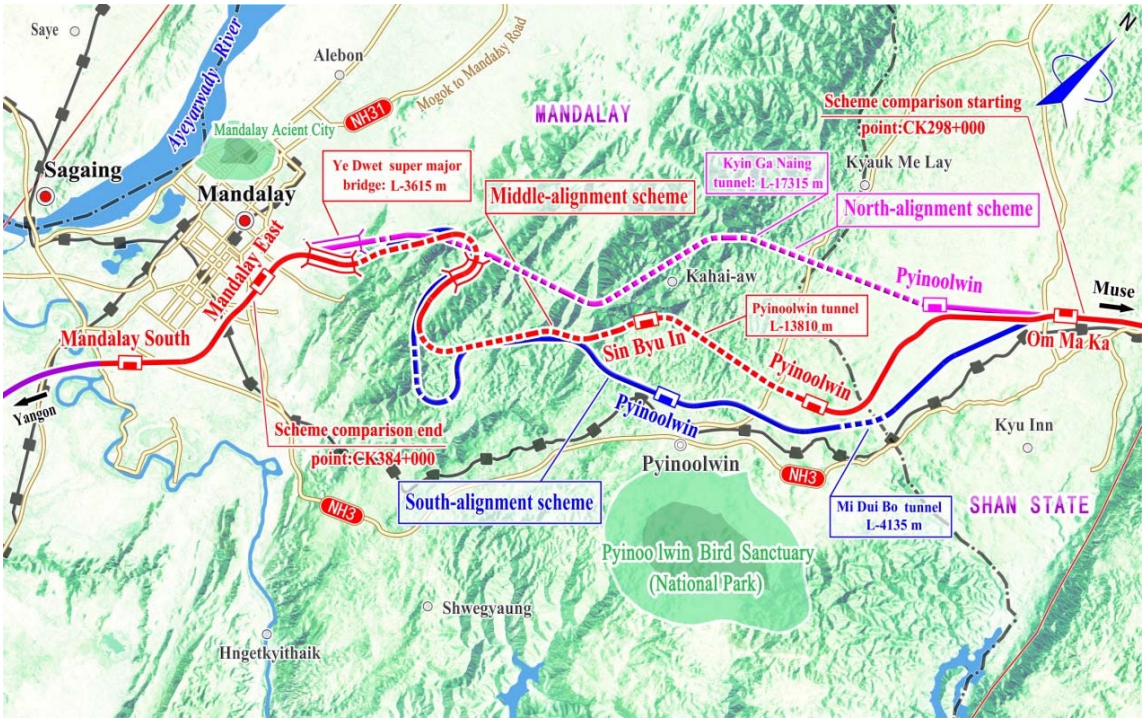


Figure 4.25 - Schematic Map for the Alignment Scheme of Om Ma Ka–Mandalay Section

Scheme Description

North-alignment scheme: The line leads out from the Om ma ka Station, and heads southwest to the north side of Pyinoolwin Station, about 25km from the city center (H=800m), and then starts the line extension to the terminal Mandalay East Station. The total length of the line is 69.449km, and the bridge & tunnel ratio is 75%.

Middle-alignment scheme: The line leads out from the Om ma ka Station, and heads southwest to the northeast side of Pyinoolwin Station, about 10km away from the city center (H=1034.2m), and then sets the Pyinoolwin tunnel (L-13810m)and starts the downhill, and arrives at the terminal Mandalay East Station. The total length of the line is 86km, and the bridge & tunnel ratio is 62.3%.

South-alignment scheme: The line leads out from the Om ma ka Station, and travels southwest along the NH3 Highway to the northwest side of Pyinoolwin Station, about 2.5km from the city center (H=1081.4m)and starts the downhill to the terminal Mandalay East Station. The total length of the line is 92.294km, and the bridge & tunnel ratio is 56.9%.

Comparison of Engineering Quantity and Cost, Technology and Economy

See Table for the engineering quantity and cost comparison of the schemes, and see Table for their main technical-economic comparison.

Table 4.19- Comparison of Major Engineering Quantities and Cost in the Om ma ka-Mandalay East Section

Comparison Scope CK298+000～CK384+000

Item		Unit	Middle-alignment scheme	South-alignment scheme	North-alignment scheme
			Quantity	Quantity	Quantity
Construction length		km	86.000	92.294	69.449
Demolition and land acquisition	Demolition	m^2	17,141.5	29,433.7	16,284.5
	Road relocation	km	15.6	20.1	12.6
	Land for permanent use	10^4m^2	377.2	485.8	304.6
	Land for temporary use	10^4m^2	172.8	185.4	139.5

Table 4.20- Comparison of Route Scheme of Om ma ka-Mandalay East Section

S/N	Item	Middle-alignment scheme	South-alignment scheme	North-alignment scheme
1	Distance of Pyinoolwin station to city center/elevation	10km/1034.2m	2.5km/1,081.4m	25km/800m
2	Impact on underground water of Pyinoolwin	no	yes	no
3	Geological conditions	good	poor	poor
4	Key tunnel works length/Nr.	23600m/2	/	33800m/3
5	Route length/ bridge & tunnel ratio	86km/62.3%	92.294km/56.9%	69.449km/75%

S/N	Item	Middle-alignment scheme	South-alignment scheme	North-alignment scheme
6	Cost of main works	1.341 billion USD	1.379 billion USD	1.131 billion USD

Scheme Comparison and Recommendations

Analyzed from Pyin Oo Lwin station location, in the north alignment scheme, Pyin Oo Lwin station is about 25km away from the city center, which is not convenient for passengers. In the middle alignment scheme, Pyin Oo Lwin station is about 10km away from Pyin Oo Lwin city center, of which the demolition amount is small and is conducive to the development of the city; In the southern alignment scheme, Pyin Oo Lwin Station is about 2.5km away from the city center of Pyin Oo Lwin, which is convenient for passengers, but the station is at the edge of the city, and the amount of demolition is large, which has certain influence on the further development of the city.

Analyzed from the impact on underground water in Pyin Oo Lwin area, the north alignment scheme and the middle alignment scheme have no impact on the groundwater in Pyin Oo Lwin City, while the south alignment scheme has certain impact, which may cause water loss in the northwest area of the Pyin Oo Lwin City, and may further induce environmental problems.

Comparison of Geological Conditions

Table 4.21- Comprehensive Comparison of Engineering Geological Conditions

Engineering geological conditions	Middle alignment scheme	South alignment scheme	North alignment scheme
Topography and Geomorphology	The front part of 29.4km belongs to the erosive dissolution hills and basin topography of the Shan State Plateau, and the undulation is relatively low, with an altitude of 760-1150m; the middle section of 36.9km belongs to the western edge of the Shan Plateau, which is characterized by erosive and dissolution of middle and low mountainous	The front part of 29km belongs to the erosive dissolution hills and basin topography of the Shan State Plateau, and the undulation is relatively low, with an altitude of 760-1150m; the middle section of 43.6km belongs to the western edge of the Shan Plateau, which is characterized by erosive and dissolution of middle and low	The front part of 19.5km belongs to the erosive dissolution hills and basin topography of the Shan State Plateau, and the undulation is relatively low, with an altitude of 760-1150m; the middle section of 30km belongs to the western edge of the Shan Plateau, which is characterized by erosive and dissolution

Engineering geological conditions	Middle alignment scheme	South alignment scheme	North alignment scheme
	landforms, there are some deep-cutting valley with an altitude of 100-1250m; the latter section of 19.7km belongs to the central basin of Myanmar, where terrain is open and flat, and the altitude is 68-100m.	mountainous landforms, there are some deep-cutting valley with an altitude of 110-1150m; the latter section of 19.7km belongs to the central basin of Myanmar, where the terrain is open and flat, and the altitude is 68-110m.	of middle and low mountainous landforms, there are some deep-cutting valley with an altitude of 110-1150m; the latter section of 20km belongs to the central basin of Myanmar, where the terrain is open and flat, and the altitude is 68-110m.
Formation Lithology	The covering layer mainly consists of Quaternary Holocene colluvial red clay, slightly expansive soil, silty clay and quaternary Holocene alluvial-proluvial slightly expansive soil, silty clay, silt and round gravelly soil; the underlying bedrock consists of Upper Paleozoic (Pz_2) dolomite and dolomitic limestone, Siluric (S) siltstone and muddy limestone as well as Ordovician (O) dolomite, sandstone, siltstone and mudstone.		
Geological Structure	ByinLay Fault and Shan State West Edge Fault are major faults found in this area. ByinLay Fault is a branch of Gohteik Fault with unknown nature and developed in Upper Paleozoic (Pz_2) limestone formation. The formation is clearly identified in aerial photography images. Rock masses in the proximity are broken. The fault intersects with the Line with an included angle of 53° . The Line passes through this area with general subgrade, for which certain engineering impacts are expected. The Shan State West Edge Fault has a transverse slipping rate of 3-5mm/a. In history, earthquakes with magnitude of 6-7 had hit	ByinLay Fault and Shan State West Edge Fault are major faults found in this area. ByinLay Fault is a branch of Gohteik Fault with unknown nature and developed in Upper Paleozoic (Pz_2) limestone formation. The formation is clearly identified in aerial photography images. Rock masses in the proximity are broken. The fault intersects with the Line with an included angle of 58° . The Line passes through this area with general subgrade, for which certain engineering impacts are expected. The Shan State West Edge Fault has a transverse	ByinLay Fault and Shan State West Edge Fault are major faults found in this area. ByinLay Fault is a branch of Gohteik Fault with unknown nature and developed in Upper Paleozoic (Pz_2) limestone formation. The formation is clearly identified in aerial photography images. Rock masses in the proximity are broken. The fault intersects with the Line with an included angle of 58° . The Line passes through this area with general subgrade, for which certain engineering impacts are expected. The Shan State West Edge Fault has a transverse

Engineering geological conditions	Middle alignment scheme	South alignment scheme	North alignment scheme
	this area, proving the fault to be a fault formed during activities of Late Pleistocene. The fault intersects with the Line by an included angle of 33°. Certain impacts on engineering are expected as the tunnel body is located in the intersecting area.	slipping rate of 3-5mm/a. In history, earthquakes with magnitude of 6-7 had hit this area, proving the fault to be a fault formed during activities of Late Pleistocene. The fault intersects with the Line by an included angle of 39°. Certain impacts on engineering are expected as the tunnel body is located in the intersecting area.	slipping rate of 3-5mm/a. In history, earthquakes with magnitude of 6-7 had hit this area, proving the fault to be a fault formed during activities of Late Pleistocene. The fault intersects with the Line by an included angle of 48°. Certain impacts on engineering are expected as the tunnel body is located in the intersecting area.
Hydrogeology	Surface water mainly comes from the branch of the Mandu River, the Ye dwet River, One Tree Reservoir, Great Waves Reservoir and its seasonal branches, showing no erosiveness. Ground water is mainly pore water, bedrock fissure water and karst water. Pore water is mainly founded in inter-mountain basins, low-lying ditches and the Mandalay Basin. Water yield property is poor in inter-mountain ditches while moderate in the Mandalay Basin. Underground water is buried shallow. Bedrock fissure water is mainly distributed in Siluric and Ordovician (O) sandstone, mudstone and other weathered formations and structural fissures, showing weak-	Surface water mainly comes from the branch of the Mandu River, the Ye dwet River, One Tree Reservoir, Great Waves Reservoir and its seasonal branches, showing no erosiveness. Ground water is mainly pore water, bedrock fissure water and karst water. Pore water is mainly found in inter-mountain basins, low-lying ditches and the Mandalay Basin. Water yield property is poor in inter-mountain ditches while moderate in the Mandalay Basin. Underground water is buried shallow. Bedrock fissure water is mainly distributed in Siluric and Ordovician (O) sandstone, mudstone and other weathered formations	Surface water mainly comes from the branch of the Mandu River, the Ye dwet River and its seasonal branches, showing no erosiveness. Ground water is mainly pore water, bedrock fissure water and karst water. Pore water is mainly found in inter-mountain basins, low-lying ditches and the Mandalay Basin. Water yield property is poor in inter-mountain ditches while moderate in the Mandalay Basin. Underground water is buried shallow. Bedrock fissure water is mainly distributed in Siluric and Ordovician (O) sandstone, mudstone and other weathered formations and structural fissures, showing weak-to-

Engineering geological conditions	Middle alignment scheme	South alignment scheme	North alignment scheme
	to-moderate water yield property and erosiveness in certain areas. Karst water is mainly distributed in Upper Paleozoic dolomite, dolomitic limestone and limestone, also in Ordovician karst formations, showing moderate-to-strong water yield property and no erosiveness. Karst water drains horizontally from the Shan State Plateau to the Mandalay Basin at an altitude of 160-260m. Karst water seeps vertically when the altitude is over 600m. Local hydro-geological conditions are complicated in general.	and structural fissures, showing weak-to-moderate water yield property and erosiveness in certain areas. Karst water is mainly distributed in Upper Paleozoic dolomite, dolomitic limestone and limestone, also in Ordovician karst formations, showing moderate-to-strong water yield property and no erosiveness. Karst water drains horizontally form the Shan State Plateau to Myitnge River and its branches and to the Mandalay Basin at an altitude of 160-260m. Karst water seeps vertically when the altitude is over 600m. Under this scheme, some of the tunnel bodies in C6K354-C6K361+900 will cross the horizontal drainage zone. Local hydro-geological conditions are complicated in general.	moderate water yield property and erosiveness in certain areas. Karst water is mainly distributed in Upper Paleozoic dolomite, dolomitic limestone and limestone, also in Ordovician karst formations, showing moderate-to-strong water yield property and no erosiveness. Karst water drains horizontally form the Shan State Plateau to Myitnge River and its branches and to the Mandalay Basin at an altitude of 160-260m. Karst water seeps vertically when the altitude is over 600m. Local hydro-geological conditions are complicated in general.
Main engineering geological problems	(1) Karst is moderately-intensively developed, possibly causing engineering geological problems including tunnel gushing, mud rush, collapse or collapse of karst in subgrade or bridge works.	(1) Karst is moderately-intensively developed, possibly causing engineering geological problems including tunnel gushing, mud rush, collapse or collapse of karst in subgrade or bridge works.	(1) Karst is moderately-intensively developed, possibly causing engineering geological problems including tunnel gushing, mud rush, collapse or collapse of karst in subgrade or bridge works.

Engineering geological conditions	Middle alignment scheme	South alignment scheme	North alignment scheme
	(2) The formation on the right side of CK337+495-CK339+800 Section is observed with bedding lateral pressure, which is lithologically composed of siltstone, limestone and shale, featured in interbedding of hard and soft rocks. Rocks can collapse or slide along any soft and weak surface once a free face is formed as a result of excavating the bedding lateral pressure section. (3) To the left of CK333+000-CK330+300 Section upstream of the Pyinoolwin Tunnel is the One Tree Reservoir. In terms of lithology, the tunnel will be built on Ordovician (O) siltstone with limestone and shale, where the formation is slightly dipped. Local formation structure and lithological combination are favorable for tunnel works. However, considering the small burial depth (about 137m) of the tunnel and the moderate degree of breakage of rock mass, reservoir water will inevitably supply local underground water and cause some impacts on the tunnel. (4) The red clay is weakly expansive, and the soft soil is distributed in the low-lying part of	(2) Carbonatite areas of the low-lying and slightly undulated hills and basin areas of the Shan State Plateau are covered with weathered eluvial red clay, which is slightly expansive in nature. Loose and soft soil is found in certain low-lying and flat areas, being a major concern for subgrade works and sloping works of tunnel entrance. (3) The silt and sandy soil layers in certain areas of the Mandalay Basin are liquefied layers, which are major concerns for subgrade and bridge works.	(2) Carbonatite areas of the low-lying and slightly undulated hills and basin areas of the Shan State Plateau are covered with weathered eluvial red clay, which is slightly expansive in nature. Loose and soft soil is found in certain low-lying and flat areas, being a major concern for subgrade works and sloping works of tunnel entrance. (3) The silt and sandy soil layers in certain areas of the Mandalay Basin are liquefied layers, which are major concerns for subgrade and bridge works.

Engineering geological conditions	Middle alignment scheme	South alignment scheme	North alignment scheme
	the local low-lying area, which has a great influence on the subgrade and tunnel entrance slope engineering. (5) The silt and sandy soil layers in certain areas of the Mandalay Basin are liquefied layers.		
Features in common	Under all the schemes, the Line passes through the Shan State Plateau and the transition area from the Shan State Plateau to the Myanmar Central Basin where the terrain is greatly undulated. In these areas, slightly expansive and liquefiable soils are distributed, possibly causing engineering geological problems including tunnel gushing, mud rush, collapse or collapse of karst in subgrade or bridge works.		
Advantages	The mileage of the tunnel works passing through the horizontal flow zone of karst is quite short.		The tunnel works are far from the One Tree Reservoir and the Shenglangd Reservoir, thus the impact on reservoir works is minor.
Disadvantages	The tunnel works are near the One Tree Reservoir and the Great Waves Reservoir, causing certain impact on reservoir works.	The mileage of the Line passing through karst areas is quite long. The tunnel works pass through the horizontal flow zone of karst in a long distance, causing great impact on engineering works by karst and karst water.	the mileage of the Line passing through karst areas is quite long, and the burial depth is shallow.
Evaluation of Engineering Geological Conditions	The engineering geological conditions are good.	The engineering geological conditions are poor.	The engineering geological conditions are poor.

It can be seen from the above table that the topography and landform of the three schemes are similar, the lithology and geological structure of the stratum are similar, and the unfavorable geology and special rock & soil are relatively developed. Geological problems such as tunnel

inrush, mud burst and collapse are existent in the tunnels, and subgrade and bridge sections have the danger of karst collapse. The middle-alignment scheme is relatively superior in controlling karst.

In summary, in the northern alignment scheme, the Pyin Oo Lwin Station is too far away from the city, which is not conducive to driving urban economic development. The construction risk of long one-way slope karst tunnel is high; the south-alignment scheme has an impact on the groundwater in the northwestern part of Pyin Oo Lwin city, prone to causing groundwater loss in the area. Although the Pyin Oo Lwin Station is slightly far from the city, the urban development space is reserved, the cost is saved, and the construction risk is relatively small. Therefore, the middle-alignment scheme is recommended.

4.5.2.2. Alternative Analysis for Alignment based on Environmental Consideration

Secondly, the alternative analysis will be based on environmental sensitive areas as shown in the following table.

	Alternatives	*Ecologically Important Area and Recreational Area*	*Historical, Archaeological, Cultural and Heritage*	*Mineral Abundance Areas*	*Surface Water Resources*	*Sensitive Forest Areas*	*Residential Areas*
Shwe Li East – Man Hawng Section	Alternative (Blue Line)	Industrial Zone	-	-	Shwe Li River Nan Paw Stream	-	Muse Nan Om
	Alternative (Red Line)	-	-	-	Shwe Li River Nan Paw Stream	-	Nam Sonn Nan Pann Wane Mine Kaung Khan Nan Om
Nam Hpak Ka to Lashio West Section	Alternative (Blue Line)	-	-	Sin Taung (Coal) (3 km) Mohochang Prospect (Lead, zinc & Silver) (21.12 km) Bawdwin Mine (Lead, zinc & Silver) (46.75 km)	Pang Phat Stream Namtu Stream	Nam Hpak Loon Protected Forest, Bone Mon Protected Forest, Kaung Lain Protected Forest	-
	2 (Red line)	-	-	Sin Taung (Coal) (3 km) Mohochang Prospect (Lead, zinc & Silver) (42.27km) Bawdwin Mine (Lead, zinc & Silver) (48.74km)	Pang Phat Stream Namtu Stream	Ho Nar Reserved Forest Nam Hpak Loon Protected Forest Kaung Lain Protected Forest Loi Sam Sit Natural Protected Forest Bone Mon Protected Forest	Nam Phat Loon Mang Lon Lwal Pal Ho Nar Nam Khone Man Nawng Par Gyo Man Chat Mang Sar Tone Wane Line Naung On Pan Sone

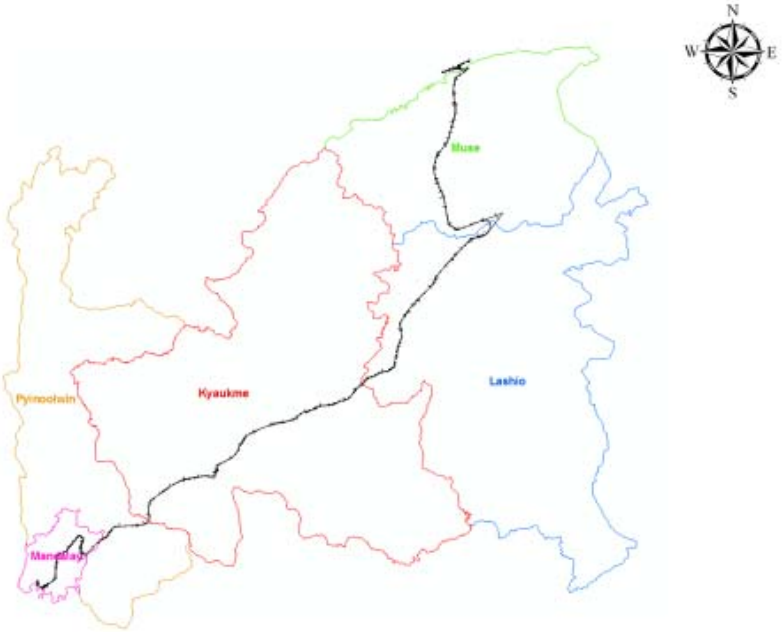
							Kungmyaung Nan Onn Nar Chat Pan Kham Nam Maw Hate Pan Phat Nam Hu Pan Hat Ho Pate
	3 (Green line)	-	-	Mohochang Prospect (Lead, zinc & Silver) (44.32 km)	Pang Phat Stream Namtu Stream	Bone Mon Protected Forest Ho Nar Reserved Forest Loi Sam Sit Natural Protected Forest	Ho Nar Nam Khone Man Nawng Par Gyo Man Peng
San Lau to Myin Gwin Section	1 (purple line)	Factory (0.79 km)	Shan Palace (1.8km) Baw Gyo Pagoda (0.9km)	Quarry (0.2 km) Namma (Coal) 26.98 km	Dokehtawady Stream	Namma Reserved Forest, Tein Lon Reserved Forest	Hsipaw Kyauk Me Pang Ywang Mway Taw HawngHang Na Ai Hkant
	2(red Line)	Factory (0.79 km)	Shan Palace (2.32 km) Baw Gyo Pagoda (1.02 km)	Namma (Coal) 26.98 km	Dokehtawady Stream Nant Lan Stream Kyin Thi Stream	Namma Reserved Forest, Pang Hsauk Protected Forest, Tein Lon Reserved Forest	Ho Nwang Soot Lan Pan Hsauk Nwang Eain Ton Kar Kyin Thi Nam Onn Ngon Sai Nwang Ann Pang Ywang Mway Taw Pauk Inn Lay Na Ai Hkant

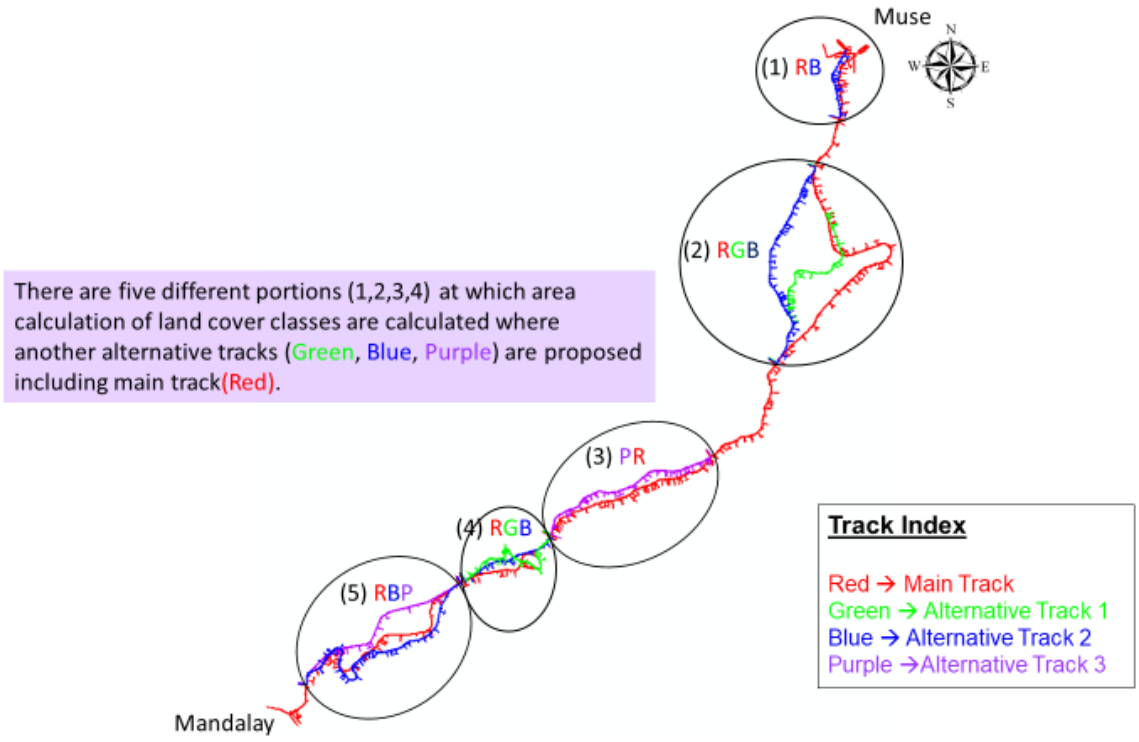
Myin Gwin to Om Ma Ka section	1(blue)	-Nawng Hkio Golf Club	Goke hteik Bridge (2.18km)	Yadanatheingi Mine (Lead, zinc & Silver) (38.18 km)	Namban Ton River	Tein Lon Reserved Forest	Khite Tone Home Kone Kaw Nam Tin Wan Ommakha Nawng Hkio
	2(red)	-Nawng Hkio Golf Club	Goke hteik Bridge (0.94 km)	Yadanatheingi Mine (Lead, zinc & Silver) (38.42 km)	Namban Ton River	Tein Lon Reserved Forest	Khite Tone Home Kone Kaw Kyaung Kone Myat Chae Nu Kone Gyi Ma Nawng Hkio (Taung Quarter) Ngoke Ka Lay Ban Bway Ommakha
	3 (green)	-Nawng Hkio Golf Club	Goke hteik Bridge (0.32 km)	Yadanatheingi Mine (Lead, zinc & Silver) (36.94 km)	Namban Ton River	Tein Lon Reserved Forest	Khite Tone Home Kone Kaw Gokhteik Nam Tin Wan Ommakha
Om Ma Ka – Mandalay East Section	1(purple)	Factory	Yankin Taung Mandalay Palace (5.8 km)	Phayaung Taung (gold) 7.95 km	Sae Taw gyi Canal	Taung Kyun Reserved Forest Taung Kyun Extended Reserved Forest Taung Khaung Reserved Forest	Kyin Ganai Samasal Yankin Taung Bo Tat Gone Shin Taw Gone Patheingyi
	2(red)	-	Mandalay Palace (5.89 km)	Pauktaw Iron 4.83 km Phayaung Taung (gold) 8.2 km	Pwe Kouk Waterfall 4.68 km Dat Taw Gyaint Water fall 7.32 km Sae Taw gyi	Taung Kyun Reserved Forest Taung Kyun Extended Reserved Forest Sakhan Gyi Reserved Forest Taung Pyo Extended Reserved Forest	Kyin Ganai Samasal Lone Yone Anauk Kyu Inn Pin Lain Myawt Taw Kone Kaw Pan Oo Taung

					Canal Thittapin Taung Watershed		Lain Pin Yankin Taung Bo Tat Gone Shin Taw Gone Patheingyi Taung ta lone Sinzagon Nyaingpinthar Thatyatkon Phyu Chaung Kho Ohn
	3(blue)	-	Pate Chin Myaung Cave (4.9km) Shwe Myin Tin Pagoda (2.43 km) National Kandawgyi Botanical Garden (6.61 km) Mandalay Palace (5.93 km)	Pauktaw Iron 3.68 km Inya Iron 7.51 km Anee Sakan (barite) 8.7 km Phayaung Taung (gold) 8.18 km	Inn Wine Waterfall 11.91 km Pwe Kouk Waterfall 2.35 km Dat Taw Gyaint Water fall 6.5 km Sae Taw gyi Canal	Taung Kyun Reserved Forest Taung Kyun Extended Reserved Forest Sakhan Gyi Reserved Forest Taung Pyo Extended Reserved Forest	Kyin Ganai Samasal Pin Lain Lain Pin Yankin Taung Bo Tat Gone Shin Taw Gone Gant Gaw Nyaung Baw Sin Lann Zu Nan Lin Khan Pwe Kauk Pyinoolwin Patheingyi

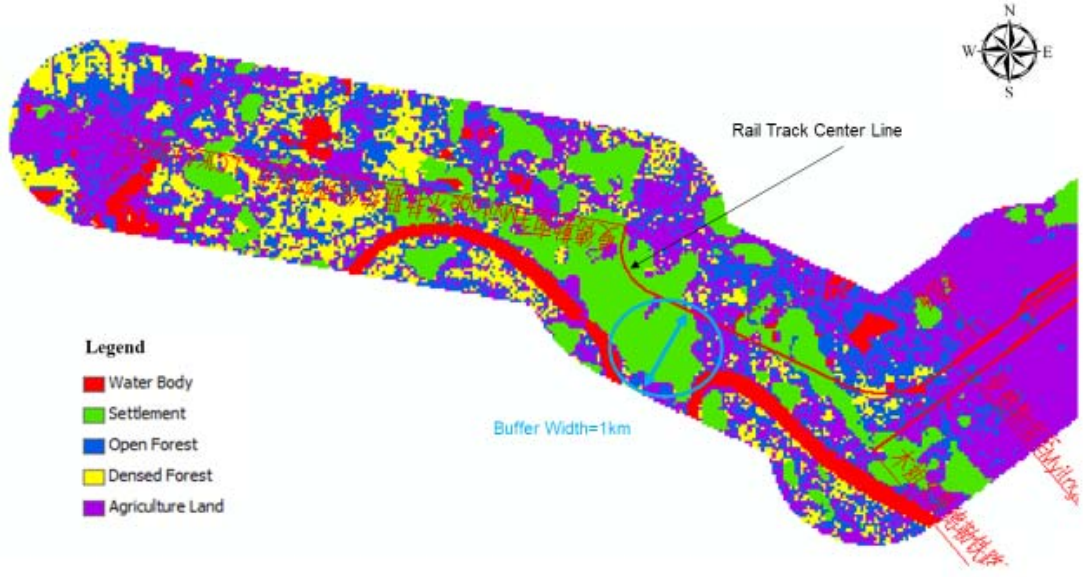
4.5.2.3. Alternative Analysis for Alignment based on Socio-economic Consideration

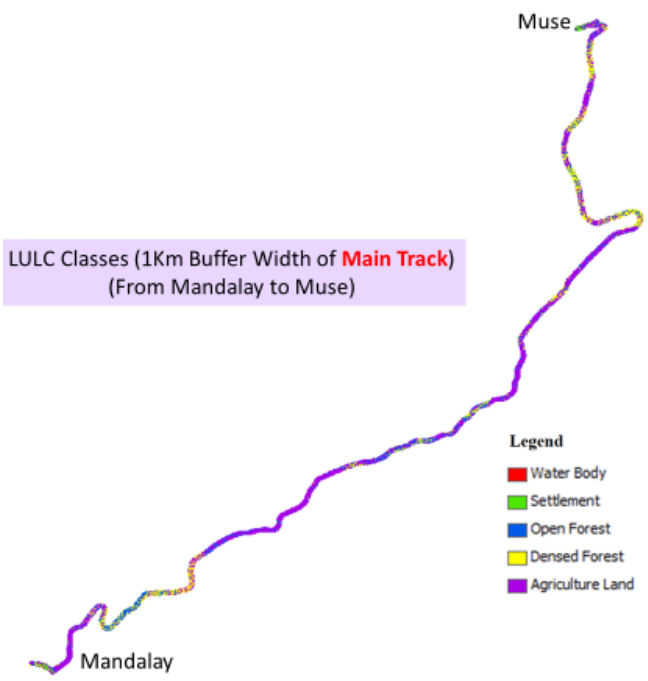
Finally, the alternative analysis will be based on socially sensitive areas such as residential area and agricultural land. All of the alternative analysis was done within 1km beside the proposed alignment expect for household that were accounted based on 100m beside the railway alignment. Firstly, alternative analysis for alignment will be based on the type of land use that the railway will pass or the use for other facilities. The land use type will be studied by GIS and Remote Sensing Method as follow:





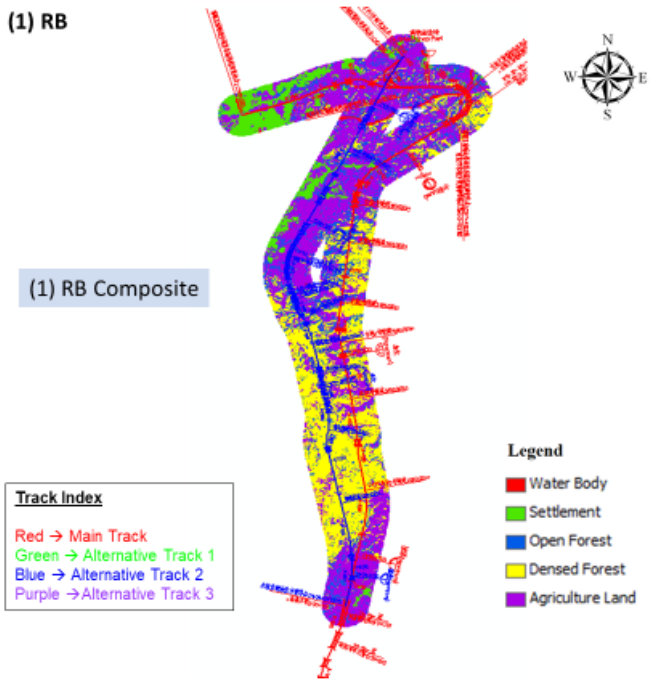
Area calculation of classified LULC classes are based on buffer width 1 Km around rail track centerline





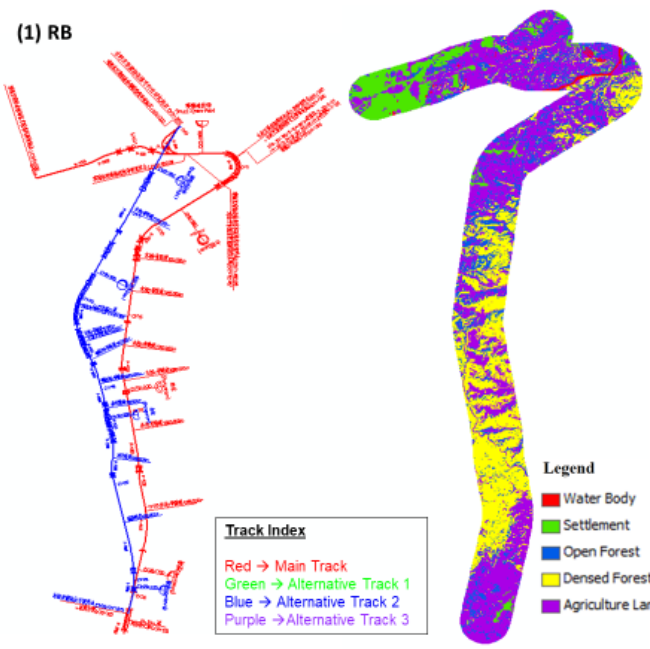
Red				
No.	Class	Area (km²)	Total Area (km²)	Area(%)
1	Water Body	0.4881	104.4952	0.467103
2	Agriculture Land	57.7331		55.249523
3	Dense Forest	22.8244		21.842534
4	Open Forest	21.7868		20.84957
5	Residential Area	1.6628		1.591269

(1) RB



Red				
No.	Class	Area (km²)	Total Area (km²)	Area(%)
1	Water Body	0.0691	9.4603	0.730421
2	Agriculture Land	4.3237		45.703625
3	Dense Forest	2.658		28.096361
4	Open Forest	1.5663		16.556557
5	Residential Area	0.8432		8.913037

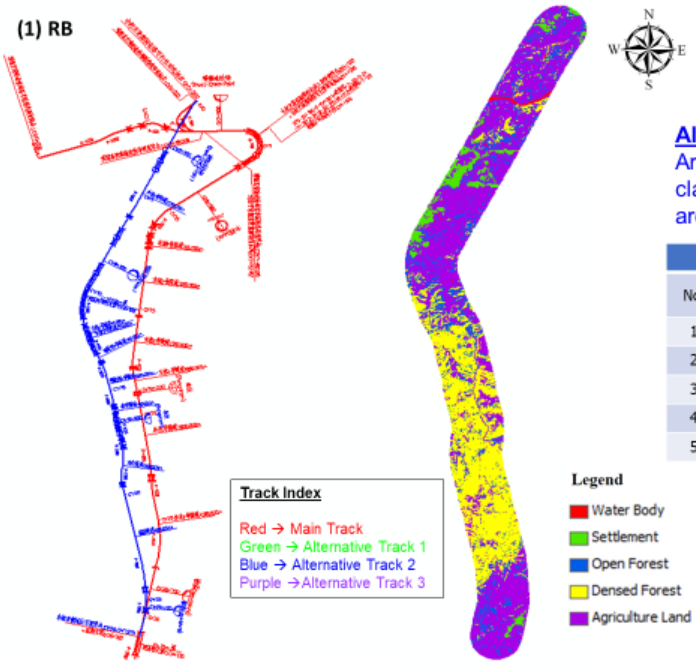
Blue				
No.	Class	Area (km²)	Total Area (km²)	Area(%)
1	Water Body	0.0347	6.9234	0.501199
2	Agriculture Land	3.2922		47.551781
3	Dense Forest	2.2543		32.560592
4	Open Forest	0.9947		14.367218
5	Residential Area	0.3475		5.01921



Main Track

Area calculation of classified LULC classes are based on buffer width 1 Km around rail track centerline

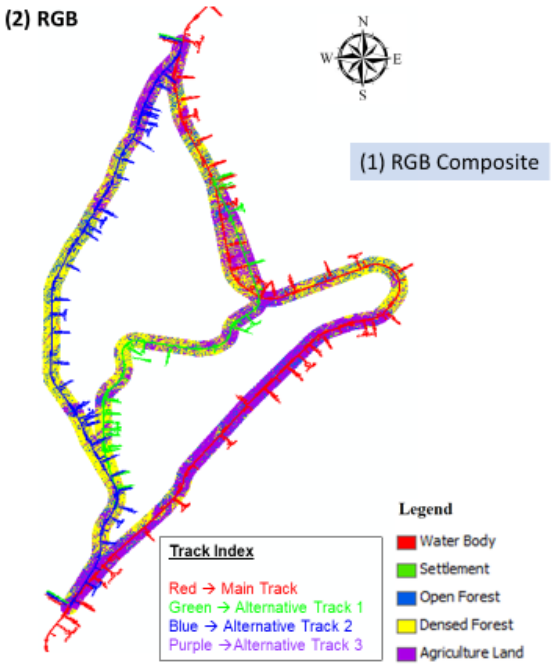
Red				
No.	Class	Area (km²)	Total Area (km²)	Area(%)
1	Water Body	0.0691	9.4603	0.730421
2	Agriculture Land	4.3237		45.703625
3	Dense Forest	2.658		28.096361
4	Open Forest	1.5663		16.556557
5	Residential Area	0.8432		8.913037



Alternative Track2

Area calculation of classified LULC classes are based on buffer width 1 Km around rail track centerline

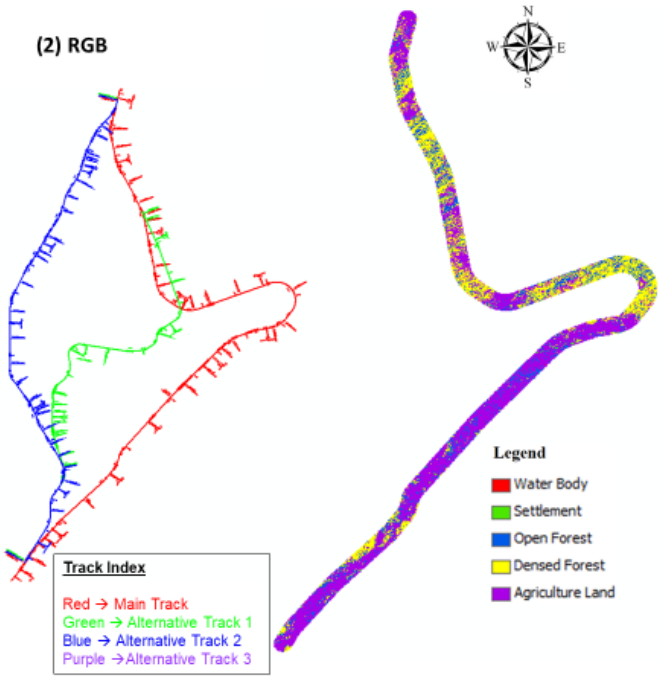
Blue				
No.	Class	Area (km²)	Total Area (km²)	Area(%)
1	Water Body	0.0347	6.9234	0.501199
2	Agriculture Land	3.2922		47.551781
3	Dense Forest	2.2543		32.560592
4	Open Forest	0.9947		14.367218
5	Residential Area	0.3475		5.01921



Red				
No.	Class	Area (km²)	Total Area (km²)	Area(%)
1	Water Body	0.0117	27.8405	0.042025
2	Agriculture Land	14.6961		52.786767
3	Dense Forest	8.1701		29.346097
4	Open Forest	4.9142		17.651263
5	Residential Area	0.0484		0.173847

Green				
No.	Class	Area (km²)	Total Area (km²)	Area(%)
1	Water Body	0.0125	27.0976	0.0461295
2	Agriculture Land	8.9109		32.884462
3	Dense Forest	14.3329		52.893614
4	Open Forest	3.8378		14.162878
5	Residential Area	0.0035		0.0129163

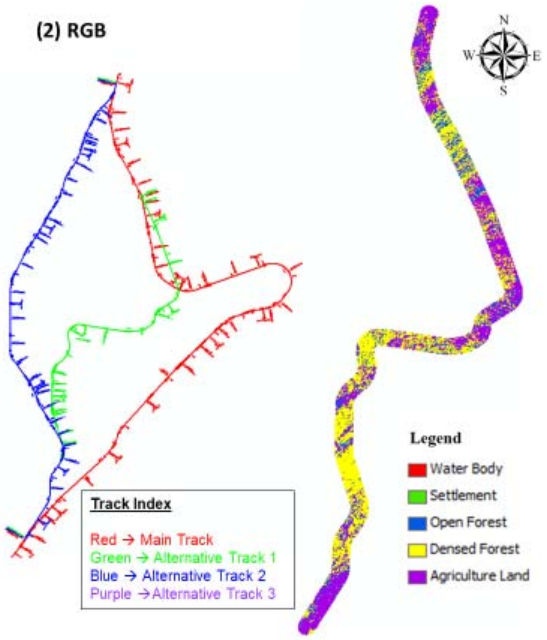
Blue				
No.	Class	Area (km²)	Total Area (km²)	Area(%)
1	Water Body	0.3828	68.9235	0.555398376
2	Agriculture Land	7.7967		11.3121069
3	Dense Forest	46.6977		67.75294348
4	Open Forest	14.0463		20.37955124
5	Residential Area	-		-



Main Track

Area calculation of classified LULC classes are based on buffer width 1 Km around rail track centerline

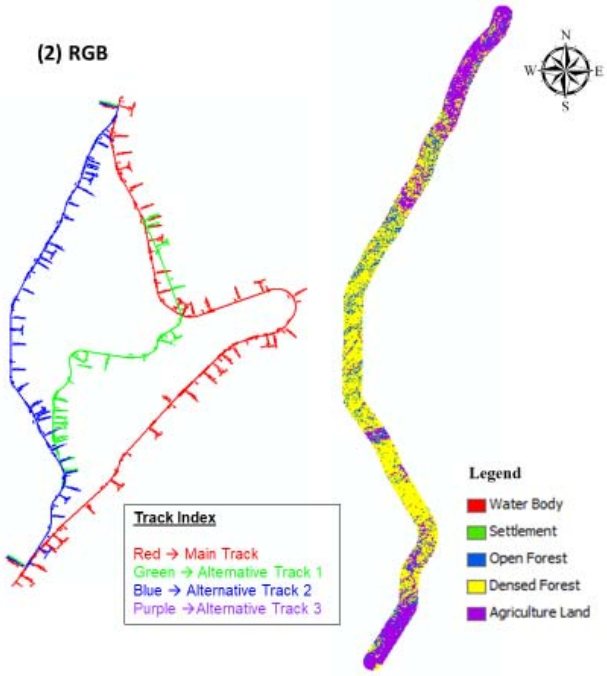
Red				
No.	Class	Area (km²)	Total Area (km²)	Area(%)
1	Water Body	0.0117	27.8405	0.042025
2	Agriculture Land	14.6961		52.786767
3	Dense Forest	8.1701		29.346097
4	Open Forest	4.9142		17.651263
5	Residential Area	0.0484		0.173847



Alternative Track1

Area calculation of classified LULC classes are based on buffer width 1 Km around rail track centerline

Green				
No.	Class	Area (km²)	Total Area (km²)	Area(%)
1	Water Body	0.0125	27.0976	0.0461295
2	Agriculture Land	8.9109		32.884462
3	Densed Forest	14.3329		52.893614
4	Open Forest	3.8378		14.162878
5	Residential Area	0.0035		0.0129163



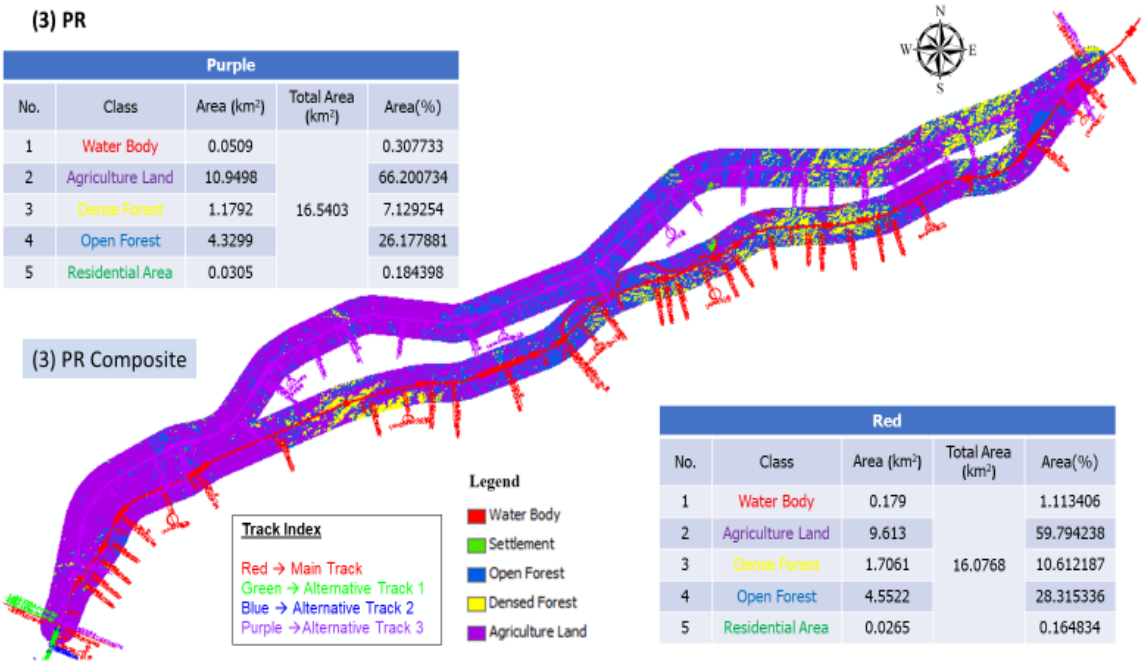
Alternative Track2

Area calculation of classified LULC classes are based on buffer width 1 Km around rail track centerline

Blue				
No.	Class	Area (km²)	Total Area (km²)	Area(%)
1	Water Body	0.3828	68.9235	0.555398376
2	Agriculture Land	7.7967		11.3121069
3	Densed Forest	46.6977		67.75294348
4	Open Forest	14.0463		20.37955124
5	Residential Area	-		-

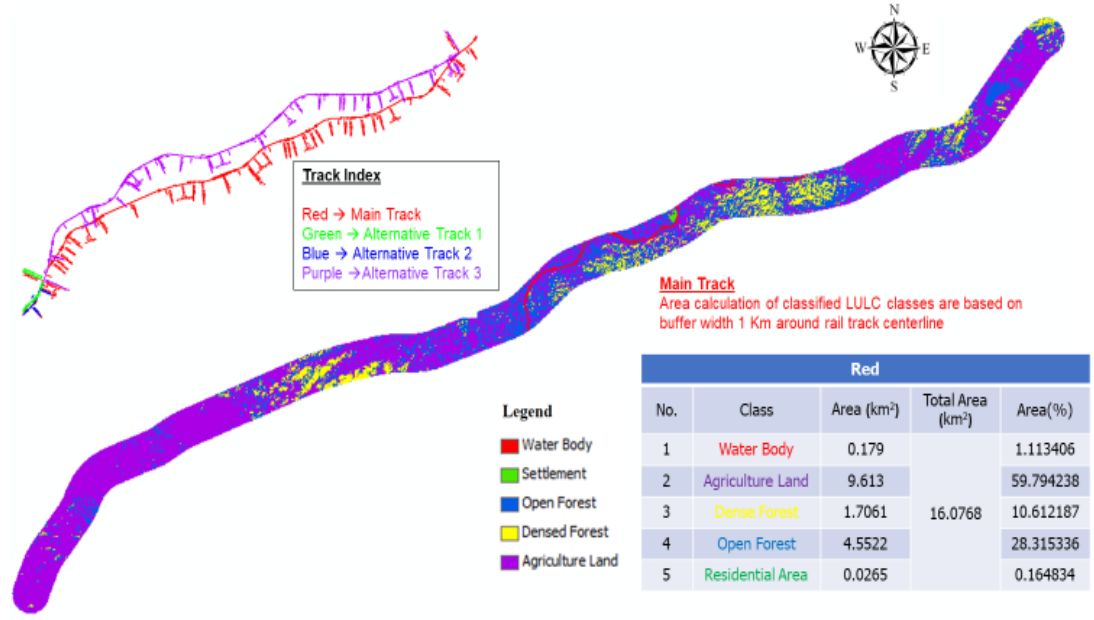
(3) PR

Purple				
No.	Class	Area (km²)	Total Area (km²)	Area(%)
1	Water Body	0.0509	16.5403	0.307733
2	Agriculture Land	10.9498		66.200734
3	Dense Forest	1.1792		7.129254
4	Open Forest	4.3299		26.177881
5	Residential Area	0.0305		0.184398



Red				
No.	Class	Area (km²)	Total Area (km²)	Area(%)
1	Water Body	0.179	16.0768	1.113406
2	Agriculture Land	9.613		59.794238
3	Dense Forest	1.7061		10.612187
4	Open Forest	4.5522		28.315336
5	Residential Area	0.0265		0.164834

(3) PR



Main Track
Area calculation of classified LULC classes are based on buffer width 1 Km around rail track centerline

Red				
No.	Class	Area (km²)	Total Area (km²)	Area(%)
1	Water Body	0.179	16.0768	1.113406
2	Agriculture Land	9.613		59.794238
3	Dense Forest	1.7061		10.612187
4	Open Forest	4.5522		28.315336
5	Residential Area	0.0265		0.164834

(3) PR

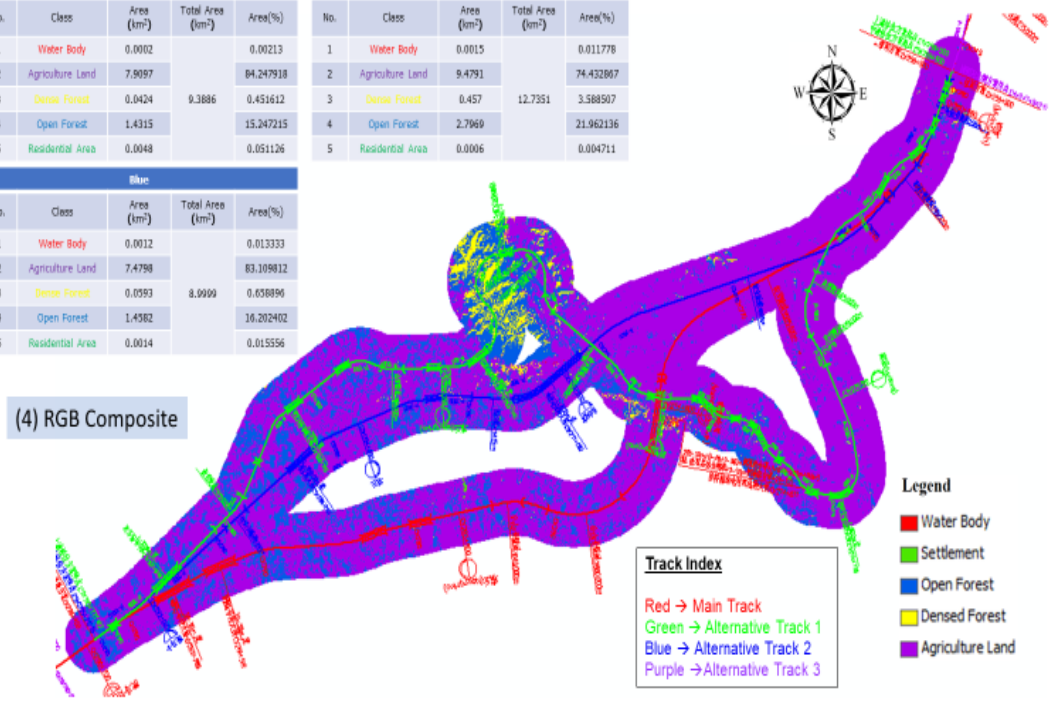
Purple				
No.	Class	Area (km²)	Total Area (km²)	Area(%)
1	Water Body	0.0509	16.5403	0.307733
2	Agriculture Land	10.9498		66.200734
3	Dense Forest	1.1792		7.129254
4	Open Forest	4.3299		26.177881
5	Residential Area	0.0305		0.184398

(4) RGB

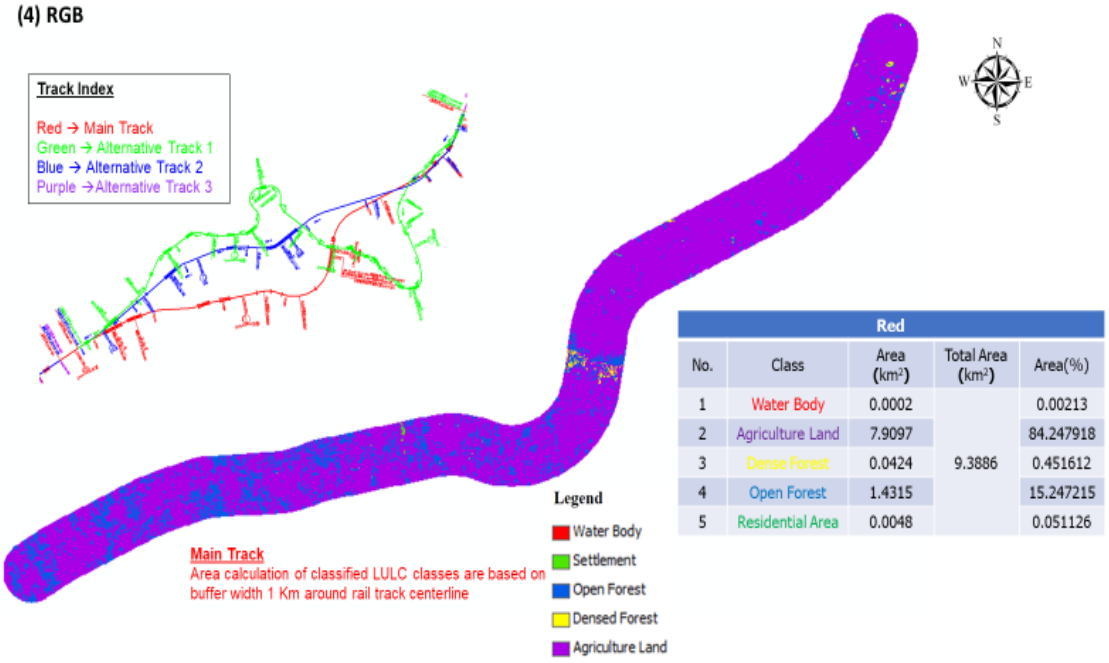
Red				
No.	Class	Area (km²)	Total Area (km²)	Area(%)
1	Water Body	0.0002	0.3886	0.00213
2	Agriculture Land	7.9097		84.247918
3	Dense Forest	0.0424		0.451612
4	Open Forest	1.4315		15.247215
5	Residential Area	0.0048		0.051126

Green				
No.	Class	Area (km²)	Total Area (km²)	Area(%)
1	Water Body	0.0015	12.7351	0.011778
2	Agriculture Land	9.4791		74.432867
3	Dense Forest	0.457		3.588507
4	Open Forest	2.7969		21.962136
5	Residential Area	0.0006		0.004711

Blue				
No.	Class	Area (km²)	Total Area (km²)	Area(%)
1	Water Body	0.0012	8.9999	0.013333
2	Agriculture Land	7.4798		83.109812
3	Dense Forest	0.0593		0.658896
4	Open Forest	1.4582		16.202402
5	Residential Area	0.0014		0.015556

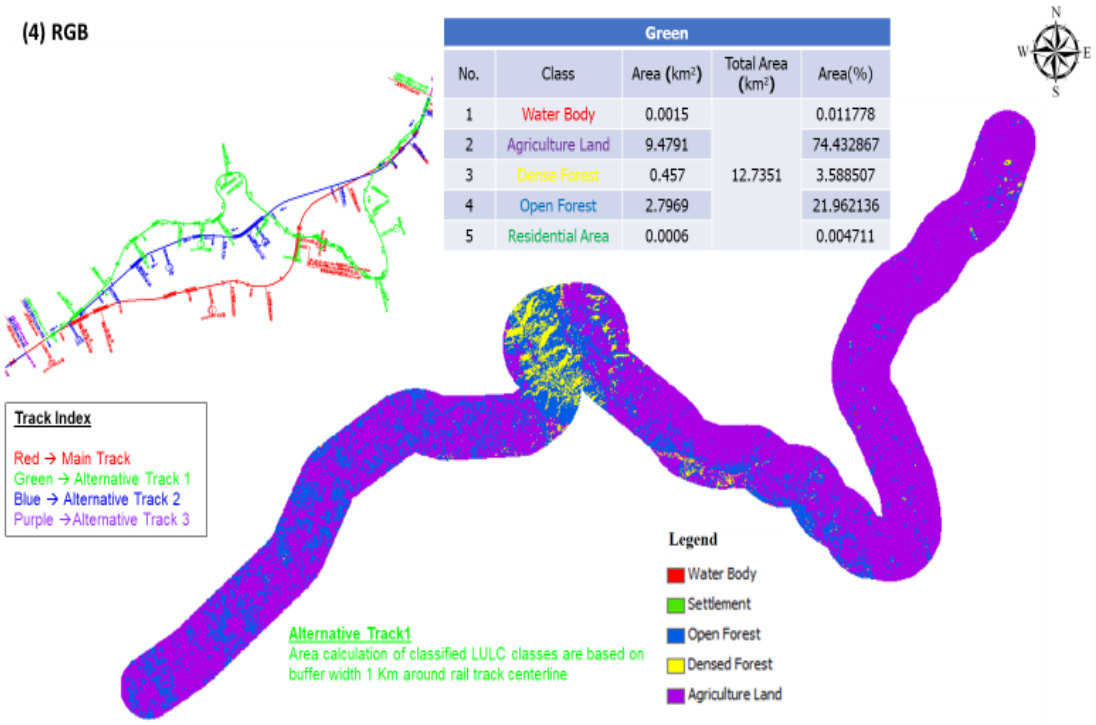


(4) RGB



Red				
No.	Class	Area (km²)	Total Area (km²)	Area(%)
1	Water Body	0.0002	9.3886	0.00213
2	Agriculture Land	7.9097		84.247918
3	Dense Forest	0.0424		0.451612
4	Open Forest	1.4315		15.247215
5	Residential Area	0.0048		0.051126

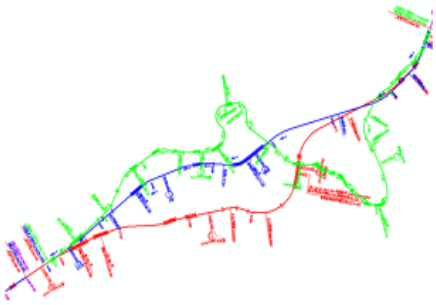
(4) RGB



Green				
No.	Class	Area (km²)	Total Area (km²)	Area(%)
1	Water Body	0.0015	12.7351	0.011778
2	Agriculture Land	9.4791		74.432867
3	Dense Forest	0.457		3.588507
4	Open Forest	2.7969		21.962136
5	Residential Area	0.0006		0.004711

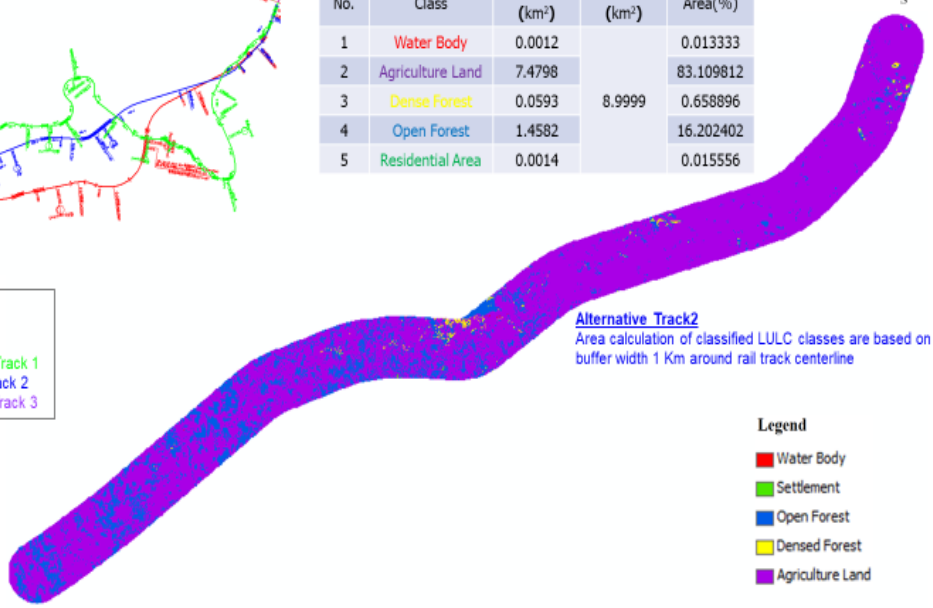
(4) RGB

Blue				
No.	Class	Area (km^2)	Total Area (km^2)	Area(%)
1	Water Body	0.0012	8.9999	0.013333
2	Agriculture Land	7.4798		83.109812
3	Dense Forest	0.0593		0.658896
4	Open Forest	1.4582		16.202402
5	Residential Area	0.0014		0.015556



Track Index

Red → Main Track
Green → Alternative Track 1
Blue → Alternative Track 2
Purple →Alternative Track 3



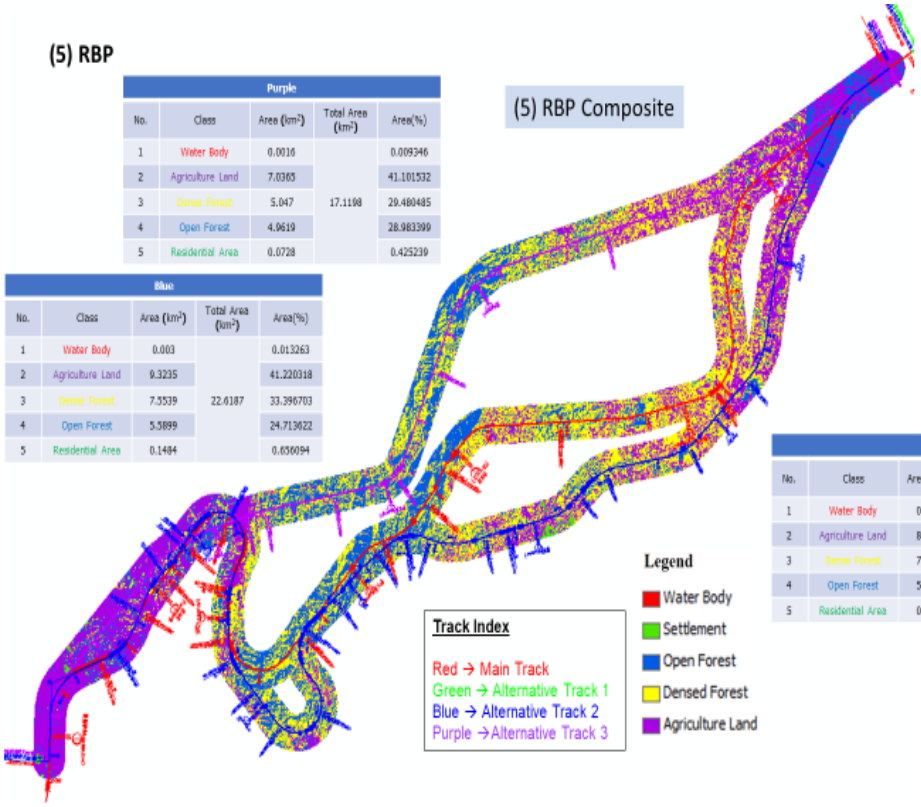
Alternative Track2
Area calculation of classified LULC classes are based on buffer width 1 Km around rail track centerline

Legend
- Water Body
- Settlement
- Open Forest
- Densed Forest
- Agriculture Land

(5) RBP

Purple				
No.	Class	Area (km^2)	Total Area (km^2)	Area(%)
1	Water Body	0.0016	17.1198	0.009346
2	Agriculture Land	7.0365		41.101532
3	Dense Forest	5.047		29.480485
4	Open Forest	4.9619		28.983399
5	Residential Area	0.0728		0.425239

Blue				
No.	Class	Area (km^2)	Total Area (km^2)	Area(%)
1	Water Body	0.003	22.6187	0.013263
2	Agriculture Land	9.3235		41.220318
3	Dense Forest	7.5539		33.396703
4	Open Forest	5.5899		24.713622
5	Residential Area	0.1484		0.656094



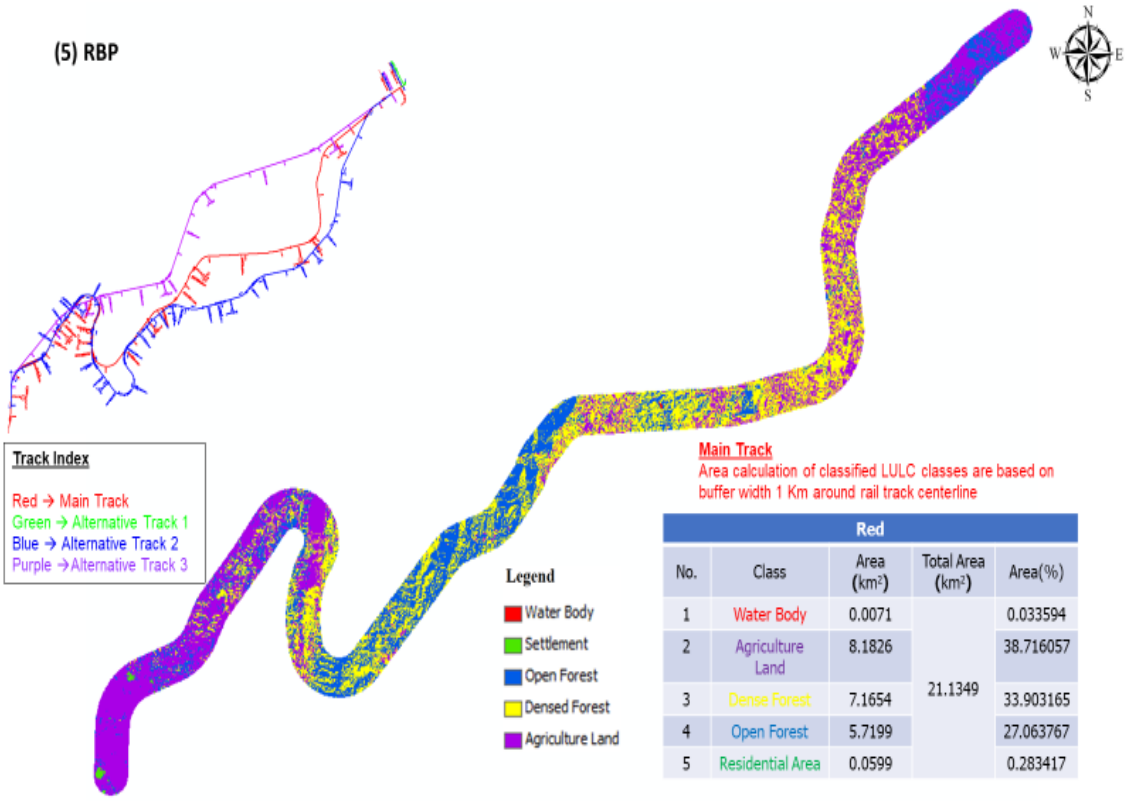
(5) RBP Composite

Red				
No.	Class	Area (km^2)	Total Area (km^2)	Area(%)
1	Water Body	0.0071	21.1349	0.033594
2	Agriculture Land	8.1826		38.716057
3	Dense Forest	7.1654		33.903165
4	Open Forest	5.7199		27.063767
5	Residential Area	0.0599		0.283417

Legend
- Water Body
- Settlement
- Open Forest
- Densed Forest
- Agriculture Land

Track Index

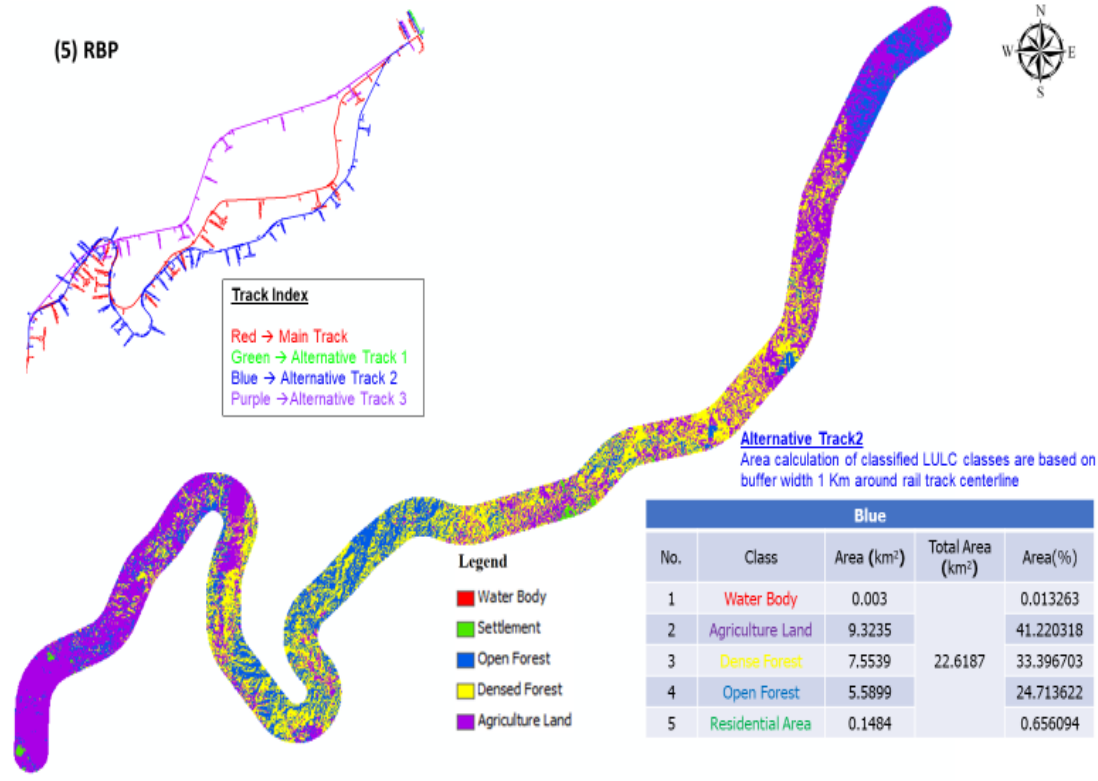
Red → Main Track
Green → Alternative Track 1
Blue → Alternative Track 2
Purple →Alternative Track 3



Main Track

Area calculation of classified LULC classes are based on buffer width 1 Km around rail track centerline

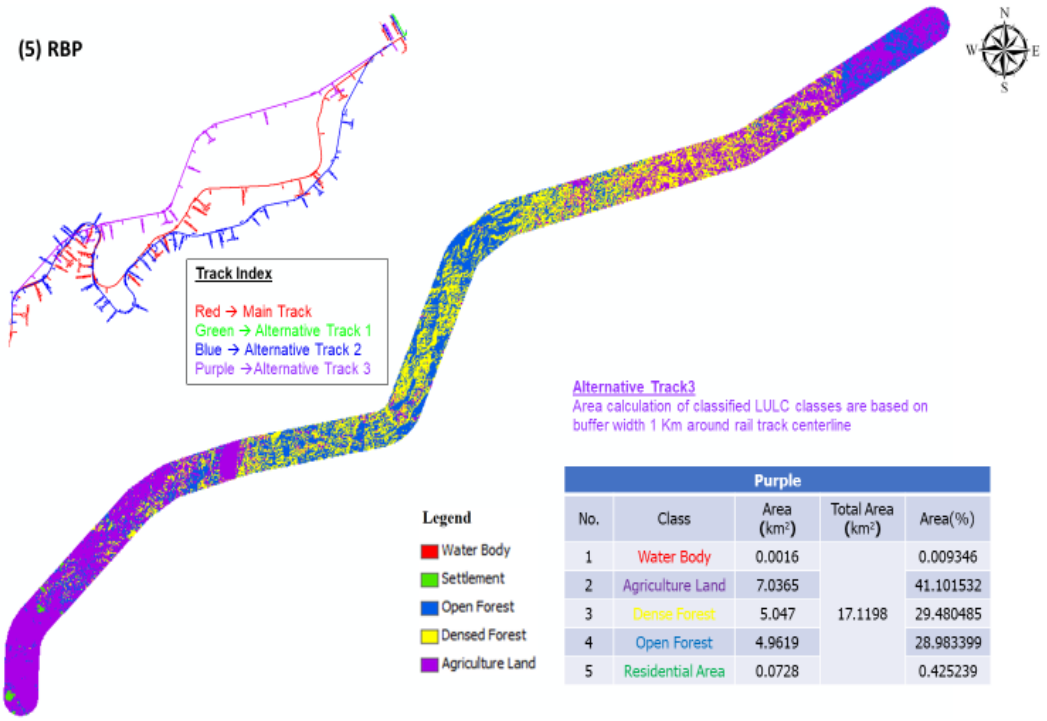
Red				
No.	Class	Area (km²)	Total Area (km²)	Area(%)
1	Water Body	0.0071	21.1349	0.033594
2	Agriculture Land	8.1826		38.716057
3	Dense Forest	7.1654		33.903165
4	Open Forest	5.7199		27.063767
5	Residential Area	0.0599		0.283417



Alternative Track2

Area calculation of classified LULC classes are based on buffer width 1 Km around rail track centerline

Blue				
No.	Class	Area (km²)	Total Area (km²)	Area(%)
1	Water Body	0.003	22.6187	0.013263
2	Agriculture Land	9.3235		41.220318
3	Dense Forest	7.5539		33.396703
4	Open Forest	5.5899		24.713622
5	Residential Area	0.1484		0.656094



Purple				
No.	Class	Area (km²)	Total Area (km²)	Area(%)
1	Water Body	0.0016	17.1198	0.009346
2	Agriculture Land	7.0365		41.101532
3	Dense Forest	5.047		29.480485
4	Open Forest	4.9619		28.983399
5	Residential Area	0.0728		0.425239

The LULC of the above GIS study can be summarized as the following tables.

No.	Alignment	Residential Area (%)	Household (%)	Agricultural Land (%)	Dense Forest (%)	Open Forest (%)
1.	Alignment 1	0.002	13.427	10.163	8.173	3.666
2.	Alignment 2	0.275	52.545	15.414	31.259	12.207
3.	Alignment 3	0.057	34.028	9.939	3.441	5.135

Weighting Method for Alternative Analysis for Alignment

All of the weighted are based on public concerns and potential to impact to environmental and socio-economic.

Household – 10 Marks
Agricultural Area – 8 Marks
Residential Area - 6 Marks
Reserved Forest – 7 Marks
Dense Forest - 3 Marks

Colouring in Table

Household – 0-25% (green colour),
26-50% (gray colour),
50-75% (orange colour),
75-100% (red colour)

According to the above alternative analysis for alignment by the type of land use, alignment 1 is the most suitable for the proposed project from the socio-economic perspective.

5.0 DESCRIPTION OF THE SURROUNDING ENVIRONMENT

5.1. Setting of the Study Limits

The proposed project will cover the alignment of the high speed railway that starts from Muse port of entry at the north, goes south to Mandalay. Muse-Mandalay Railway (MMR) connects with China's railway network at the north, and links up with Myanmar existing meter-gauge railway by a break of gauge at Mandalay. The railway will also pass through or near the big township such as Kut Kai, Thein Ni, Lashio, Thipaw, Kyauk Mae, Pyin Oo Lwin and Mandalay. The total length of the main railway line is 409.960 km. Study limit was set up based on AOI described in scoping report. AOI for railway bridges and culverts will be considered by the following methodology:

(a) Consideration of AOI by significance of key potential impacts;
(b) Consideration of AOI by sensitive of project location; and
(c) Consideration of AOI by most public concerns.

5.1.1. Consideration of AOI by Key Potential Impacts

AOI for railway alignment will be considered by the following matrix table. This matrix table will be based on key potential environmental and social impacts.

Table – Key Potential Environmental Impacts

	Project Actions/Activities		Soil Quality	Soil Erosion	Top Soil	Surface water Quality	Surface water flow patterns	Sediments deposition	Groundwater quality	Hydrogeological flow patterns	Air quality	Noise and Vibrations	Landscape	Flora	Fauna	Habitats	Protected and designated sites	Cultural Heritage
Pre-Construction & Construction Phase	1.	Clearance of existing land, vegetation and building	√	√	√	√	-	√	-	-	√	√	√	√	√	√	√	√
	2.	Temporary sites used for construction works (material storage and equipment maintenance camps, concrete batching plants, crushing plants) and housing of construction workers	√	√	√	√	-	√	-	-	√	√	√	√	√	√	√	√
	3.	Above ground construction, earthworks, cut and fill or excavations, and building of liner at structures and stations	√	√	√	√	√	√	-	√	√	√	√	√	√	√	√	√
	4.	Borrow pits for earth filling	√	√	√	√	-	√	-	-	√	√	√	√	√	√	√	√

	Project Actions/Activities		Soil Quality	Soil Erosion	Top Soil	Surface water Quality	Surface water flow patterns	Sediments deposition	Groundwater quality	Hydrogeological flow patterns	Air quality	Noise and Vibrations	Landscape	Flora	Fauna	Habitats	Protected and designated sites	Cultural Heritage
	5.	Haulage roads	√	√	-	√	√	√	-	√	√	√	√	√	√	√	√	√
Operational Phase	6.	Blockage of surface water and natural spring	-	-	-	√	√	-	-	√	-	-	-	-	-	-	-	-
	7.	Rise in the number of migrant workers	√	√	-	√	-	√	-	-	√	-	√	√	√	√	-	√
	1.	Trains Passing	-	-	-	-	-	-	-	-	√	√	√	√	√	√	-	-
	2.	Presence of permanent ways, and stations	-	-	-	√	-	-	-	-	-	√	√	-	-	-	-	-
	3.	Passengers/loads in/out the trains and at stations				√					√	√						√
	4.	Maintenance of railway track	√			√			√									
	5.	Presence of permanent way, and stations, passengers and freight traffic	-	-	-	-	√	√	-	-	-	-	√		√	√	√	-
		Fire hazard	-	-	-	-	-	-	-	-	√	-	√	√	√	√	√	√

Table – Key Potential Socio-economic Impacts

		Project Actions/ Activities	Land and Property	Community Health and Safety	Community tensions	Disruption of utilities	Economy	Employment	Workforce related impacts	Communities "Quality of Life"
Pre-Construction and Construction Phase	1.	Above ground construction, earthworks, cut and fill or excavations, and building of liner at structures and stations	√	√	√	√	√	√	√	√
	2.	Temporary sites used for construction works (material storage and equipment maintenance camps, concrete batching plants, crushing plants) and housing of construction workers, placement of borrow pits and landfill	√	√	√	√	-	√	√	-
	3.	Presence of permanent way, and stations, passengers and freight traffic	√	√	√	√	√	√	√	-
	4.	Haulage roads	√	√	√	√	-	√	√	-
	5.	Construction traffic and machinery movement	-	√	√	-	-	-	√	-
	6.	Aesthetic	-	-	√	-	-	-	-	√
		Working Condition including Occupational Health and Safety	-	√	√	-	-	-	√	-
		Involuntary Resettlement	√	-	√	-	√	-	-	√
		Rise in the number of migrant workers	-	√	√	√	√	√	√	√
Operation phase		Passengers/loads in/ out the trains and at stations	-	-	-	√	√	√	√	√
		Maintenance of railway track	√	-	-	-	-	√	√	-
		Accidents	-	√	√	-	-	-	√	√
		Fire hazard and electrical hazard	-	√	√	-	√	-	√	√

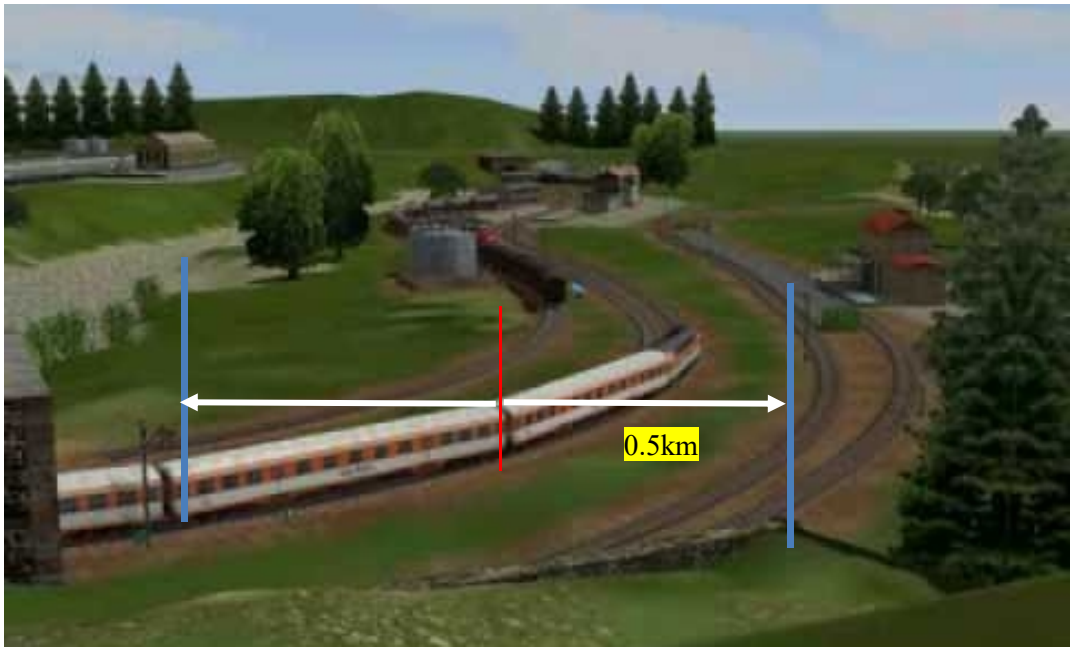
According to the above matrix table, the most possible environmental impacts will be impact on air environment (mostly in noise & vibration), impact on surface water environment, impact on soil environment, impact on biodiversity environment and impact on socio-economic environment..

5.1.2. Consideration of AOI by Sensitivity of Project Location

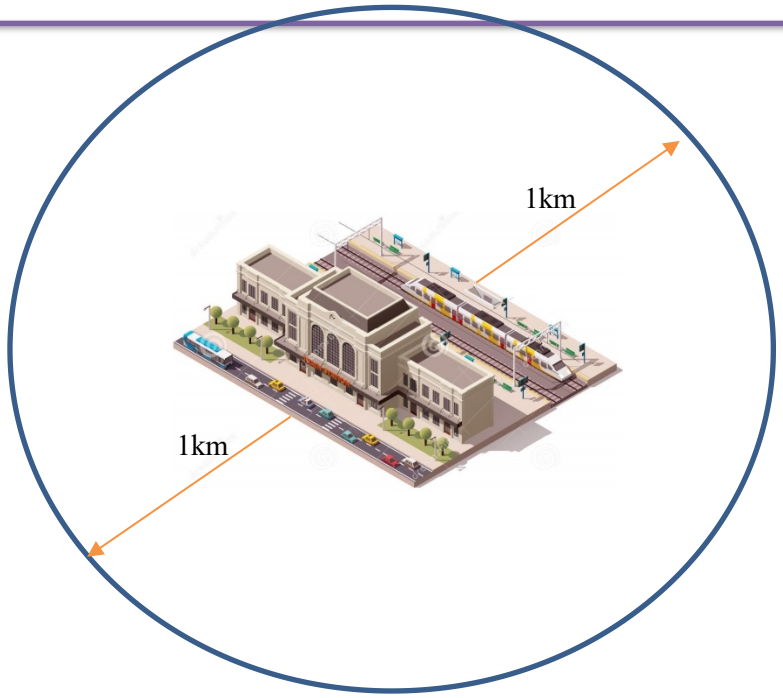
According to the land use pattern by GIS study, most of the land use by proposed railway will be agricultural land, forest area, and residential area. So, the AOIs for railway alignment, railway stations and access road will be considered based on impacts related to the types of land use.

5.1.3. Consideration of AOI by Most Public Concerns

AOI will also be considered by the most public concerns during public consultation process. According to the public consultation and participation process (household survey, group discussion and PCMs), the most public concerns were land acquisition and compensation, blockage of natural drainage system and water spring, blockage of village road and inflow of migrant workers. So, the AOIs will consider above these public concerns.



AOI for Railway Alignment



AOI for Railway Stations

Table – Consideration of AOI for Railway Alignment

Phase	Potential Impacts	Affected Receptors	Baseline Study	Considerations of AOI for
During construction phase	Land use	- Impact on agricultural land and forest area	Baseline soil quality will be good due to less industrialization in rural area. Sensitive for land acquisition and some people do not have land right although they use the land for long time ago.	The railway area (railway width + embankment + borrow pit) will range in size from as little as 25 feet wide up to 400 feet wide or more.(Source: Right of Way March/April 2006). So, the AOI of 500m will be covered for land use.
	Biodiversity	- Direct impact on flora diversity due to cutting of tree will be within 25 to 400 m beside the railway - Indirect impact on fauna diversity due to constructio noise especially for generator will be within 500m beside the project site - Indirect impact on flora and fauna diversity due to cutting of trees and killing of animals by migrant workers	Nature Reserve, National Park, Protected Area, National Park and ASEAN Heritage Park, Wildlife Sanctuary, Bird Sanctuary, Wildlife Park, Mountain Park, Wildlife Sanctuary and ASEAN Heritage Park, Elephant Range and Wildlife Sanctuary) are not included along Muse-Mandalay.	500m as AOI for railway alignment will be covered for impact on flora and fauna diversities for both direct and indirect impacts during construction phase.
	Blockage of	- Potential to flood,	There are a lot of natural	Blockage of drainage system will occur

	natural drainage system	Impact on agricultural land and changes in hydrology regeme, surface water quality	drainage system and water spring along the railway alignment.	when the crossing with railway and drainage system and so the impact zone will be within 500m.
	Socio-economic	- Traffic - Pressure on local services due to migrants workers - Impact on agricultural land	Most of the local residents near the alignment are villagers and very few number are dense populated area.	Most of the construction sites are far away from dense populated area and so proposed AOI will cover for the socio-economic conditions for whole alignment For land use, detailed compensation will include in RAP
During operation phase	Noise	- Local residents - Fauna diversity	The existing nosie quality is good and below the NEQ due to less industrilization in rural area.	The noise level of electric train without horn will be approximately 73dB(A) from 15m away and all of the noise level will be less than 55dB(A) in day time and 45dB(A) in night time (National Emission Standard) at the boundary of AOI (500m).
	Vibration	- Nearest local residents	The existing vibration level will be good due to less industrilization in rural area.	According to the German Standards DIN 4150 and DIN 45669-1 the vibration level will allow 0.3mm/s in residential area and vibration produced by electric railway is 0.6mm/s (max). The vibration level will reduce to 0.3mm/s at the boundary of 500m.

Table – Consideration of AOI for Railway Stations

Duration	Potential Impacts	Affected Receptors	Baseline Study	Considerations of AOI
During construction phase	Land use	- Impact on agricultural land and forest area	Baseline soil quality will be good due to less industrialization in rural area. Sensitive for land acquisition and some people do not have land right although they use the land for long time ago.	The effect of land use of railway station will be within 1km of the proposed AOI.
	Biodiversity	- Direct impact on flora diversity due to cutting of tree for railway station - Indirect impact on flora and fauna diversity due to cutting of trees and killing of animals by migrant workers	Nature Reserve, National Park, Protected Area, National Park and ASEAN Heritage Park, Wildlife Sanctuary, Bird Sanctuary, Wildlife Park, Mountain Park, Wildlife Sanctuary and ASEAN Heritage Park, Elephant Range and Wildlife Sanctuary) are not included along Muse-Mandalay.	1km as AOI for railway station will be cover for impact on biodiversity during construction phase.
During operation phase	- Solid and Liquid Wastes	- Local residents - Ecosystem	Some of the agricultural lands are close to the railway station.	The impact of solid and liquid wastes will be within 1km radius of the railway stations

5.2. Methodology and Objectives for Environmental Baseline Study

Environmental baseline study will conduct by the following methodology and objectives.

5.2.1. Ambient Air Quality Monitoring

Objectives

Ambient air quality monitoring collects and measures samples of ambient air pollutants to evaluate the status of the atmosphere as compared to clean air standards and historical information. Monitoring helps in assessing the level of pollution in relation to ambient air quality standards. Standards are a regulatory measure to set the target for pollution reduction and achieve clean air.

Methodologies

Ambient Air Quality monitoring will be conducted by Haz-Scanner EPAS by the following methodologies.

Figure - Haz-Scanner EPAS for Ambient Air Quality Monitoring

(a) Monitoring Parameters

The parameters for ambient air quality monitoring will be SO_2, NO_2, CO_2, CO, H_2S, O_3, $PM_{2.5}$ and PM_{10}.

(b) Sampling Rate and Sensors

Determination and analysis of ambient air qualities were conducted by using Haz-Scanner Environmental Perimeter Air Station (EPAS).

Sampling rate of air quality will be recorded automatically every one minute for important gases (Sulfur dioxide, Nitrogen dioxide, Carbon dioxide, Carbon monoxide, Hydrogen sulfide, Particulate matter, Hydrogen sulfide and Ozone) to describe ambient air quality. Sampling pump was adjusted to 2 liter/min. Different analysis methods will be integrated in the instrument, such as particulates 90° Infrared Light Scattering for particulate matters (PM_{10}, $PM_{2.5}$), electrochemical sensors for toxic gases (SO_2, NO_2, CO, H_2S), NDIR (optional sensor) for (CO_2) and Gas Sensing Semiconductor- GSS technology (optional sensor) for O_3.

Table - Important Gases for Ambient Air Quality

No.	Parameters	Analysis Methods
1.	Sulfur dioxide (SO_2)	Electrochemical sensors
2.	Nitrogen dioxide (NO_2)	Electrochemical sensors
3.	Carbon Dioxide (CO_2)	NDIR (optional sensor)
4.	Carbon monoxide (CO)	Electrochemical sensors
5.	Hydrogen Sulfide (H_2S)	Electrochemical sensors
6.	Particulate matter 2.5 ($PM_{2.5}$)	Infrared Light Scattering
7.	Particulate matter 10 (PM_{10})	Infrared Light Scattering
8.	Ozone (O_3)	Gas Sensing Semiconductor- GSS technology (optional sensor)

5.2.2. Existing Noise Level

Objectives

As the construction and operation of railway bridges will impact on existing noise level, existing noise level will have to monitor as baseline study.

Methodology

The approach will be based on SANS 10328:2008, 'Methods for Environmental noise impact assessments' as well as the IFC PS and Equator Principles. The technical guidelines will be based on good engineering practice, SANS 10103:2008, 'The measurement and rating of Environmental noise with respect to annoyance and to speech communication' and the IFC EHS Guidelines for noise.

Scope of Work

Proposed project along railway network generally rural and agricultural nature of the existing environment, noise levels can be predicted to be low. So, measure the present ambient noise levels will be done at every points where the main bridges exist along the proposed railway project.

Noise Level Monitoring Equipment

To monitor the existing noise level, the team will use TES-1353H Integrating Sound Level Meter which is applicable with IEC61672-1: 2003, IEC60651: 1979, ANSI S1.4: 1983 and IEC60804: 1985 standards. Existing noise level will be monitored in both day time (07:00 to 22:00) and night time (22:00 to 07:00).

Figure - TES 1353H Integrating Sound Level Meter

Noise Quality Monitoring Results

The results for noise level monitoring will be calculated by using Panel V8.01 Software as follow:

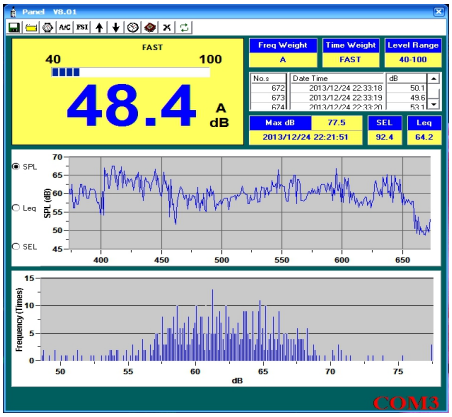


Figure - Integrating Sound Level Software (Panel V8.01)

Noise Level Monitoring Standard

Noise level monitoring results will be compared with Myanmar Emission Guidelines, 2015 for residential, institutional and educational areas as follow:

Table - Noise Level Monitoring Standard

Receptor	One Hour LAeq (dBA)[a]	
	Day time (07:00-22:00) (10:00-22:00 for Public holidays)	Night time (22:00-07:00) (2200-10:00 for Public holidays)
Residential, Institutional, Educational	55	45

Source: Myanmar Emission Guidelines (2015)

5.2.3. Existing Water Quality

Objectives

As the railway bridge construction will impact on existing water quality, existing water quality will have to monitor and test in qualified laboratory.

Methodology

Sampling Method

Water samples will be collected in terms of Grab sampling method (especially for the river with regular flow rate) with the following approaches;

- Rinsing the water bottle with river water
- Hold uncapped bottle upside down and submerse it
- Tip bottle upright and allow water to fill bottle
- Remove bottle from water and screw on cap

Sample Handling and Preservation

- use water resistant label for each sample bottle with the date, time, and site number/name
- documentation is done in field logbook
- store the samples in ice box immediately after sampling and transport for laboratory analysis.

5.2.4. Existing Vibration Level Monitoring

Objectives

Vibration impact assessment will be made to monitor the existing vibration level and to predict the vibration level of railway on bridge when the rail travel during operation phase.

Methodology

Existing vibration level will monitor by using g vibration level by ground blast vibration meter (Vibro Series) and prediction of vibration level at nearest local residents within 1km radius of the proposed bridge project.

Vibro Vibration Meter

Analysis Method

The laboratory testing results of water samples are presented in the following table. Almost all of the water qualities are desirable as permissible limits of National Drinking Water Quality Standard expect for some water qualities (Colour and Turbidity) in Nant Paung Stream.

5.2.5. Existing Soil Quality Testing

Objective

The objectives of the soil quality assessment for will be as follow:

- To assess the current physical and chemical status of the greenfield area targeted for the development;
- To determine the pre-development land capability of the soil cover to be affected by the proposed project; and
- To assess the expected impacts posed on the soil resource by the proposed development.

Methodologies

The entire area comprises greenfields. In terms of the legislation it is proposed to conduct a soil investigation based on the Soil Classification System for SA, 1991. Such an assessment will include a physical investigation of the soil cover to be disturbed by the bridge construction. The scope of work entails the following:

- Conduct a desktop study as a prerequisite prior to a field visit;
- Conduct a field visit during which a physical assessment of the soil covering the areas to be disturbed will take place;
- Compile soil, land use and land capability maps for the assessed area; and
- Compile a report on the findings and results of the assessed area.

Desktop Study

A desktop study will be conducted to gain a general understanding of the soil resource covering the area in question. Existing broad scale maps will be obtained and reviewed to address the input requirements for the EIA report.

In-field Soil Assessment

In preparation for a field visit soil survey locations will be generated to optimise coverage of the expected soil types. Actual field mapping and classification will be supported by soil profiling to serve as a platform for detail level mapping. During soil mapping, the extent of ecologically sensitive areas, such as wetlands, will be identified and delineated on the basis of soil types. The following attributes listed recorded at each location point:

- Soil form and depth;
- Estimated soil texture and structure;
- Content of coarse fragments;
- Underlying material;
- Current land use; and
- Land capability.

Sampling of Representative Areas

Chemical balance in the soil profile may be subjected to disturbance during the planned development and post-activity restoration. In order to obtain fertility status of the soil

resource prior to commencement of any development activities, a sampling program is recommended in conjunction with the soil mapping exercise.

The sampling of major delineated units is good practice. A maximum of 4 sample locations are deemed sufficient to exhibit the required soil properties and chemical status. The following analysis package is proposed and will be submitted to the laboratory of the Department of Agricultural:

- Particle size distribution on selected samples (3-fraction testing);
- pH (water);
- Exchangeable cations Na, K, Ca, Mg (Saturated paste method);
- Phosphorus (Bray1 method);
- Organic carbon content on selected topsoil samples (Walkley Black method); and
- Electrical conductivity (indication of salt presence).

Testing of Soil Quality

All of the soil samples will be tested in National Laboratory under the Myanma Research and Innovation Department.

5.2.6. Existing Biodiversity Situation

Objectives

- Undertaking the collection of baseline environmental data;
- Characterisation of the baseline Environment;
- Identification, and assessment of key adverse impacts that may result from the activities of the project;
- Identification, assessment and recommendations of appropriate and practical mitigation measures to remove or minimize the adverse impacts identified; and
- Providing specialist ecological input into the Environmental and Social Management Plan (ESMP).

Methodology

This section considers the effects that the proposed project might have on biological, nature conservation resources including habitats, species, and individual sites of nature conservation

value. It addresses effects at all stages of the project cycle, including site clearance and construction, operation, and decommissioning.

(a) Desk Based Research

Data on statutory designated sites within 5 km of the proposed project boundary, non-statutory designated sites within 2 km, and protected species within 2 km were requested or gathered from the existing records. Publications mainly consulted included: National Biodiversity Strategy and Action Plan 2011 and National Biodiversity Strategy and Action Plan 2015-2020.

(b) Study Area and Biodiversity Opportunity Areas

Muse-Mandalay Railway starts from Muse port of entry at the north, goes south to Mandalay, the second largest city in Myanmar, and connects cities, towns such as Muse port of entry, Lashio, Pyin Oo Lwin and so on. Biodiversity Opportunity Areas are areas identified as being particularly beneficial for implementing conservation measures.

Proposed Method of Assessment

The assessment will address habitats, plant and animal species and sites of special importance for any of these. It will address these receptors in their scientific, ecosystem functioning, and nature conservation aspects only. It will not address them in respect of their contribution to agriculture or the landscape, nor in their socio-economic aspects. These matters will be addressed in the appropriate chapter.

- ✓ London Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, London, 1990 (Date Ratified: 1993)
- ✓ United Nations Framework Convention on Climate Change (UNFCCC), New York, 1992 (Date Ratified: 1994)
- ✓ Convention on Biological Diversity, Rio de Janeiro, 1992 (Date Ratified: 1994)
- ✓ Stockholm Convention on Persistent Organic Pollutants (POPs), 2001 (Date Ratified: 2004 (Accession))

Desk-based Studies

- ✓ Records will also be requested from governmental and non-governmental natural history and conservation groups that are likely to be consulted as part of the ecological assessment process.

- ✓ An air-photo assessment of border networks in an 2-5 km buffer around the proposed project site will be conducted.
- ✓ A further search for published literature and reports of previous surveys relevant to the survey area will be conducted.

Field Surveys

A number of habitat and species surveys have been and will be undertaken and he following additional field surveys will be required:

- ✓ initial surveys of areas for which access was not available in May 2019 (follow-on surveys that arise from the findings);
- ✓ scientifically botanical surveys
- ✓ scientifically fauna surveys
- ✓ scientifically bat surveys

Interview Survey for Flora and Fauna

In addition to the field observation, secondary data will also surveyed by interviewing local residents and through literature review. In the interview survey, the surveyor visited the residents in and around the survey area and asked about the name of plants and animals existing in and around the area.

Data Analysis of Plant species

Samples of some species were not directly identified in field. After field trip, plant identification will be conducted based on available literatures such as key to the families of the flowering plants, issued by Department of Botany, Yangon University (1994), Backer *et. al.*(1963), Kress *et. al.* (2003), Gardner *et al.* (2000), Caton *et al.* etc., and verification will be also conducted by recorded field photographs and some useful internet websites. Finally, the threatened levels of plant species of the survey area will be checked and mentioned in accordance with "The IUCN Red List of Threatened Species, 2018"

Data Analysis of Fauna Species

- ✓ **Bird Species:** The recorded species will be then identified using reference books.

- ✓ **Mammal Species:** All data recorded in the survey area will be entered into the field data sheet. Information on some species will obtained from interviews with the local people.

Consultation

The following groups having a statutory role in the EIA process will be consulted:

- ✓ the local authority Planning and Biodiversity officer
- ✓ Environment Agency and
- ✓ Non-Governmental Organization

In addition, a wide range of non-statutory natural history and nature conservation groups will be consulted.

Procedure Impact Assessment

.In order to assess the likely significant environmental impacts, potential Impacts of the Proposed Project will be preliminary identified based on the project description and overall environmental conditions. The impacts of flora and fauna will be classified as A to D in accordance with the following criteria, assuming no specific measures toward the impacts are taken:

1) A-: Significant negative impact A+: Significant positive impact
2) B-: Some negative impact B+: Some positive impact
3) C: Impacts are not clear, need more investigation
4) D: No impact or impacts are negligible, no further study required

5.2.7. Baseline Hydrological Environment

Objectives

It aims at assessing sensitivity of the baseline hydrological environment and the potential impacts of the proposed development upon it and proposes mitigation measures in order to ensure that the potential adverse impacts of the proposed project development on the hydrological environment will be slight and neutral. For tunnel construction, the potential impact will be impact on surface water quality during construction. So, the impact study for surface water quality will be based during tunnel construction. The potential impacts on the

surface water environment from the proposed project development, in the absence of suitable mitigation measures, are considered to be as follows:

- Direct impacts of the project construction on the hydrological environment for example contamination of surface water (if encountered in excavations) from the spillage/leakage of fuels from vehicles and fuel/ waste storage areas and water from waste dump.
- Direct impacts from overburden dumping site and waste rock dumping site where vegetation has been removed through release of soil loaded surface water runoff into local watercourses due to soil erosion from dumping site.

Methodology

The following tasks are proposed

- Compilation of a baseline report to characterise the existing hydrology and water quality of the area;
- Development of floodlines for the area;
- Development of a stormwater management plan for the site.

Scope of Work

The scope of work for the surface water assessment will be below.

Site Visits for Surface Water Quality

Two site visits will be conducted. The first visit will be a reconnaissance visit to understand the site location of tunnel and the next site visit is to set up the baseline monitoring program and take field measurements.

Field Survey Methodology

In order to inform the hydrological impact assessment, a site walkover was carried out by the hydrologist to record observations and features of significance in the project area.

Blockage of Natural Drainage System

The EIA team will make study on potential to blockage of natural drainage system due to the surplus soil and waste rock dumping site during tunnel construction.

Existing Water Quality Monitoring

Existing water quality will be monitored just for surface water qualities because tunnel construction and operation will not impact on ground water quality.

Monitoring of Surface Water Quality: The locations that the surface water samples will be take in the nearest river or water body of the proposed tunnels construction project.

Water Quality Testing

All of the surface and ground water quality will be tested in Water Quality Testing Laboratory under the Department of Occupational Health.

5.2.8. Existing Visual Condition

As tunnel construction will cause some visual impact and the followings are the methodologies for visual impact study.

Objectives

The objectives of the Visual Impact Assessment (VIA) will be to:

- Assess the baseline conditions of the visual context within which the proposed project will take place;
- Determine what visual receptor groups may potentially be affected by the project;
- Establish what visual impacts may potentially arise as a result of the project and determine their social significance; and
- Investigate possible methods with which the potential impacts may be mitigated.

Methodologies

The specific scope of works is briefly described below:

- The VIA will assess the value of the study area as a visual resource, as a function of its perceived aesthetic value, and will assess the magnitude and significance of the potential visual impact of the proposed activities;
- A Visual Resources Analysis will be carried out, which will identify elements that are considered to be of visual significance. Conversely elements that detract from the visual quality of the landscape will also be identified;
- A Visual Receptor Analysis will be done which will identify receptors that may be negatively impacted upon by the proposed activity. This will include adjacent

landowners as well as significant commuting routes and areas where large groups of people may congregate;

- The VIA will also explore potential visual mitigation strategies and implementation measures that need to be considered during construction and implementation, operations and possible closure of the proposed project.

5.2.9. Cultural and Heritage

Objectives

The preparation of cultural and heritage impact assessment involves the listing of

- Classified or listed monuments and sites together with their protective perimeter, and the perimeters of Areas of Protection of Architectural, Urban and Landscape Heritage,
- Known Archaeological areas and areas of high archaeological potential.
- Declaration file that contains the description of works, the surface area used as a basis for calculating the preventive archaeology fees and impacts on the subsurface.

Methodology

In fact, there are possible necessaries to do cultural heritage assessment as follows;

1. Baseline data for the existing cultural heritage sites
2. The potential impacts on the cultural heritage sites and landscape
3. Making cultural map
4. Writing the strong mitigation and monitoring plans to reduce the negative impacts

5.3. Public Administration and Planning

As the project will be in FS stage, the detailed data for the project construction and operation phase have not been identified. Generally, the construction of the project will be also be conducted by CREEC and/or tender winning company after the international tendering process. The operation of the Muse-Mandalay Railway will be conducted by MR and tender winning company.

5.4. Physical Components

5.4.1. Geological Characteristics

The Republic of the Union of Myanmar (Pyidaungsu Thammada Myanmar Naing Ngan Daw), formerly Burma, occupies the northwestern part of the Southeast Asian. It is bounded to the west by India, Bangladesh, the Bay of Bengal and the Andaman Sea, and to the east by China, Laos and Thailand. Coastal line is 2100km long and border line is more than 4000km (border with China mostly). It comprises seven regions (Ayeyarwaddy (Irrawaddy), Bago, Magway, Mandalay, Sagaing, Tanintharyi (Tenasserim) and Yangon) and seven states (Chin, Kachin, Kayah, Kayin, Mon, Rakhine (Arakan) and Shan) (see following figure). From north to south Myanmar extends for some 2200 km from 28° N to 10° N, and from east to west, Myanmar has 950km from 82° 30' to 101˚dividing the country into a temperate to subtropical north and a tropical south. Although Myanmar is located within the Monsoon Belt of Asia, the climate is influenced locally by geographical position and topography.

Figure - Myanmar Map

(a) Tectonic setting of Myanmar

Myanmar lies at the junction of the Alpine–Himalayan Orogenic Belt and the Indonesian Island Arc System. The Himalayas and the mountain ranges of northern Myanmar mark the

collision between the Indian subcontinent and the southern margin of the Eurasian continent. Here Myanmar has the oblique collision with Indian subcontinent. Detritus from the Himalayas, transported by the rivers Ganges and Brahmaputra, has built an extensive delta into the Bay of Bengal on Indian Ocean crust. At the present day the Indian Tectonic Plate, carrying India and the Indian Oceanic Crust, is moving northeastwards at 5 cm a−1, and is moving past Myanmar on transcurrent faults. The collision between Indian continental crust and Eurasia continues at the Eastern Himalayan Syntaxis. Here Myanmar Microplate has also oblique subduction with Indian oceanic plate. Curray et al. (1979) defined a Burma (Myanmar) Microplate, delimited to the west by the active Andaman subduction zone and a major strike-slip fault between the Indian Plate and Myanmar, and to the east by the north–south-aligned strike-slip Sagaing Fault. The Burma (Myanmar) Microplate is presently moving northwards at a rate of 18 mm a−1 relative to Southeast Asia along the Sagaing Fault (Maurin et al. 2010). In short, Myanmar region has encountered one oblique collision (northern Myanmar) and one oblique subduction (Myanmar Microplate) with India Plate.

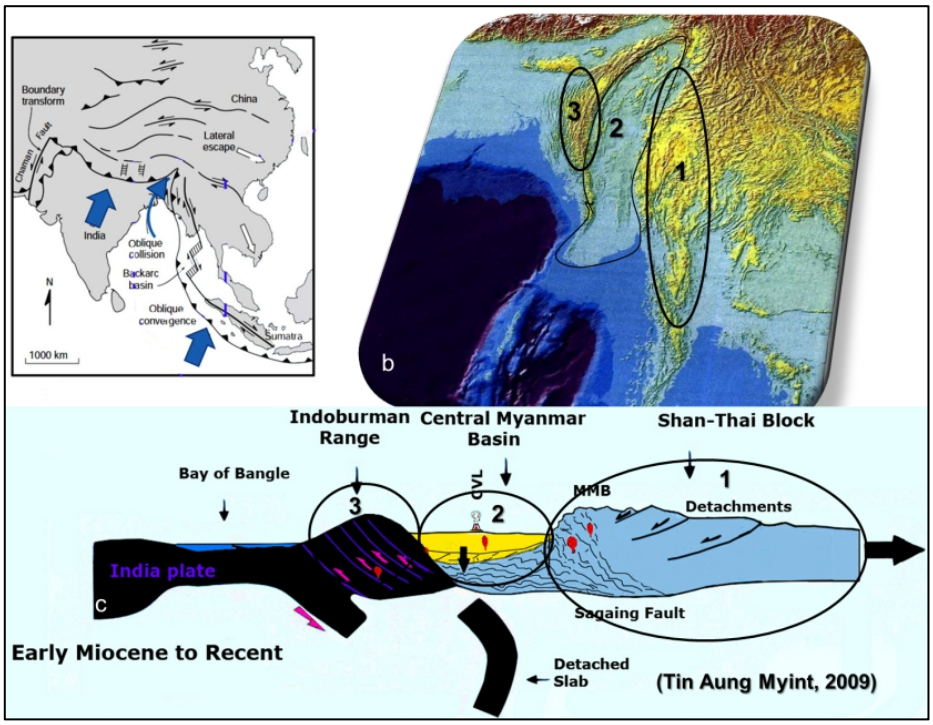


Figure 5.1. (a) Tectonic Map of Myanmar and Surrounding Region (Source: Pluijm, B .A. D. and Marshak, S., (2003). (b) Satellite Image of Myanmar and (c) Tectonic Cross Section of Myanmar (GIAC, 1999 & Tin Aung Myint, 2009)

Tectonically as well as geographically, Myanmar is divided into four provinces: 1. Shan-Thai Block, 2. Central Myanmar Basin 3. Western range (Indoburman Range) and 4. Rakhine coastal plain (Fig.5.1 b & c). Actually, Sagaing Fault is divided Shan-Thai Block (part of Eurasian continent) and other three provinces (Also called Myanmar Microplate). The

proposed Muse-Mandalay railway line will mainly pass through the rock units exposed in Shan-Thai Block.

(b) General Geology along Muse-Mandalay Railway

Lithologic units exposed along Muse-Mandalay railway are mostly of Paleozoic to Mesozoic clastic and carbonate rocks (Table 5.1 and Fig.5.2). The occurrence of the rock units are 1. Igneous rocks including rhyolite, tuff and granite, 2. Metamorphic rocks containing schist, phyllite, and quartzite and sedimentary rocks consisting of carbonate (limestone & dolomite), sandstone, siltstone, clay, shale and evaporite. Among them, limestone is the most abundant rock in the area.

Table 5.1. Stratigraphic Succession of the Rock Units Exposed along Muse-Mandalay High Speed Railway Line (Compiled by Tin Aung Myint, 2019)

Lithology	Geologic Age
Alluvium	Quaternary
Unconformity	
Namyau Group (Hsipaw Red Beds, Tati Limestone)	Triassic
Bawgyo Group (Napeng Fm & Pannyo evaporate)	Jurassic
Maymyo Formation (Plateau Limestone+ Shan Dolomite)	Mid-Devonian to Triassic
Zebingyi Formation	Early to Middle Devonian
Nyaungbaw Formation	Silurian
Kyaingtaung Formation	Late Ordovician
Sitha Formation	Middle Ordovician
Ngwetaung Group (Pangyun Group)	Cambrian
Granite (granitoid)	Paleozoic
Chaung Magyi Group	Proterozoic

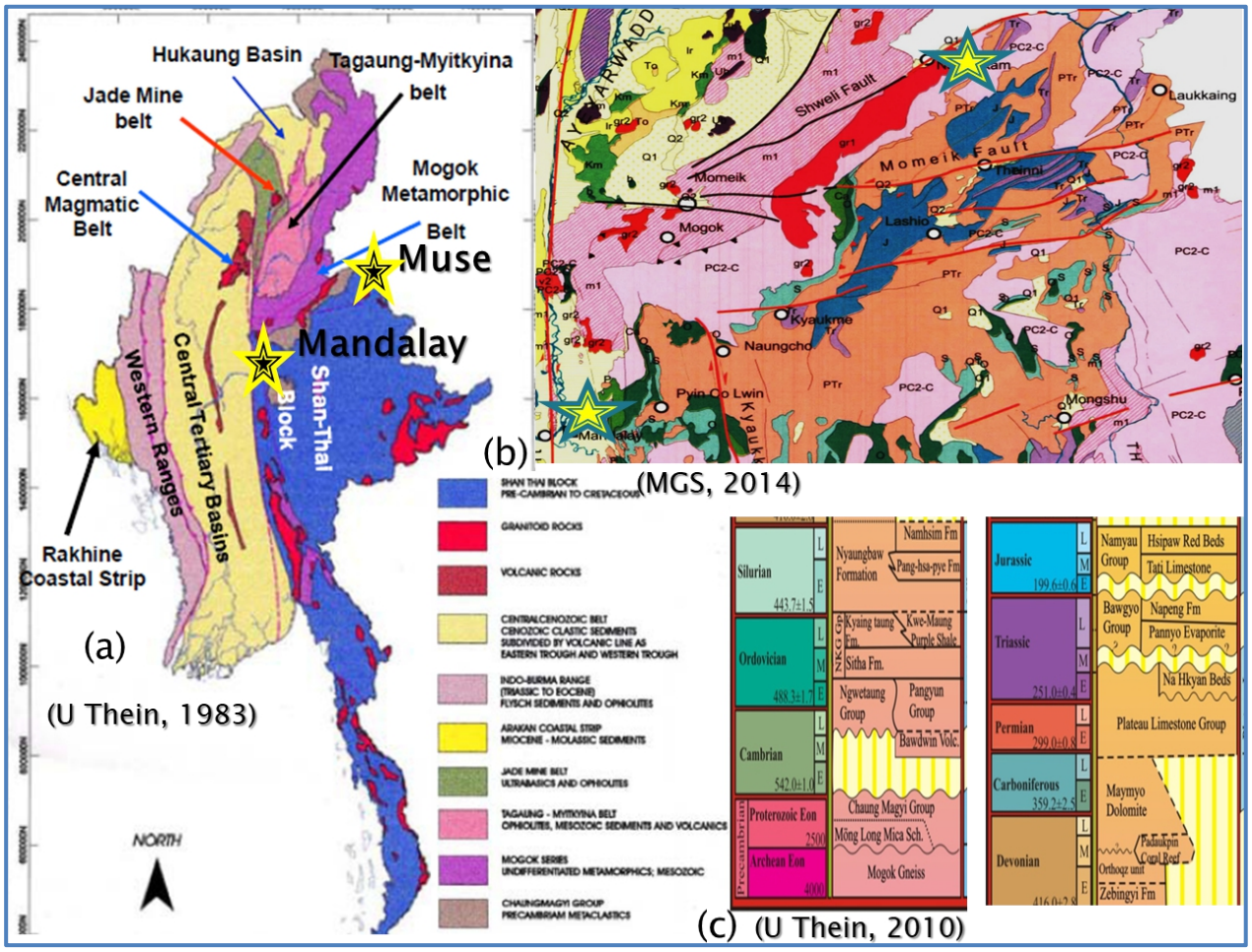


Figure 5.2 (a) Generalized Geological Map of Myanmar (Source: U Thein, 1983), (b) Geological Map of Northern Shan State (Source: MGS, 2014) and Stratigraphic Column of Northern Shan State (Source; U Thein, 2010)

The oldest one is the Chaung Magyi Group. It is a thick sequence of generally low-grade metasedimentary rocks. The major rock types in an approximate order of abundance are: phyllite, slate (often pyritiferous), metagraywacke, sandy phyllite, mica schist, calc-phyllite, graphite schist,and laminated marble. It occurs north of Naungcho, N of Kyaukme and between Namkhan-Muse.

The Cambrian beds are mainly sandstones. They overlie unconformably the Chang Magyi Group, and underline conformably the Ordovician beds. The Cambrian rocks are rather limited in distribution. It consists of rhyolitic rocks, tuffs and volcanoclastic sediments, purple shales, thinly bedded sandstones, hard greyish green, chololate-coloured micaceous quartzites and grit. The Cambrian succession along railway mainly exposed in two areas: western part (N of Pyinoolwin) and central part (mainly Bawdwin area).

Unlike the Cambrian system, the Ordovician System is distributed rather widely in Shan State as well as along the railway. According to La Touche (1913), it is the second most wisely distributed rock group, next to Maymyo Formation (Plateau Limestone+ Shan Dolomite) in Shan State. Middle Ordovician Sitha Formation is well exposed near Sitha and Thabyegyin villages and Taunggyun area, at east of Sedawlay (especially between First and Third Reversing on Mandalay-Maymyo old railway line), and at Kyaukchaw Hill north of Kyaukchaw village, Patheingyi Township, Mandalay. A thick, beautifully exposed road-cut section occurs along the road down the Gokteik Gorge, east of Naungkhio (Myint Thein, 1983). This formation is composed mainly of medium to thick-bedded (generally1-3ft thick) grey and dark grey blue limestones intercalated with partings, thin beds or subunits of buff-coloured, compact siltstones and marls. Another upper Ordovician Kyaingtaung Formation is composed mainly of thin to medium-bedded, white, yellow, orange, and sometimes purple siltstones, mudstones, and marls with occasional bands or beds of limestone. The beds are often deformed, and with distorted fossils.

The Silurian Nyaungbaw is widely exposed within Pyin-Oo-Lwin Township. Its lower contact with the Nyaungkangyi is conformable. It is mainly exposed Nyaungbaw village (W of Pyin Oo Lwin), S of Pyin Oo Lwin, W of Kyaukme and bent to the NW of Lashio. The Nyaungbaw Formation is a red brown, purple to blue-grey limestone with claystone sequence which has a strikingly phacoidal (nodular) aspect.

The Early to Middle Devonian Zebingyi Beds to a group of limestone and shale occur sporadically along Mandalay -Pyin-oo-lwin old railway line near Zebingyi station and along Kyinganaing stream near Thondaung village and Pathin village. It is largely a calcareous one with admixture of shale.

The Mid-Devonian to Permian Maymyo Formation is the largest outcrop along the Muse – Mandalay railway line. The limestone in this formation appears to have passed into finely crystalline dolomites and dolomitic limestones. It occurs Pyin Oo Lwin and its environs, Naungcho. Between Kyaukme and Lashio and S of Muse.

Jurassic Bawgyo Group (Especially Napeng Formation) consists chiefly of yellow-to buff-highly fossiliferous siltstone such as (pelecypods, gastropods) variegated shales, clay, arenaceous limestone, calcareous mudstone, argillaceous limestone intercalated with yellowish shale. This unit occurs mainly from E of Kyaume through Lashio, then bends again and passing S of Theinni and finally in south of Muse.

Triassic Namyau Group consists of hard and compact, bluish grey limestone, light grey fossiliferous limestone, cross- bedded arenaceous limestone, highly folded argillaceous limestone and calcareous shale, the red and purple shales, siltstones and sandstones. It is cropping out on both sides of the Namtu River, Kyaukme, northern part of Hsipaw, around Theinni, Nan Pha Ka and Muse towns. The rugged mountainous terrain is covered with relatively dense forest in this area.

It is also found that the granitoid rocks (mostly granite of Paleozoic age) are found largely along Muse-Namhkam trending NE-SW. It is the huge granite batholith in the area and intruded into the Chaung Magyi Group.

(c) Geological Hazards

Myanmar indeed is earthquake - prone as it lies in a major earthquake belt, called the **Alpine Belt**, which is a Tertiary orogenic belt that extends from northern Mediterranean, through Iran, the Himalaya and Myanmar, to Indonesia. Myanmar is situated in a tectonically active zone of continental collision, oceanic subduction and strike-slip faulting that make an earthquake prone with many recorded earthquakes (Oldham 1833; Brown & Leicester 1933; Chhibber 1934a; Thawbita 1976; Win Swe & Win Naing 2008; Than Tin Aung et al. 2008; Wang Yu et al. 2011, 2014; Rangin 2017; Sloan et al. 2017). Earthquakes with scattered hypocenters occur in eastern Shan State near the borders with China, Laos and Thailand related to strike-slip movements in the central part of Southeast Asia, extending into China. Myanmar is also faced with other natural hazards, especially storms, cyclones, floods and landslides, often leading to disasters that affect many more people than earthquakes.

The most probably catastrophic earthquake is this region is **Myanmar earthquake (Kyaukkyan Fault) of 23 May 1912**. It was been the strongest earthquake (with R. M. 8) felt in Myanmar in modern times. However, it occurred away from the populated areas, thus causing only moderate damage and destruction. J. C. Brown (1914) suggested that a sudden movement along the Kyaukkyan Fault near Naungcho had caused this earthquake. The well-known Sagaing Fault runs just 14km W of Mandalay, and make strong earthquakes (with R.M. 7) happened in the region several times.

The proposed Muse-Mandalay Railway line is actually located in the Shan-Thai Block and the rocks are mostly of limestones of Paleozoic age with some ragged mountain terrains. The carbonate rocks are mostly of the limestones from Maymyo Formation which has karst topography, cave and sinkhole natures. As the railway line is expected to be 431 kilometres

long, it will be needed a significant number of bridges and tunnels. So it is necessary to construct those infrastructures systematically and qualitatively. Another important thing is that as Myanmar itself falls in an earthquake prone and the strongest earthquake (Kyaukkyan Fault) happed in the railway line near Naungcho town, it should be conscious and thoroughly made any structures that must be resisted the magnitude (> R.M.8) of earthquake. According to seismic record, there was no record for earthquake of Kyaukkyan Fault after 1912. However, the past seismic records and the nature and magnitude of the neotectonic structures (especially active faults) suggest that there is little likelihood of the occurrence of catastrophic earthquakes (with Richter Magnitude > 8.5) in Myanmar in future. Earthquake related landslide and other natural disasters such as storms, cyclones, floods and landslide caused by heavy rains should be aware and taken into account in considering engineering designs. In addition to high cost involved, seismic, geological and natural hazardous issues are major burdens to the engineering project along Muse-Mandalay speed railway line.

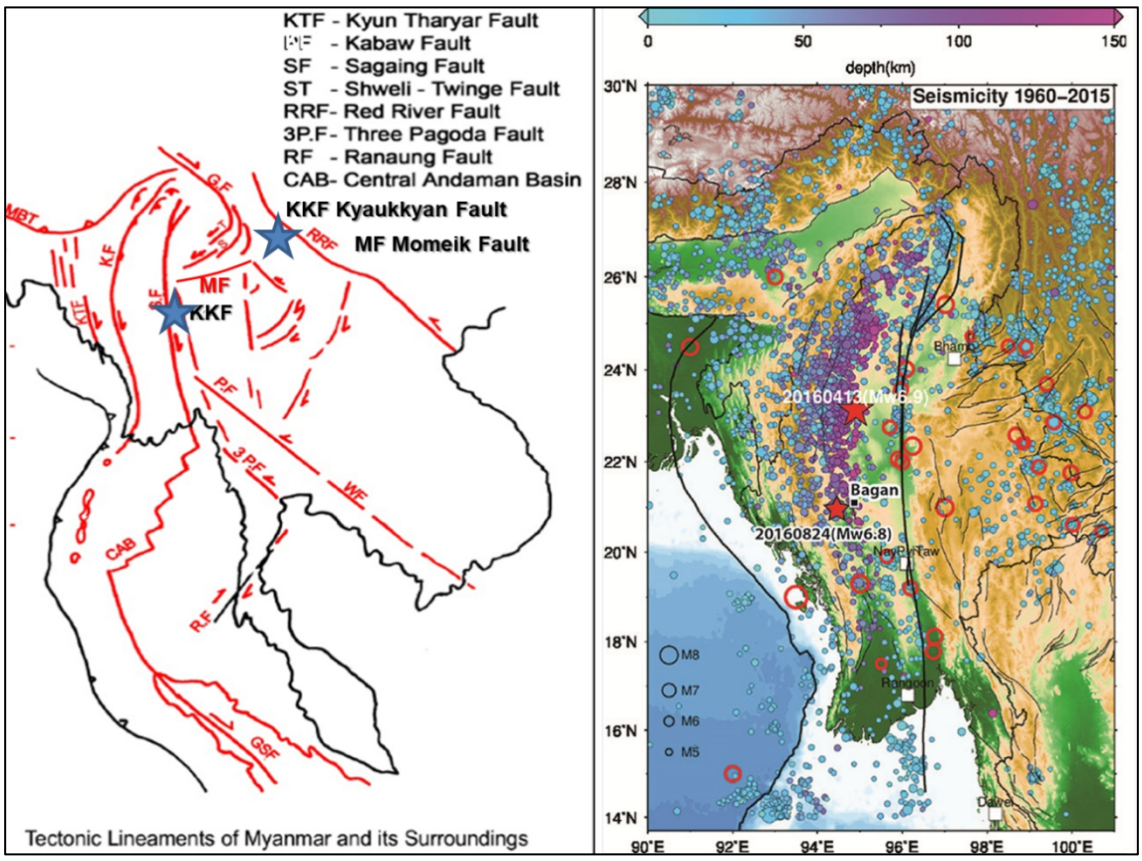


Figure 5.3. Tectonic Lineaments of Myanmar and its Surrounding Region (Modified from Hla Hla Aung,) (b) Seismic Map of Myanmar (Source: EOS, Singapore, 2016)

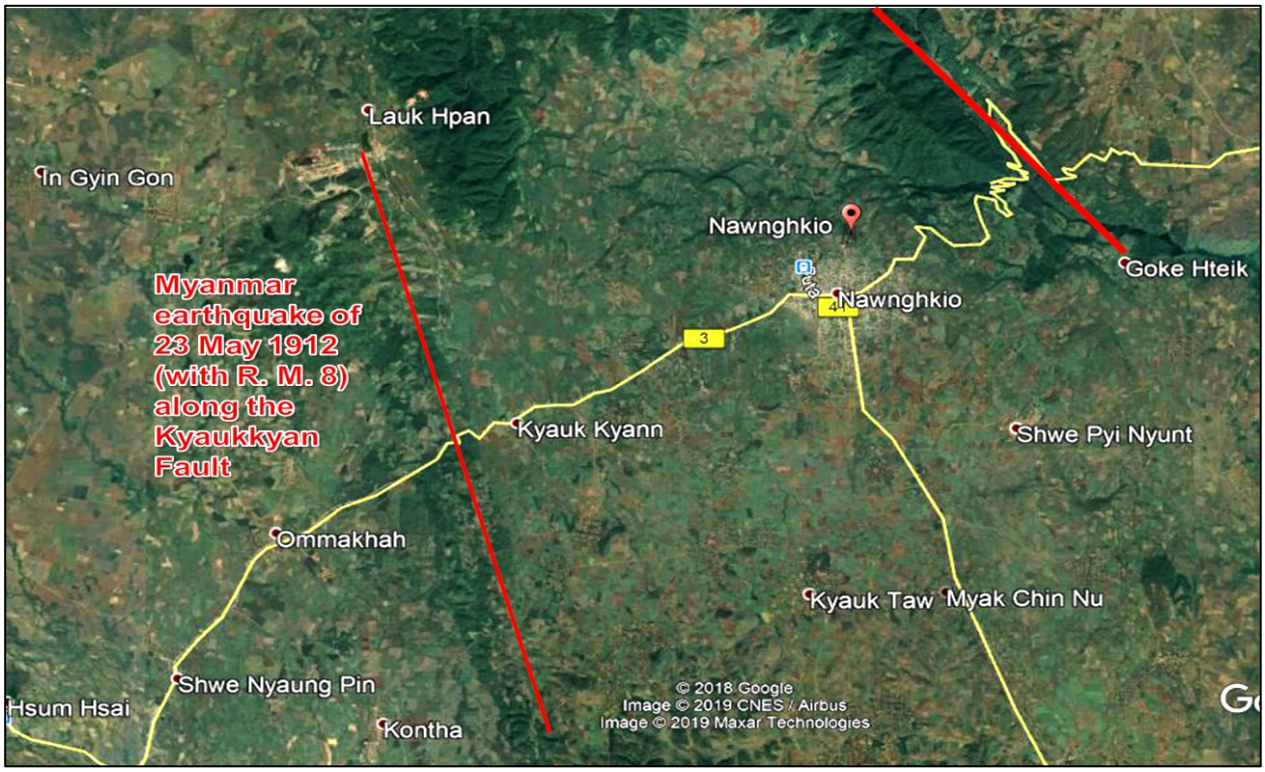


Figure 5.4. Satellite Image of the Kyaukkyan Fault near Naungcho Town. (Source: Google, 2018)

(d) Geotectonic Background

The Muse-Mandalay railway line runs diagonally along the southwestern direction through Upper Myanmar. The geological structure is between two first-order geotectonic units of the mountain - nyenchen tanglha range fold system (II) and the India-Myanmar-Sumatra fold system (III).

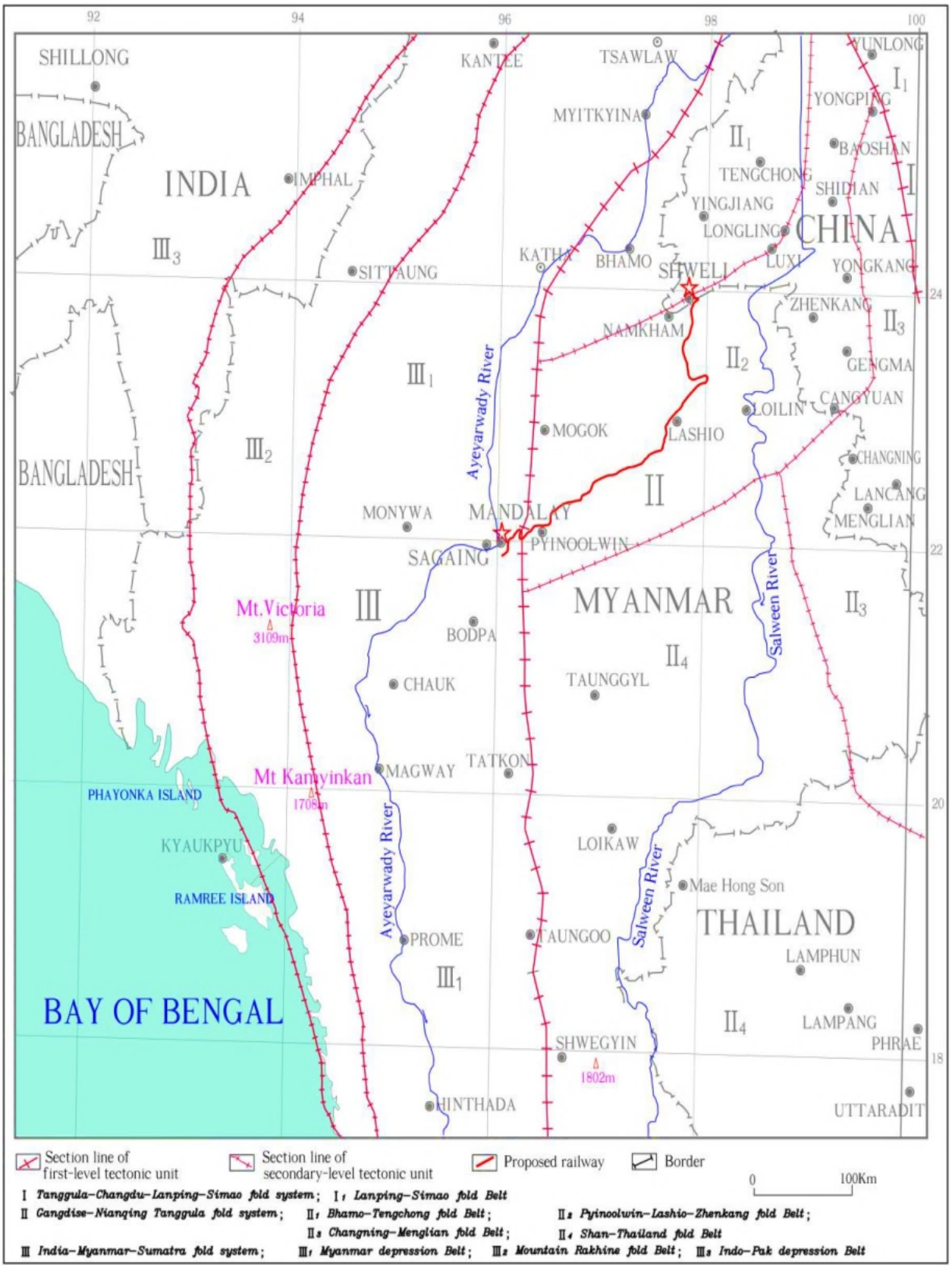


Figure 5.5. Zoning Map of Regional Tectonic Elements

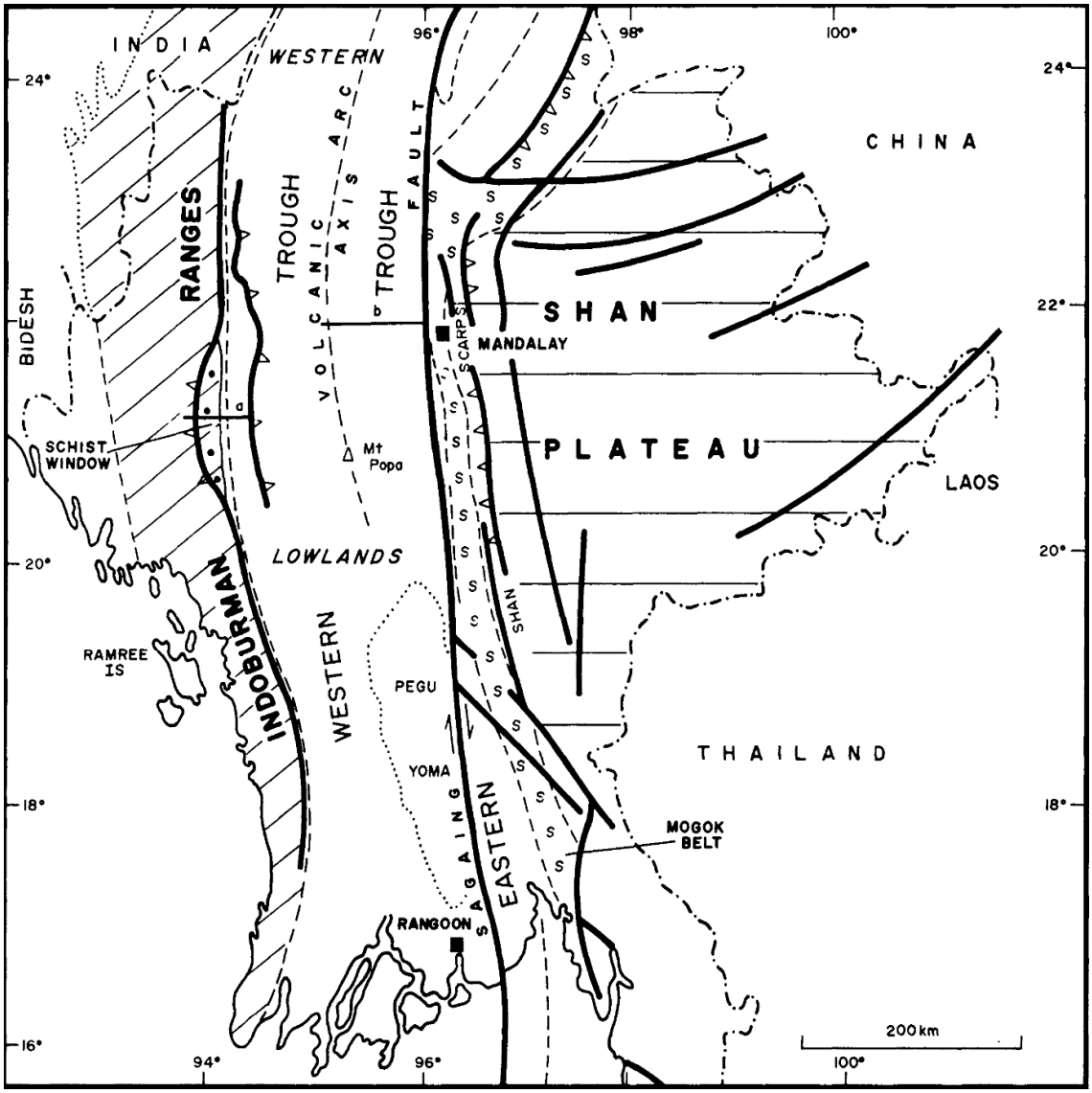
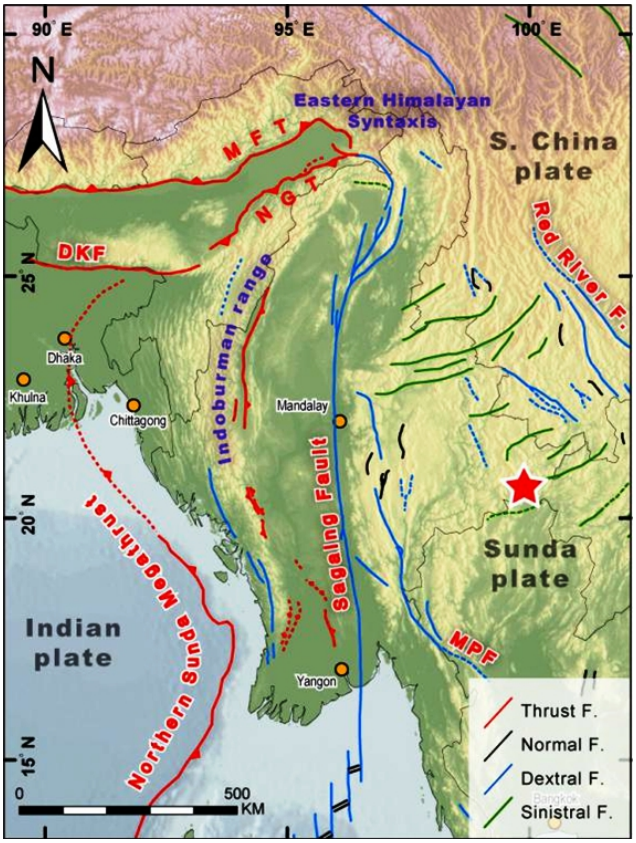


Figure 5.6. Major Structural Units, Shan Plateau and Western Myanmar

[Source: A.H.G.Mitchell]

(e) Neotectonic Movement Characteristics

The line is located at the upwelling area of Shan state plateau and Thailand north plateau, which turned into a relatively stable block after late Mesozoic, with overall uplift as the main action. There are different actions but not obvious. The topography shows a plateau with a slightly higher height in the north and gradually decreases to the south. The height of the mountain is between 1000m and 1500m and the highest is about 2000m. On the basis of the large-scale overall intermittent uplift, the survey area is affected by the fault activity, and there is also a significant fault block differential movement.



[Source: http://www.earthobservatory.sg/news/strong-quake-myanmar#.U4wB1ncxXmQ, Accessed 2016]

Figure 5.7 - Neotectonic Map of Myanmar

(f) Fold

The line spans a wide area, and is located on the east side of the Mandalay-Thazi synclinorium.

Mandalay-Thazi synclinorium: between Mandalay and Meiktila westwards, there is Mandalay-Thazi Valley area, the development of the valley is controlled by the late Neogene syncline deformation structure: the Mandalay - Thazi synclinorium. The Miocene-Pliocene mudstone and argillaceous siltstone are widely distributed in the syncline core, and there are thin layers of Quaternary alluvial deposits in the core. The wings (mainly the west wing) are the Miocene sandstone and mudstone intercalated with conglomerates. From the distribution of the stratum, the syncline should be relatively wide and flat, with the axial plane leaning to the west side, which also includes some sub-level wide anticlines and synclines. The near north-south Sagaing fault zone passes through the central part of the syncline valley, leading to regional deformation.

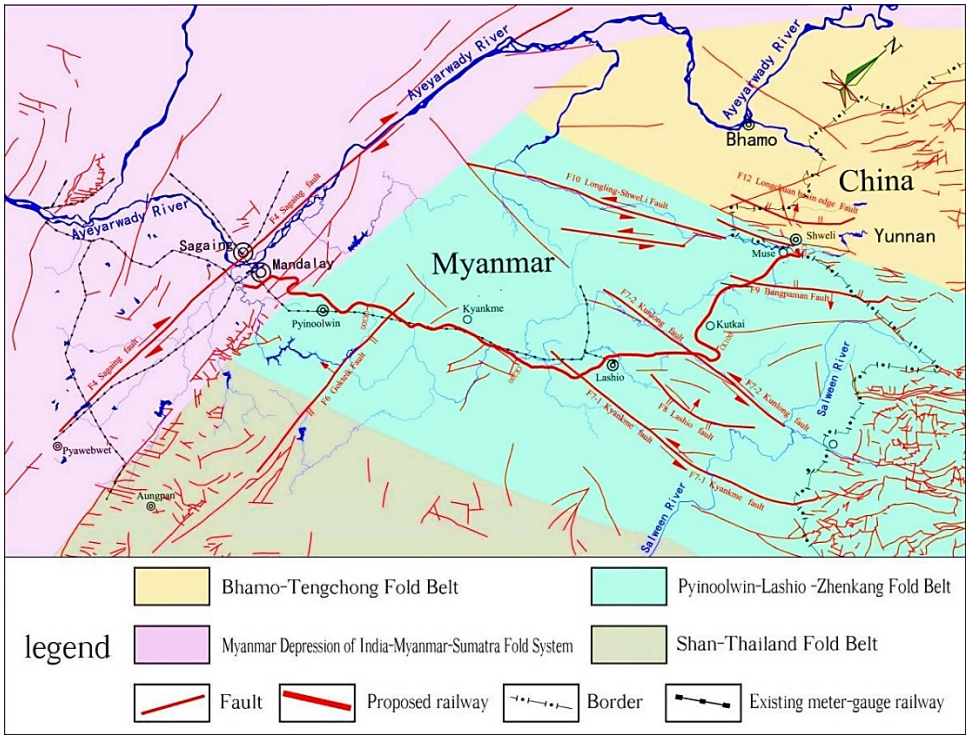


Figure - Outline Map of the Regional Tectonics along the Line

(g) Fault

The main fault structures in the area are NNW, near SN, NE, and NEE, in different directions. There are six main faults near the line: Bangpaman fault (F9), branch fractures (Kyaukme fault F7-1and Kunlong fault F7-2) of Nantinghe fault (F7), Lashio fault (F8), Goteik fault (F6), and Sagaing fault (F4). In which, the faults that have been active since the Late Pleistocene to the Holocene are the Nantinghe fault (F7) and the Sagaing fault (F4).

(h) Geological Engineering Feature

Affected by tectonic movement, the geological action along the line area is intense; the terrain is undulating with valley everywhere; the geotechnical structure is loose and broken, and carbonate is widely distributed along Muse-Mandalay Railway. There are many types of unfavorable geology and special geotechnical developed along the line, and geological disasters occur frequently. The main engineering geological problems along the line include landslides, talus, bedding, unstable rock, rock fall, karst, coal seam, high-intensity seismic zones and sand liquefaction, weathering spalling, high geostress and local high temperature hot springs, and other unfavorable geological phenomena. Special rock and soil include soft soil, mollisol, expansive rock soil and others. Sections with highly-developed landslide, talus

and unstable rocks alongside slopes of deep valleys control the alignment plan and the feasibility to establish major engineering. The line is located at high-intensity seismic zone with relatively bad overall engineering geology condition. The geological problems that have a great impact on the project are as follows:

(i) Seismicity

Geographically, Myanmar is a land located at the southern part of major earthquake belt, known as the Alpide Belt (Richter, 1958) which is a young orogenic belt formed by the collision of Australian-Indian Plate and Eurasian Plate. Due to this seismotectonic situation, the country is exposed to hazard of large earthquakes. A seismic zone map of Myanmar (see Fig. 5.19) shows that the Innwa-Mandalay-Sagaing area lies very close to the Sagaing Fault, the main source of earthquakes in Myanmar and it is the largest, and perhaps the youngest and presumably the most active fault in Myanmar (see also Win Swe & Win Naing, 2004).
Seismicity along the course of the Sagaing Fault is quite well known since the days of the Myanmar kings, because many of ancient royal capitals of Myanmar, such as Hanthawady (Bago), Kaetumade (Taunggoo), Ava (Innwa), Zayyarpura (Sagaing), Yadanapura (Amarapura), and Yadanapon (Mandalay), and Tagaung were incidently located on or close to the Sagaing fault zone. The intermittent slips along the fault have caused earthquakes at (from north to south) Putao (1908), Tagaung (1946), Thabeikkyin (2012), Sagaing (1956), Innwa (1839), Swa (1929), Phyu (1930) and Yangon (1927).

(j) Earthquake and Active Fault

Among the faults that occurred during the Late Pleistocene to Holocene, the most active and large-scale active faults are the Sagaing fault and the Nantinghe fault, which are all regional active faults in Holocene, and where witnessed earthquakes of magnitude 7 or higher for many times in history.

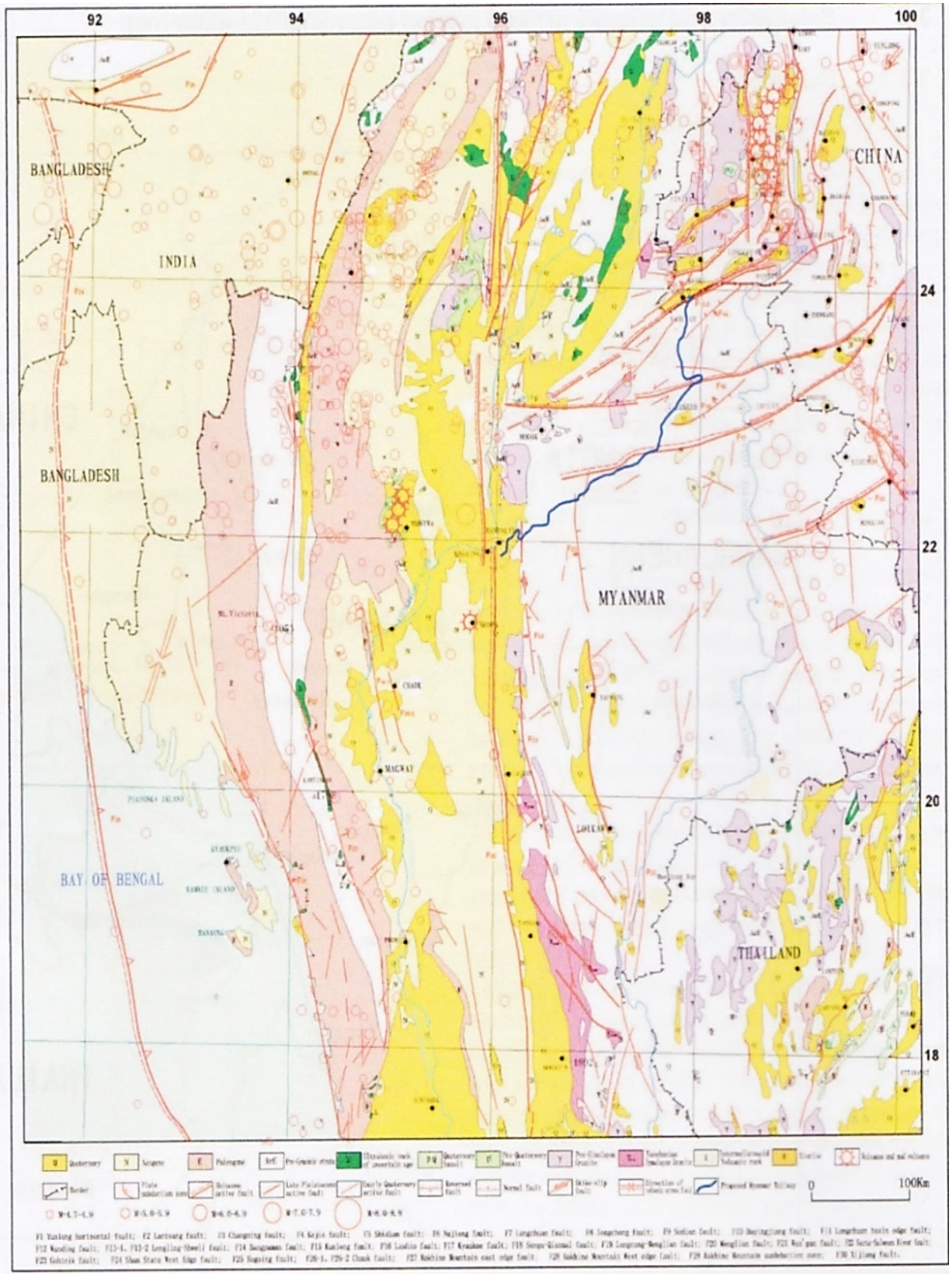
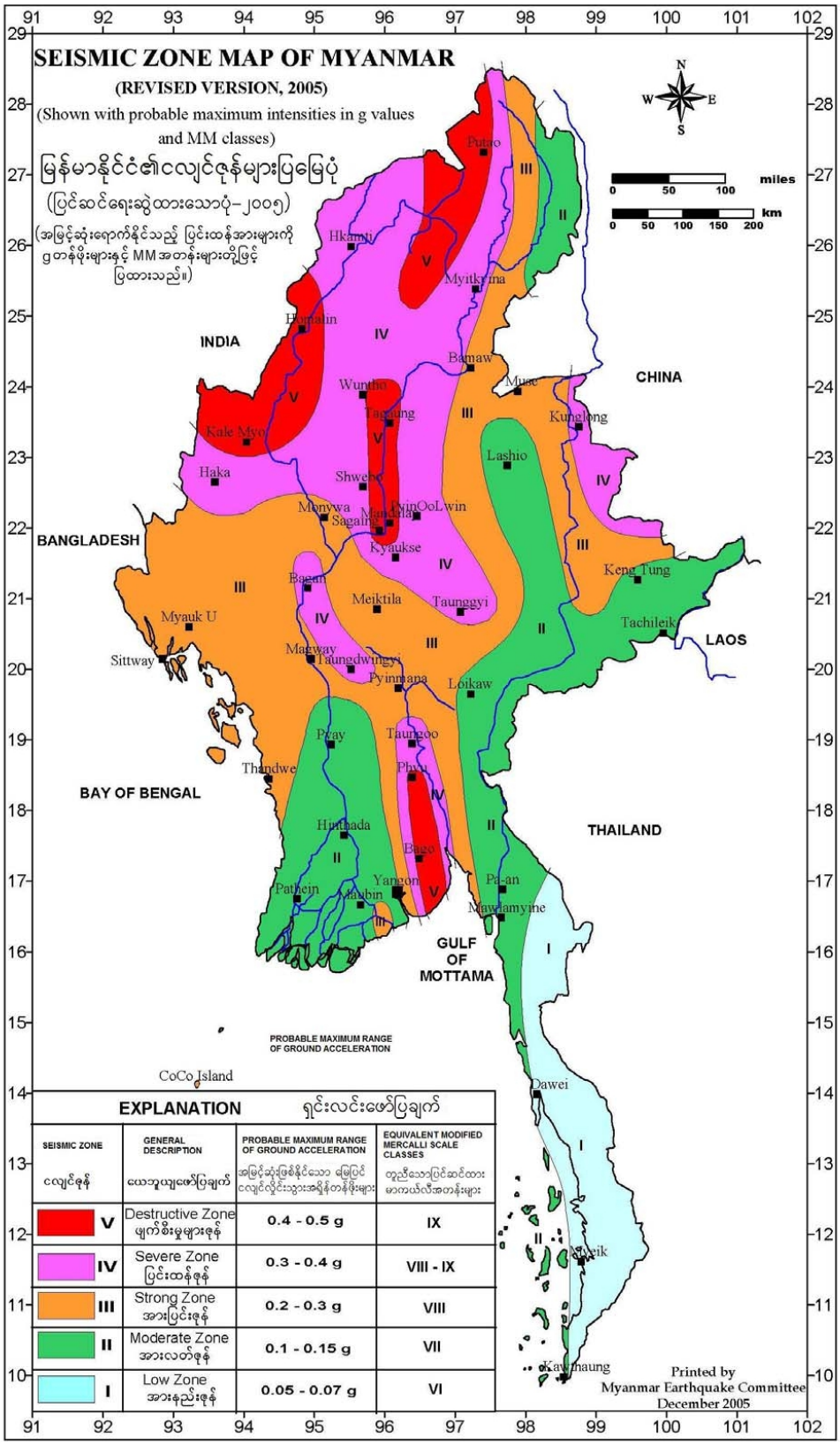


Figure 5.8. Regional Seismotectonic Map



Source: MIMU [Myanmar Information Management Unit]

Figure 5.9. Seismic Zone Map of Myanmar

There is still the possibility of an earthquake of magnitude 7 or higher in the future. Nantinghe Fault (F7): including the Kyaukme fault (F7-1) and the Kunlong fault (F7-2), which is part of the regional Nanting River fault in the near-field region. The Kyaukme fault (F7-1),overall strike 70°～80°, inclined to SE or NW, dip angle 50°～80°, 100km long, fractured zone is as wide as tens of meters to hundreds of meters. Due to the strong squeezing action of the fracture zone, a large number of mylonites are formed, in which the squeezed lenticles and tectonic rock often form a strip alternatively in gray, black and white, indicating that it has multi-stage tectonic activities; subrage for the alignment will be constructed here, which has a certain impact on the project. Kunlong fault (F7-2), strike of 70°～90°, inclined to SE or NW, dip angle of 50°～80, 150km long.

The faults are mainly developed in the Ordovician, Silurian, Triassic, Jurassic, Cretaceous and Cenozoic strata. It is characterized by a squeezed fracture zone alternatively in grayish green and offwhie with a width of up to 100 meters. The mylonitization action is strong and the crushing phenomenon is common. The foliation is developed in the fault gouge; there are many hot springs exposed along the fractured zone, accompanied by eruption of gas spring with high pressure; subgrade engineering will intersects with the fracture by a small angle (about 25°) , which has a great impact on the subgrade engineering. Sagaing fault zone:it is a deep and large fault extending over 1000 kilometers, is at the junction zone between the Baoshan-Shan state & Thailand block and the west Myanmar block and is submerged into the Andaman Sea at the south. It is also one of the main seismically active zones in the area. In history, there happened strong earthquakes of magnitude 7 or higher in the vicinity of Mandalay-Sagaing and its northern areas, and in Bago and its northern areas. The fracture is around 9km away from the line at the nearest point, with the surface covered by soil layer. No structural traces are found, but it has a certain impact on the project.

5.4.2. Geotechnical Characteristics

The carbonate rocks (limestone and dolomite) along the line are mainly distributed on the Shan State plateau (Muse-Mandalay section). According to statistics, there are 25 places with karst conditions along the line, with a total length of 297.08km, accounting for 72.46% of the line length. The strata consist of upper Paleozoic (Pz_2) dolomite with dolomite limestone; karst is weakly-strongly developed, with surface karst trace, solution crack, karren, karst cave, karst depression and sinkhole.

Karst cave

Karst depression

(Source: EIA Team, 2019)

(a) Landslide and talus

Landslides along the line are mainly distributed in Muse-Mandalay section on Shan State Plateau; they are bypassed by the alignment, thus having no impact on the alignment. Landslides and talus at a total of 24 locations are near the alignment.

Landslide

Talus

(Source : EIA Report, 2019)

(b) Dangerous rock & rockfall

Rockfall mostly occurs on the slope of deep-cut valley in hard rock and steep slope on the verge of some basins, posing great hazards to the Project. The alignment shall bypass sections with high mountains, steep slopes, rock formations deeply cut by joints and dense overhanging rocks wherever possible; if this is impossible, comprehensive treatment measures such as clearing, slope protection with wire mesh and support shall be taken to ensure safety during construction and operation.

Dangerous rock &Rockfall

(Source: EIA Team, 2019)

(c) Bedding

The distribution of sedimentary rocks along the line is long, and the angle between the strike of the rock stratum and the line in some sections is less than 45°, posing a bedding problem. Excavation is likely to cause bedding slide, especially in soft rock which softens easily when meeting water. The bedding has a big impact on slope stability.

Bedding

(Source: EIA Team, 2019)

(d) Earthquake-induced liquefaction

The line is located in a high seismic intensity area, where Quaternary loose saturated sandy soil is prone to earthquake-induced liquefaction. Sand liquefaction problems exist in Lashio basin (Lashio Station) and Thazi valley in Ayeyarwady basin. Saturated sand layers within 20m depth below the surface on the riverbed, flood plain and terrace in tributaries of Ayeyarwady River are prone to sand liquefaction. Liquefiable sandy soil has a big impact on bridge and subgrade works, to which great importance needs to be attached; appropriate anti-liquefaction measures shall be taken to eliminate its impact on the Project.

(d) Soft soil and loose soft soil

Soft soil and loose soft soil are mainly distributed along the line in basins (Shwe Li, Lashio and Theinni basins) and Ayeyarwady basin area (Mandalay), ranging from 0-5m to 5-15m in thickness; 0-5m thick soft soil and loose soft soil are distributed sparsely in paddy fields, water pond and low-lying gullies. Give their big impact on the Project, soft soil and loose soft soil shall be subject to checking calculation by worksite. Soft soil along the line is under significant seasonal influence, mainly because of valley facies soft plastic silty clay as a result of poor drainage; special attention shall be given to the adverse effect of steep cross slope on the Project. Soft soil and mollisol have great influence on the project and are easy to produce large and uneven settlement. The bridge foundation should be open-cut spread foundation or pile foundation based on the soft soil and the underlying layer properties, and the foundation pit retaining wall should be strengthened at the same time.

(e) Expansive soil

Weathered red clay and Neozoic(N) residual soil in Sinian-Cambrian (Z- ∈) and upper Paleozoic (Pz_2) carbonatite areas are weakly expansive, and moderately-highly expansive locally; most of them have a high liquid limit. Subgrade in expansive soil area should be of low fill and shallow cut type, with gentle cut slope or enhanced anti-slip retaining works; attention should be given to slope protection. For bridges, open-cut spread foundation or pile foundation shall be adopted depending on the property of expansive soil and the underlying stratum; meanwhile, wall protection for the foundation pit shall be enhanced. All foundations shall be placed below the zone affected by abrupt change in atmosphere and provided with a proper drainage system.

Red clay

Residual Soil of Neogene System (N)

The clay stone and mudstone of the Neogene System (N) are generally weathered to be soil-like along the line. The minerals include montmorillonite, kaolin, etc., which may become

softening and disintegrated with water and shrink and crack without water. So, it is the weak expansive rock with weak expansion. The line should keep away from the front mountain slope of the expansive rock and the combination zone of different geomorphic units and should pass perpendicular to the axis of the ridge. Expansive rock is of little influence on bridge works.

(f) Expansive Rock

The Tertiary (N) mudstones, clay rocks, etc. along the line have weak expansion property and some are expansive rocks. The line should avoid the mountain front slope of expansive rock and the joint zone of different geomorphic units, and should pass through the area perpendicularly to the ridge axis. Cuttings shall strengthen slope drainage and protection; tunnels shall reserve deformation joints, and strengthen retaining, protection and drainage measures.

(g) High Ground Stress

High ground stress may exist in the deep buried long tunnels along the line, and the deformation of weak surrounding rock or weak rockburst of hard rock may occur during construction. The high ground stress has a great impact on tunnel construction. During the design and construction process, the lining supports should be strengthened.

5.4.3. Ground Motion Parameters Zonization

In reference to the report on “Evaluation of Seismic Safety of Pipeline Engineering Sites along China-Myanmar Oil and Gas Pipeline inside Myanmar” by Beijing Zhongzheng Entrepreneurship Engineering Science and Technology Research Institute, the ground motion peak acceleration value and ground motion response spectrum characteristic period of each section along the line (surpass 10% in 50 years) are shown in Table 5-2 Muse-Mandalay Railway Ground Motion Parameter Zonization.

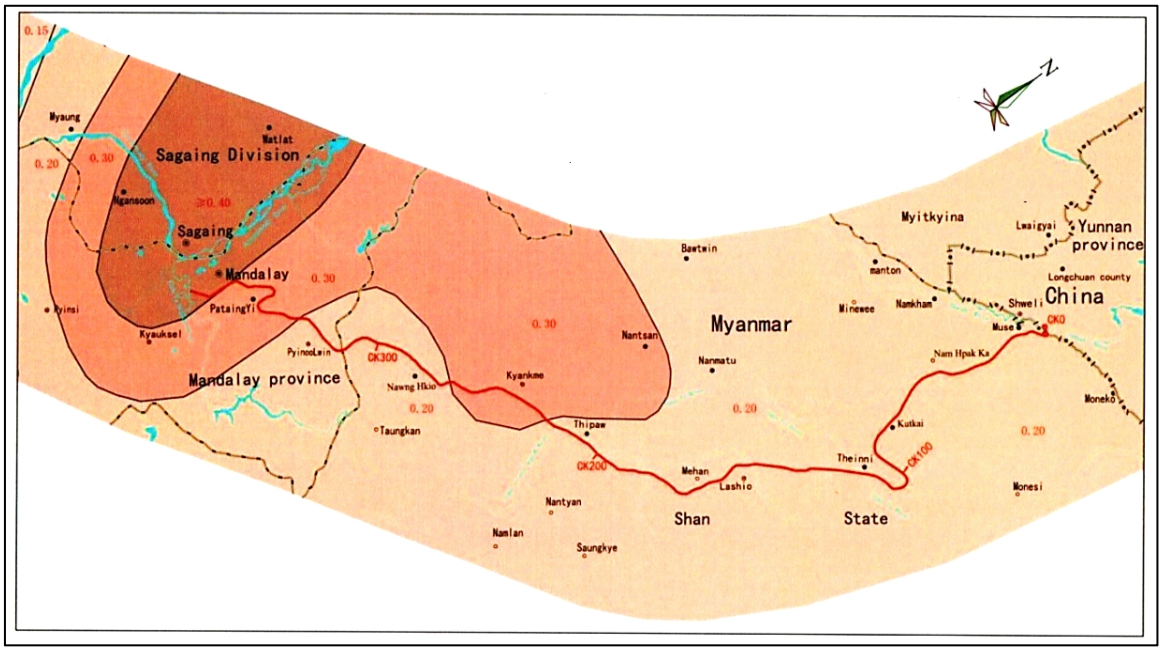


Figure 5.10 – Zoning Map of Seismic Ground Motion Parameters along the Line

Table 5.2 - Muse-Mandalay Railway Ground Motion Parameter Zonization

Mileage	Length(km)	Ground motion peak acceleration (g)	Dynamic response spectrum characteristic period (s)
CK0+000-CK219+600	249	0.2	0.45
CK219+600-CK272+700	39.5	0.3	0.45
CK272+700-CK338+500	65.8	0.2	0.45
CK338+500-CK382+700	44.2	0.3	0.45
CK382+700-CK398+300	15.6	⩾0.4	0.45

5.4.4. A Brief Account on the Mineral Deposits of Myanmar

Myanmar, the second largest country in Southeast Asia, occupies geologically and tectonically a key position located in the northeast corner of the Indian Ocean. Tectonically Myanmar has collided with the Indian continent in the Naga Hills and is juxtaposed with the eastern end of the India-Asia collision zone and Himalayas to the east. It is found that Myanmar has a several number of world-class metallic mineral deposits, including copper, nickel, tin and tungsten, offshore and onshore reserves of oil and gas, and an abundance of gemstones especially ruby, sapphire and jade, etc.

(1) Tin-Tungsten Deposits

Although more than 122 mineral occurrences have been recorded (Gossens, 1978), only about ten can be economically worked as large and medium sized mines especially in Thannitharyi Region, Southern Myanmar. The larger tin-tungsten mines in Myanmar are: – Mawchi (Fig.1) in Kayan State, Heinda, Heinze, Hermyingyi, Kanbauk, Yadanabon, Kyaukmetaung and Nanthila mines, whereas Mawchi, Hermyingyi, Yadanabon and Nanthila mines work on vein deposits and the other work on placer deposits.

(2) Lead-Zinc-Sliver Deposits

Although 39 mineral occurrences are listed by Gossens in 1978, only three are of economic important to be developed as mines. They are, in order of importance: Bawdwin mine and Yadanatheingi mine in Northern Shan State (Figs. 1 & 2) and Bawzaing mine in Southern Shan State (Fig.1). Lead mineralization occurred as massive type, disseminated type and stock work and irregular stringers.

(3) Copper Deposits

Out of 45 mineral occurrences of copper ore, only three are of economic importance. These are Monywa deposit which is an only one world-class deposit (now producing by Chinese Companies), Shangalon deposit (about 16 miles SW of Kawlin), and Sabe-Taung deposit (about 12 miles ESE of Kyaukse).

(4) Nickel and Chromite Deposits

The Nickel deposits occur in close association with the Ophiolite Belt of Jurassic-Cretaceous age emplaced in northern Chin Hills (Mwetaung) within Western Ophiolite Belt in West Mynamar and Tagaung- Innettaung within Tagaung-Myitkyina Belt or Eastern Ophiolite Belt in northern Myanmar. At least 15 chromite occurrences are known at Mwetaung and Tagaung Taung.

(5) Manganese

Residual Manganese deposit originated in Mergui Group of Carboniferous age occurs in Tanintharyi region, Southern Myanmar.

(6) Antimony Deposits

Out of 30 mineral occurrences of stibnite listed by Goossens in 1978, only four have been developed as small mines. These are Thabyu, Lebyin (Fig.1), Natsan and Painchit mines in fold thrust belt zone in Sibumasu block. Mining of antimony ore in the slate hosted in Taungnyo Group of Permo-carboniferous age is carried out at Kadaik Area of Mon State.

(7) Iron Deposits

Out of 48 iron oxide occurrences listed by Goossens in 1978, only six may be said to be of some economic importance. These are Pangpet in Southern Shan State, Kyatwinye and Inya, near Pyin Oo Lwin (Figs. 1-3), Khogyum, Mah Putah and Kathaing Taung.

(8) Coal

Clegg (1944) listed 11 occurrences of Mesozoic coals and 60 occurrences of Tertiary coals. At present, two mines are producing Tertiary coals. They are Kalewa (Sagaing Region) and Namma mines (Near Hsipaw) (Figs. 1 & 2). Tigyit (near Pinlaung in S Shan State), Kesi-Mansan (Shan States) and Kawmapyin, Mawtaung (Tanintharyi Region) deposits are very promising target areas for producing coals.

(9) Gemstones

Myanmar is quite famous for its gemstones, especially ruby, sapphire and jade. In fact, the Myanmar rubies, sapphires and jadeite jades are the finest in the world. The two most famous localities of gemstones are the Mogok-Kyatpyin area for rubies and sapphires, and the Tawmaw-Phakant area for jades. Other famous ruby and sapphire areas are Mong Hsh area, Wan Ying and Wan Hatt in Shan Plateau. Amber in Hu Kaung basin in Northern Myanmar is also famous.

(10) Oil & Gas

Myanmar is fairly rich in oil & gas. Oil & gas have been found in large quantities in the Minbu and Chindwin basins accumulated in en-echelon anticlines trending roughly NNW-SSE. The reservoir rocks are commonly Oligocene-Miocene sandstones and occasionally Eocene sandstones. The Petroleum geology of offshore Myanmar are found in Late Miocene deltaic sandstone in Moattama offshore, in Early Miocene marine sandstone in Thanintharyi shelf and early Pliocene deep marine sandstone in Rakhine coastal area.

(11) Gold

In Myanmar, placer gold has long been extracted. At present, there is no primary world class gold deposit in Myanmar. Recently Myanmar government and local mining companies are dynamically exploring gold and have discovered many promising deposits in the locally well-known areas such as Kyaukpahto area, Thabeikkyin area, Phayaung Taung (Fig. 5.11), Yamethin East area (Modi-Momi area) and Meyongale-Meyongyi area, etc.

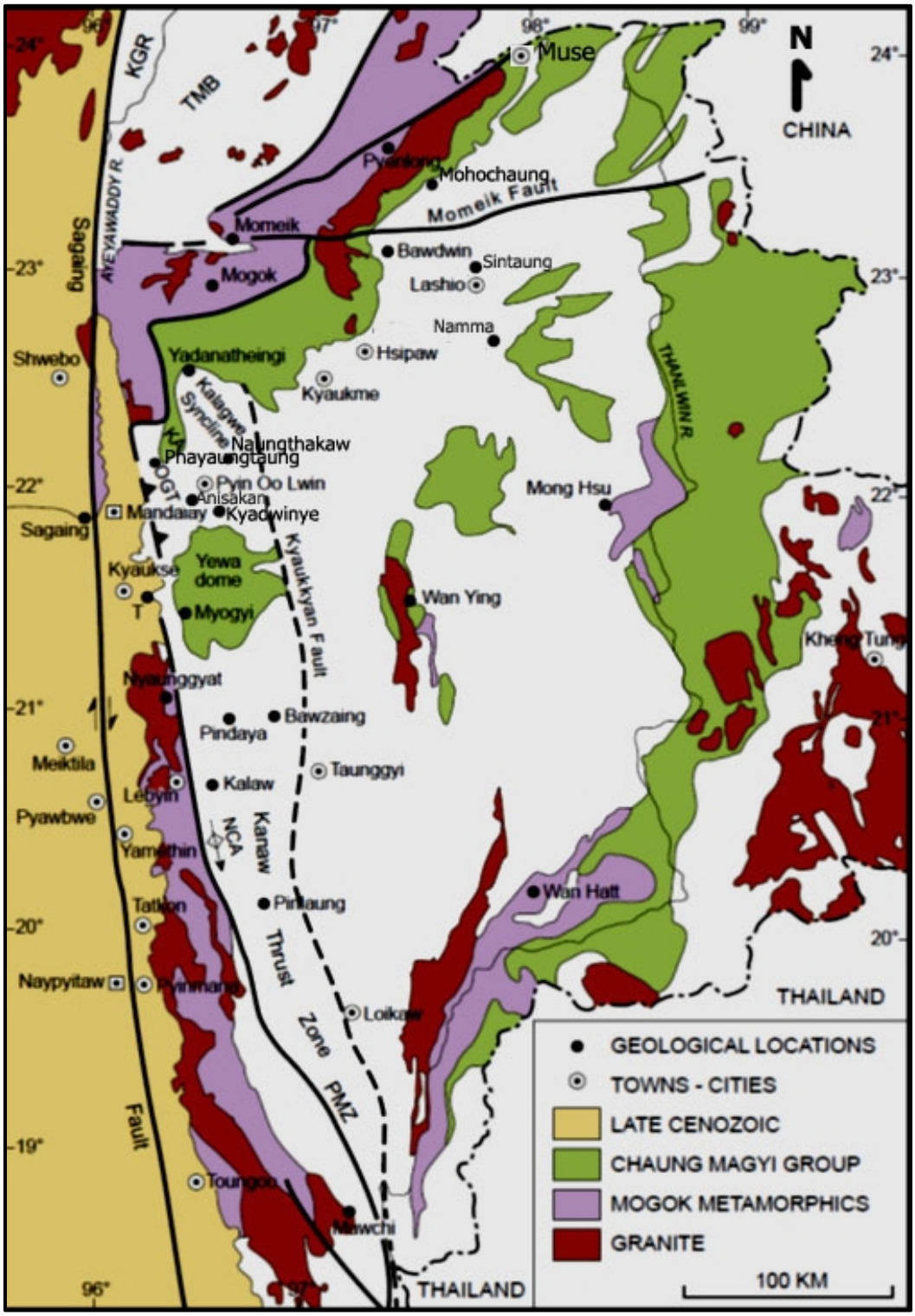


Fig. 5.11 - Map of part of Shan Plateau showing mineral and gemstone locations described in text.(Modified from Mitchell, 2018)

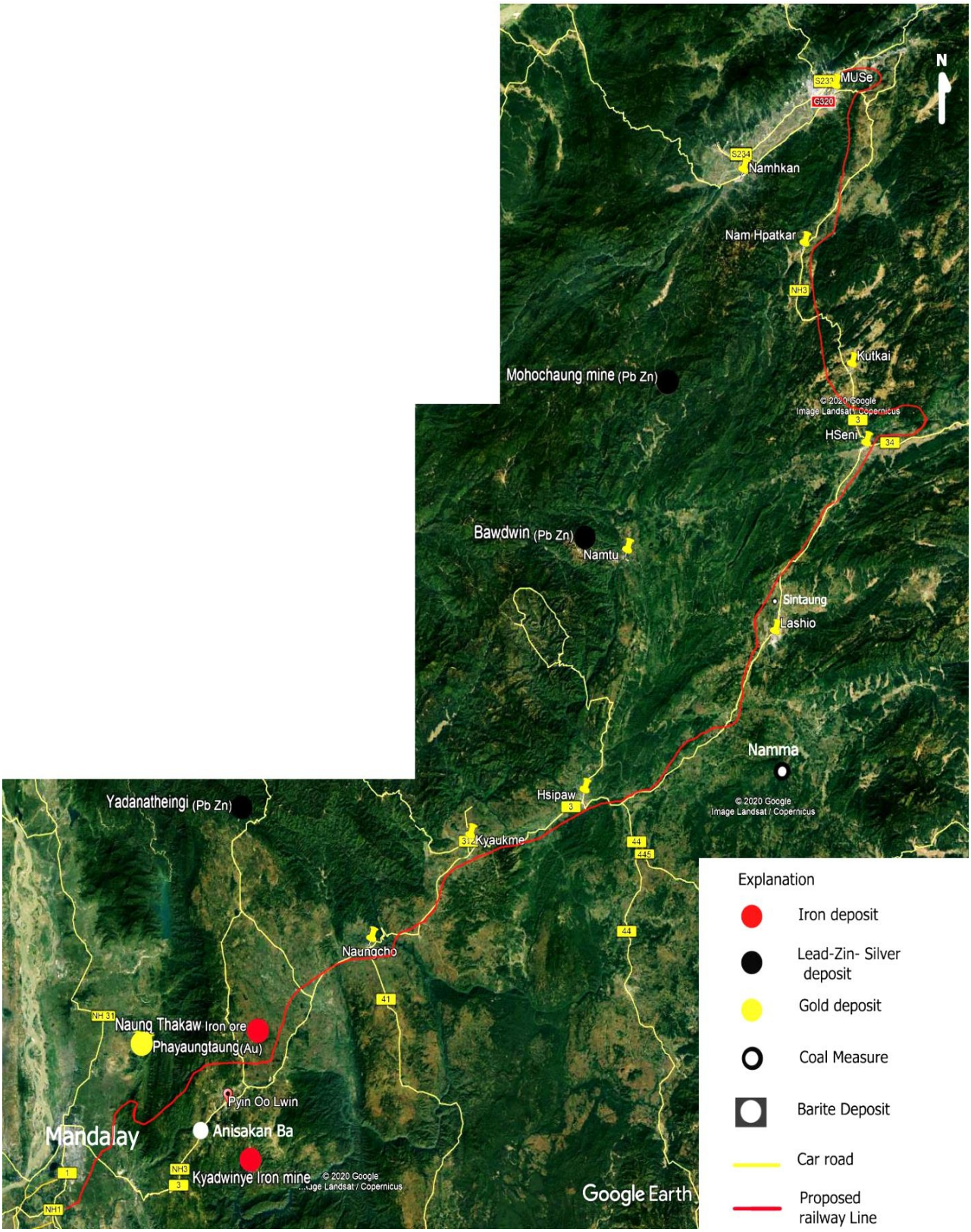


Fig. 5.12 - Satellite image showing the location of proposed railway line and localities of known mineral deposits along and around it. (Tin Aung Myint, 2020)

Fig. 5.13 - GIS image showing Localities of Known Mineral Deposits along the Railway Line

5.4.5. Mineral Deposits along and around the Muse-Mandalay Railway line

Lead-Zinc-Silver Deposits

Mohochang Prospect (Latitude 23° 25' N, Longitude 97° 30' E)

The Mohochang mine is located 25 miles northeast of Bawdwin/ Namtu and the old workings are centered around Mohochaung. At present there are no existing roads to the area but during the dry season the present trails can be converted into mule tracks (Soe Win, 2017). The Mohochang mines are in an area of rugged terrain, the Mohochang Peak reaching an elevation of 6439 feet can be viewed from Namtu. It is far from railway line.

The Chaung Magyi Group is of great importance in the Mohochang area in that it contains horizons in which the main lead-zinc mineralization occurs. They comprise the oldest rocks in the area. The white sandstone occurs along the contact of the Chaung Magyi rocks with the overlying Pangyun Formation. Pb-Zn mineralization is confined to this horizon (having an average of 43% Pb). The Tawnpeng granite (a biotite granite) lies along the northwest margin of the area and it intrudes the Chaung Magyi rocks. The main faults strikes N-S, NNW-SSE and E-W.

Mineralization is confined to the magnesian limestone horizon of the Chaung Magyi Group. Quartz veins occupy fracture and carry the sulphides, pyrite, little chalcopyrite, sphalerite, and galena. The gangue minerals are quartz, calcite and siderite. The views on the control of mineralization are varied. Seaton assumed that the mineral solutions owe their origin to the Tawnpeng granite and that the granite mass may have contributed to the process of mobilization and flow of solutions. Deposition took place along fractures in the magnesian limestone. It is 50 feet thick near the village of Kong Namlek and its general strike is NE-SW with a 25-35 degrees dip to NW.

Bawdwin Mine (23° 6'23.57"N & 97°17'52.62"E)

The Bawdwin mine (Figs.5.10&5.11) in Myanmar has been one of the world ranking lead mine before the World War II. This mine is situated about 8 miles west of Namtu and 60 miles from the border with the peoples' Republic of China. This mine is also far from railway line. According to the historical records, the Chinese first extracted silver from this area in 1912. Bawdwin stands at an elevation of more than 3000 feet above sea level. The terrain is rugged and devoid of vegetation, thought to be result of deforestation of crude smelting

operations by the early Chinese artisanal mining. The main drainage is the Nam Pangyun river that flows through the mine camp. The oldest rocks belong to the Chaung Magyi Group of Pre-Cambrian age comprising slate, phyllites, greywackes and schists exposed to the west of the Bawdwin mine and Pangyun Formation of Cambrian age overlying unconformably on the Chaung Magyi Group form the main host to mineralization.

The Tawnpeng granite occupies an extensive area especially west and northwest of Bawdwin and intrusive into the Chaung Magyi metasediments. The Loi Mi quartz porphyry occurs as a small stock and as sills and irregular masses along the Bawdwin ore zone. The Bawdwin lead zinc silver ore deposit consists of three sulphide high grade Pb-Zn ore and small pyire-chalcopyrite ore body. The mineralization is approximately 1.5 miles long and about 400 feet wide NW-SE fault zone. At Bawdwin three main lodes are known. The Shan Lode in the north, the Chinaman the central lode and Meingtha in the south.

Name	Max. Length	Max. Vert Dimension	Avg. Width
Shan Lode	380m	350m	6m
Chinaman Lode	400m	350m	42m
Meingtha Lode	550m	450m	6m

The ore reserve given by the Bawdwin in 1982-83 is 142877 tons (with 7.73%Pb, 3.45%Zn and 4.8602Ag) by underground mining, 105402 tons (with 5.98%Pb, 0.99%Zn) by open-cast mining.

Yadanatheingi Mine (22°34'35.26"N, 96°29'43.54"E)

The Pb ores of Yadanatheingi is located about 50 miles NE of Pyinoolwin (Figs.5.10&5.11). Yadanatheingi is in the northeastern limb of the regional southeast-plunging Kalagway Syncline some 100km southwest of and along strike from the Bawdwin mine. A high Ag content of the ores is a noteworthy feature of this mine. It is mined from a shear zone about 30 feet thick which cuts across the Chaung Magyi Group in an NW-SE direction. Some similarity between the geological setting of Yadanatheingi and that of Bawdwin is suggested by the presence at Yadaantheingi of mineralized structures extending from the Chaung Magyi into quartzites of the Cambrian Pangyun Formation (Mitchell, 2018).

The ore is found as fissure veins and stockworks and the Pb content is about 5-10%. In 1974-75, the mine produced 1600 tons of lead concentrate containing 50% Pb and 1% Zn (Bender, 1983). In 1986-87, 1322 tons of lead concentrate was produced. After privatization the Yadantheingi mine is operated by the Lin Pyae Mining Co., which is extracting the remnants from old deposits. Apparently no efforts have been made to search for ore extensions laterally or at depth. The possible ore reserve is about 1207000 tons of Pb concentrates.

Barite Deposits

Anisakan Barite deposits

The barite deposits in the vicinity of Anisakan area are located at Peinnegon, Taunggyun, Indon-ye, Sitha, Dattaw, Bayaw and Byingyi. Barite occurs along fissures and fractures trending NNW-SSE to nearly N-S, in the Ordovician limestones and siltstones. The veins dipping steeply 50 to 90 degrees and their thickness vary from a few feet to more than 20 feet. The proved reserve amounts to about 213,000 tons with 97% barite, and the probable reserve amounts over 400,000 tons.

Iron Ore Deposits

Kyadwinye (21°53'39.64"N, 96°30'58.67"E)

It is located on the eastern limb of a major anticline (Kyaingtaung anticline) whose anticlinal crest is located about six miles to the west. Iron ore occurs entirely in Maymyo Formation of Devonian age. Kyadwinye deposits contain high iron content (50%-60% Fe).

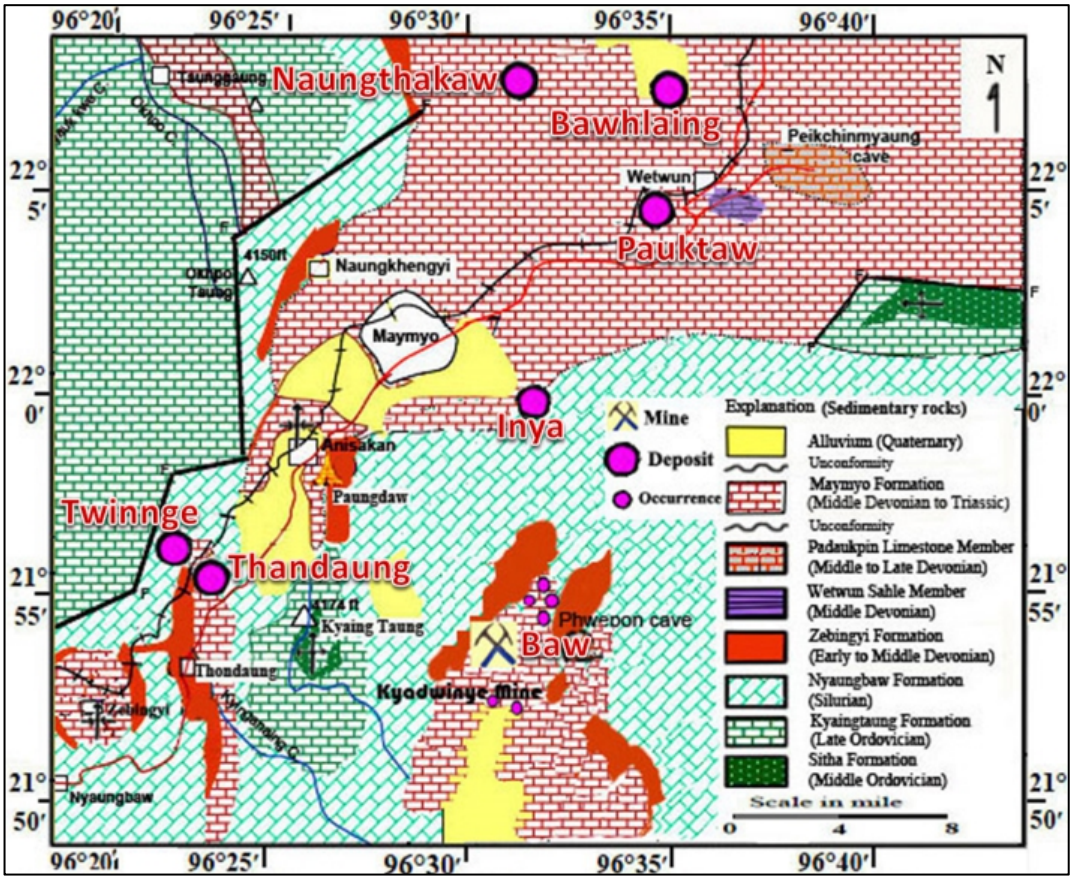


Fig.5.14 - Geology map of Pyinoolwin area including Iron Localities. (Tin Aung Myint, 2014)

Moreover, numerous small scale iron occurrences which are economically unfeasible are found throughout the area. In Kyadwinye mine, (Figs.5.10&5.11) the iron deposit occurs on the Main hill (Foot wall) (3498') and mine site in lower hill (Hanging Wall) separated by Kyadwinye normal fault. The area coverage is about 6725640 square feet (624811.9 sq.m.). The thickness of iron deposit on the Main hill is only 12.8' (4m) thick. However, at the mine, the iron ore deposit is much thicker, reaching up to 70' (22m) in thickness. The deposit is sedimentary in origin and the hematite and limonite ores occur in the cavities and depressions of the underlying. Plateau Limestone (Maymyo Dolomite). Field investigation shows that the mine is situated on the down thrown side of the fault.

In Kyadwinye, the iron ore deposit comprises limonite and hematite with minor amount of pyrite and magnetite found in dolomite and sandstone of Maymyo Formation. The bore-hole data indicates gradual increase of limonite content with depth. The surface of the ground shows scattered light brown ferruginous gravel and larger pieces of iron ores. Iron ore occurs in different forms: as boulders, nodular masses, gravels or floats. The biggest one is reaching up to 15 cubic meters (530cubic feet).

The ore is trucked to the No.1 Iron and Steel Plant at Aniskan located about 16 km west of Pyinoolwin. The plant produces pig iron, steel billet, rounded bars and steel grinding balls (Soe Win, 1994). Although Krupp and BGD (1961-62) gave a reserve of 3 million tons, the estimated iron ore reserve is less than 2 million tons with average iron content of 58.5% (Tin Aung Myint & Mi Mi Ko, 2004).

Inya (22° 0'57.77"N, 96°32'53.19"E):

It is located 9 km SE of Pyin Oo Lwin (Fig.5.14). Brecciated limonitic ore occurs in dolomitic limestones. 4.5 million tons with an average Fe content of 35.2 %, Ti O_2 content of 1.5 %. The deposit although favorable for open cast mining, the ore is difficult to dress (intergrowth of hematite ore / laterite / bauxite). The Fe content is generally low and high TiO_2 content renders the ore difficult to smelt.

Pauktaw (22° 4'46.78"N, 96°35'13.07"E):

It lies close to the Mandalay- Lashio railway old line, 4 miles SW of Wetwin railway station (Fig.5.14). It is a small excavation worked in 1920 and 1921 by the Burma Corporation. 1,700 tons of ore, with an average iron content of 56- 57 %, have been removed from this working. The analysis of pisolitic materials contains 25.2 % Fe, 19.0 % Al_2 O_3, 6.2 % MgO, and 10 % Si O_2 (Soe Win, 1994).

Naungthakaw (22°8'47.03"N, 96°31'45.46"E):

It lies about 6 miles to the NW of Pauktaw. Workable hematite ore vary from thin bands of few inches to thick ones of several feet thick. The deposit is covering the area of about 8 sq. miles. It is of residual type in Plateau Limestone. The iron content is 56 % Fe. This was mined by the Burma Corporation Ltd, in pre- war years with an annual production between 35,000 and 40,000 tons. The deposit is very close to the proposed railway line.

Gold Deposit

Phayaung Taung Gold Mine (22° 7'39.79"N, 96°16'36.97"E)

It is situated about 32 km northeast of Mandalay. It is located at the junction of Slate Belt, eastern part of Mogok Metamorphic Belt and Shan Plateau bounded by two dextral strike-slip faults, the Sagaing fault to the west and the Shan scarp fault system to the east. The

stratigraphic units exposed in the area are Chaung Magyi Group (CMG). Mineralization is commonly formed in quartzite (aks Maukkaw Quartzite) and mica schists. Phayaung Taung fault plays an important role to form large concentration of fluid flows. The Phayaung Taung gold mineralization is characterized by the gold bearing quartz with variable comb and ribbon textures. Ore mineral assemblage includes gold, chalcopyrite, pyrite, hematite, malachite and azurite. The Kin sandy phyllite of CMG, mica schists, garnet-staurolite schist of MMB at Baw Taung area and Maukkaw quartzite of the CMG are potential hosts for gold mineralization. There was also 12 drill holes were completed and estimated about 3.23Mt @ 4.78 g t−1 Au (DGSE 2013). Now the mine is operated by Htawaya mining company.

Coal Occurrences

The occurrences of coal measure along the railway line is mainly Tertiary coal-bearing layers occurred in Muse and Lashio Basin (Figs.5.10&5.11). Here, it is mainly emphasized on the coal occurrences around Lashio. Sintaung (23° 0'16.45"N, 97°45'9.18"E) near Lashio is very close to the line. It is an open pit mining of approximately 120m (L) x 72 m (W), with the thickness of 0.5-7m dipping 20˚N. Other occurrences are found at Namma (22°39'14.71"N, 97°45'27.61"E) which is an old open coal mines and there are also some underground mines to the E of area. It has about 1600m (L) x 100m (W) with the thickness of 3-15m (including 3 layers), dipping 30˚-60˚ NW. Since it is found as layers in Tertiary sediments, the age could be Late Miocene-Pliocene.

Conclusion and Suggestion

All known deposits and occurrences mentioned here are typically exposed along and around the proposed Muse-Mandalay railway line. But some exposed the line between Nanhphtka-Muse are missing because of insurgent area and difficulty to do field works. Consequently there is also missing some geological information for that area. According to the existing geological records and possible structural trends, there would be lead-zinc-silver, antimony, gold that could be expected in it. Coal and phosphorous deposits might also be found as well. Some deposits are a little far from the proposed railway line. Why mentioned here is that mineral deposits are trending approximately N-S direction and those could be probably found

during construction of the line such as tunneling, bridge, station and railway line etc.,. For example, although Phayaung taung gold is far from the construction, gold occurrences are sporadically found along the western margin of Shan scarp, trending N-S direction. For Yadanatheingi lead-zinc-silver deposit, similar deposits and occurrences could be estimated in Pyin Oo Lwin, Naungcho and Kyaume as regional structural trending passing in these areas. Similarly, deposits at Bawdwin mine and Mohochaung mine, they might also be extended more or less into Hsipaw, Lasho, Kutkai and Nam Hpatkar areas. For those reason, those deposits are plotted on the map as well.

Suggestion here is that if some precious mineral deposits or occurrences found along the line, it is needed to officially inform the authorized person from government and local community as well. Those communities should do monitoring work and help the construction railway project for mutual benefit. Legal law enforcement should act to give penalty for those people who carry away it from the line or make mineral dressing in situ.

5.4.6. Hydrogeological Characteristics along the Railway Line

Myanmar is primarily an agricultural country and the economy of the nation is also mainly relied on the agricultural products. Myanmar has a tropical monsoon climate and the rainfall is highly seasonal. The mean annual rainfall is around 2341 mm and 90 per cent of the discharge flows between May and October. Geographically, the country is mountainous, rising to more than 5800 m above sea level in the far north, and reaching an elevation of well over 2000 m over much of Shan state in the northeast, and in Rakhine and Chin states in the west. Myanmar is endowed with abundant water resources. Therefore the north-south direction of Myanmar's mountain ranges is reflected in the flow of its major rivers (Fig. 5.15). There are many river basins: the Ayeyarwady (Irrawaddy) river basin, the Sittaung river basin, the Thanlwin river basin, Rakhine coastal basin and the Tanintharyi coastal basin respectively. In Myanmar the cultivated areas are largely concentrated in the Ayeyarwady river basin. The rivers along the Muse-Mandalay railway line finally joined into the Ayeyarwady river.

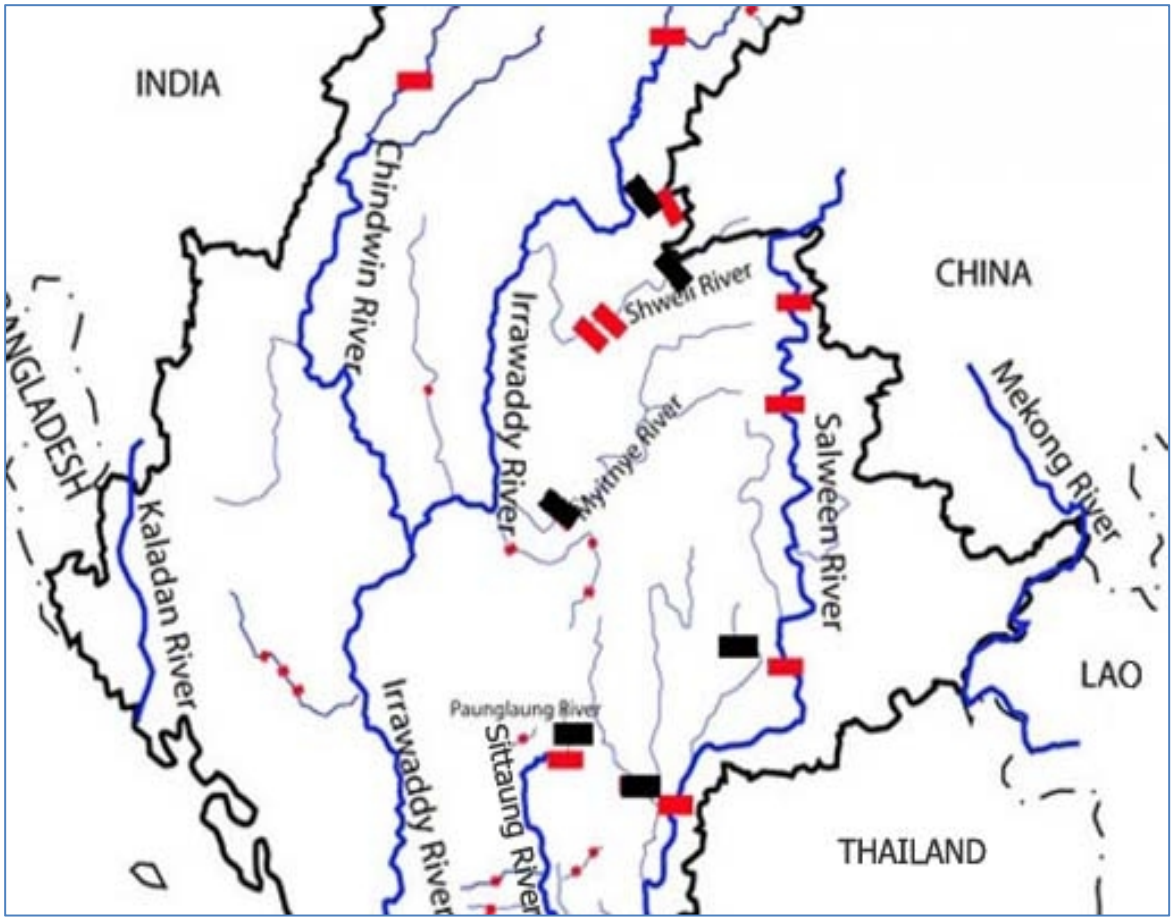


Fig.5.15 - Major river system in Myanmar together with major hydropower dams (red is under construction, & black is finished). (Sources: Government data, state media, and Burma Rivers Network & The Myanmar Times, 2012)

5.4.6.1. Occurrences and Distribution of Surface Water

As mentioned above, the river water system along the line finally jointed into the Ayeyarwady River. In fact, the Ayeyarwady River is one of the biggest rivers on the Indo-China Peninsula in Asia, as well as the biggest international river flowing from N to S through Myanmar. It has about 2030km long, starting from the northern mountainous area, through central dry area and southern delta and finally into the Andaman sea. Although it consists of more than 30 tributaries, with a drainage area of 404,200 km^2, the main tributaries from north to south are Taping river, Shweli river, Myitnge river, Mu river and Chindwin river. The volume of the Irrawaddy and its tributaries is varying greatly throughout the year. In summer, the melting of the snow and glaciers in Northern Myanmar adds to the volume. The discharge averages 13,000 cubic metres (460,000 cu ft) per year.

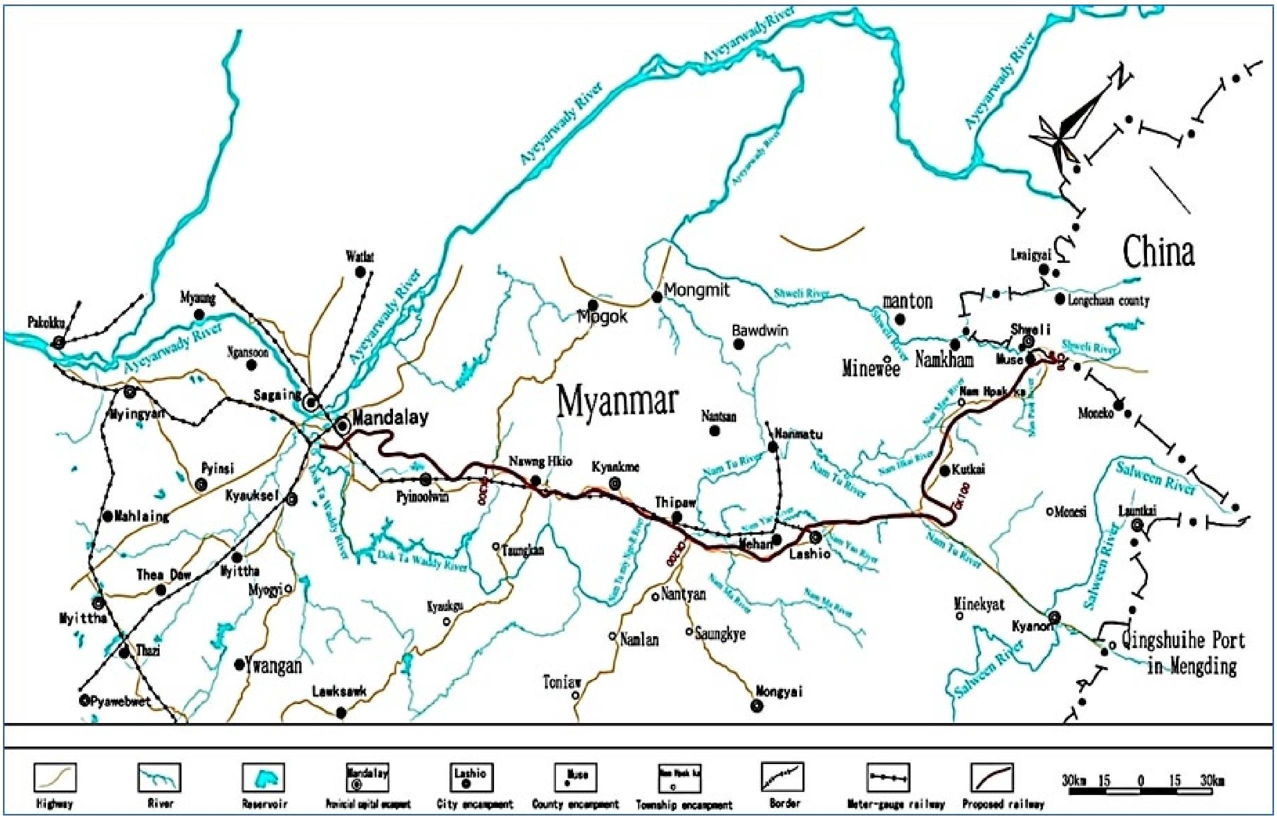


Figure 5.16 - Map of surface water systems along the line (partially modified from China Railway Eryuan Engineering Group Co., LTD., 2019)

The Muse-Mandalay railway line serially crosses several rivers such as the Shweli River, Nan Paw River, Nam Hkai River, Nam Tu River, Nam Yao River, Nam Ma River and Nam Tu/Myitnge River or Dok Ta Waddy River. Drainage system includes dendritic drainage pattern, trellis drainage pattern, parallel drainage pattern and rectangular drainage pattern observed along the line and dendritic drainage pattern is the most prominent. In limestone area, because of karst nature, there is also internal drainage pattern developed. There are also several dams especially constructed on Myitnge river and Shweli river for hydropower demand and cultivation purposes. On Nam Tu-Myitnge river, Yeywa Dam has completed. Namtu Dam and upper Yeywa dam are still under construction and Middle Yeywa dam and Deedoke dam are planned to be constructed. On Shwe Li river Shwe Li I hydropower project is already finished and Shwe Li II and III is also under construction. There are many natural lakes, ponds, waterfalls, springs and small reservoirs found around or along the line and local people get used to them for agricultural and domestic utilization in the area.

Yeywa Dam (21°41′20″N 96°25′17″E***) (2010)***

The Myanmar government first announced plans for the Yeywa dam in late 2001. In 2004, Ministry of Electric Power Enterprise (MEPE) signed MoU with a consortium of Chinese companies to build the dam on the Myitnge river in Mandalay Division, one of the biggest tributaries of the Ayeyarwady river. It is one of the largest roller-compacted concrete (RCC) dams in the world. The dam is 134 meters high with an installed capacity of 790MW and an annual production of 3550 Gwh. MEPE signed an agreement with a consortium created by China International Trust & Investment Co (CITIC) and Sinohydro Corporation in 2004. The overall cost is estimated at $ 700 Million and construction was completed in 2010.

Figure - (a) Existing and planned dams on the mainstream of Namtu-Myitnge river. (Source: MEPE and Geohack, 2018), (b) Scenic view of Namtu River confluence with Nam Pom Stream (photo by- Thandar Su Naing) and (c) Yeywa hydropower dam (source: https://upload.wikimedia.org/wikipedia/commons/thumb/e/e6/Yeywa_Dam.jpg/1024px-Yeywa_Dam.jpg)

Shweli I Dam (23°39′11″N 97°28′52″E***) (2008-2012)***

Myanmar Ministry of Electric Power Enterprise (MEPE) has signed its first Build-Operate-Transfer agreement with China for a hydropower dam on the Shweli River, a tributary of the Ayeyarwady river in northern Shan State since 2006. Two additional dams, Shweli II and III are planned downstream. The dams will have a total installed capacity of 1440 MW with 600MW for Shweli I . Investment could reach $ 1.4 billion for all dams. Electricity will be transmitted to China and government-run mining operations in Myanmar. The project is a joint venture between MEPE and Yunnan Joint Power Development Company (Source: Myanmar Times).

(Source: www.internationalrivers.org./ shweli 1 hydropower project)

Figure - Construction of Shweli I Dam on Shweli river

Major river water system features and hydrology along the line

The water system along the route is mainly the Ayeyarwady River and its tributaries. The route passes through larger rivers, including the Shwe Li River, and rivers within the territory of Myanmar like the Nan Paw River, the Nam Hkai River, the Nam Tu River, the Nam Yao River, the Nam Tu miy Nge-R River, the Nam Ma River and Nam ban ton River. The Shwe Li River and Nam Tu River are the first tributaries of Ayeyarwady River; the Nam Paw River, Nam Hkai River, Nam Yao River, Nam Ma River and Nam ban ton River belong to the tributaries of Nam Tu River.

(1) The Ayeyarwady River, one of the large rivers in the Indo-China Peninsula and the longest river in Myanmar with 2030km long within the country, runs from north to south across Myanmar, passing through the northern mountains, the central dry regions and the southern delta. The River, which has more than 30 tributaries with a drainage area of 430,000 km² covering 8 divisions (states) of Kachin state, Chin State, Mandalay Division, Sagaing division, Magway division, Bago Division, Ayeyarwady Division and Rangoon Division, 32 counties and 90 towns. Myanmar scholars divide the Ayeyarwady River into three parts: upstream, midstream and delta. The Ayeyarwady River generally flows windingly from north to south and reaches the sea at southwest corner, facing the Bay of Bengal in the west and linking with the Andaman Sea in the south. With many rivers in the vicinity and flowing into the sea simultaneously, a unique landform forms. The main tributaries of the Ayeyarwady River are the Chindwin River, the Myitnge, the Mu River, the Yaw River, the Mon River and the Nam tu River.

Ayeyarwady River

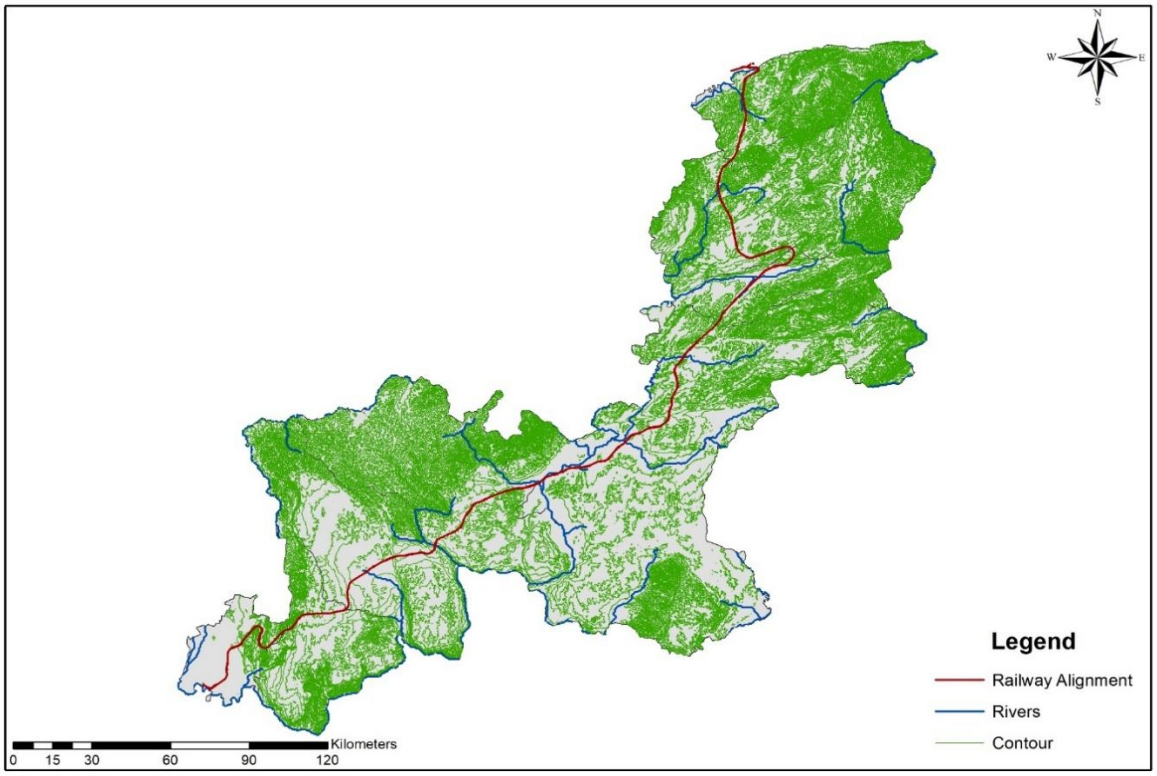
(2) Shwe Li River, called Nam Mao River by Dai ethnic group, also known as Mengmao River. The total length of Shwe Li River is about 332km and the drainage area is about 5,576km^2. It is an important river in the west of Yunnan Province, China. Its main stream and tributary are all parts of Ayeyarwady river system. In China, through Tengchong, Longling and Lianghe, Longchuan, there are Mangshi River (Longchuan River) flows into Shwe Li River in Mangshi (Dehong). Shwe Li River has a length of about 53km located in China and a width of about 100-200m. After Ruili, it flows to west along the Myanmar-China border and flows into Ayeyarwady River. The once-in-a-hundred-year flow of Shwe Li River connecting line at the bridge location is 2,870m^3/s.

Shwe Li River

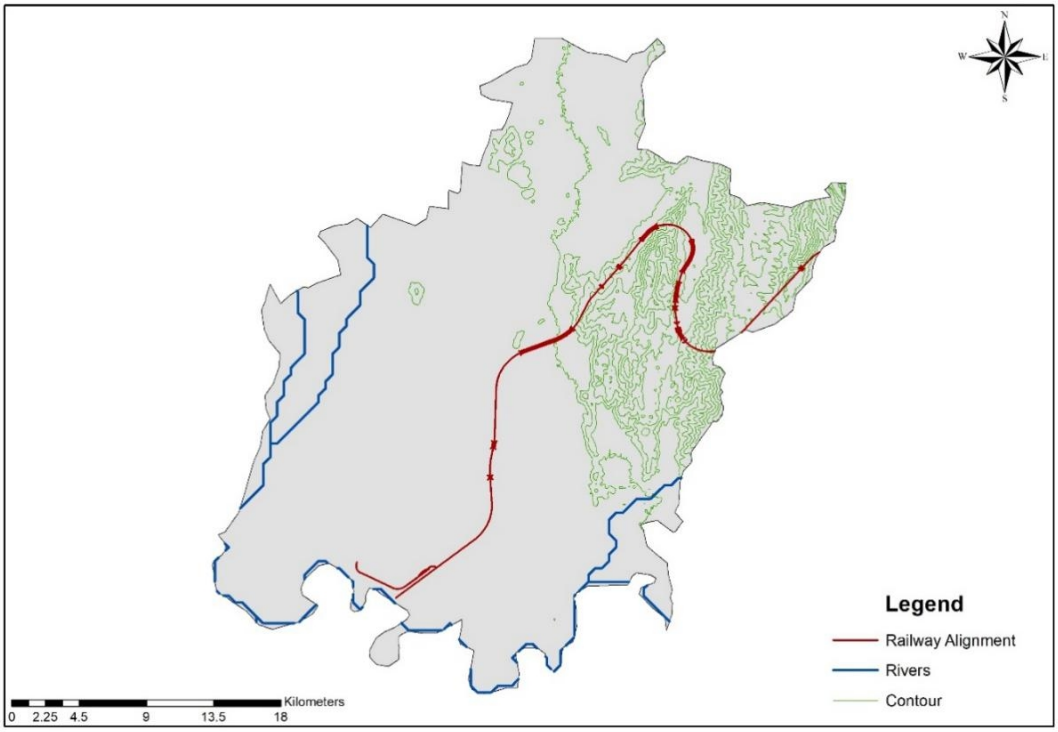
(3) Nam Ma River, a tributary of Nam Tu River, is about 105km long, and the drainage area is about 2,702.5km^2. The width of main channel of the bridge location is about 50m, and the once-in-a-hundred-year flow is about 485 m^3/s.

(4) Nam Tu - Myit Nge River, the upstream of which is the intersection of Nam Tu River and Nam Ma River. The basin length is about 230km, and the drainage area is about 14,100km^2, and the main channel of the bridge location is about 96m wide, and the once-in-a-hundred-year flow is about 2,231m^3/s. For the tributary Nam ban ton River, the basin length is about 36.5km, and the drainage area is about 809km^2. For the tributary Nam pan his River, the basin length is about 50km, and the drainage area is about 681km^2. These two rivers finally flow into the Nam Tu - Myit Nge River.

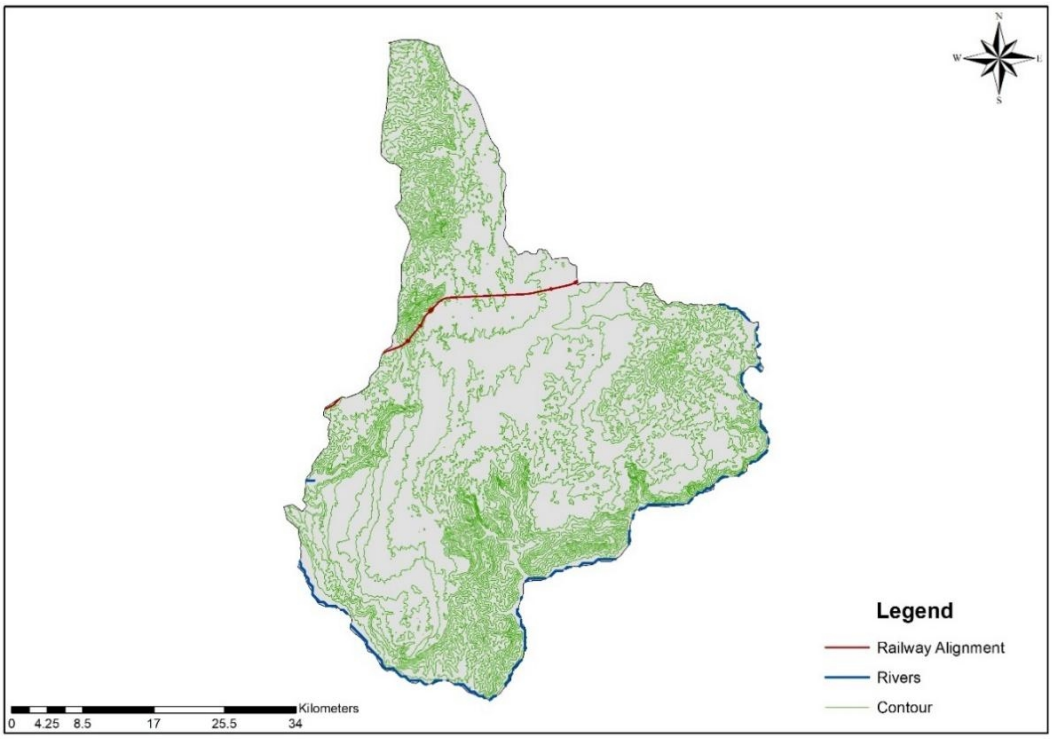
This project mainly passes through Shan Plateau in northern mountain area of Myanmar, and goes through Pyinoolwin and then into the Ayeyarwady river basin in Mandalay plain. The rainfall in Shan Plateau is mostly sudden rainstorm. In a year, the rainy season is long with abundant rainfall. The rainfall intensity is large but the duration is short. The terrain within this area is severely cut by the water flow, forming plenty of gullies and valleys, and the catchment condition is good. The surface water is relatively developed, and the vegetation is dense. The surface is easy to form ponding, so the flow and water level of the mountain river changes greatly with the seasons. The scope of study area and area of influence will be within 500 m of the railway alignment.



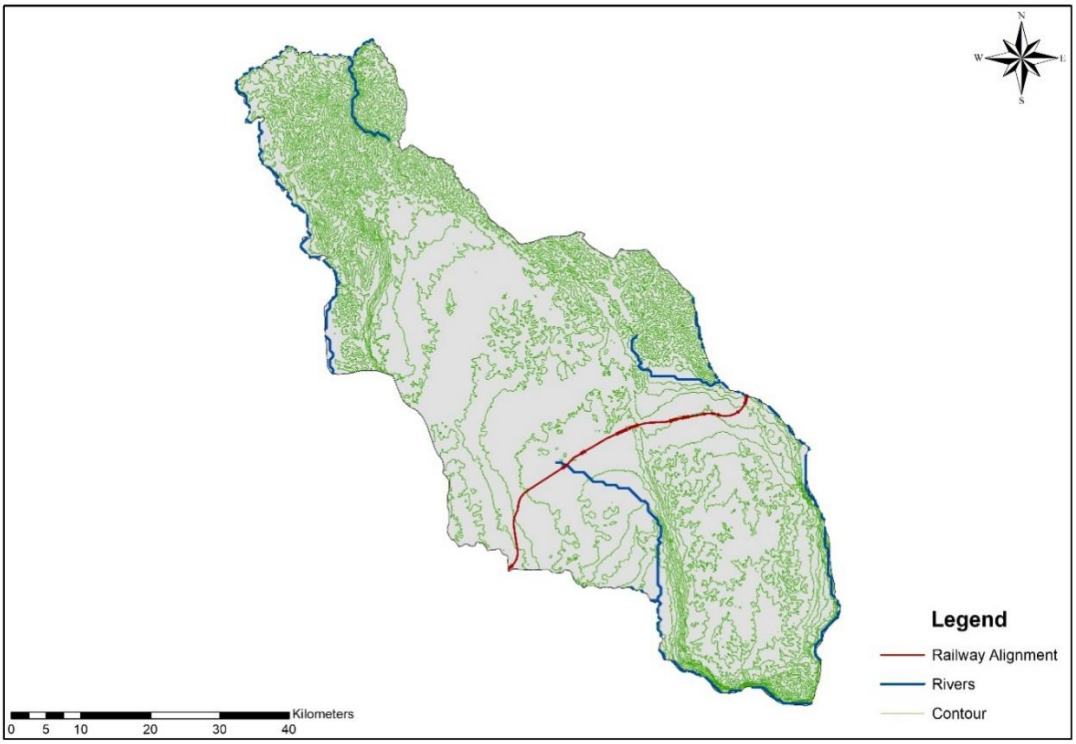
Mandalay – Muse Railway



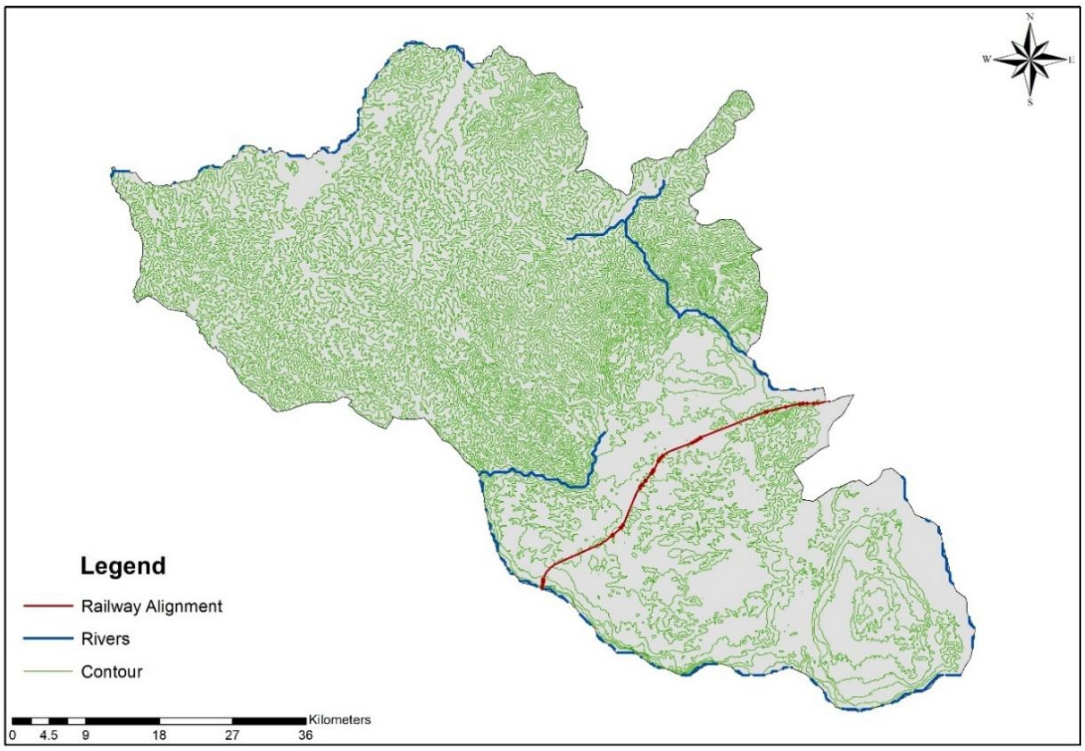
Major Rivers in Mandalay in Topography Map



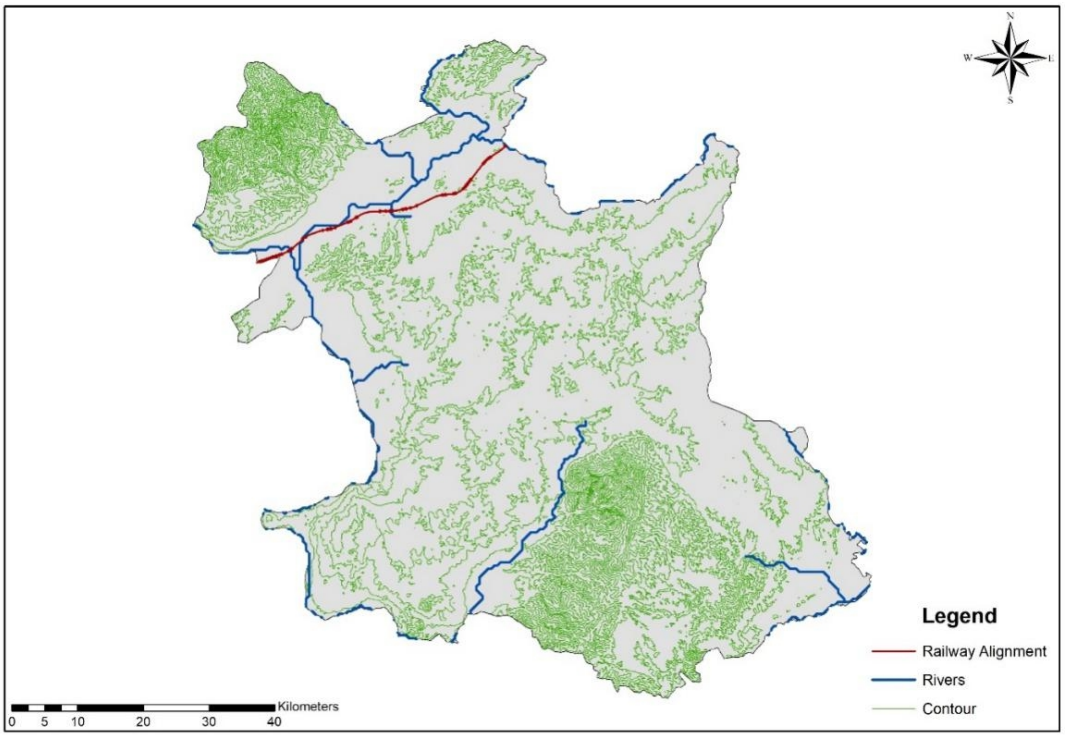
Major Rivers in Topography Map (Pyin Oo Lwin)



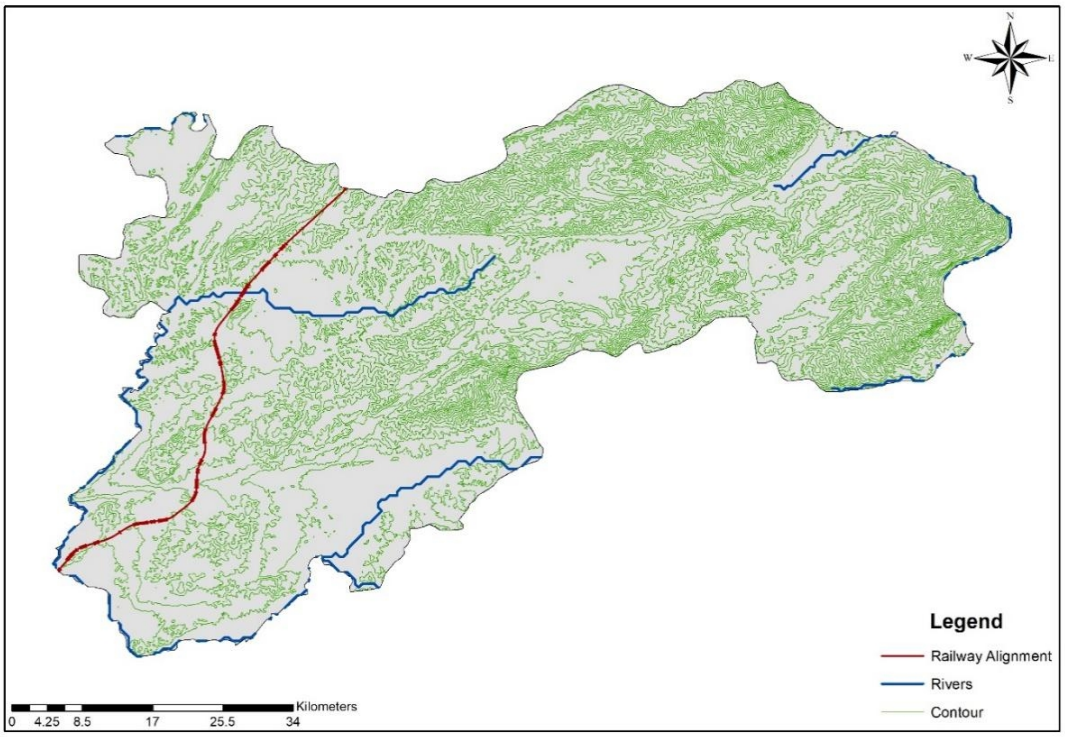
Major Rivers in Topography Map (Nawnghkio)



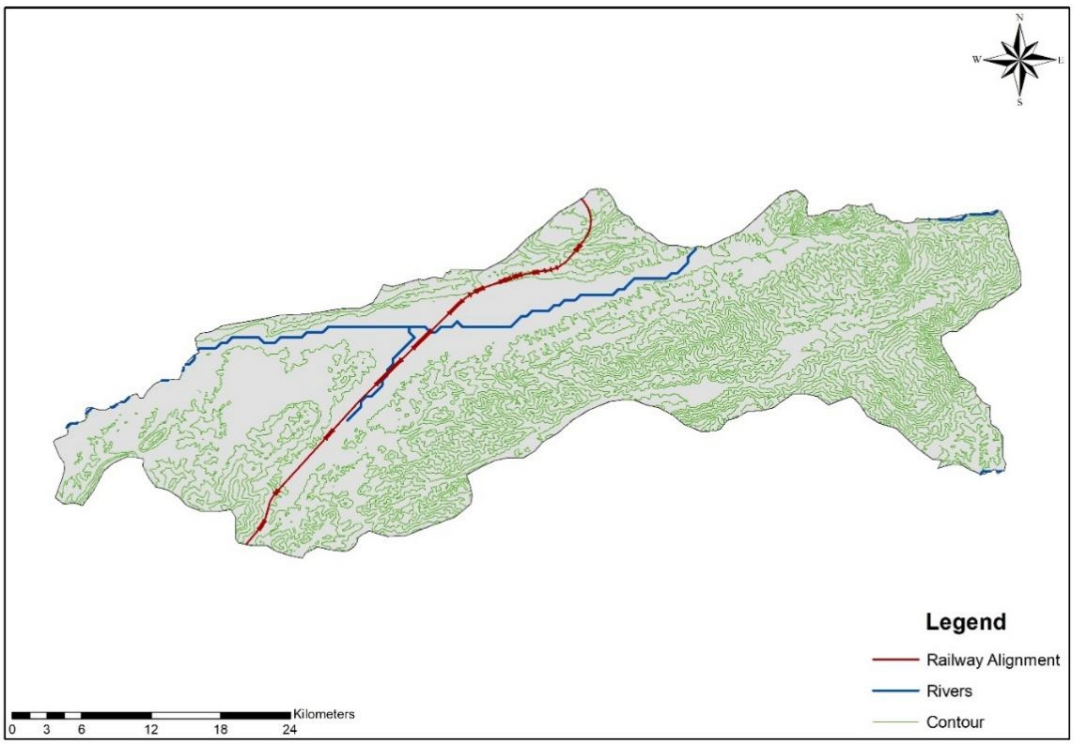
Major Rivers in Topography Map (Kyaukme)



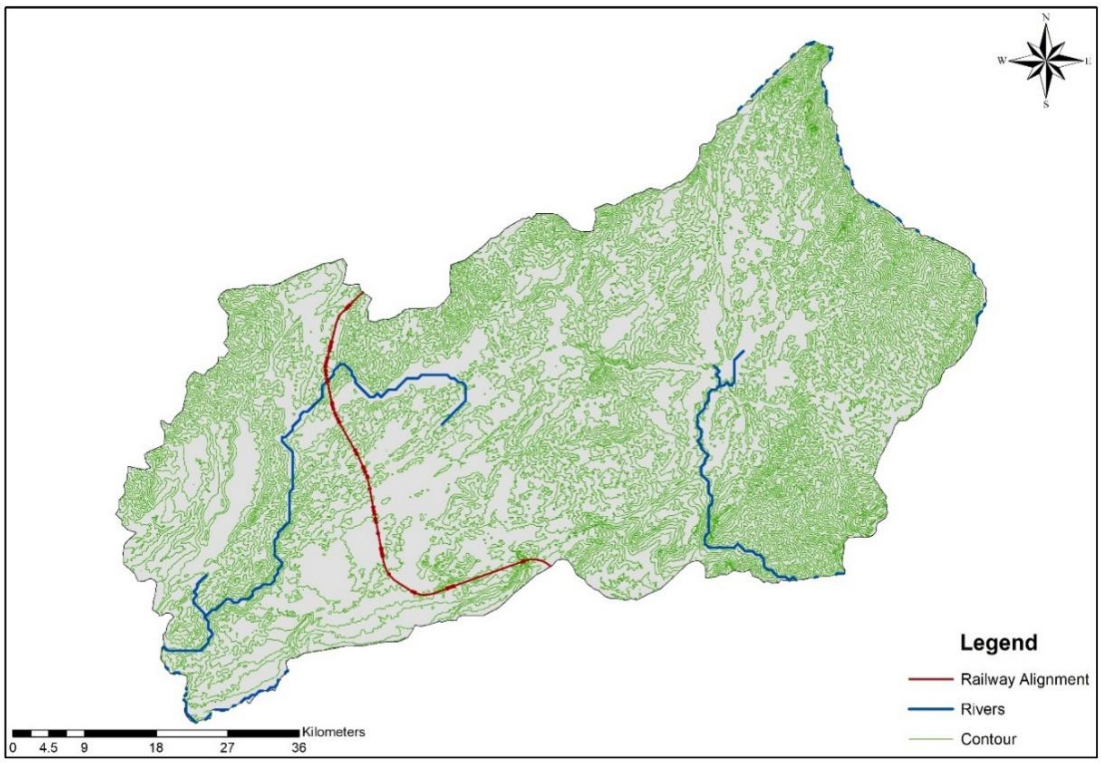
Major Rivers in Topography Map (Hsipaw)



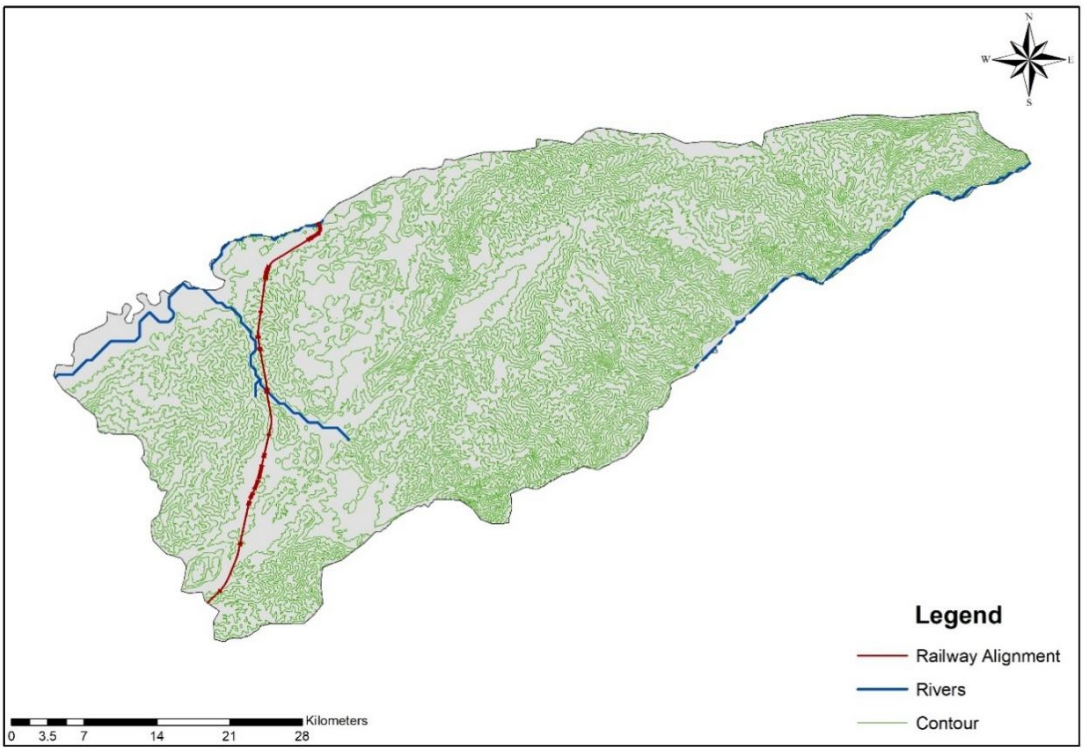
Major Rivers in Topography Map (Lashio)



Major Rivers in Topography Map (Hseni)



Major Rivers in Topography Map (Kutkai)



Major Rivers in Topography Map (Muse)

5.4.6.2. Occurrence and Distribution of Groundwater

Groundwater along the line occurs as four types; 1. Pore-water in loosely cemented soil and younger rock, 2. Bedrock fissure water in clastic and crystalline rocks, 3. Karst water in carbonate rocks and 4. geothermal water from the earth.

1. Pore water

It mainly occurs in the pore space of unconsolidated sediments especially within the Quaternary basins (such as Theinni, Lashio and Hispaw basins). Pore water is also found on both sides of the Ayeyarwady River and its tributaries and river banks as well occurring as Quaternary alluvial-proluvial and deluvial-proluvial layers.

In red soil (a.k.s. Terrarossia soil) on the surface of the Shan Plateau Area, the shallow groundwater is generally buried 1-5m and pore water mainly found at the contact between Terrarossia soil and underlying carbonate bedrocks.

Mainly occurring in the pores between particles of Quaternary non-consolidated sediments of various genesis, the water-bearing rock layers are mostly distributed in layers and have even water content. Under natural conditions, the free surface of groundwater is consistent with the buried form of the rock layers. The pore water in loose rocks along the line generally occurs in the Quaternary alluvial deposit, slope diluvium, red weathering crust and littoral facy sediment. The Quaternary alluvial and pores in slope diluvium are mainly distributed along the Ayeyarwady River and its tributaries, as well as in the Quaternary basins of Shan State Plateau (such as the Lashio Basin, the Hsenwi Basin) and along both sides of rivers. In the red weathering crust of the Shan State Plateau, the shallow groundwater level is generally 1~10m deep, and it develops along the interface between the red weathering crust and the bedrock.

2. Bedrock fissure water

Normally, bedrock fissure water occurs in all sorts of fissures such as diagenetic fissure, structural fissure and weathered fissures. Those fissure water are emerged in consolidated and semi-consolidated rocks of various geologic ages (mainly clastic rocks including sandstone, shale, mudstone & conglomerate, some magmatic rocks and low-grade metamorphic rocks).

Between Muse and Kutkai, bedrock fissure water is mainly found in magmatic and metamorphic rocks. Between Kutkai and Kyaukme, fissure water along the line is mainly found in sandstone, thin-bedded hard and compact limestone, shale, marl, mudstone and other clastic rocks from Precambrian to Mesozoic strata exposed on the northern Shan State. It is found that bedrock fissure water is generally buried 10-15m deep and locally develops in the

form of spring from both sides of entrenched streams and gorges. Several bedrock fissure waters occur frequently and local people use it as drinking water and plantation purposes as well.

The bedrock fissure water mainly occurs in the diagenetic fissures, tectonic fissures and weathering fractures (consolidated or semi-consolidated, mainly of clastic rocks, magmatic rocks and metamorphic rocks) in various geological ages. The distribution of water-bearing stratum is governed by the degree of fracture development.

The bedrock pore fissure water along the line is mainly distributed in the Tertiary basin of the Shan State Plateau, and the sand & mudstone distributed areas in the Muse-Lashio section and the Hispaw-Baoshan Basin. The bedrock fissure water level is generally 8-15 m, and some bedrock fissure water is exposed in the form of spring water on both sides of intrenched rivers and valleys.

3. Karst water

Karst is a topography formed from the dissolution of soluble rocks such as limestone, dolomite and gypsum. It is characterized by underground drainage systems with sinkhole and caves. Karst water is the groundwater which is formed in the karst channel, fissure and caves of carbonate rocks. The formation, runoff and discharge conditions of this groundwater depend on limestone diagenesis, precipitation, vegetation and climate. There are many karstic water aquifers occur along the line from Muse through Lashio to the northeast of Mandalay as the majority of Shan Plateau is built up with limestone and dolomite of Ordovician to Triassic in age. A lot of karst water is more predominant between Kyaukme and NE of Mandalay. In other words, karst depressions, sinkholes, underground drainage and karst caves are moderately-heavily developed in that area. Water regularly emerges as spring in cave from mountain front areas and as water fall in valley slope areas.

For groundwater in the dissolution pipelines, fissures and caverns of carbonate rocks, the degree of karst development and distribution characteristics determine the occurrence state, runoff and discharge conditions of such groundwater. The fractured karst water aquifer along the line is distributed in the Shan State Plateau area from Muse-Kutkai-Lashio to the northeast of Mandalay. The carbonate rocks in this section are widely distributed; the water yield property is medium to strong, and water is mainly concentrated in the Upper Paleozoic (Pz2) and Sinian-Cambrian (Z-∈) pure carbonate rocks. The degree of karstification is high, and the karst forms such as dissolved depression, karst funnel, underground river and cavern etc are moderately~ intensively developed. The karst water level is obviously affected by the surface elevation and topography. In the mountain front and along the valley slope, it is often exposed in the form spring water.








Figure 5.17 - Distribution of groundwater along the line (a) bedrock fissure water entered into a stream (b) spring came out from mountain front area in well-known Peikchinmyaung Cave, (c) karst water emerges along valley slope as water fall and geothermal water from well-known Lashio hot spring. (From Google Earth-https://lh5.googleusercontent.com)

4. Geothermal water

Geothermal water mainly occurs near the northwest of Bangpaman fault, Kunlong fault, northwest of Lashio fault and Kyaukme fault. Those geothermal waters are exposed in the form of hot springs, with the average temperature of 25° - 45°C. A hot spring, hydrothermal spring, or geothermal spring is a spring produced by the emergence of geothermally heated groundwater that rises from the earth's crust. That is why hot springs are basically distributed along the fault zone, controlled by geological structure as well as by topographic and

geodynamic conditions. Mostly they are related to hydrothermal deposits and those hot springs are genetically expressing of underlying epithermal ore system.

5. Underground Hot/Thermal Springs

There are four hydrothermal activities along the line, which are located respectively in the Bangpaman fault zone, the Hsenwi fault zone and its branch faults, the Lashio fault zone and the Hispaw Nankang fault zone. The spring water is a medium-low temperature hot spring (30～45°C).

Suggestion

Myanmar is rich in water resources and the catchment area of Myanmar's rivers comprises about 737800 km². Potential water resources volume is about 1082 km³ for surface water and 495 cubic km for groundwater annually. Water utilization for agricultural sector stands for 90% while industry and domestic use is only about 10% of the total water use. The total utilization of the nation's water resources is only about 5 percent of the potential. (From MEPE's data)

River water system along the Muse-Mandalay line is largely concerned with two large catchment areas namely Shweli river watershed areas and Namtu-Myitnge river watershed areas where the former is located to the north of Muse and its environs and the latter is along and around the line between Namhpakka and Mandalay. So the debris, dust and waste particles from construction activities should not to be discharged into the river systems as it will be made negative impact on society. Care should be also taken for railway construction which must be avoided for water resource along the line because the line will cross several rivers and natural water resources. For example, to the NW of Pyinoolwin, there is also natural water resource (locally called Thitdapin lake) that will be passed by the line very closely. It is particularly very important because whenever we meet with local people in the field as well as public meeting especially in Pyinoolwin, Thipaw, Lashio and Muse, they worried about the issue that railway construction will destroy their water resources. With the increase of population and enhanced need for water for various purposes, there is also increasing demand for the use of water. Therefore, how to control and manage to use surface water and groundwater is the key for sustainable development of the country in future.

The major aquifers of Myanmar range from Precambrian to Recent age and vary from coastal and north-south trending tectonically controlled basins. The major groundwater recharge is from monsoonal rainfall, which extends from June to September, ranges up to 3050 mm in the deltaic area, 3810 mm in the north, ~2000 mm in the eastern mountainous region, and only 760 mm in the central dry zone. The largest aquifer is the Irrawaddy river basin, which like the IGBM basin is the most prolific aquifer, however, much of the aquifers of the basin have been identified to have groundwater enriched with As. The other aquifers are in the Thanlwin, the Chindwin, and the Sittaung.

5.4.6.3. Hydrologically Sensitive Area along the Railway Line

In order to inform the hydrological impact assessment, a site walkover was carried out by the hydrologist to record observations and features of watershed area, natural spring and surface water body as shown in the following figures.

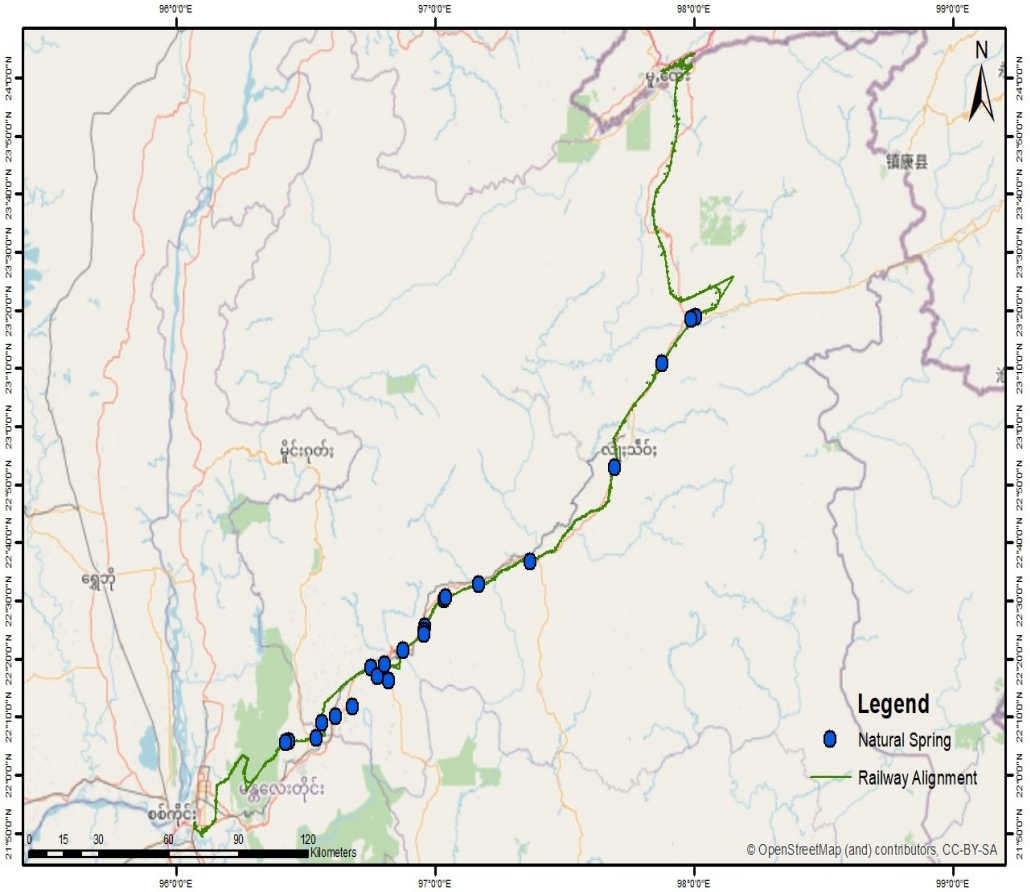


Figure 5.18. Natural Springs and Rivers along the MMR

(Source: EGT EIA Team, 2020)

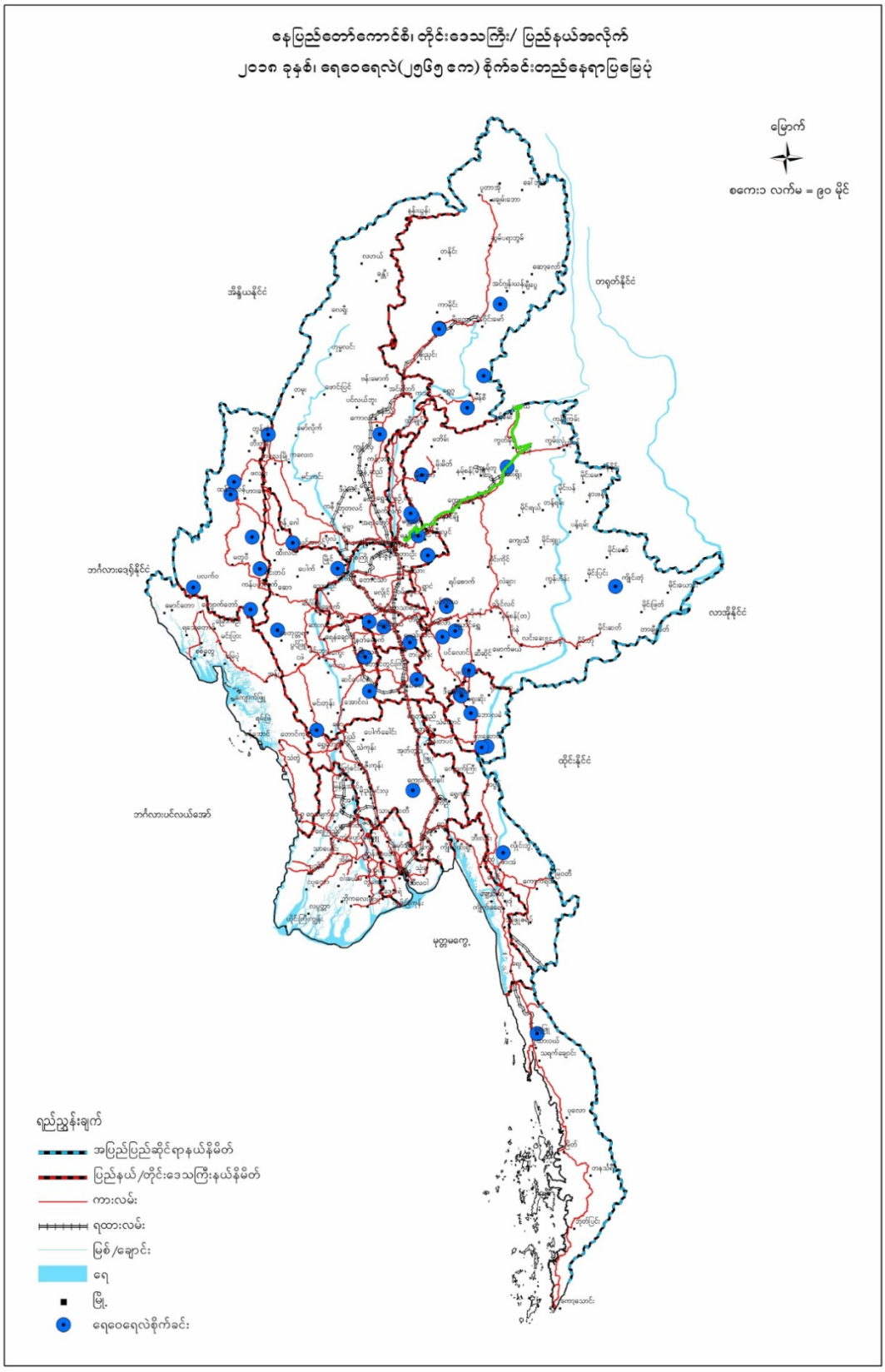


Figure 5.19. Locations of Plantation for Watershed (Source: DOF, 2018)

No.	Village Name (Natural Spring)	Location	Description	Baseline Study
1.	Mang Chat	23.313305°, 98.008298°	Natural water spring	Occurrence and flow pattern
2.	Wane Line	23.309188°, 97.988722°	Natural water spring	Occurrence and flow pattern
3.	Nar Chat	23.181866°, 97.877292°	Natural water spring	Occurrence and flow pattern
4.	Mehan	22.883921°, 97.694954°	Natural water spring	Occurrence and flow pattern
5.	Pang Hsauk	22.611549°, 97.367325°	Natural water spring	Occurrence and flow pattern
6.	Nwang Ann	22.546527°, 97.166665°	Natural water spring	Occurrence and flow pattern
7.	Pang Ywang	22.508405°, 97.039741°	Natural water spring	Occurrence and flow pattern
8.	Mway Taw	22.503216°, 97.033525°	Natural water spring	Occurrence and flow pattern
9.	Na Ai Hkant	22.425912°, 96.961091°	Natural water spring	Occurrence and flow pattern
10.	Khite Tone Home	22.414476°, 96.957989°	Natural water spring	Occurrence and flow pattern
11.	Kone Kaw (Kyaukme)	22.405297°, 96.957967°	Natural water spring	Occurrence and flow pattern
12.	Kyaung Gone	22.358234°, 96.877519°	Natural water spring	Occurrence and flow pattern
13.	Myat Chae Nu	22.271596°, 96.821246°	Natural water spring	Occurrence and flow pattern
14.	Taung Quarter	22.316893°, 96.803754°	Natural water spring	Occurrence and flow pattern
15.	Ngokkalay	22.281051°, 96.775510°	Natural water spring	Occurrence and flow pattern
16.	Lone Yone	22.308319°, 96.750980°	Natural water spring	Occurrence and flow pattern
17.	Kon Gyi	22.196934°, 96.678743°	Natural water spring	Occurrence and flow pattern
18.	Kyein Ga Naing	22.166371°, 96.615714°	Natural water spring	Occurrence and flow pattern
19.	Anauk Kyu Inn	22.148223°, 96.563513°	Natural water spring	Occurrence and flow pattern
20.	Middle Pin Lain	22.105234°, 96.539294°	Natural water spring	Occurrence and flow pattern
21.	Kone Kaw (Pyin	22.095427°,	Natural water spring	Occurrence and

	Oo Lwin)	96.435934°		flow pattern
22.	Pan Oo Taung	22.092211°, 96.423717°	Natural water spring	Occurrence and flow pattern
23.	Pyin Oo Lwin Watershed	22.100212°, 96.465955°	Watershed Area	Watershed condition
24.	Lashio Watershed	23.046681°, 97.758647°	Watershed Area	Watershed condition
25.	Shweli River (Muse)	24.01721°, 97.90384°	Surface water body	Water quality
26.	Nant Paung Stream (Muse)	23.85798°, 97.97741°	Surface water body	Water quality
27.	Nant Khaing Stream (Kutkai)	23.57058°, 97.81950°	Surface water body	Water quality
28.	Namtu Stream (Thenni)	23.28817°, 97.95394°	Surface water body	Water quality
29.	Pan Phet Stream (Thenni)	23.13200°, 97.84320°	Surface water body	Water quality
30.	A-T Stream (Lashio)	22.99409°, 97.76455°	Surface water body	Water quality
31.	Sint In Stream (Lashio)	22.70178°, 97.53847°	Surface water body	Water quality
32.	Kho Lone Stream (Hsipaw)	22.61445°, 97.39456°	Surface water body	Water quality
33.	Dokehtawady River (Hsipaw)	22.60728°, 97.30748°	Surface water body	Water quality
34.	Kyin Thi Stream (Kyauk Me)	22.56428°, 97.20963°	Surface water body	Water quality
35.	Goke Twin Stream (Nawnghkio)	22.35489°, 96.83371°	Surface water body	Water quality
36.	Yae Ni Stream (Pathein Gyi)	21.99596°, 96.12399°	Surface water body	Water quality
37.	Se Taw Gyi Cananl (Pathein Gyi)	21.91917°, 96.18635°	Surface water body	Water quality
38.	Myaung Ma Gyi Stream	21.85159°, 96.12443°	Surface water body	Water quality

	(Amarapura)			
39.	Myaing Gyi Stream (Min Village)	21.84470°, 96.10187°	Surface water body	Water quality
40.	Dotehtawady River (Myit Nge)	21.83646°, 96.07781°	Surface water body	Water quality

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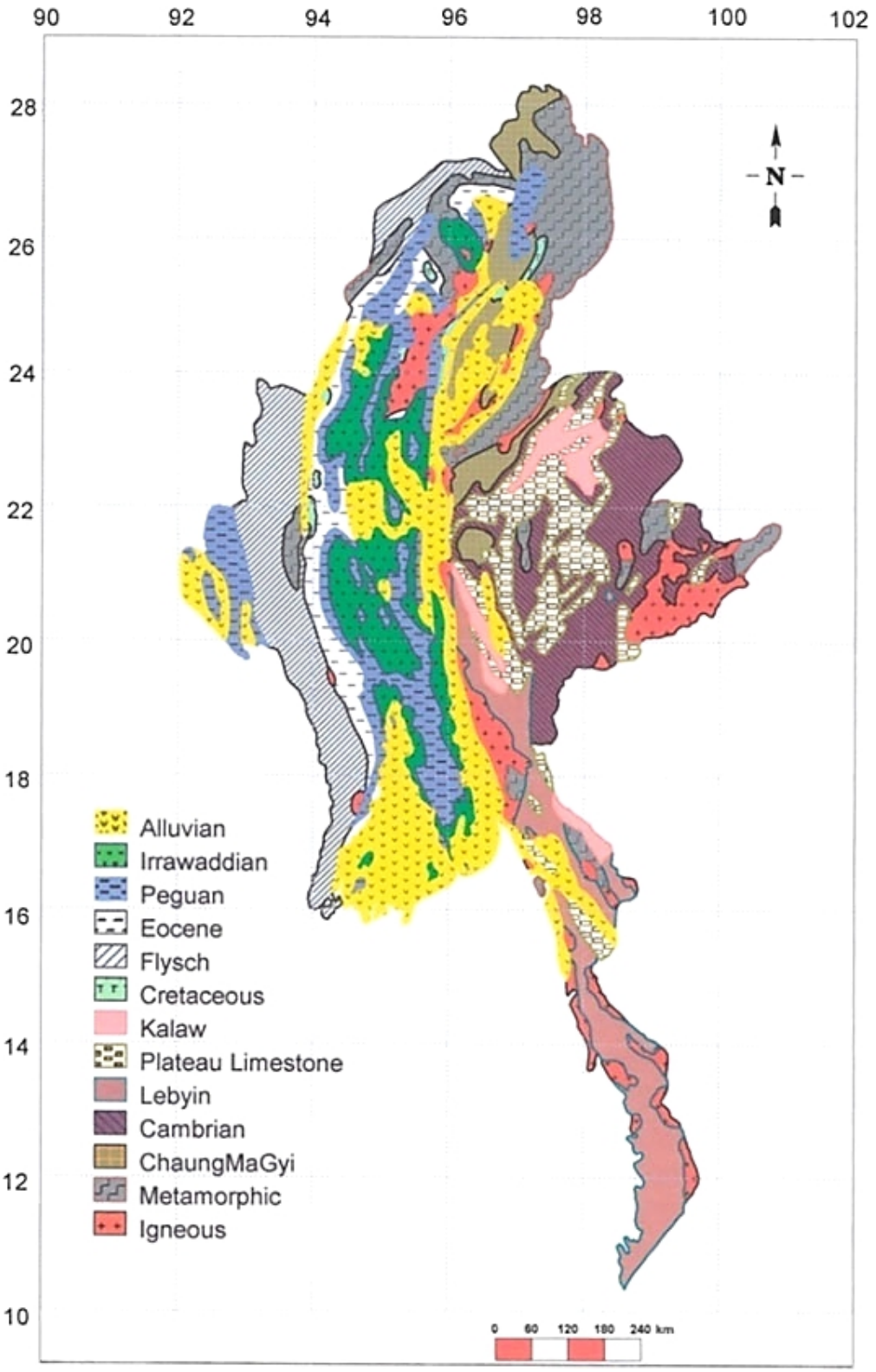


Figure 5.20 - Aquifers in Myanmar [Source WRUD]

The total groundwater potential of Myanmar is ~495 km^3/year, respectively. The groundwater use in Myanmar is mostly for agriculture purposes, ranging up to ~90%, the rest ~10% being used in industrial practices and domestic purposes. On the basis of stratigraphic unit, Myanmar has eleven different types of aquifers. Depending on their lithology and depositional environment, groundwater from those aquifers varies in quality and quantity. Of these, groundwater from alluvial and Irrawaddian aquifers is more potable for both irrigation and domestic uses. The types of groundwater along the line are mainly divided into pore phreatic water in Quaternary loose rocks, bedrock fissure water and karst water.

The lineside water system is of Ayeyarwady River system. The line passes through in turn the Shweli River, Nan Paw River, Nam Hkai River, Nam Tu River, Nam Tu miy Nge-R River, Nam moven tai River and other relatively large rivers as shown in the following figures.

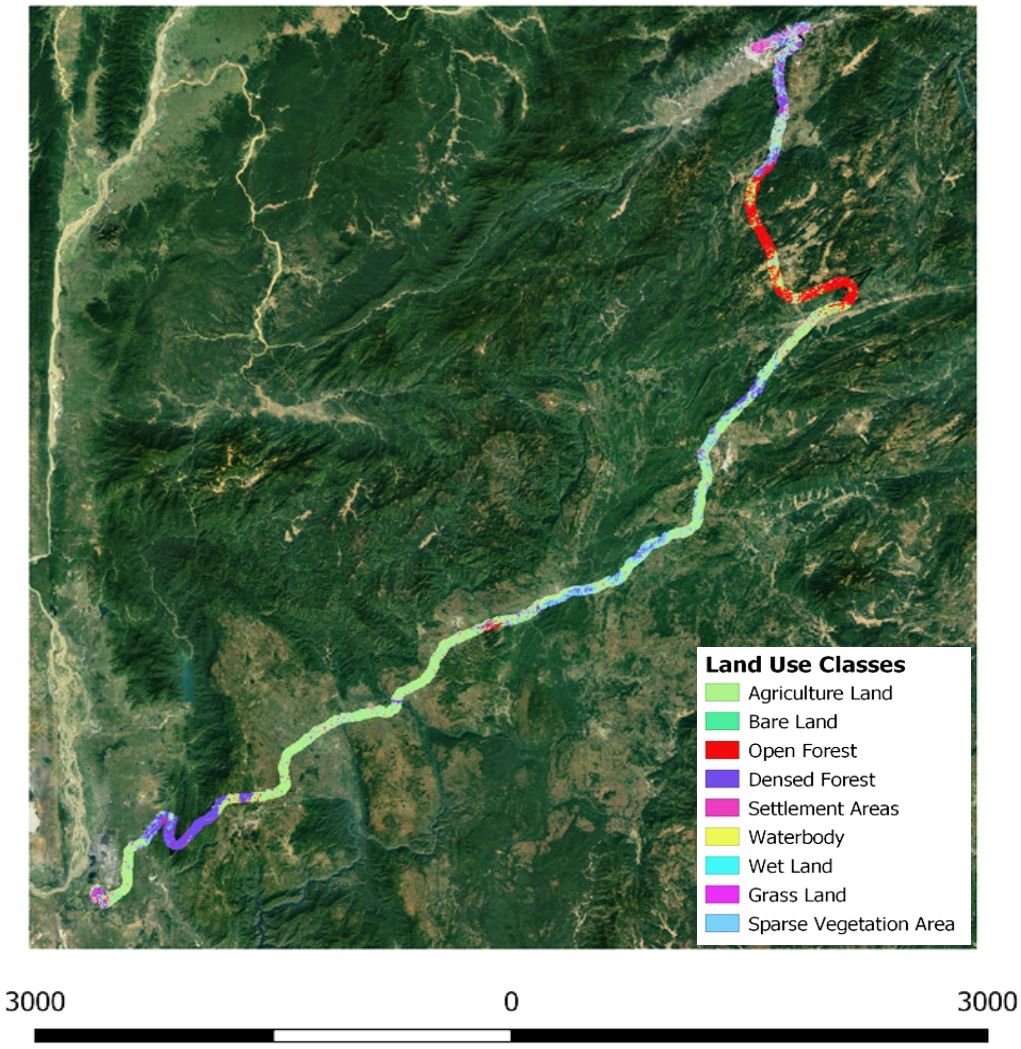


Figure 5.21 – Land Use Map of Muse-Mandalay Railway

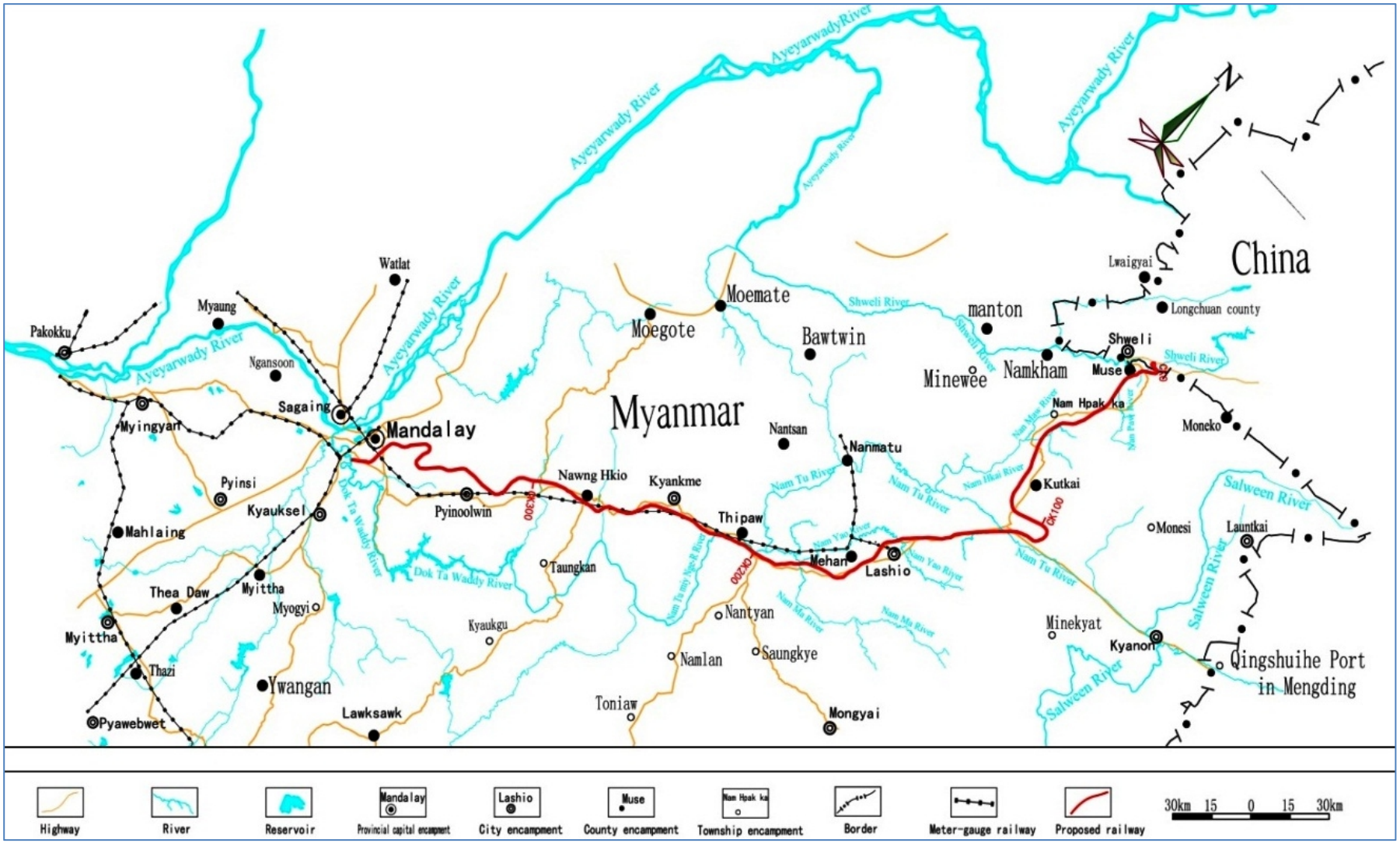


Figure 5.22 - Map of Surface Water System along the Line

5.4.7. Climatic Characteristics

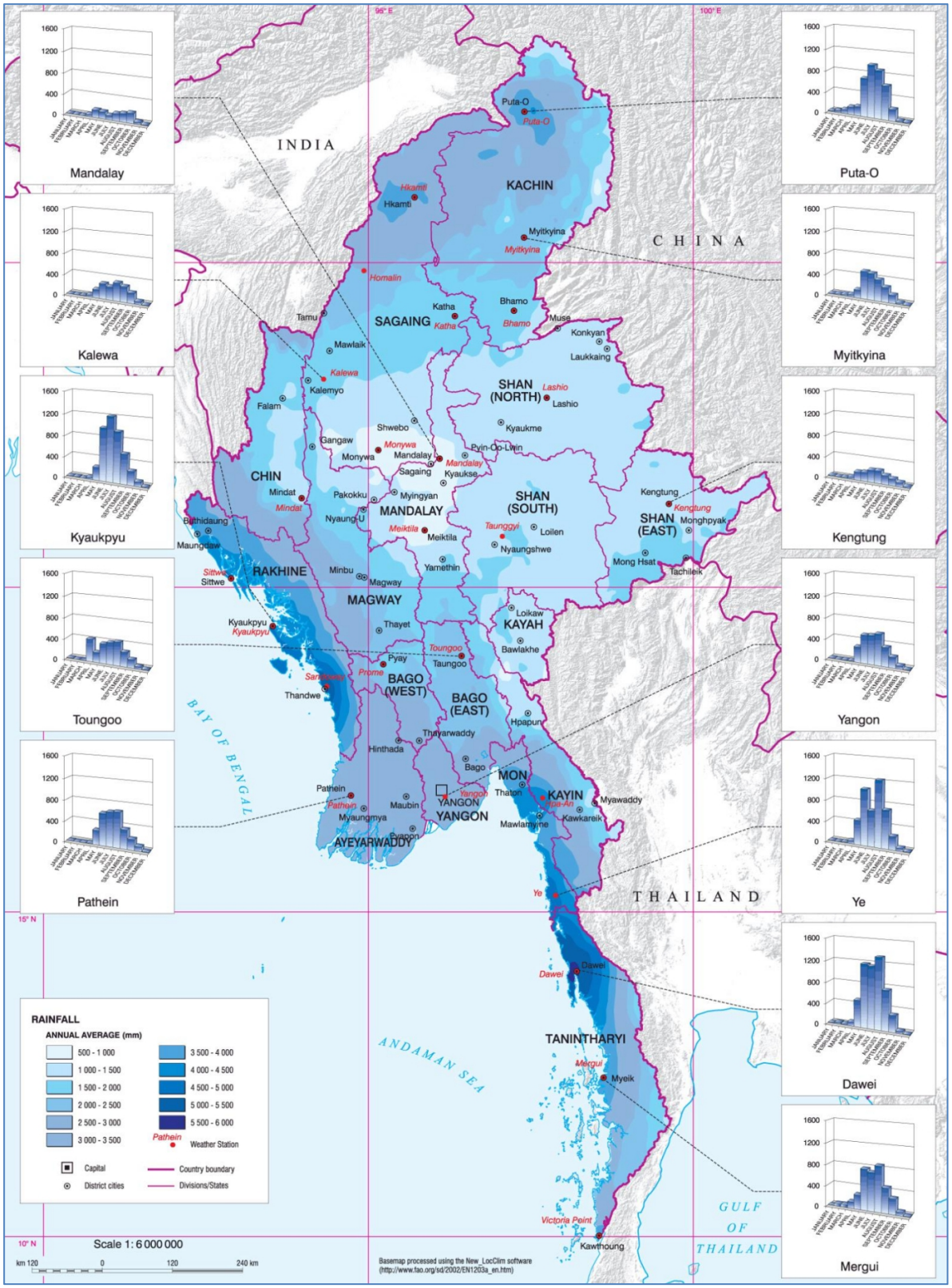
The climate along the line belongs to tropical monsoon climate zone, which can be divided into three seasons: cool, hot and rainy season.

The cool season is generally after mid-September, when the temperature rises and the cyclone gradually weakens. At about mid-November, cool season has officially arrived, until March of the when it turns into the hot season. The cool season is most typical from December to January, with frequent weak northeast wind or northwest wind; it is always sunny with plenty sunshine. The average monthly temperature is between 15 °C and 22 °C, which is the mildest and most pleasant season.

The hot season generally begins in early March. The temperature rises rapidly and reaches the highest peak in the whole year in April~May. The average monthly temperature is generally above 25 °C. Temperature at the middle and lower reaches of the Ayeyarwady River are generally above 30 °C, with the highest temperature above 40 °C. In addition to the occasional heavy rains along the coast, the hot season generally has little rainfall and strong evaporation. The rainy season generally begins after mid-May and is in full swing after mid-June. After mid-September, the rainy season begins to turn into a cool season. According to the rainfall statistics of major cities along the line, the rainfall in Shan Plateau is moderate. The average annual rainfall of Lashio is 1329mm. The middle reaches of the Ayeyarwady River have the least rainfall, which is less than 1000mm, and have become a famous arid area in Myanmar. The average annual rainfall in Mandalay is 901mm. The meteorological parameters of main areas along the line are shown in Table 5.4.

Table 5.3 - Main Areas Meteorological Parameters along the Line

Content		Ruili	Muse	Kutkai	Theinni	Lashio	Mandalay
Temperature (℃)	Highest temperature in history	36.0	35.0	35.0	34.0	28.0	41.5
	Lowest temperature in history	3.7	-	-	0.4	-1.9	12.4
	Average highest temperature in 2009	28.0	30.7	30.7	29.9	32.5	32.3
	Average lowest temperature in 2009	16.9	14.2	9.7	15.0	12.1	21.8
Rainfall	Annual average rainfall (mm).	1364	1329	1771	1453	1329	901
	Annual average rainy days (day)	150	93	108	97	94	83



[Source: http://dwms.fao.org/atlases/myanmar/atlas_en.htm]

Figure 5.23 - Rainfall Map of Myanmar with Monthly Distribution Patterns

5.4.8. Environmental Quality

5.4.8.1. Ambient Air Qualtiy Monitoring

Emission of air pollutants can occur from a wide variety of activities during the construction, operation, and decommissioning phases of the project. These activities can be point sources, fugitive sources, and mobile sources and by process such as Transportation, vehicles Movements, combustion, materials storage, or other specific processed. projects will prevent or minimize impacts by ensuring that emissions do not result in pollutant concentrations that reach or exceed relevant ambient quality guidelines and standard, and emission do not contribute a significant portion to the attainment of relevant ambient air quality guidelines or standards. Following is the US National Ambient Air Quality Standards (NAAQS) guidelines values for ambient air quality standard applicable as a reference standard for the current project since there is no national ambient air quality standard currently in Myanmar.

Survey Item

The parameters for air quality survey were SO_2, NO_2, CO_2, CO, CH_4, H_2S, O_3, $PM_{2.5}$, and PM_{10}, Solar Radiation, Odour, Temperature, Relative Humidity, Wind Speed and Wind Direction, Noise and Vibration.

Survey Location

The air quality survey was carried out in Seven locations. AS-1, AS-2, and AS-7were located near railway station project area.. The details of the location of air quality survey points are presented in figure below during August 2019.

Table 5.4 - Location of Air Sample (AS) of the Muse-Mandalay Railway Project

Sr. No	Sample Name	Coordinates		Remark
		Latitude(N)	Longitude(E)	Sensitive Areas
1	AS0	21°51'11.93"N,	96° 4'17.38"E	Myitnge Railway Station
2	AS-1	21°52'48.75"N,	96°13'34.70"E	Ohn Chaw Tar Zone
3	AS-2	22° 2'13.97"N,	96°27'57.83"E	Pyin Oo lwin Railway Station
4	AS-3	22° 3'30.29"N,	96°29'51.88"E	Pyin Oo Lwin Industrial Zone
5	AS-4	22°21'4.94"N,	96°54'50.62"E	Naung Peng Rail way station
6	AS-5	22°37'5.20"N,	97°17'40.17"E	Hsipaw Railway Station

7	AS-6	22°58'22.88"N,	97°43'50.33"E	Lashio Railway Station

Survey Methodology

Sampling and analysis of ambient air quality were conducted by referring to the recommendation of the United States Environmental Protection Agency (U.S. EPA). The Haz- Scanner Environmental Perimeter Air Station (EPAS) was used to collect ambient air survey data. Sampling rate or air quality data were measured automatically every one minute and directly read and recorded onsite for measured parameters (SO_2, NO_2, CO_2, CO, H_2S, O_3, CH_4,PM_{10}, $PM_{2.5}$), as shown in Table. Sampling pump was operated at 2 L/min. Different analysis methods are integrated in the instrument, such as Particulates 90° Infrared Light Scattering for particulate matters (PM_{10}, $PM_{2.5}$), electrochemical sensors for toxic gases (SO_2, NO_2, CO, H_2S), NDIR (optional sensor) for (CO_2, CH_4) and Gas Sensing Semiconductor- GSS technology (optional sensor) for O_3.

Table 5.5 - Sampling and Analysis Method for Air Quality

No.	Parameter	Analysis Method
1	Sulfur dioxide (SO_2)	On site reading
2	Nitrogen dioxide (NO_2)	On site reading
3	Carbon Dioxide (CO_2)	On site reading
4	Carbon monoxide (CO)	On site reading
5	Hydrogen Sulfide (H_2S)	On site reading
6	Particulate matter 2.5 ($PM_{2.5}$)	On site reading
7	Particulate matter 10 (PM_{10})	On site reading
8	Methane (CH_4)	On site reading
9	Hydrogen Sulfide (H_2S)	On site reading
10	Solar Radiation	On site reading
11	Wind Direction	On site reading
12	Wind Speed	On site reading
13	Temperature	On site reading
14	Relative Humidity	On site reading
15	Ordor	On site reading
16	Noise and Vibration	On site reading

Figure - Air Sampling Location Point One, AS0, 21°51'11.93"N, 96° 4'17.38"E Myitnge Railway Station

Figure - Air Sampling Location Two, AS1, 21°52'48.75"N, 96°13'34.70"E Ohn Chaw Tar Zone

Figure - Air Sampling Location Point Three, AS2, 22° 2'13.97"N, 96°27'57.83"E Pyin Oo lwin Railway Station

Figure - Air Smapling Location Four, AS3, 22° 3'30.29"N, 96°29'51.88"E Pyin Oo Lwin Industrial Zone Public Area

Figure -Air Smapling Location Five, AS4, 22°21'4.94"N, 96°54'50.62"E Naung Peng Rail way station

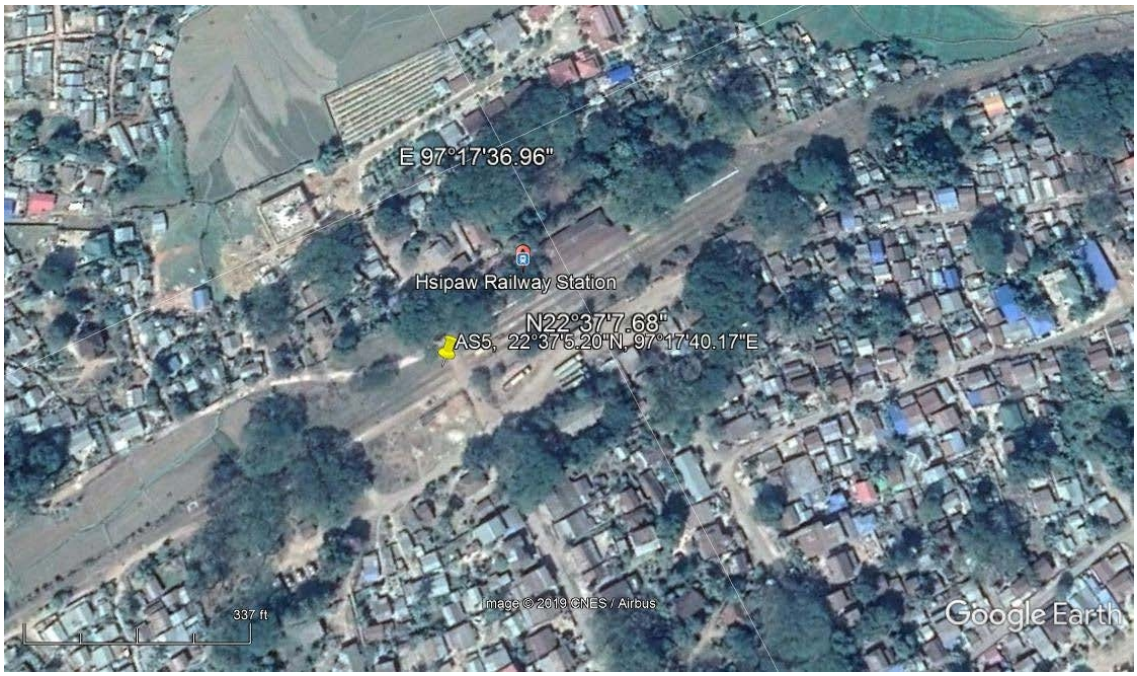


Figure - Air Sampling Location Point Six, AS5, 22°37'5.20"N, 97°17'40.17"E Hsipaw Railway Station

Figure - Air Sampling Location Point Seven, AS6, 22°58'22.88"N, 97°43'50.33"E Lashio Railway Station

Table - General Conditions of Ambient at the Time of Sampling on Points

Sr.	Latitude(N)	Longitude(E)	Air Temp	WBT	Dew Point	Humidity
1	21°51'11.93"N,	96° 4'17.38"E	31.6°	33.2°	30.6°	74.6%
2	21°52'48.75"N,	96°13'34.70"E	40°	28.8°	27°	51.1%
3	22° 2'13.97"N,	96°27'57.83"E	36°	28.3°	26.7°	55.5%
4	22° 3'30.29"N,	96°29'51.88"E	34°	28.2°	28.1°	66.2%
5	22°21'4.94"N,	96°54'50.62"E	34°	28.2°	26.7°	70.9%
6	22°37'5.20"N,	97°17'40.17"E	33°	27.2°	27.5°	64.3%
7	22°58'22.88"N,	97°43'50.33"E	33.11°	27.7°	26.6°	61.5%

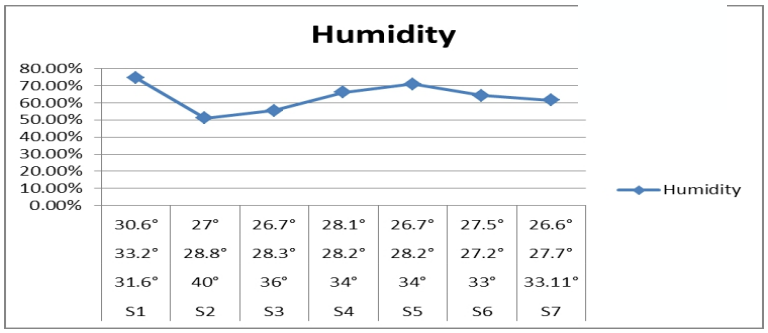


Figure – Humidity

Table - Wind Speed and Direction

Sr. No	Sample Name	Coordinates		Remark
		Latitude(N)	Longitude(E)	
1	AS0	21°51'11.93"N,	96° 4'17.38"E	AS0, Myitnge Railway Station
2	AS-1	21°52'48.75"N,	96°13'34.70"E	Ohn Chaw Tar Zone
3	AS-2	22° 2'13.97"N,	96°27'57.83"E	Pyin Oo lwin Railway Station
4	AS-3	22° 3'30.29"N,	96°29'51.88"E	Pyin Oo Lwin Industrial Zone Public Area
5	AS-4	22°21'4.94"N,	96°54'50.62"E	Naung Peng Rail way station
6	AS-5	22°37'5.20"N,	97°17'40.17"E	Hsipaw Railway Station
7	AS-6	22°58'22.88"N,	97°43'50.33"E	Lashio Railway Station

Wind speed and wind direction of proposed Muse Mandalay Railway Project site had been measured by using EPAS.

Table - Wind Speed and Air Direction of AS1

Date	Time	WDir, Deg.	WSpM,mps	Date	Time	WDir, Deg.	WSpM,mps
19-5-2019	11:46:01	292	4.8	19-5-2019	12:54:01	264	8.7
19-5-2019	11:50:01	298	3.4	19-5-2019	12:55:01	257	6
19-5-2019	12:00:01	176	2.3	19-5-2019	12:56:01	249	6.3
19-5-2019	12:10:01	134	0.8	19-5-2019	12:57:01	265	6.6
19-5-2019	12:20:01	22	0	19-5-2019	12:58:01	242	5.4
19-5-2019	12:30:01	284	0	19-5-2019	12:59:01	252	5.8
19-5-2019	12:40:01	225	7.4	19-5-2019	13:00:01	231	6.6
19-5-2019	12:50:01	253	4.8	19-5-2019	13:01:01	254	8.1
19-5-2019	12:51:01	240	5.3	19-5-2019	13:04:01	236	9.6
19-5-2019	12:52:01	248	7	19-5-2019	13:05:01	233	10.5
19-5-2019	12:53:01	260	8.2	19-5-2019	13:07:01	240	8.3

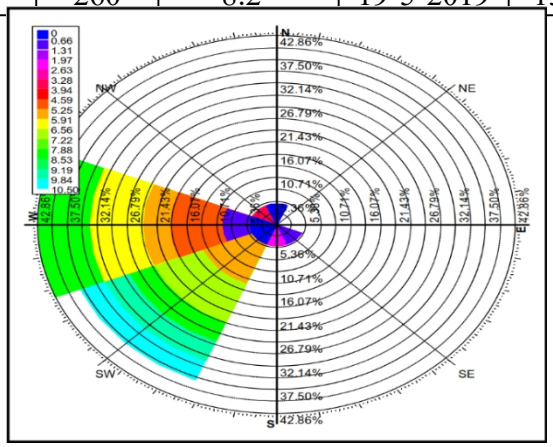


Figure - Wind Rose Diagram at AS1 at Myitnge Railway Station

Table - Wind Speed and Air Direction of AS2

Sr. No	Sample Name	Coordinates		Remark
		Latitude(N)	Longitude(E)	Sensitive Areas
2	AS-2	21°52'48.75"N,	96°13'34.70"E	Ohn Chaw Tar Zone

Date	Time	WDir, Deg.	WSpM, mps	Date	Time	WDir, Deg.	WSpM, mps
19-5-2019	14:40:01	161	1	19-5-2019	15:21:01	148	0
19-5-2019	14:45:01	166	1	19-5-2019	15:24:01	170	0.2
19-5-2019	14:50:01	178	0.4	19-5-2019	15:27:01	193	0.2
19-5-2019	14:55:01	147	2	19-5-2019	15:30:01	151	0
19-5-2019	15:00:01	160	0.7	19-5-2019	15:33:01	208	0.3
19-5-2019	15:05:01	154	0.2	19-5-2019	15:34:01	179	3.2
19-5-2019	15:10:01	132	0.1	19-5-2019	15:36:01	280	0.8
19-5-2019	15:11:01	157	0.6	19-5-2019			
19-5-2019	15:12:01	131	0.2	19-5-2019			
19-5-2019	15:15:01	149	0.5	19-5-2019			
19-5-2019	15:18:01	149	0	19-5-2019			

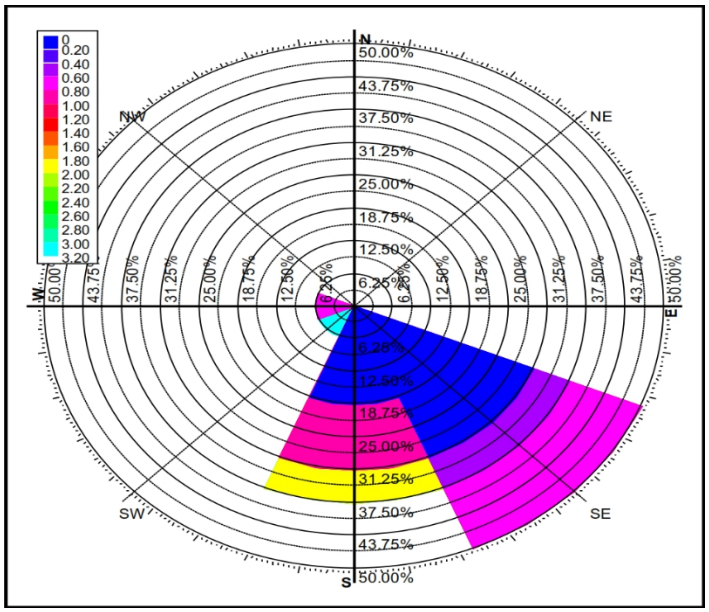


Figure - Wind Rose Diagram at AS2

Table - Wind Speed and Air Direction of AS3

Sr. No	Sample Name	Coordinates		Remar
		Latitude(N)	Longitude(E)	Sensitive Areas
4	AS-3	22° 3'30.29"N,	96°29'51.88"E	Pyin Oo Lwin Industrial Zone Public Area

Date	Sample point	Time	Wind Speed (km/h)	Wind Direction (degree)	Wind Direction (cardinal point)
20.5.2019	Air Sample 3	8: 00 AM	1.6	312°	NW
		9: 00 AM	3.1	328°	NNW
		10: 00 AM	2.2	310°	NW
		11: 00 AM	6.2	66°	SSW
		12: 00 PM	4.2	56°	ESE
		13: 00 PM	2.1	129°	SE
		14: 00 PM	6.1	160°	SSE
		15: 00 PM	4.2	201°	SSW

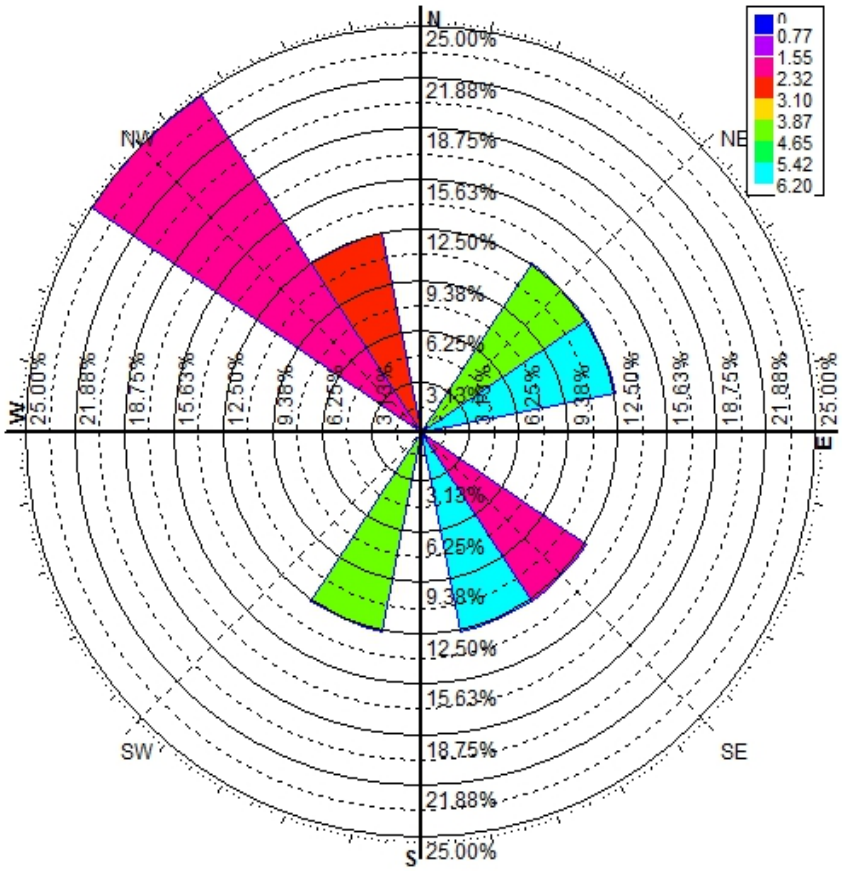


Figure - Wind Rose Diagram for AS3

Table - Wind Speed and Air Direction of AS4

Sr.	Sample	Coordinates	R

		Latitude(N)	Longitude(E)	Sensitive Areas
5	AS-4	22°21'4.94"N,	96°54'50.62"E	Naung Peng Rail way station

Date		Sample point	Time	Wind Speed (km/h)	Wind Direction (degree)	Wind Direction (cardinal point)
21.5.2019		Air Sample 4	8: 00 AM	7.2	358°	N
			9: 00 AM	6.5	315°	NW
			10: 00 AM	4.4	293°	WNW
			11: 00 AM	5.8	319°	NW
			12: 00 PM	7.1	312°	NW
			13: 00 PM	5.4	352°	N
			14: 00 PM	5.1	18°	NNE
			15: 00 PM	6.4	329°	NNW

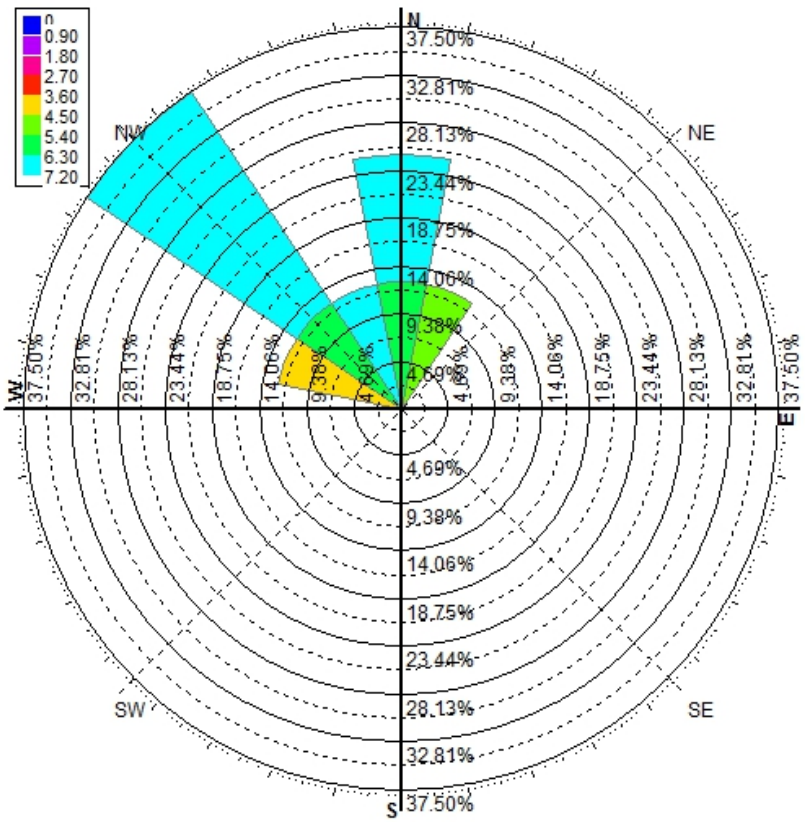


Figure - Wind Rose Diagram at AS4

Table - Wind Speed and Air Direction of AS5

Sr. No	Sample Name	Coordinates	Remark

		Latitude(N)	Longitude(E)	Sensitive Areas
6	AS-5	22°37'5.20"N,	97°17'40.17"E	Hsipaw Railway Station

Date	Sample point	Time	Wind Speed (km/h)	Wind Direction (degree)	Wind Direction (cardinal point)
22-5-.2019	Air Sample 5	8: 00 AM	5.6	182°	S
		9: 00 AM	4.6	292°	WNW
		10: 00 AM	4.3	38°	NE
		11: 00 AM	5.2	327°	NW
		12: 00 PM	3.2	178°	S
		13: 00 PM	3.5	51°	NE
		14: 00 PM	2.1	69°	ENE
		15: 00 PM	3.1	340°	NNW

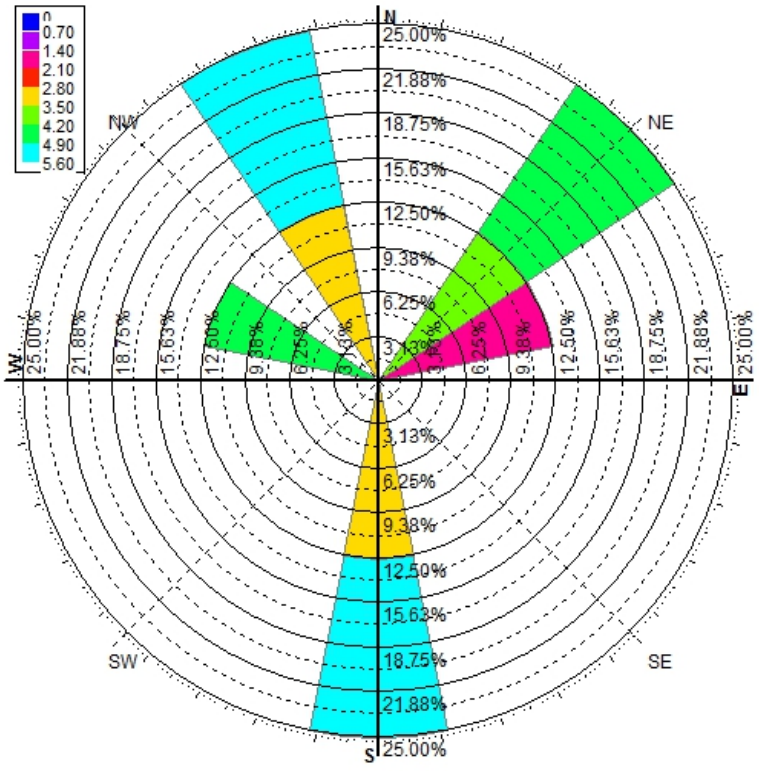


Figure - Wind Rose Diagram at AS5

Table - Wind Speed and Air Direction of AS6

Sr.	Sample	Coordinates	Remark

		Latitude(N)	Longitude(E)	Sensitive Areas
7	AS-6	22°58'22.88"N,	97°43'50.33"E	Lashio Railway Station

Date	Sample point	Time	Wind Speed (km/h)	Wind Direction (degree)	Wind Direction (cardinal point)
23-5-2019	Air Sample Point AS-6	9: 00 AM	1.6	246°	WSW
		10: 00 AM	1.3	198°	SSW
		11: 00 AM	2.9	221°	SW
		12: 00 PM	2.8	269°	W
		13: 00 PM	4.6	216°	SW
		14: 00 PM	2.7	64°	ENE
		15: 00 PM	6.7	66°	ENE
		16: 00 PM	5.5	331°	NNW

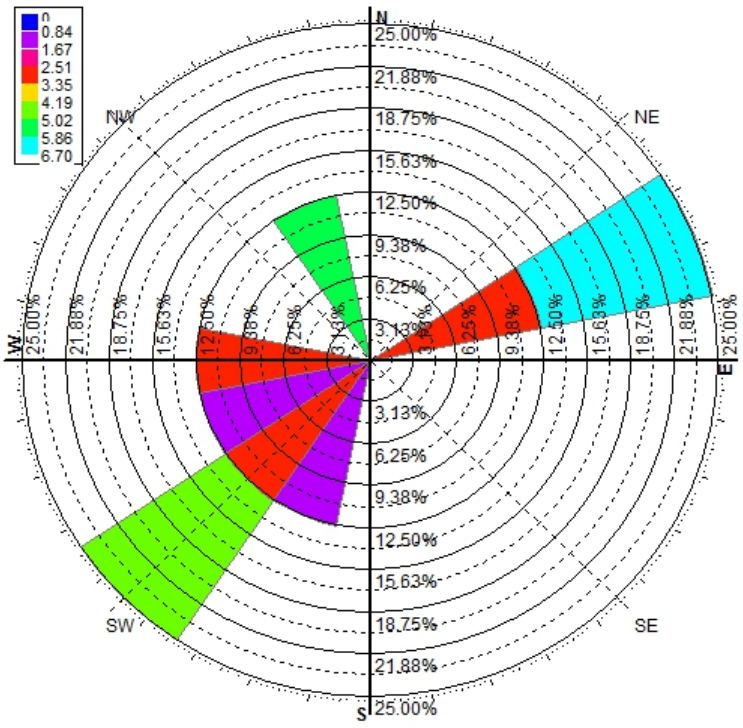


Figure - Wind Rose Diagram at AS6

5.4.8.1.1. Measurement of Air Quality for Dry Season Comparing with the Air Quality Standards and Guidelines

CO, CO_2, NO_2, SO_2, O_3, PM_{10} and $PM_{2.5}$ are measured at the proposed MUSE-MANDALAY RAILWAY PROJECT Project site from myitnge to lashio (7 points). The site is in the pre construction stage and the collected data shown below are due to the movement of vehicles along the road and the transportation works. The standards for applicable to the possible air pollutants were determined from review of Myanmar National Environmental Emission Guideline and World Health Organization (WHO) Guideline. The average concentrations of pollutants at three sampling points for about 8 hours total, 8 hours for each are shown in the table below.

Table - Average concentrations of pollutants at the sample points for 8 hours for each

Sr. No	Sample Name	Coordinates		Remark
		Latitude(N)	Longitude(E)	Sensitive Areas
1	AS0	21°51'11.93"N,	96° 4'17.38"E	Myitnge Railway Station
2	AS-1	21°52'48.75"N,	96°13'34.70"E	Ohn Chaw Tar Zone
3	AS-2	22° 2'13.97"N,	96°27'57.83"E	Pyin Oo lwin Railway Station
4	AS-3	22° 3'30.29"N,	96°29'51.88"E	Pyin Oo Lwin Industrial Zone Public Area
5	AS-4	22°21'4.94"N,	96°54'50.62"E	Naung Peng Rail way station
6	AS-5	22°37'5.20"N,	97°17'40.17"E	Hsipaw Railway Station
7	AS-6	22°58'22.88"N,	97°43'50.33"E	Lashio Railway Station

Sample Time	Sensitive Areas	Average Value Parameters					
		CO_2 (ppm)	CO (ppm)	SO_2 (ppm)	NO_2 (ppb)	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)
Time 8 hours for each points	Myitnge Railway Station	479	6	1	31	29	11
	Ohn Chaw Tar Zone	498	15	4	29	43	22
	Pyin Oo lwin Railway	524	3	2	21	22	10
	Pyin Oo Lwin Industrial Zone Public Area	519	7	1	21	21	14
	Naung Peng Rail way	509	11	3	12	26	10
	Hsipaw Railway Station	526	5	1	21	28	17

	Lashio Railway Station	491	9	1	19	29	18

The chart below show that the concentration of Carbon Dioxide (CO_2) measured in all the sampling times at sampling point was between the ranges of 479 ppm – 526 ppm.

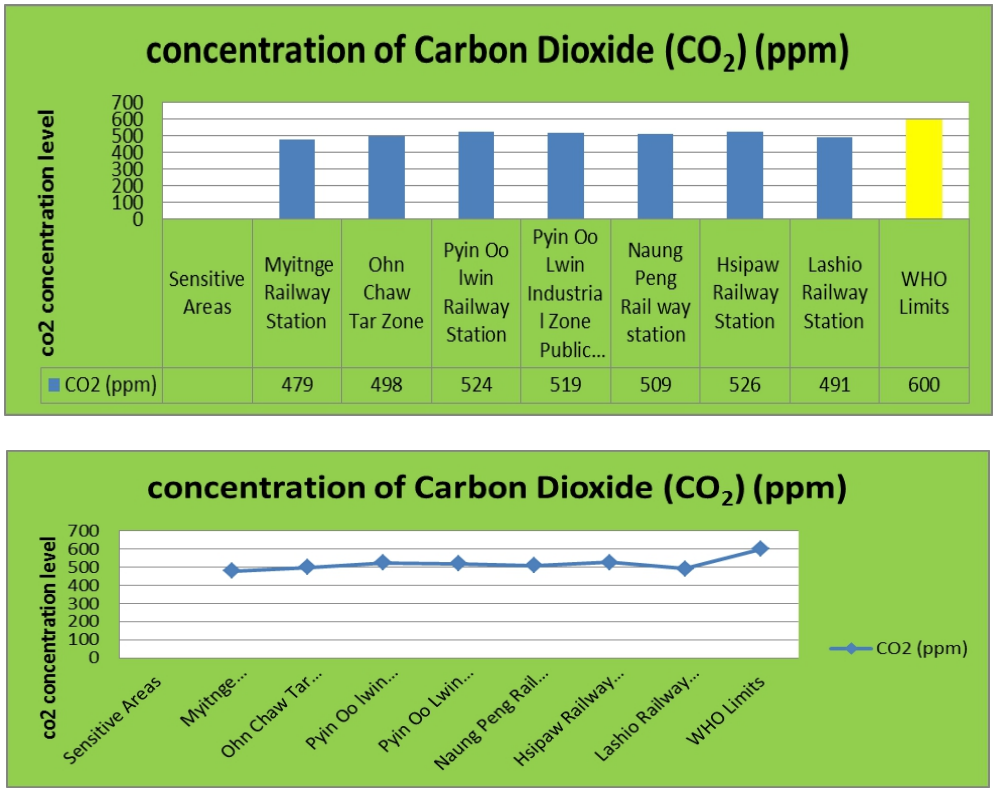


Figure – Concentration of Carbon Dioxide

The concentration of Carbon Dioxide measured in all the sampling times at sampling point was below the World Health Organization (WHO) Guidelines, which specifies 600 ppm for the limitation of CO_2 concentration. CO_2 concentration of 526 ppm was the highest and 479 ppm was the lowest at the proposed area.

The chart below show that the concentration of Carbon Monoxide (CO) measured in all sampling times at sampling point 1 was between the ranges of 5 ppm – 15 ppm

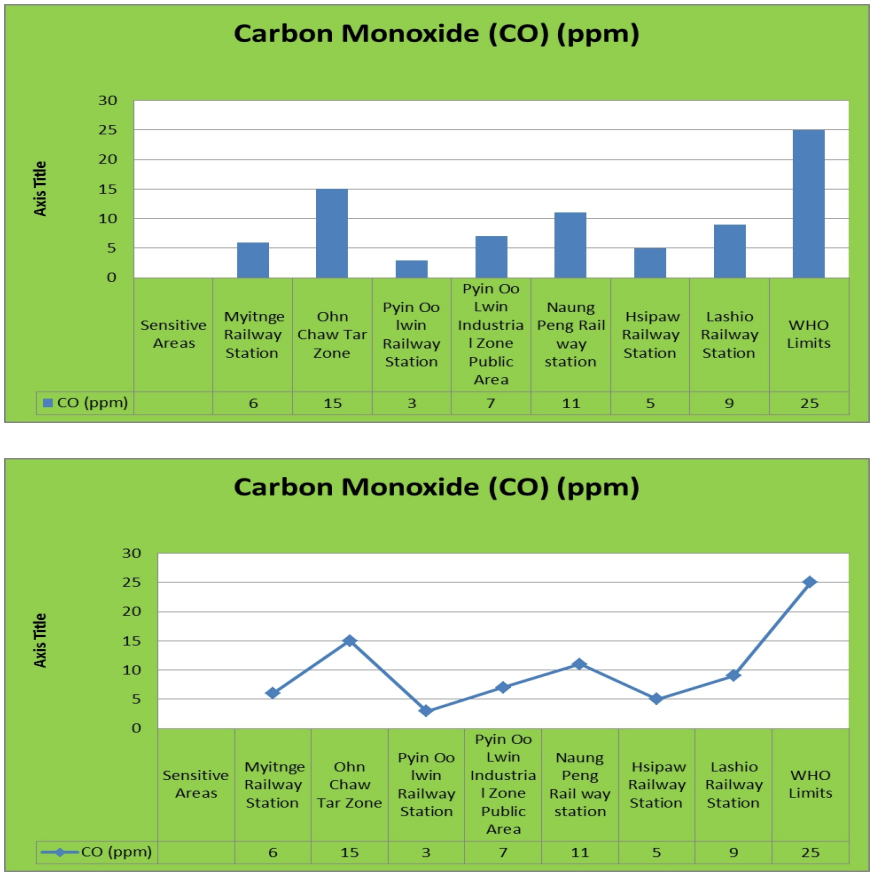
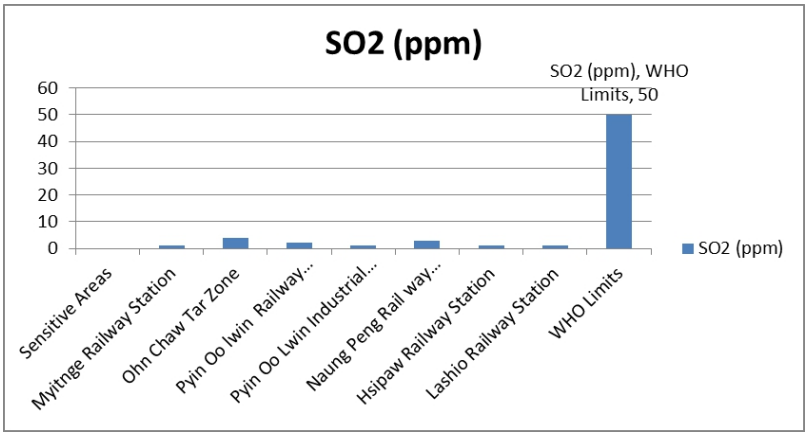


Figure – Concentration of Carbon Monoxide

The concentration of Carbon Monoxide measured in all the sampling times at sampling point 1 was below the World Health Organization (WHO) Guidelines, which specifies 25 ppm for the limitation of CO concentration. CO concentration of 15 ppm was the highest and 5 ppm was the lowest at the proposed area.

The chart below show that the concentration of Sulfur Dioxide (SO_2) measured in all sampling times at sampling point was between the ranges of 1 ppm and 4 ppm.



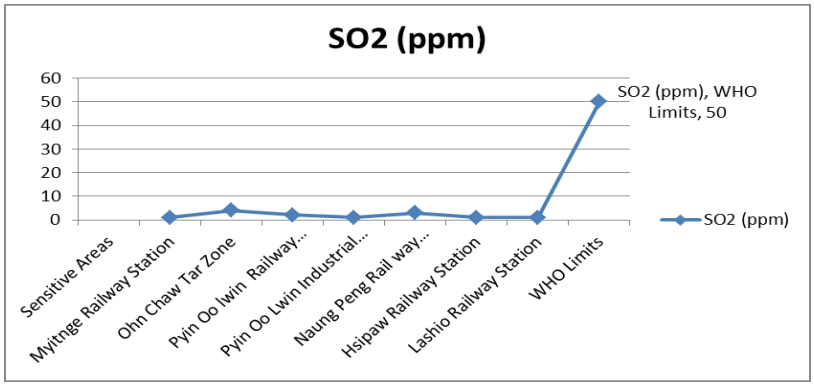
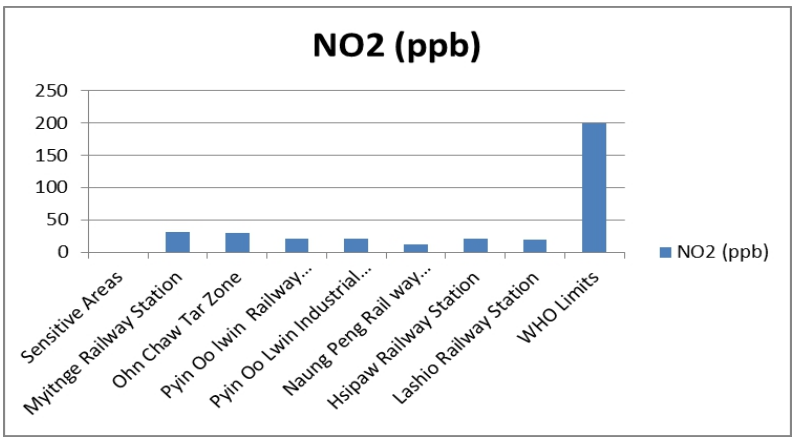


Figure – Concentration of Sulfur Dioxide

The concentration of Sulfur Dioxide measured in all the sampling times at the sampling point 1 was below the World Health Organization (WHO) Guideline, which specifies 50 ppm for the limitation of SO_2 concentration. SO_2 concentration of 4 ppm was the highest and 1 ppm was the lowest at the proposed area.

The chart below show that the concentration of Nitrogen Dioxide (NO_2) measured in all sampling times at sampling point 1 was between the ranges of 12 ppb – 31 ppb.



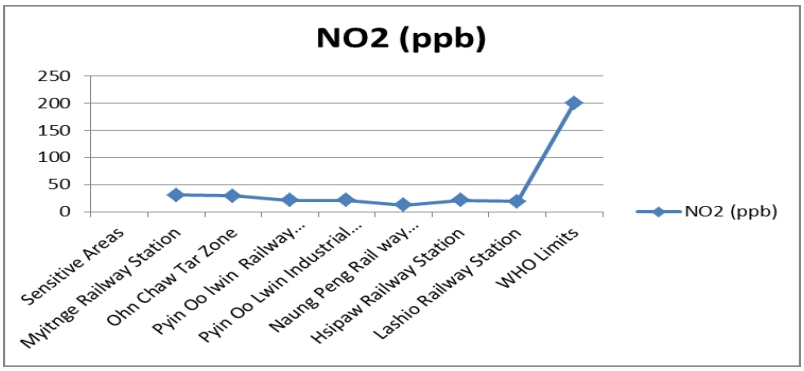
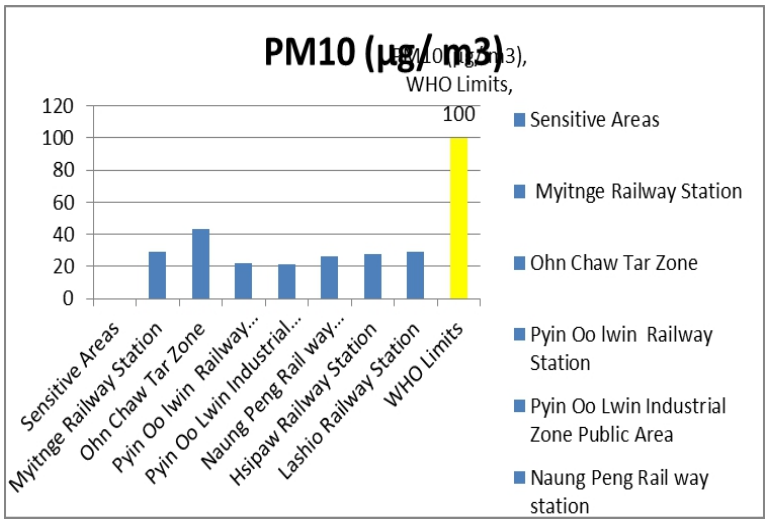


Figure – Concentration of Nitrogen Dioxide

The concentration of Nitrogen Dioxide measured in all the sampling times at sampling point 1 was below the Myanmar National Environmental Quality Emission Guideline (NEQEG), which specifies 200 ppb for the limitation of NO_2 concentration. NO_2 concentration of 31 ppb was the highest and 12 ppb was the lowest at the proposed area.

The chart below show that the concentration of Particulate Matter (PM_{10}) measured in all sampling times at sampling point was between the ranges of 21µg/m^3 – 43µg/m^3.



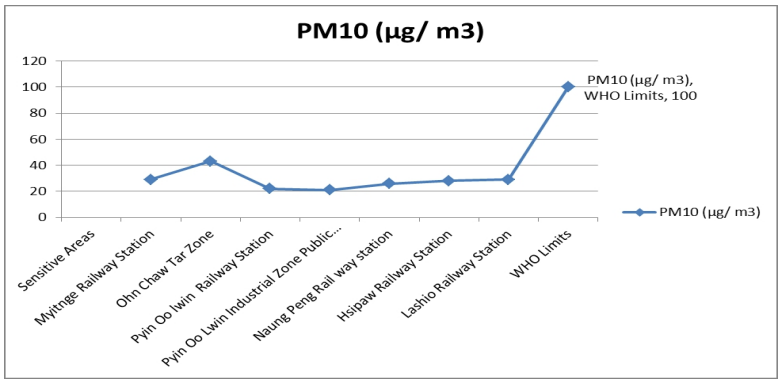


Figure – Concentration of Particulate Matter

The concentration of Particulate Matter measured at sampling point was below the limit of World Health Organization (WHO) Guideline which specifies 100µg/m^3 for the limitation of PM10 concentration. PM_{10} concentration of 43µg/m^3 was the highest and 21µg/m^3 was the lowest at the proposed area.

The chart below show that the concentration of Fine Particulate Matter ($PM_{2.5}$) measured in all sampling times at sampling point was between the ranges of 10 µg/m^3 – 22µg/m^3.

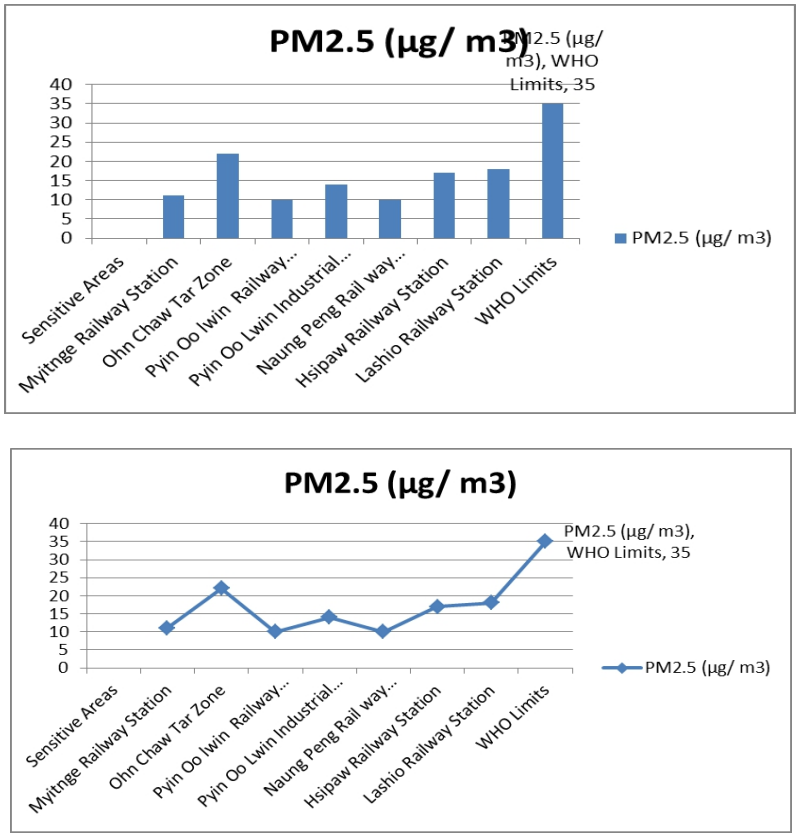


Figure – Concentration of Fine Particulate Matter

The concentration of Fine Particulate Matter measured in all the sampling times at the sampling point 1 was below the World Health Organization (WHO) Guideline which specifies 35µg/m^3 for the limitation of $PM_{2.5}$ concentration. $PM_{2.5}$ concentration of 22µg/m^3 was the highest and 10µg/m^3 was the lowest at the proposed area.

5.4.8.1. 2. Measurement of Air Quality for Wet Season Comparing with the Air Quality Standards and Guidelines

CO, CO_2, NO_2, SO_2, O_3, PM_{10} and $PM_{2.5}$ are measured at the proposed Muse- Mandalay Railway Project site from Pyinoolwin to Muse (8 points). The site is in the pre construction stage and the collected data shown below are due to the movement of vehicles along the road and the transportation works. The standards for applicable to the possible air pollutants were determined from review of Myanmar National Environmental Emission Guideline and World Health Organization (WHO) Guideline. Eight sampling points for about 8 hours total, 8 hours for each are shown in the table below.

Table - Measuring Points of Air Quality

S/N	Name of Places	GPS Coordinate	
		Latitude (N)	Longitude €
1	Oak Pho Village (Pyin Oo Lwin)	22°.071081°	96°.399531°
2	Shwe Pyi Nyunt Villag (Naung Cho)	22°.304525°	96°.833933°
3	Baw Gyo Pagod (Hsipaw)	22°.583272°	97°.233222°
4	Sam Laung	22°.676006°	97°.507519°
5	Lashio West (NE 350m)	22°.984836°	97°.706414°
6	Theinni	23°.306658°	97°.974528°
7	Nam Hpak Ka	23°.689414°	97°.817433°
8	Muse	24°.000783°	97°.940464°

Moreover, the further parameters for air quality that are temperature and air humidity were measured at the proposed Muse- Mandalay Railway Project site from Pyinoolwin to Muse (8 points).

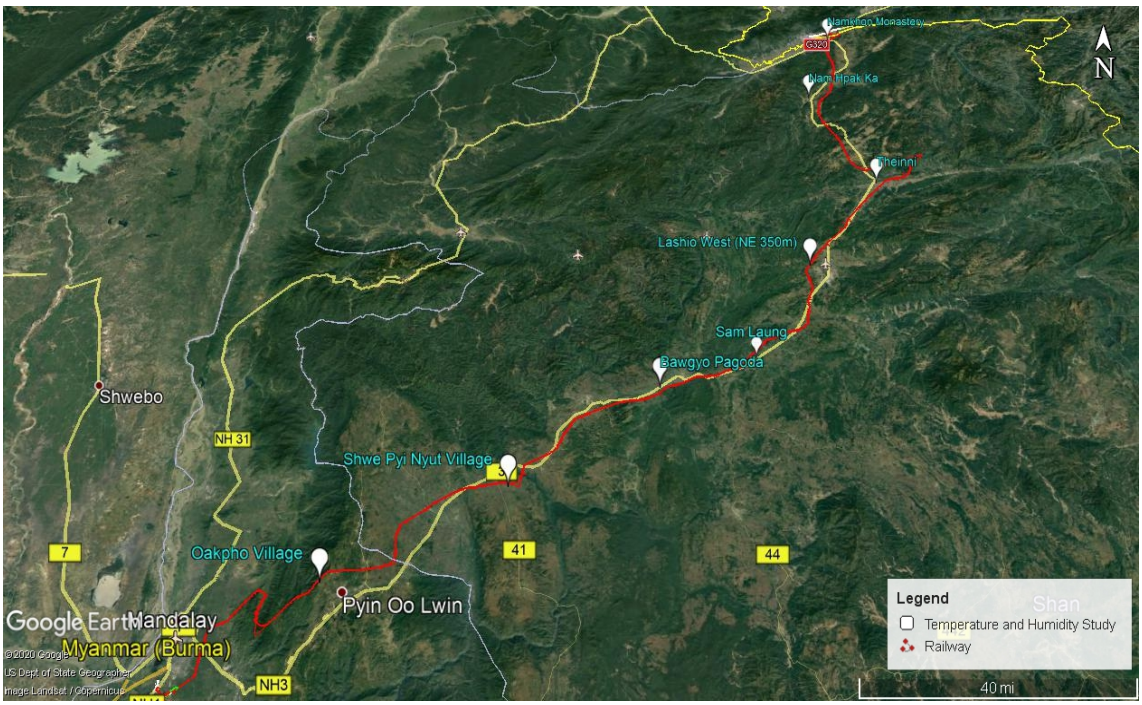
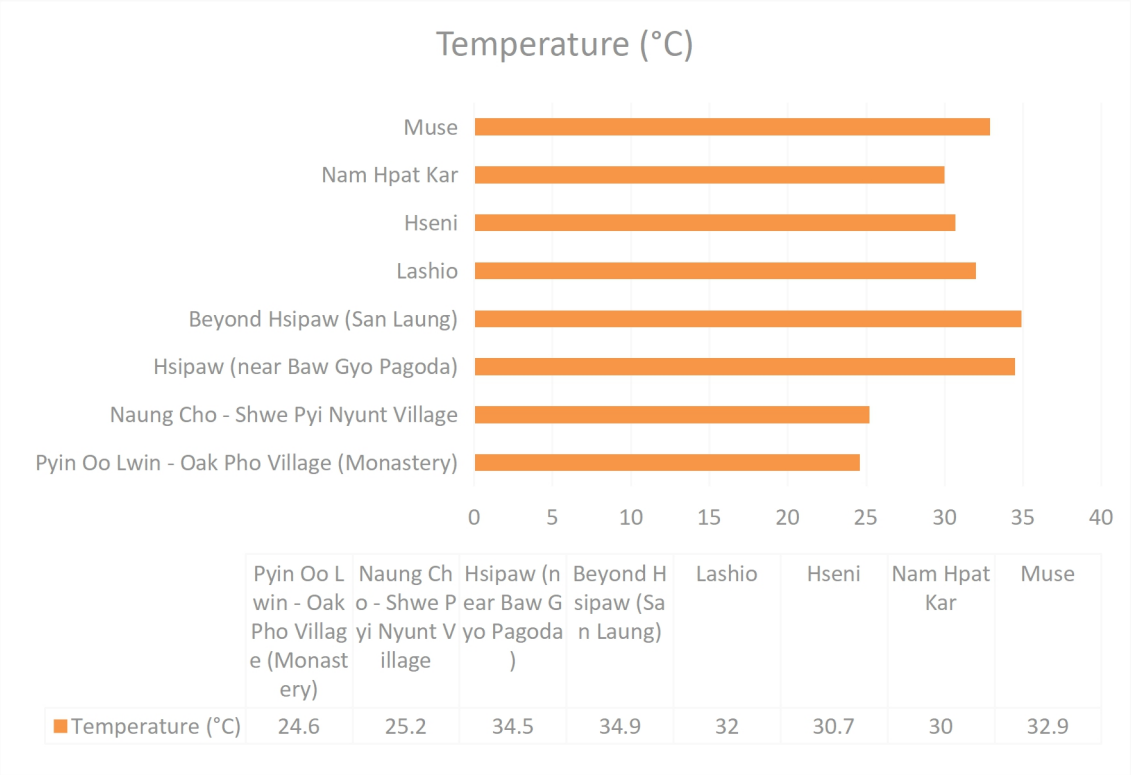


Figure - Locations of Temperature and Humidity Study along the Proposed Project Muse-Mandalay Railway

Table - General Conditions of Ambient at the time of Sampling on Points

No.	Place	Location		Temperature (°C)	Air Humidity (%RH)
		Latitude(N)	Longitude(E)		
1	Pyin Oo Lwin - Oak Pho Village (Monastery)	N 22° 04' 15.87"	E 096° 23' 58.30"	24.6	98.7
2	Naung Cho - Shwe Pyi Nyunt Village	N 22° 18' 16.29"	E 096° 50' 02.16"	25.2	93.9
3	Hsipaw (near Baw Gyo Pagoda)	N 22° 34' 59.78"	E 097° 13' 59.62"	34.5	71.9
4	Beyond Hsipaw (San Laung)	N 22° 40' 33.66'	E 97° 30' 17.4"	34.9	62.9
5	Lashio	N 22° 59' 05.41"	E 097° 42' 23.09"	32	59.9
6	Hseni	N 23° 18' 23.97"	E 097° 58' 28.30"	30.7	72.6
7	Nam Hpat Kar	N 23° 41' 21.89"	E 097° 49' 02.76"	30	72.4
88	Muse	N 24° 00' 03.10"	E 097° 56' 25.90"	32.9	64.8

Temperature Results for Muse-Mandalay Railway



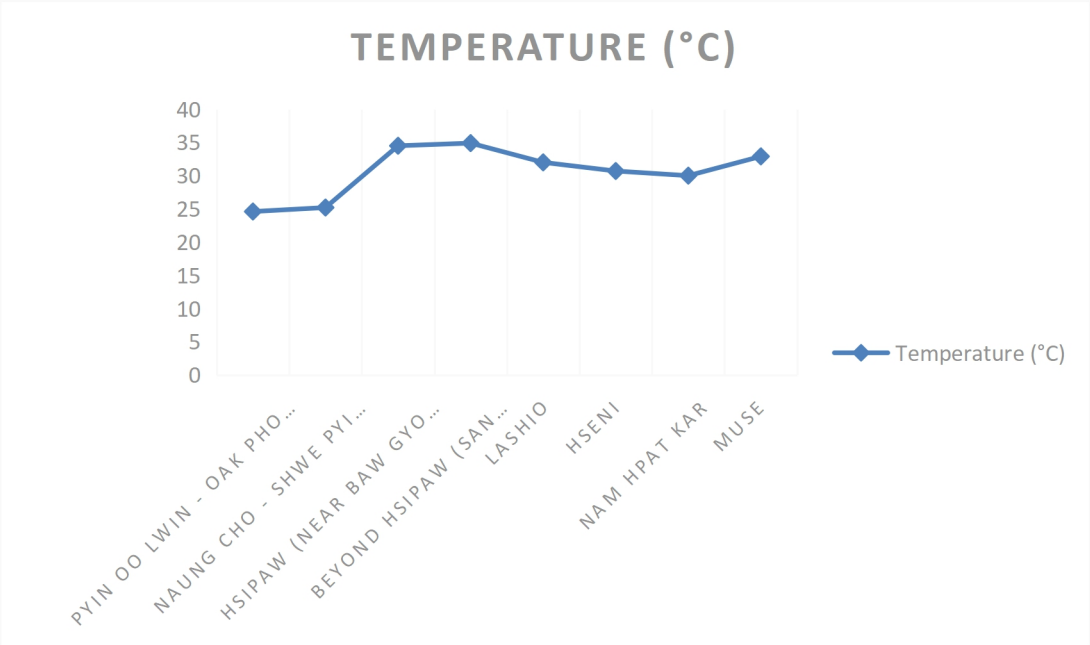
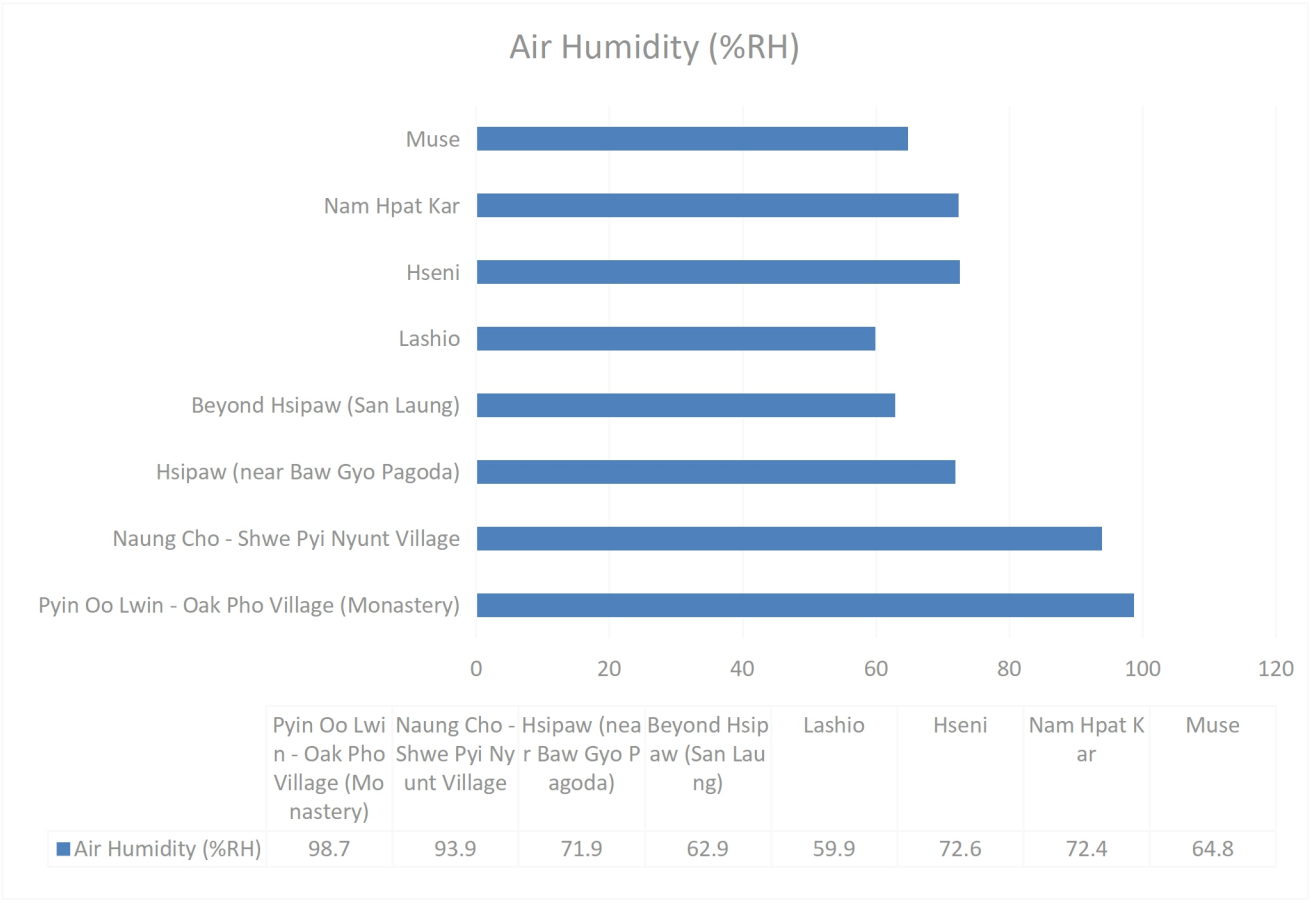


Figure – Temperature Results in Muse-Mandalay Region

Air Humidity Results for Muse-Mandalay Railway



	Pyin Oo Lwin - Oak Pho Village (Monastery)	Naung Cho - Shwe Pyi Nyunt Village	Hsipaw (near Baw Gyo Pagoda)	Beyond Hsipaw (San Laung)	Lashio	Hseni	Nam Hpat Kar	Muse
Air Humidity (%RH)	98.7	93.9	71.9	62.9	59.9	72.6	72.4	64.8

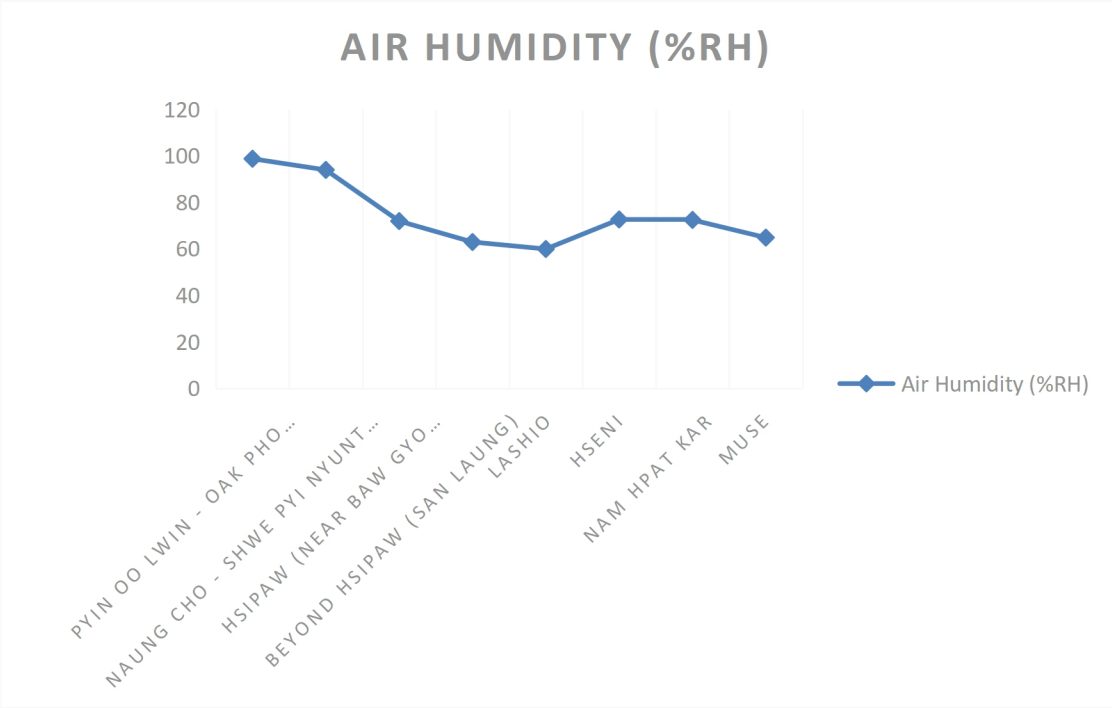


Figure – Air-Humidity Results for Muse-Mandalay Region

Figure -Recorded Photos for Measuring Temperature and Air Humidity

5.4.8.1. 3. Air Dispersion Comparison at Average 8 hours on No Project and Project Conditions (Construction Phase)

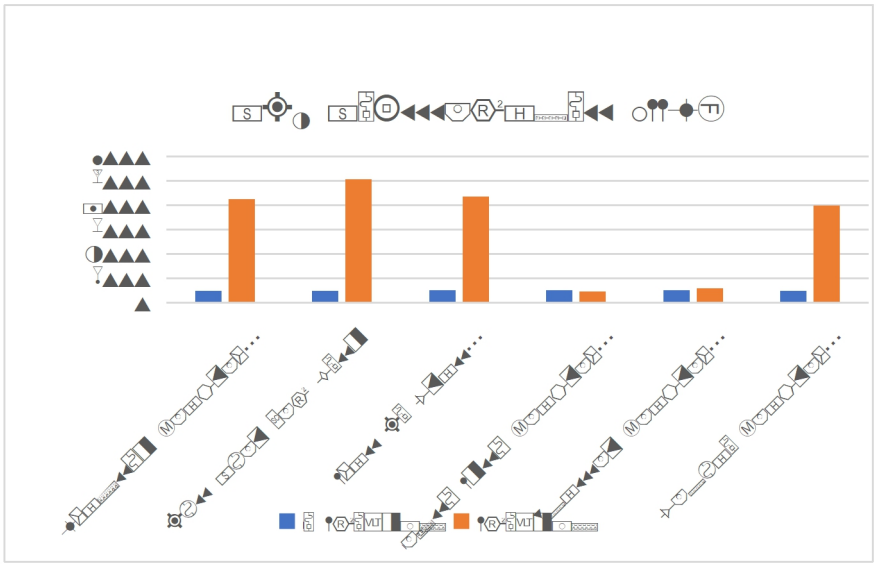
The air dispersion is predicted by using AERMOD VIEW modelling software. Wind speeds, wind directions and gas emission rate are used as input data. And the software gives the concentration level of gases as results. The machines and their emission rates are assumed to be able to predict the possible concentration levels of gases in the construction phase. At Naung Peng Railway Station and Hsipaw Railway Station, the wind speed is measured over 6 km/s and 4 km/s average, thus the concentration levels at those points are lower compared to the other points. The prediction is done by assuming the construction works are 8 hours continuous operation. But the actual construction work will be discontinuous operation meaning the concentration levels can be lower than the predicted model. The concentration levels of pollutants are shown in following tables and figures.

Table – Average Concentration of pollutants at the sample points for 8 hours for each in No Project Condition

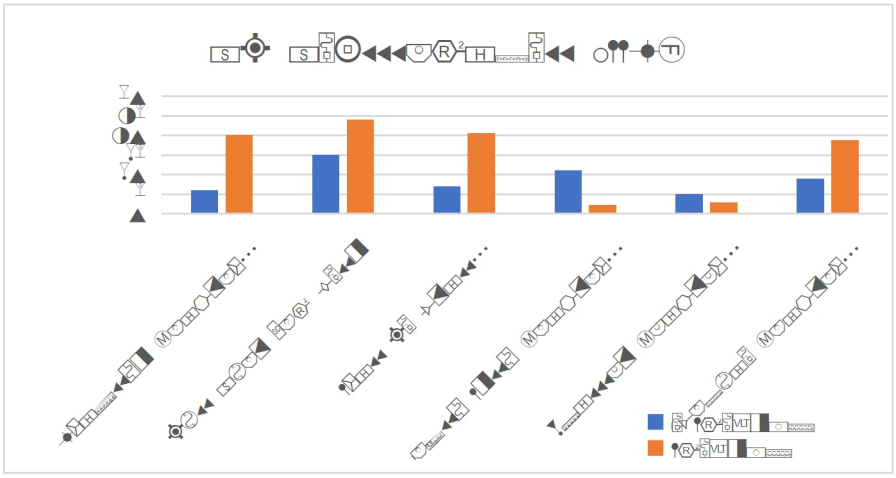
Sample Time	Sensitive Areas	Average Value Parameters					
		CO_2 (ppm)	CO (ppm)	SO_2 (ppm)	NO_2 (ppb)	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)
Time 8 hours for each point	Myitnge Railway Station	479	6	1	31	29	11
	Ohn Chaw Tar Zone	498	15	4	29	43	22
	Pyin Oo Lwin Industrial Zone Public Area	519	7	1	21	21	14
	Naung Peng Railway Station	509	11	3	12	26	10
	Hsipaw Railway Station	526	5	1	21	28	17
	Lashio Railway Station	491	9	1	19	29	18

Table – Average Concentration of pollutants at the sample points for 8 hours for each in Project Condition

Sample Time	Sensitive Areas	Average Value Parameters					
		CO_2 (ppm)	CO (ppm)	SO_2 (ppm)	NO_2 (ppb)	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)
Time 8 hours for each point	Myitnge Railway Station	4268	20.1	5.88	45.8	4.03	3.92
	Ohn Chaw Tar Zone	5085	24	7.01	54.6	4.796	4.669
	Pyin Oo Lwin Industrial Zone Public Area	4366	20.6	6.02	46.85	4.12	4.01
	Naung Peng Railway Station	463.4	2.19	0.639	4.97	0.437	0.426
	Hsipaw Railway Station	592	2.8	0.817	6.36	0.559	0.544
	Lashio Railway Station	3992	18.8	5.5	42.8	3.77	3.67



CO_2



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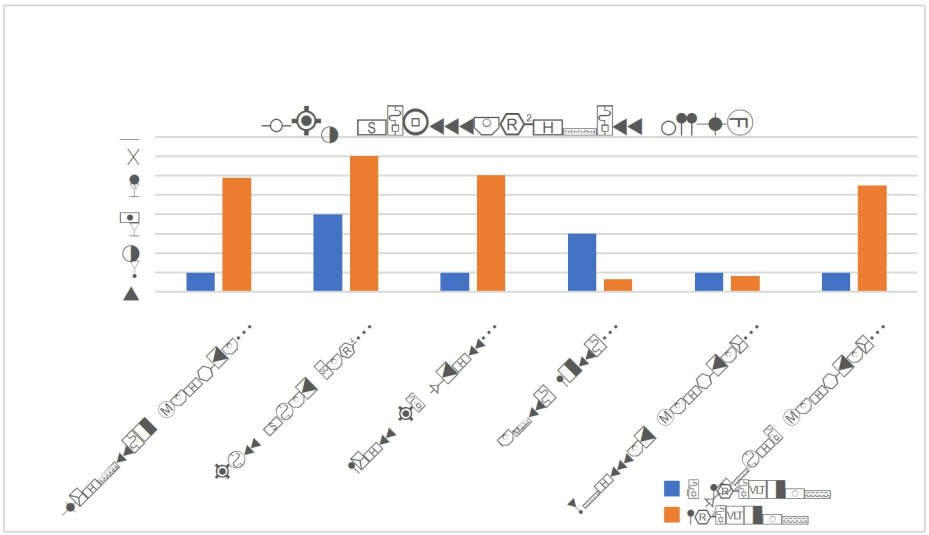

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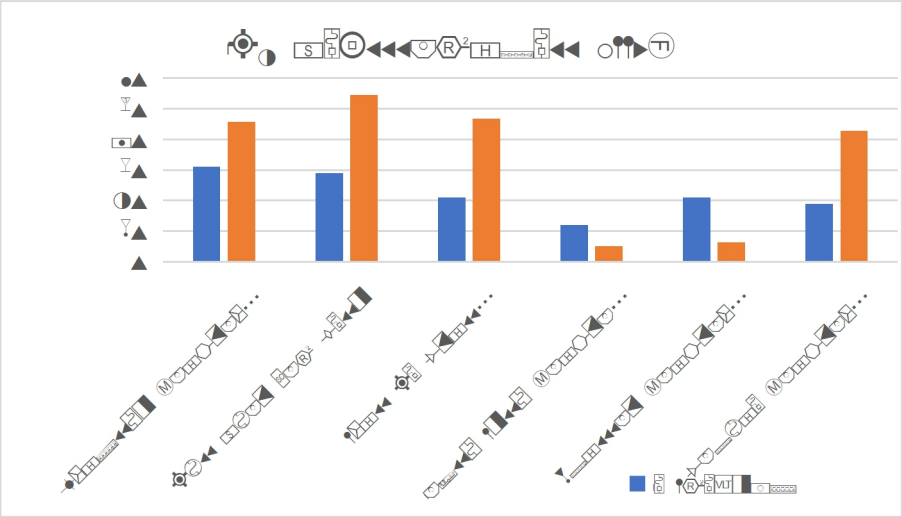

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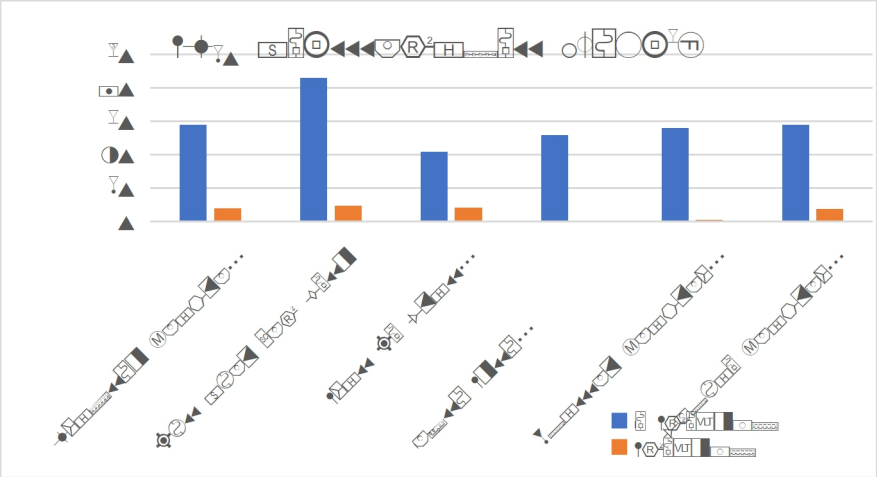

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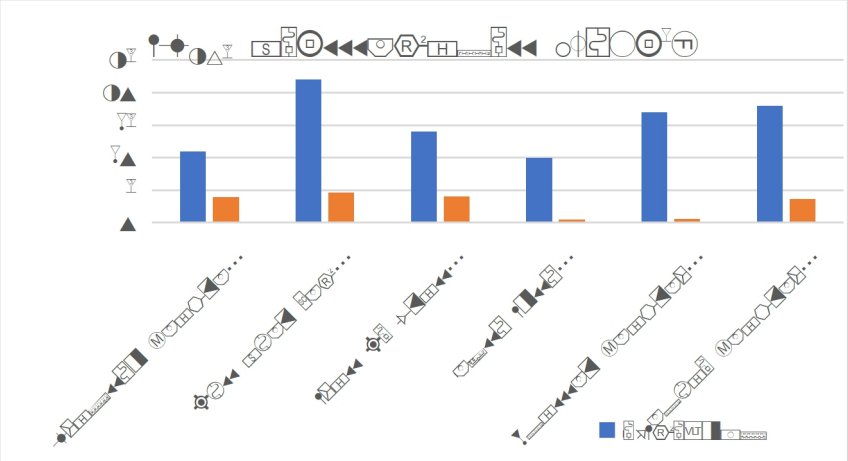
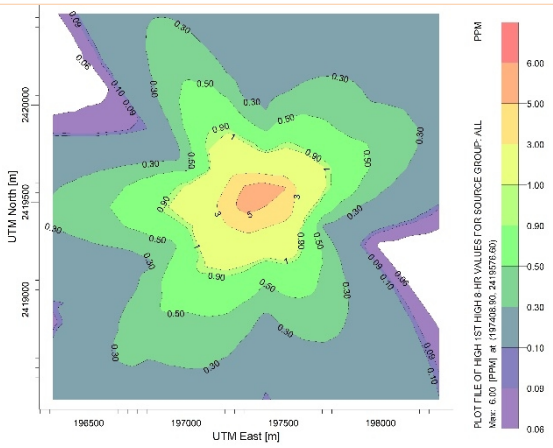


$PM_{2.5}$

CO



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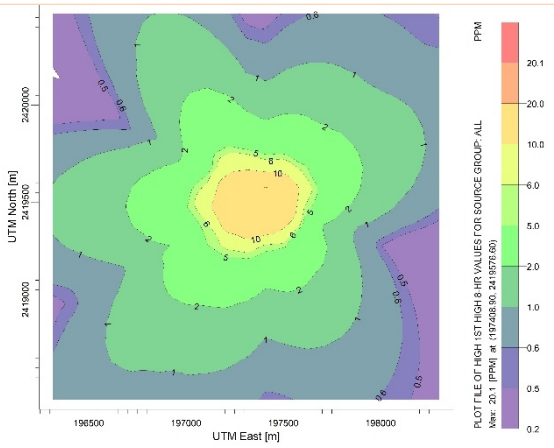
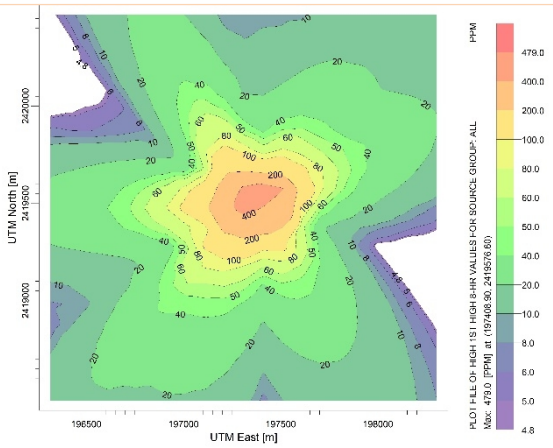


Project Condition

CO_2



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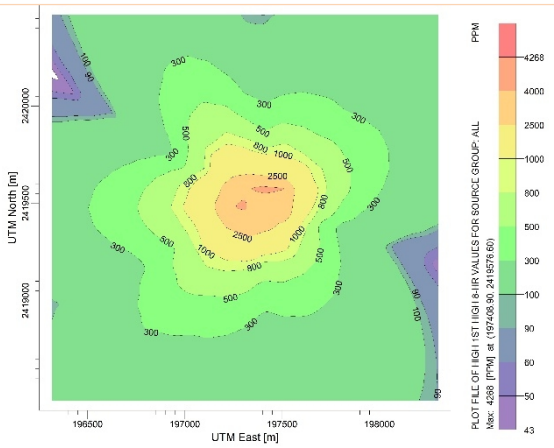

Project Condition

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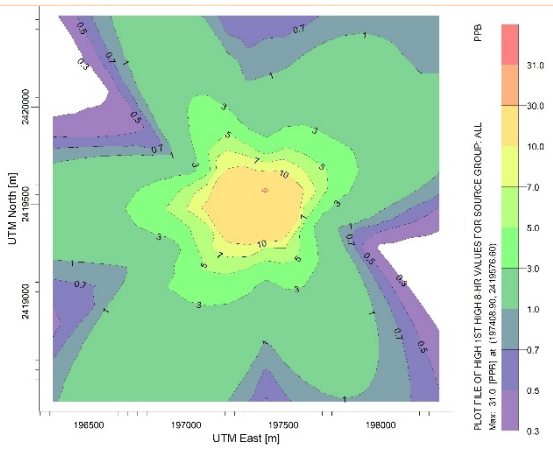

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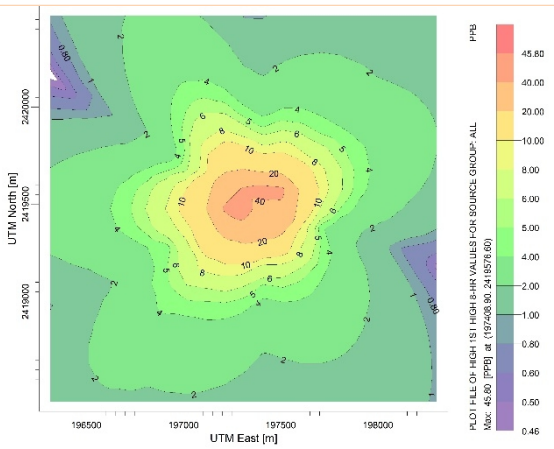
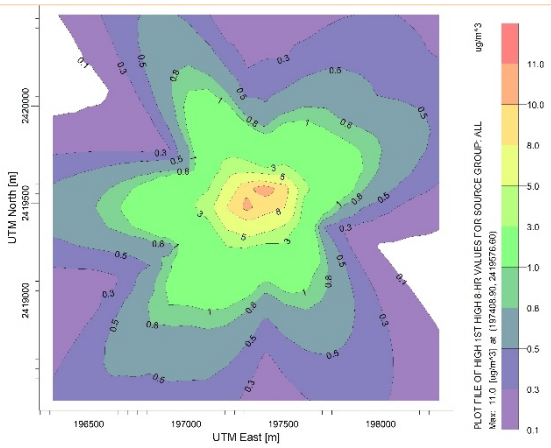


Project Condition

$PM_{2.5}$



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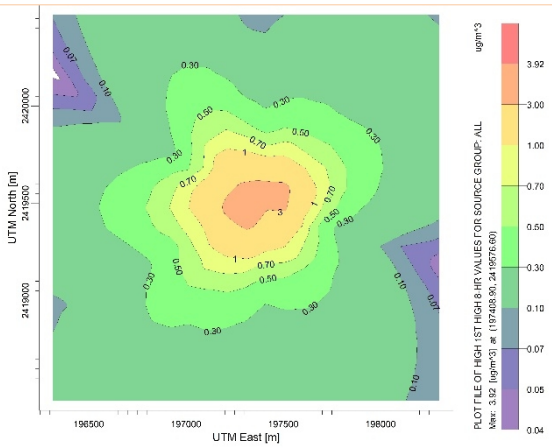

Project Condition

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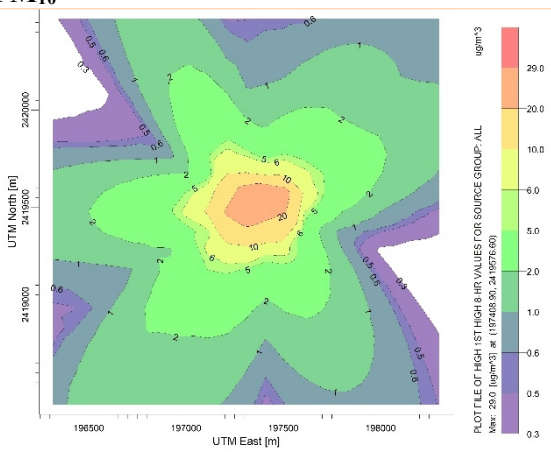

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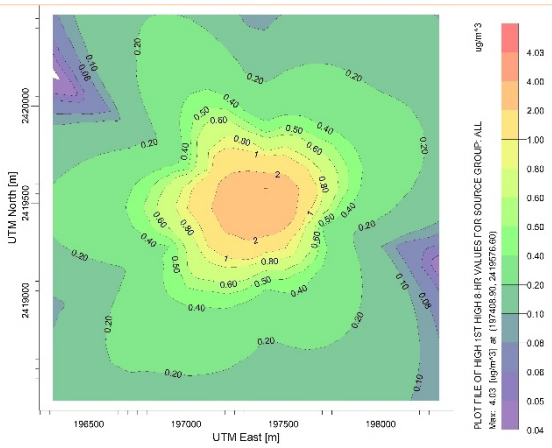
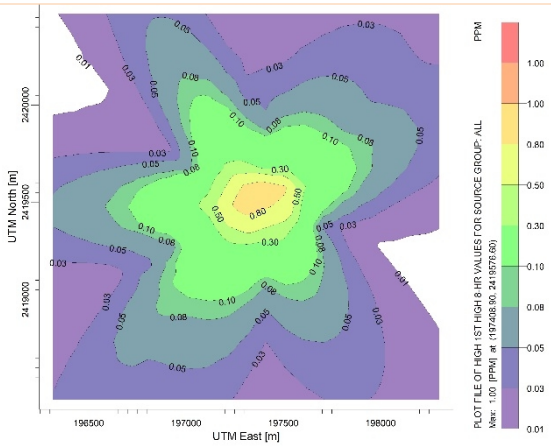


Project Condition

SO_2



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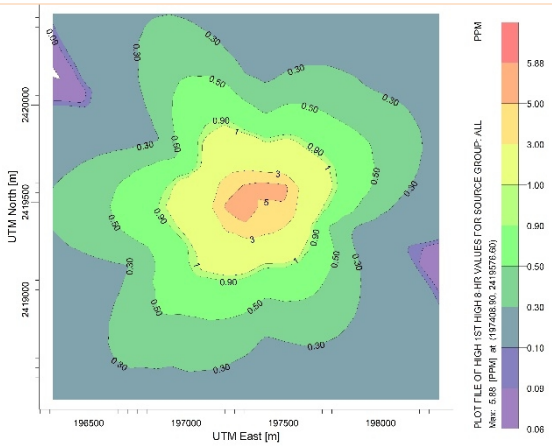
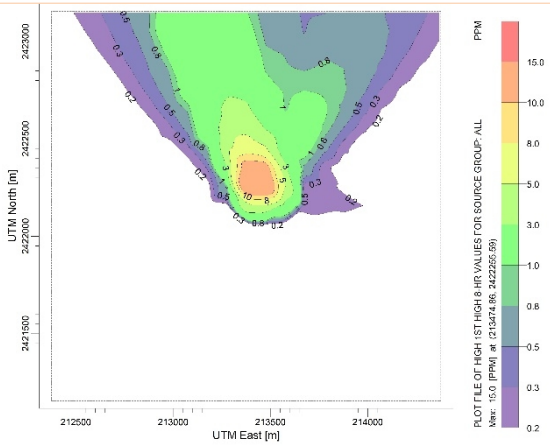


Project Condition

Ohn Chaw Tar Zone

CO



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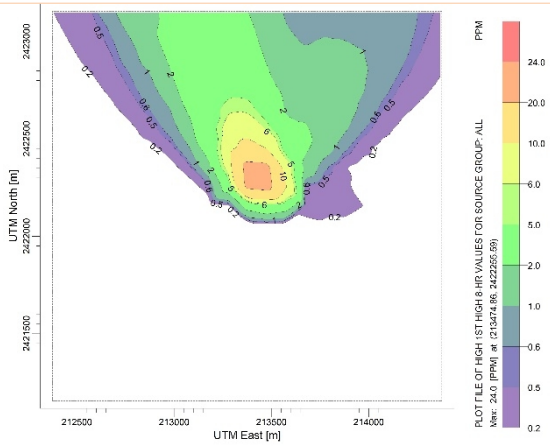

Project Condition

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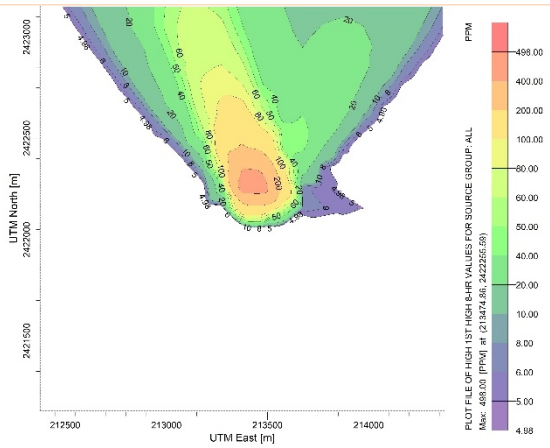

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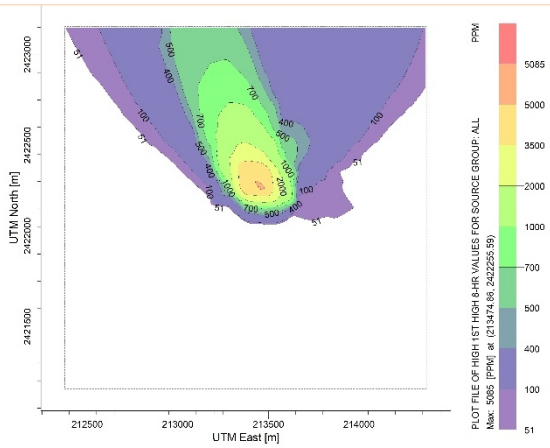

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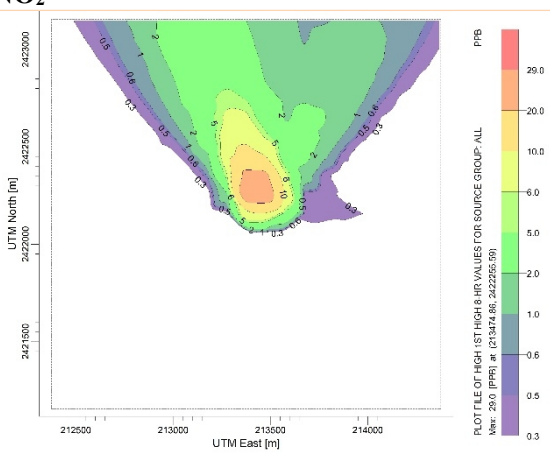

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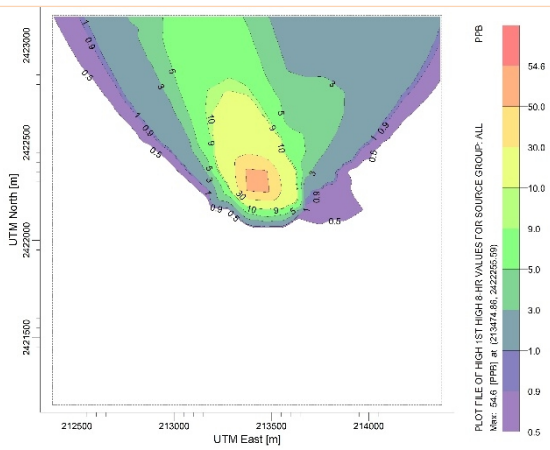
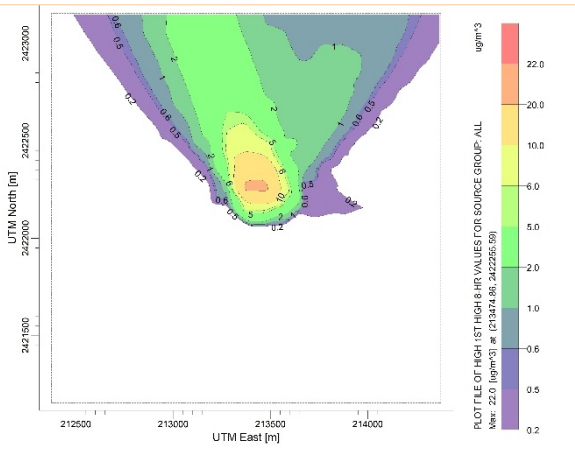


Project Condition

$PM_{2.5}$



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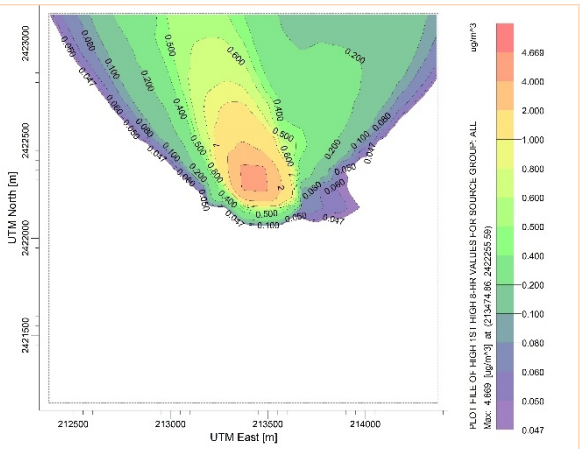
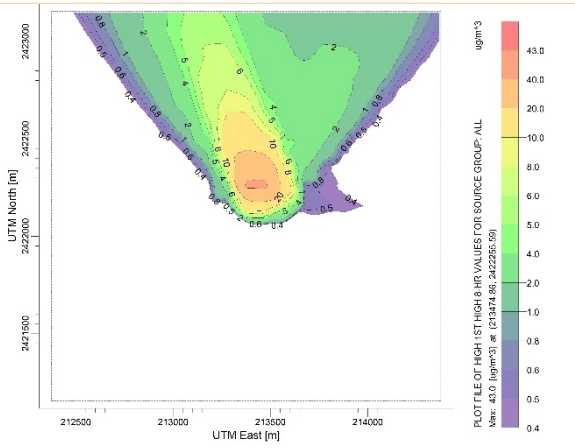


Project Condition

PM_{10}



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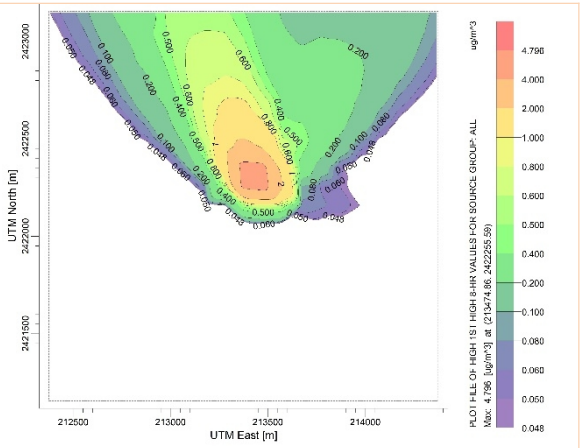
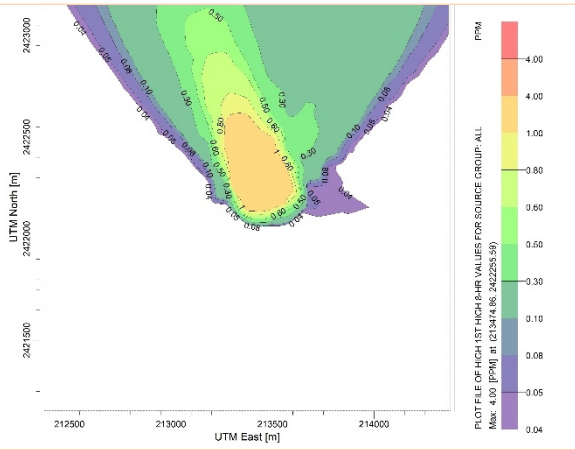


Project Condition

SO_2



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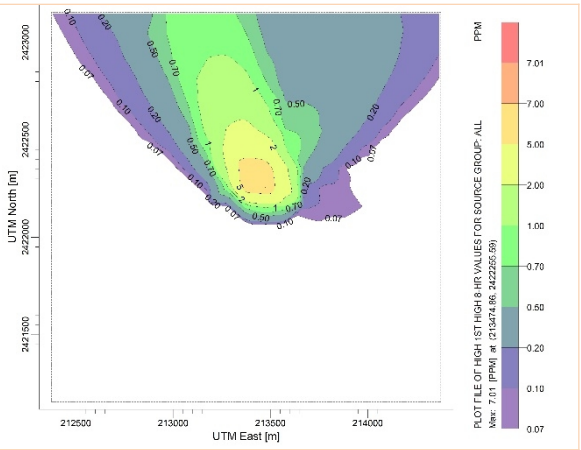
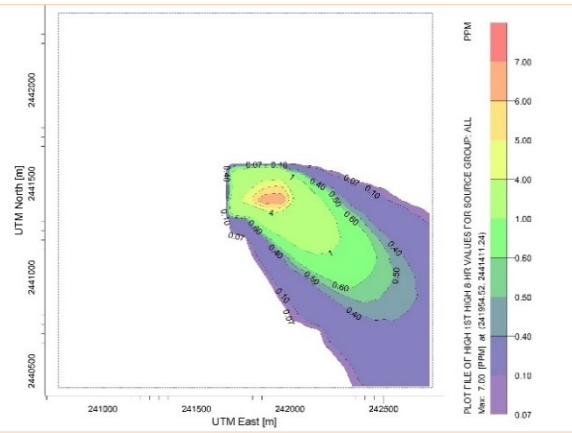


Project Condition

Pyin Oo Lwin Industrial Zone Public Area

CO



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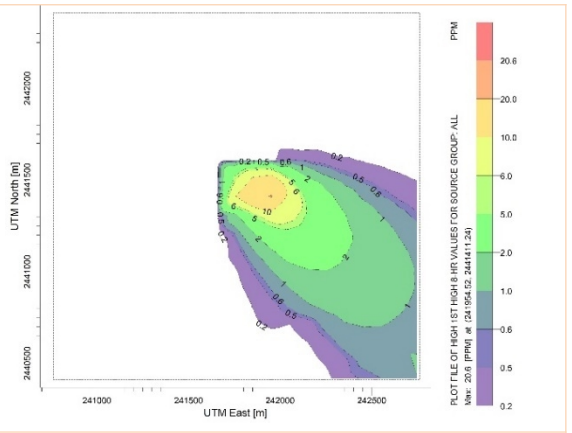
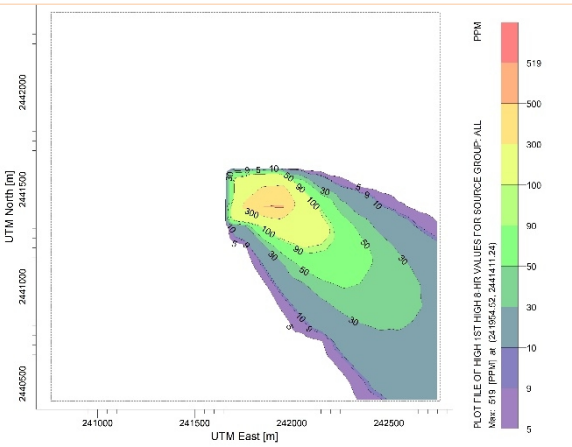


Project Condition

CO_2



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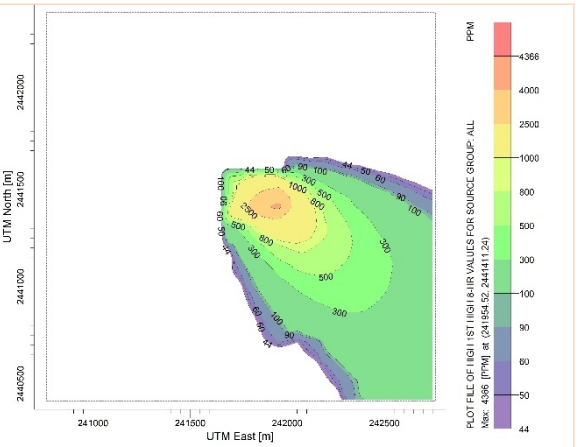
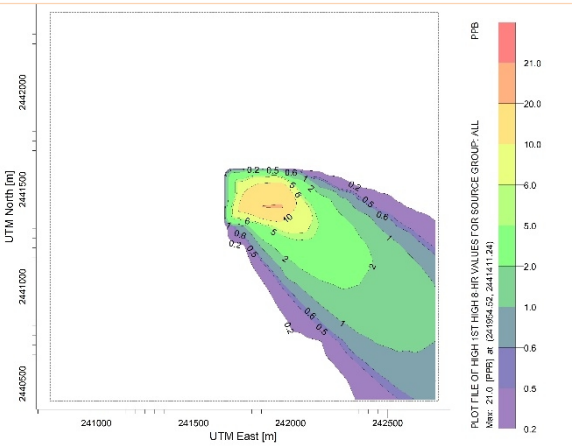


Project Condition

NO_2



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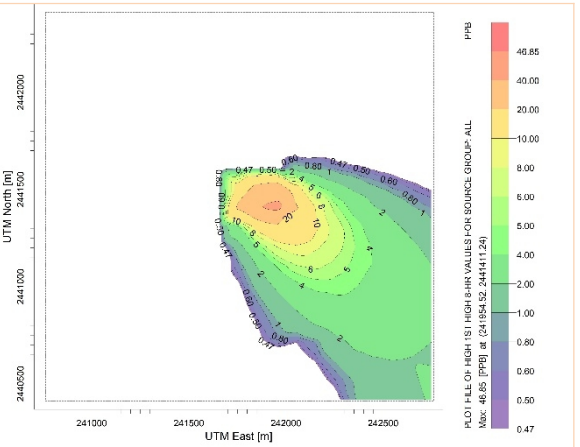
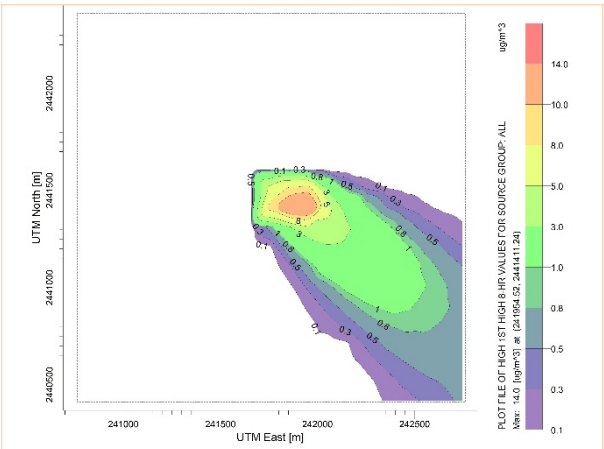


Project Condition

$PM_{2.5}$



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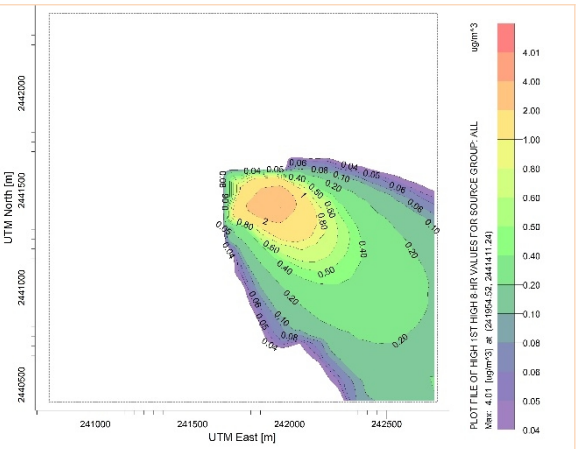
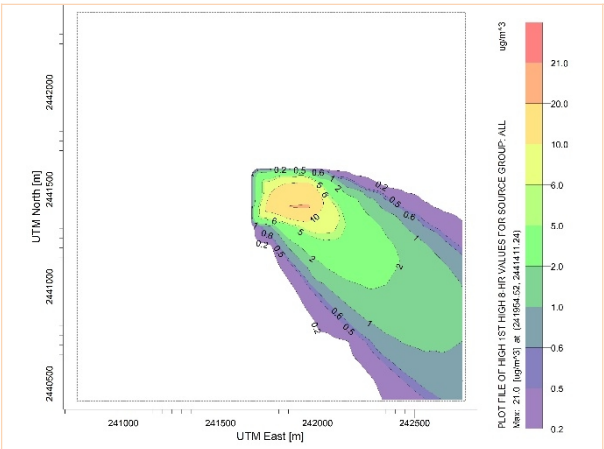


Project Condition

PM_{10}



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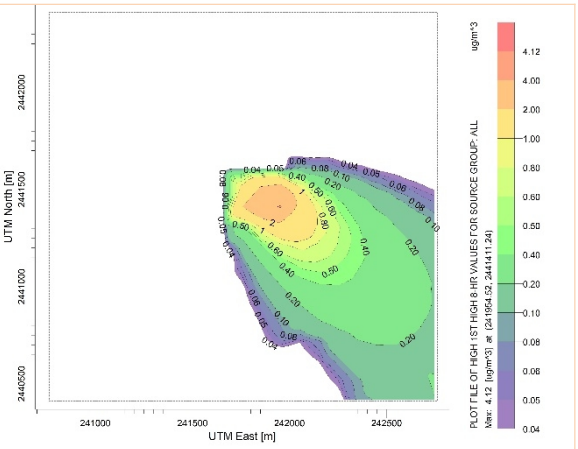
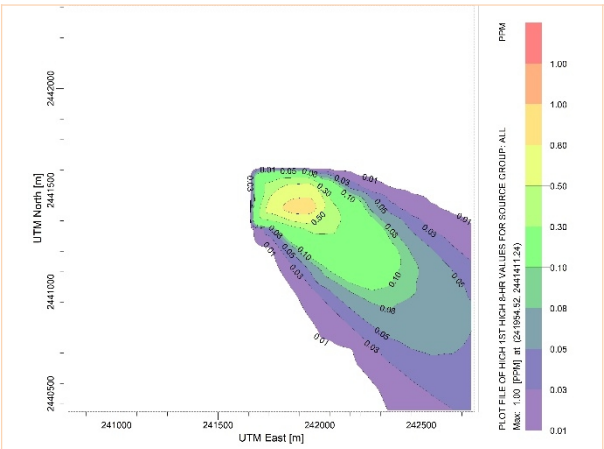


Project Condition

SO_2



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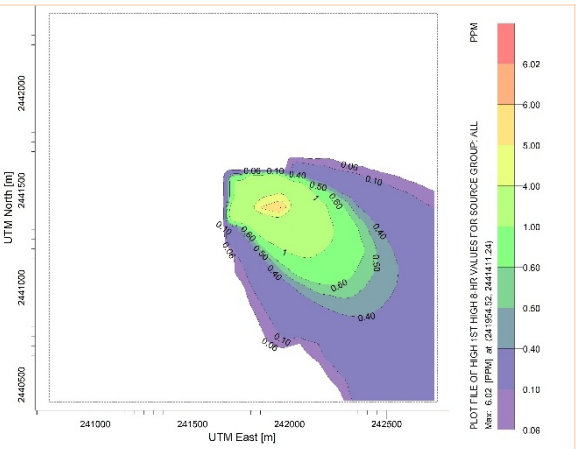
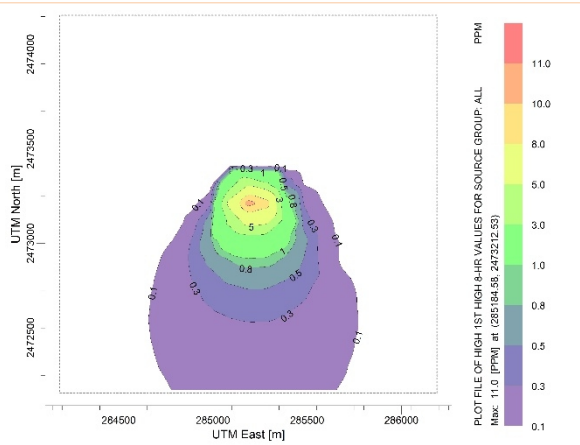


Project Condition

Naung Peng Railway Station

CO



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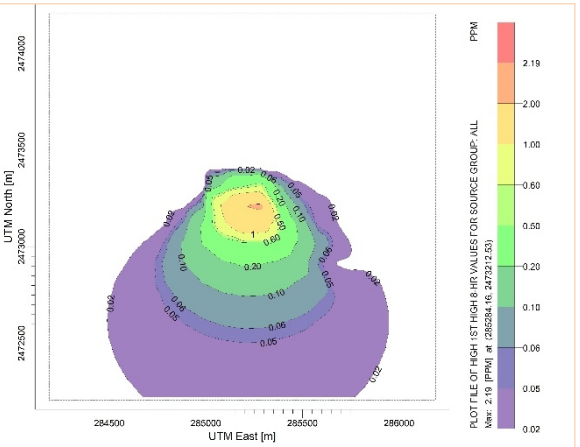
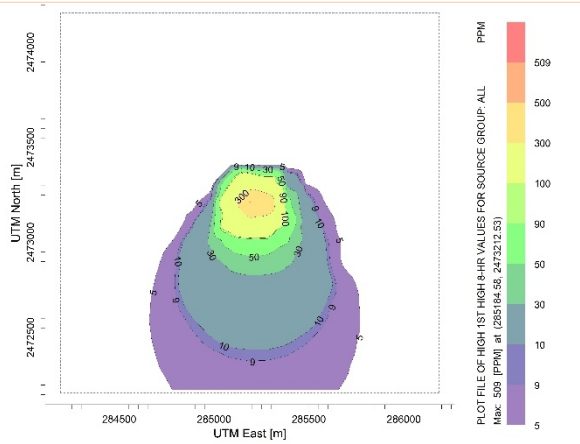


Project Condition

CO_2



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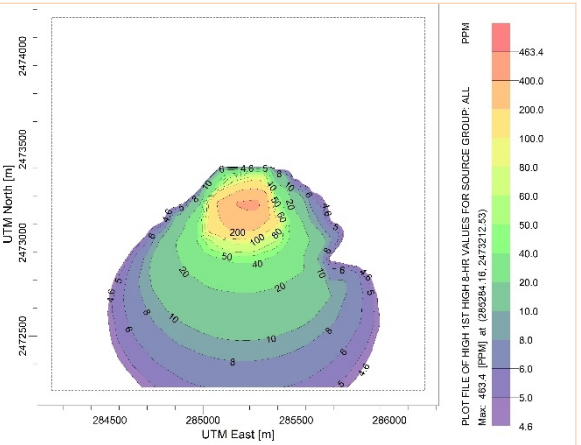
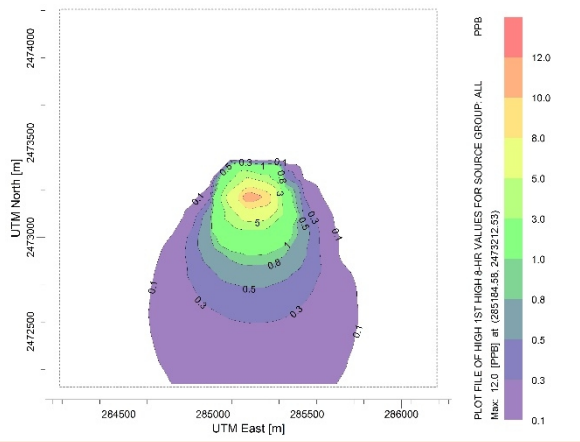


Project Condition

NO_2



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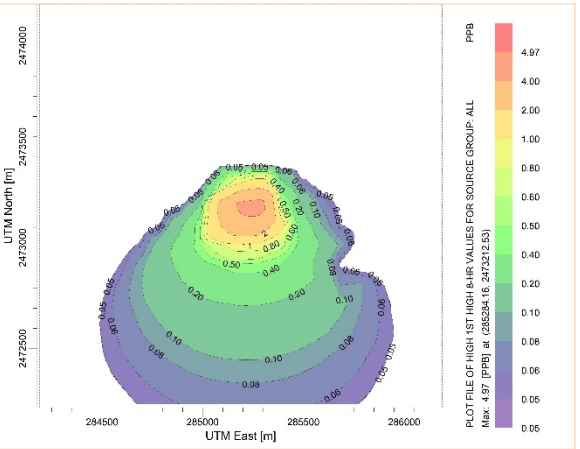
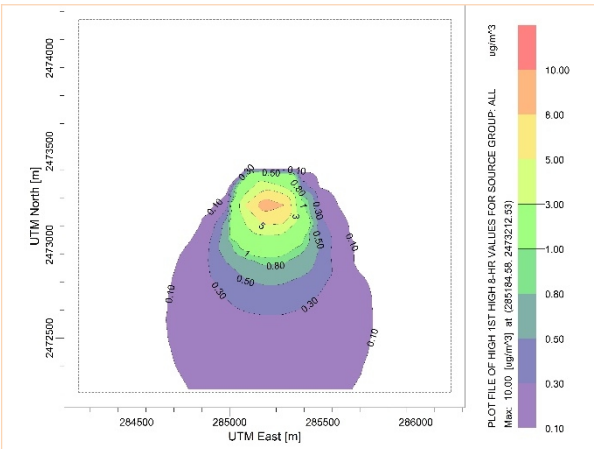


Project Condition

$PM_{2.5}$



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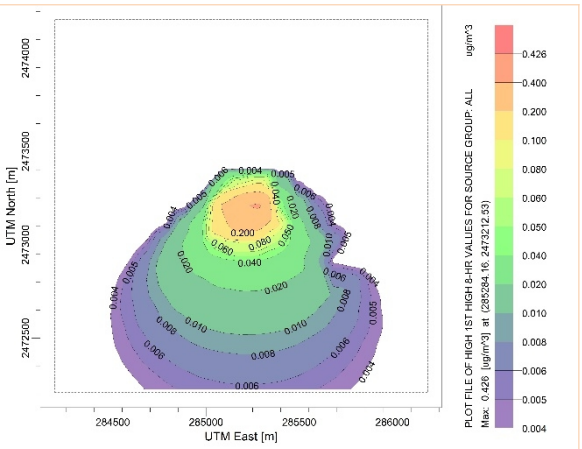
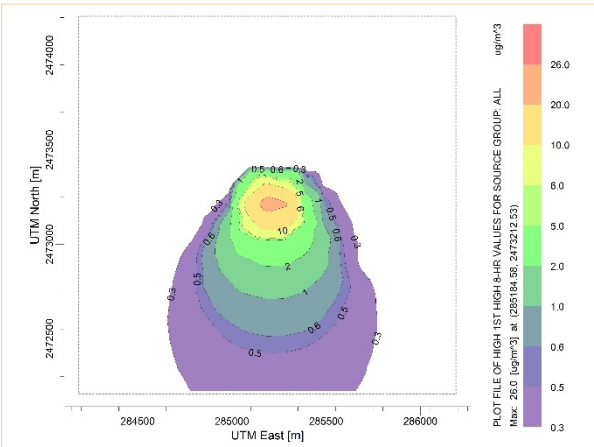


Project Condition

PM_{10}



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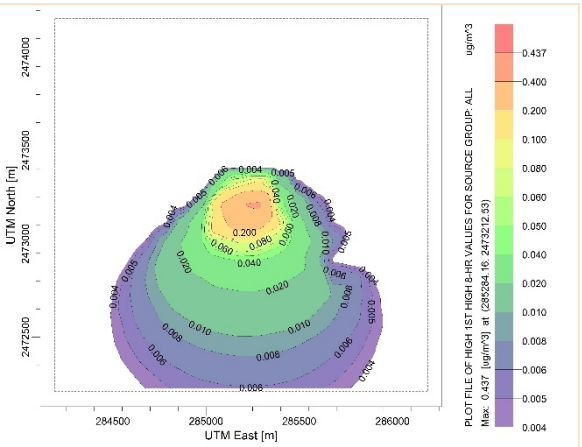
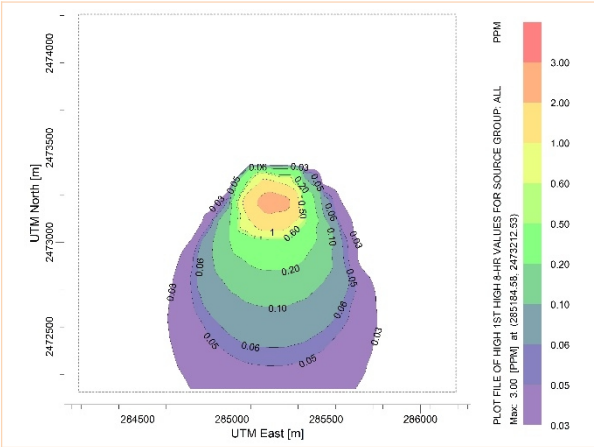


Project Condition

SO_2



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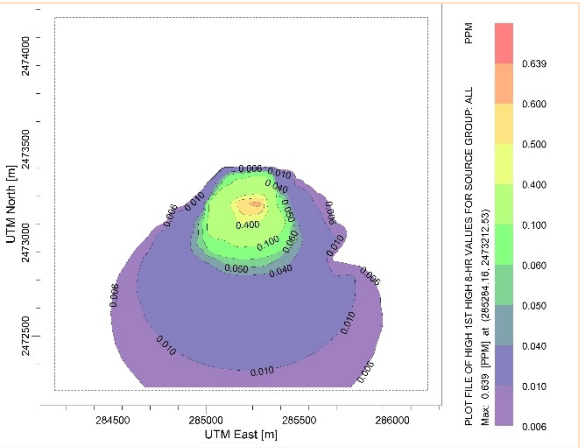
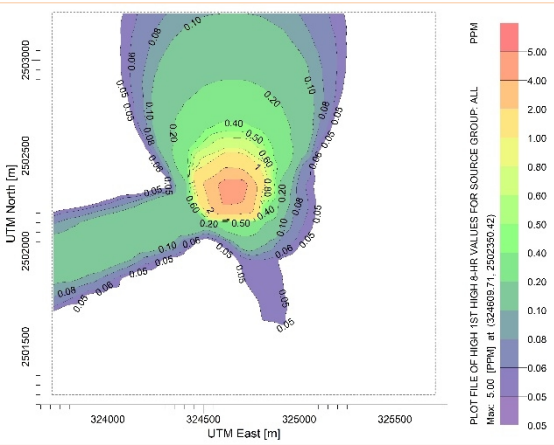


Project Condition

Hsipaw Railway Station

CO



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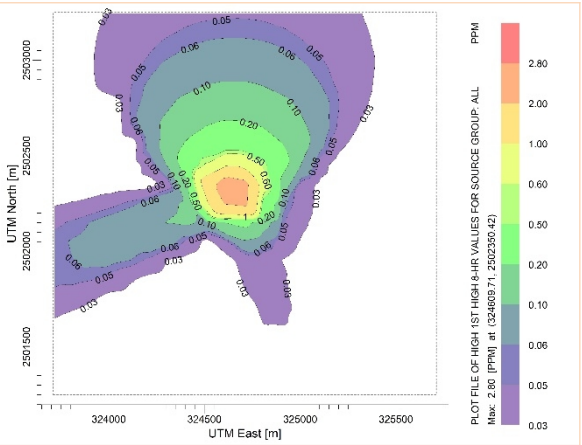

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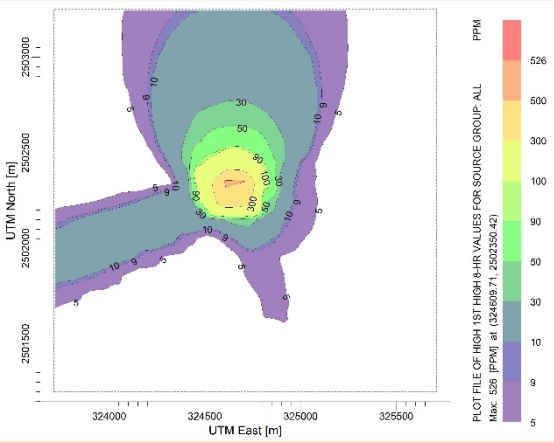

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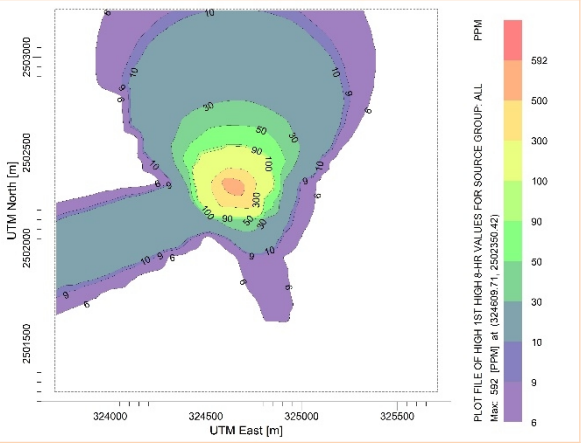

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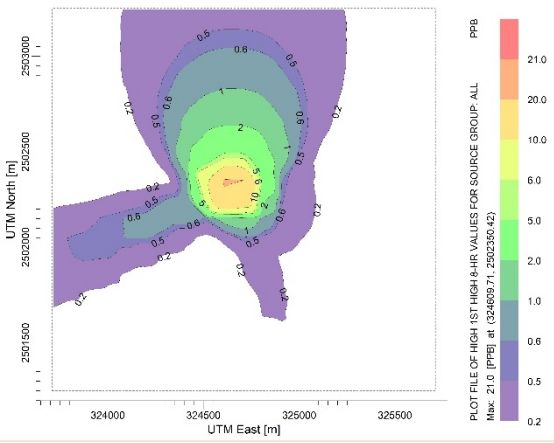

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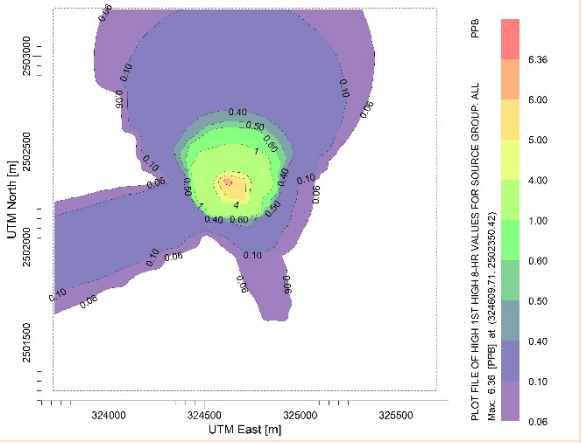

Project Condition

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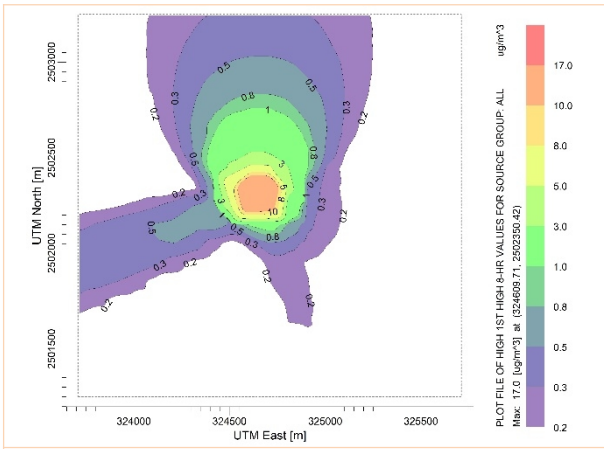

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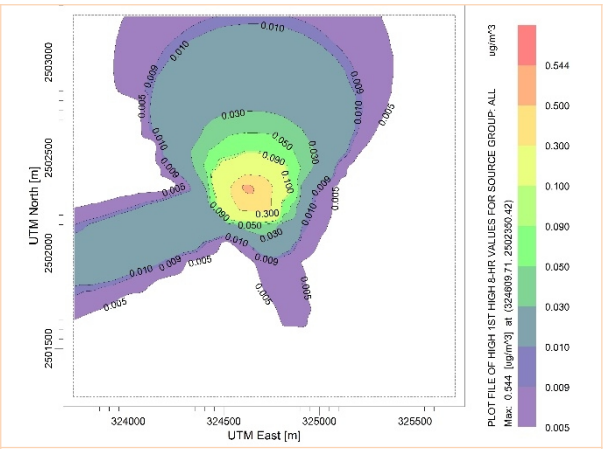

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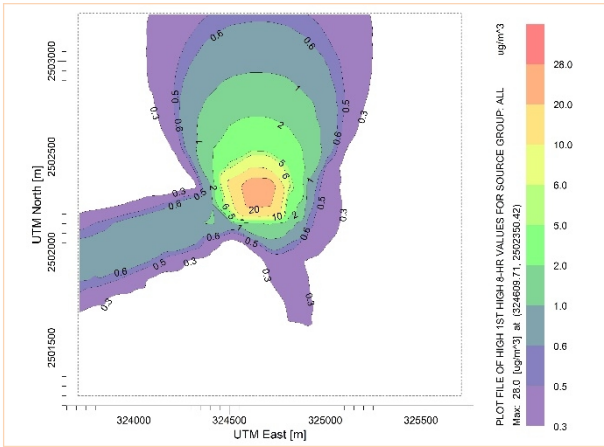

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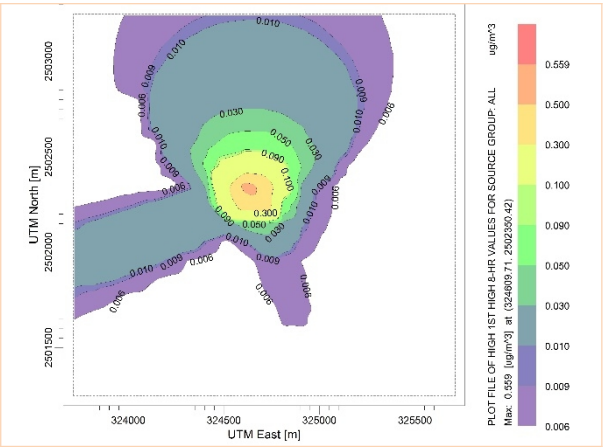

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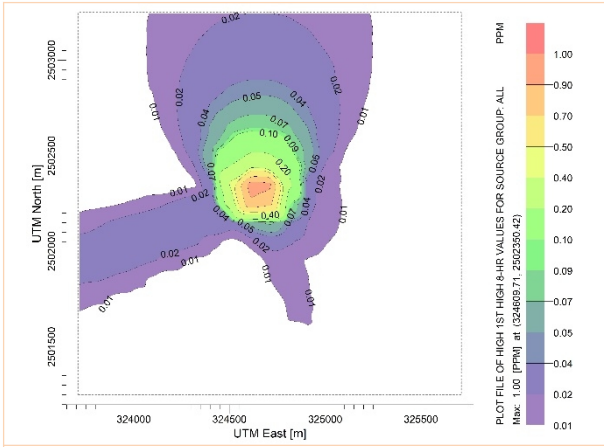

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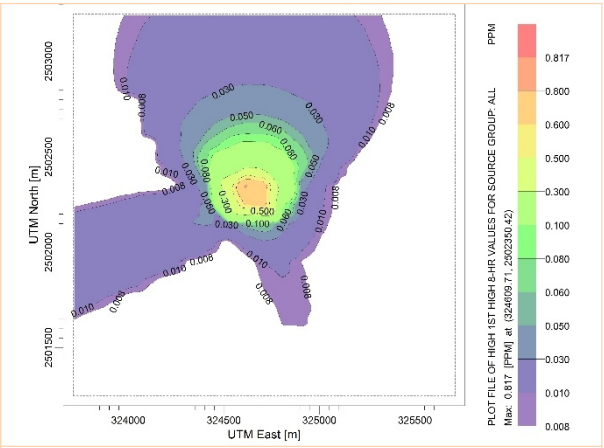
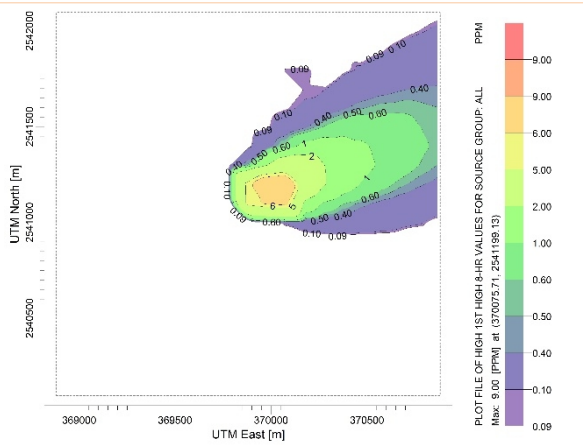


Project Condition

Lashio Railway Station

CO



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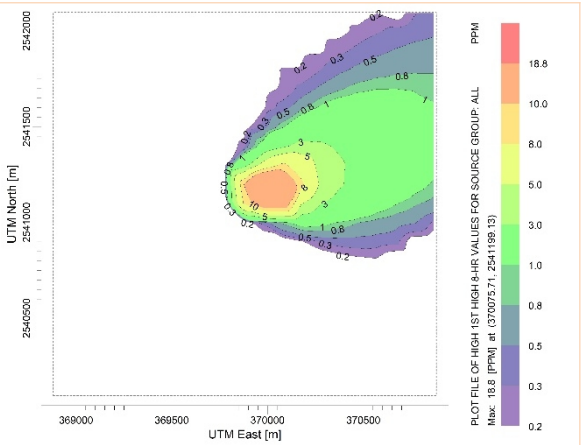

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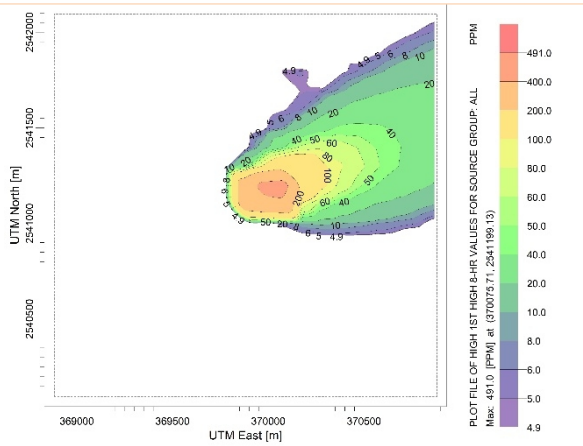

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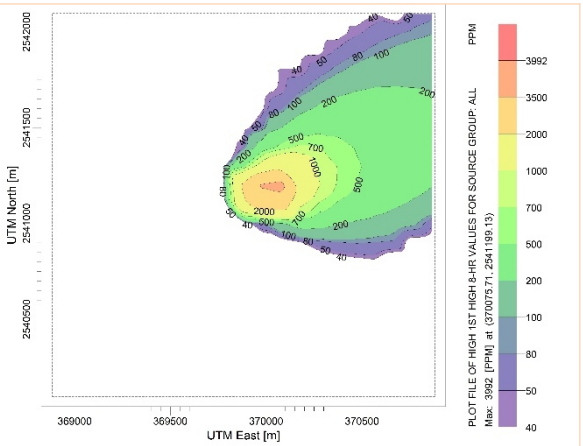

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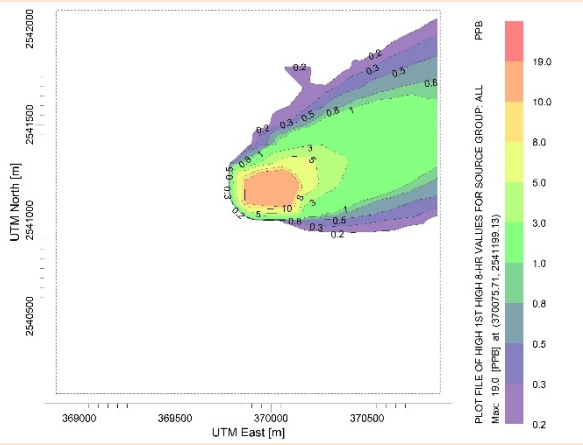

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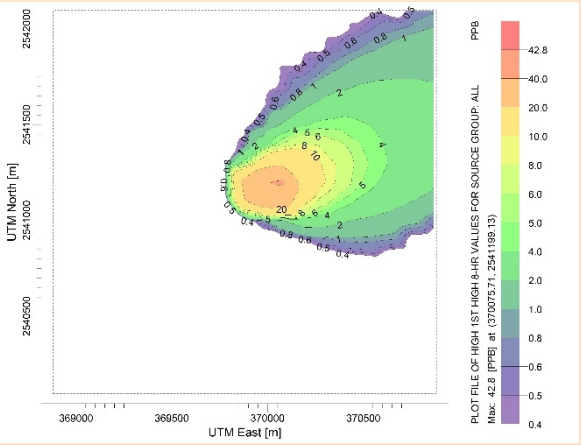
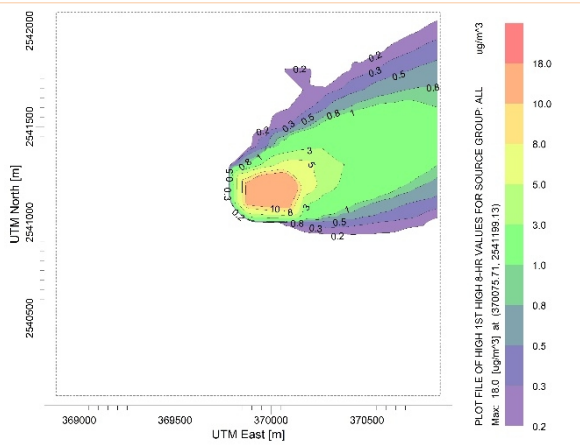


Project Condition

$PM_{2.5}$



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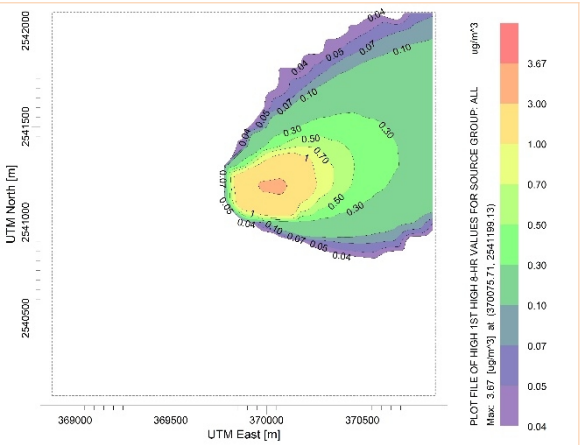

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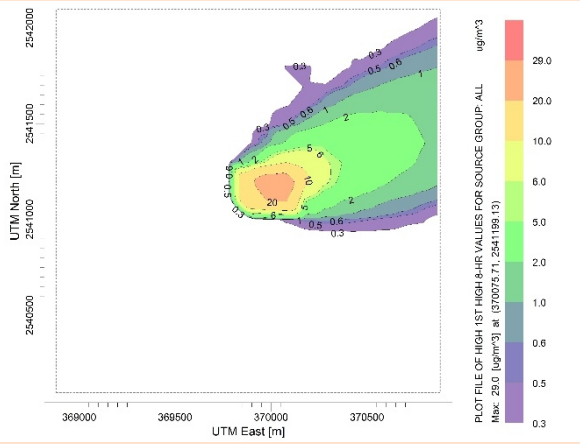

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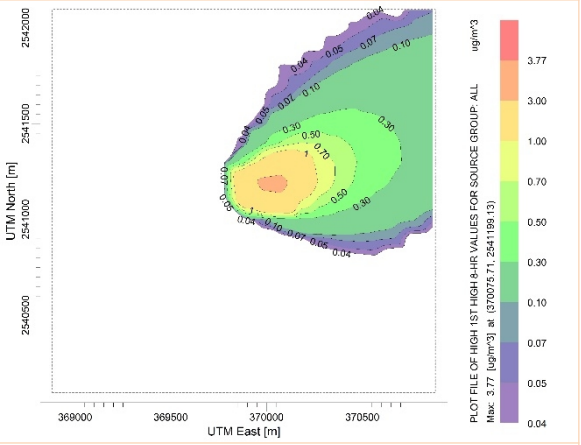

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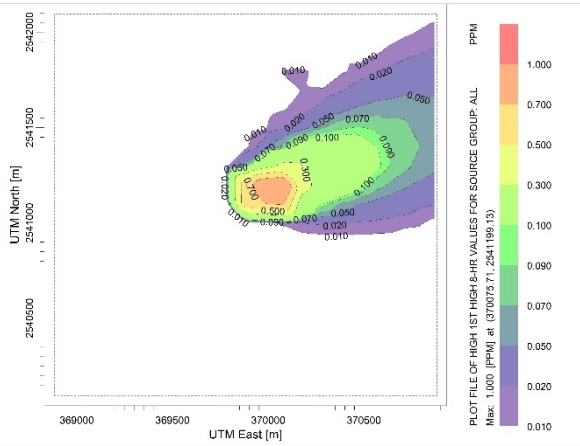

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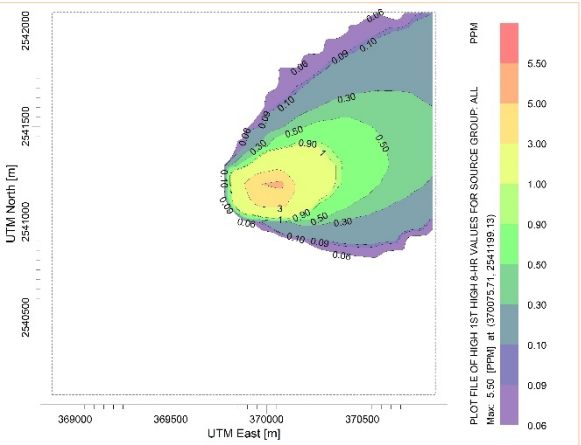


Project Condition

5.4.8.2. Existing Noise Level Monitoring

Noise in our daily environment fluctuates over time. Some fluctuations are minor, but some are substantial. Some noise levels occur in regular patterns, but others are random. Some noise levels fluctuate rapidly, but others slowly. Some noise levels vary widely, but others are relatively constant. Various noise descriptors have been developed to describe time-varying noise levels. The following are the noise descriptors most commonly used in noise analysis.

- **Equivalent Sound Level (L_{Aeq})**: Leq represents an average of the sound energy occurring over a specified period. In effect, Leq is the steady-state sound level containing the same acoustical energy as the time-varying sound that actually occurs during the same period. The 1-hour A-weighted equivalent sound level (Leq[h]) is the energy average of A- weighted sound levels occurring during a one-hour period, and is the basis for noise abatement criteria (NAC).
- **Percentile-Exceeded Sound Level (L_{xx})**: Lxx represents the sound level exceeded for a given percentage of a specified period (e.g., L10is the sound level exceeded 10% of the time, and L90 is the sound level exceeded 90% of the time).
- **Maximum Sound Level (L_{max})**: L_{max} is the highest instantaneous sound level measured during a specified period.
- **Day-Night Level (L_{dn})**: Ldn is the energy average of A-weighted sound levels occurring over a 24-hour period, with a 10-dB penalty applied to A-weighted sound levels occurring during nighttime hours between 10 p.m. and 7 a.m.
- **Community Noise Equivalent Level (CNEL)**: Similar to Ldn, CNEL is the energy average of the A-weighted sound levels occurring over a 24-hourperiod, with a 10-dB penalty applied to A-weighted sound levels occurring during the nighttime hours between 10 p.m. and 7 a.m., and a 5-dB penalty applied to the A-weighted sound levels occurring during evening hours between 7 p.m. and 10 p.m.

The vegetation along the surface is dense. The project area is mainly located in rural areas, with a small number of residential areas. No obvious noise and vibration sources are observed, and acoustic environment and vibration environment are good.

Noise Level Guidelines

As Myanmar is still attempting to regulate the noise level standards for different sectors, World Bank IFC General Environmental, Health and Safety Guidelines are used for reference. They can be used to address impacts of noise beyond property boundary of the facilities. The

guidelines show the impacts should not exceed the levels presented in the following table, or result in a maximum increase in background level of 3 dB at the nearest receptor location off-site.

Table - NEQG Noise Level Standards

Noise Level Guidelines		
	One Hour L_{Aeq} (dBA)	
Receptor	Day time 07:00 – 22:00	Night time 22:00 – 07:00
Residential; institutional; educational	55	45
Industrial; commercial	70	70

Study Methods

Measurement time

The noise under investigation is measured for sufficient time to establish that the measured value adequately represents the subject source noise. The source noise is measured over a time interval of at least 15 minutes or, if the noise continues for less than 15 minutes, the duration of the source noise.

Typical monitoring periods should be sufficient for statistical analysis and may last 48 hours with the use of noise monitors that should be capable of logging data continuously over this time period, or hourly, or more frequently, as appropriate (or else cover differing time periods within several days, including weekday and weekend workdays). The type of acoustic indices recorded depends on the type of noise being monitored, as established by a noise expert.

Measurement location

Normally, when undertaking a noise assessment, it is essential to make note of the following on a site map:

- location of noise source
- background noise measurement location
- source noise measurement location
- topography between noise source and sensitive receivers.

Table - Measurement location

Sr. No	Sample Name	Coordinates		Remark
		Latitude(N)	Longitude(E)	Sensitive Areas
1	NS-0	21°51'11.93"N,	96° 4'17.38"E	AS0, Myitnge Railway Station
2	NS-1	21°52'48.75"N,	96°13'34.70"E	Ohn Chaw Tar Zone
3	NS-2	22° 2'13.97"N,	96°27'57.83"E	Pyin Oo lwin Railway Station
4	NS-3	22° 3'30.29"N,	96°29'51.88"E	Pyin Oo Lwin Industrial Zone Public Area
5	NS-4	22°21'4.94"N,	96°54'50.62"E	Naung Peng Rail way station
6	NS-5	22°37'5.20"N,	97°17'40.17"E	Hsipaw Railway Station
7	NS-6	22°58'22.88"N,	97°43'50.33"E	Lashio Railway Station

Noise Measurement Results

The noise environment at the project is dominated by human activities, with most activities during daytime hours.

The noise monitoring results are summarized in the following table to demonstrate baseline noise levels at the monitoring sites. There has been no development in the area since this time that would have led to a change in the baseline noise environment. As most of the monitoring stations are near the Muse-Mandalay Road, all of the cumulative noise level are mainly sourced from vehicle movement in Muse-Mandalay Road.

Existing Noise Levels

Noise level survey at the vicinity of the project was done by the team. The noise stations, the noise levels and their coordinates are shown in the following table.

Table - Noise Measurement Results

Sample Name	Sensitive Areas	Noise Level (dB)		Latitude(N)	Longitude(E)
		day	Night		
NS-1	Myitnge Railway Station	66	68	21°51'11.93"N,	96° 4'17.38"E
NS-2	Ohn Chaw Tar Zone	77	78	21°52'48.75"N,	96°13'34.70"E
NS-3	Pyin Oo lwin Railway Station	65 65	65 65	22° 2'13.97"N,	96°27'57.83"E
NS-4	Pyin Oo Lwin Industrial Zone Public Area	68	58	22° 3'30.29"N,	96°29'51.88"E
NS-5	Naung Peng Rail way station	67	66	22°21'4.94"N,	96°54'50.62"E
NS-6	Hsipaw Railway Station	69	67	22°37'5.20"N,	97°17'40.17"E
NS-7	Lashio Railway Station	68	69	22°58'22.88"N,	97°43'50.33"E

According to NEQG Noise Level Standards, limit of noise level for industrial, commercial is 70DbA at daytime and night time. But at Ohn Chaw Tar zone, the noise level around this area is a little bit beyond the limit because of Ohn Chaw Tar Zone is near highway road and also this road is used mostly for transportation.

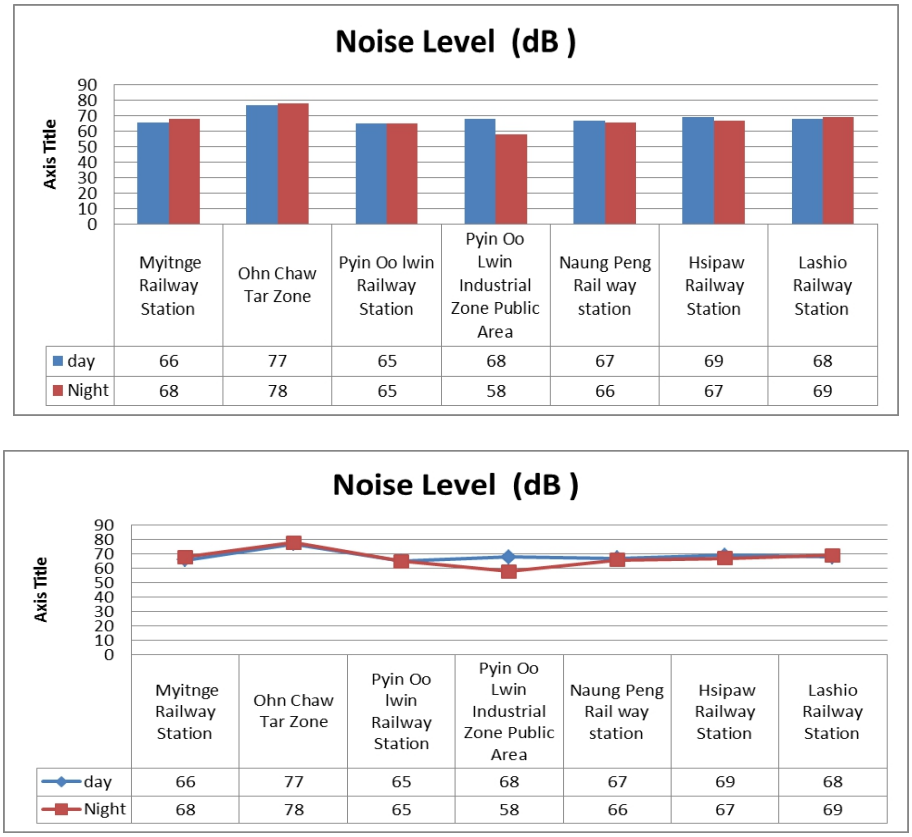


Figure – Noise level near Ohn Chaw Tar Zone

Noise Level Monitoring along Muse-Mandalay Railway

For noise quality measurement, more sampling points are added more to measure specifically for EIA Study at the proposed Muse- Mandalay Railway Project site from Pyinoolwin to Muse (8 points).

Table - Measurement location

No.	Place	Coordinates	
		Latitude(N)	Longitude(E)
1	Pyin Oo Lwin - Oak Pho Village (Monastery)	N 22° 04’ 15.87”	E 096° 23’ 58.30”

2	Naung Cho - Shwe Pyi Nyunt Village	N 22° 18’ 16.29”	E 096° 50’ 02.16”
3	Goke Hteik	N 22° 20’ 08.94”	E 096° 51’ 53.42”
4	Hsipaw (near Baw Gyo Pagoda)	N 22° 34’ 59.78”	E 097° 13’ 59.62”
5	Beyond Hsipaw (San Laung)	N 22° 40’ 33.66’	E 97° 30’ 17.4”
6	Lashio	N 22° 59’ 05.41”	E 097° 42’ 23.09”
7	Hseni	N 23° 18’ 23.97”	E 097° 58’ 28.30”
8	Nam Hpat Kar	N 23° 41’ 21.89”	E 097° 49’ 02.76”
9	Muse	N 24° 00’ 03.10”	E 097° 56’ 25.90”

Figure – Noise Level Monitoring

Figure - Noise Study location along the Proposed Muse-Mandalay Railway Project

Noise Level Monitoring Results

Noise level survey at the vicinity of the project was done by the team. The noise stations, the noise levels and their coordinates are shown in he following table.

Table - Noise Level Results

No.	Place	Location	Noise (dB)	
			Lowest	Highest
1	Pyin Oo Lwin - Oak Pho Village (Monastery)	N 22° 04' 15.87" E 096° 23' 58.30"	40	45.4
2	Naung Cho - Shwe Pyi Nyunt Village	N 22° 18' 16.29" E 096° 50' 02.16"	44.2	48.4
3	Goke Hteik	N 22° 20' 08.94" E 096° 51' 53.42"	47.6	53
4	Hsipaw (near Baw Gyo Pagoda)	N 22° 34' 59.78" E 097° 13' 59.62"	51	57.8
5	Beyond Hsipaw (San Laung)	N 22° 40' 33.66' E 97° 30' 17.4"	42.7	78.6
6	Lashio	N 22° 59' 05.41" E 097° 42' 23.09"	51.9	61.6
7	Hseni	N 23° 18' 23.97" E 097° 58' 28.30"	50.7	56.1
8	Nam Hpat Kar	N 23° 41' 21.89" E 097° 49' 02.76"	50.4	53.3
9	Muse	N 24° 00' 03.10" E 097° 56' 25.90"	42.7	45

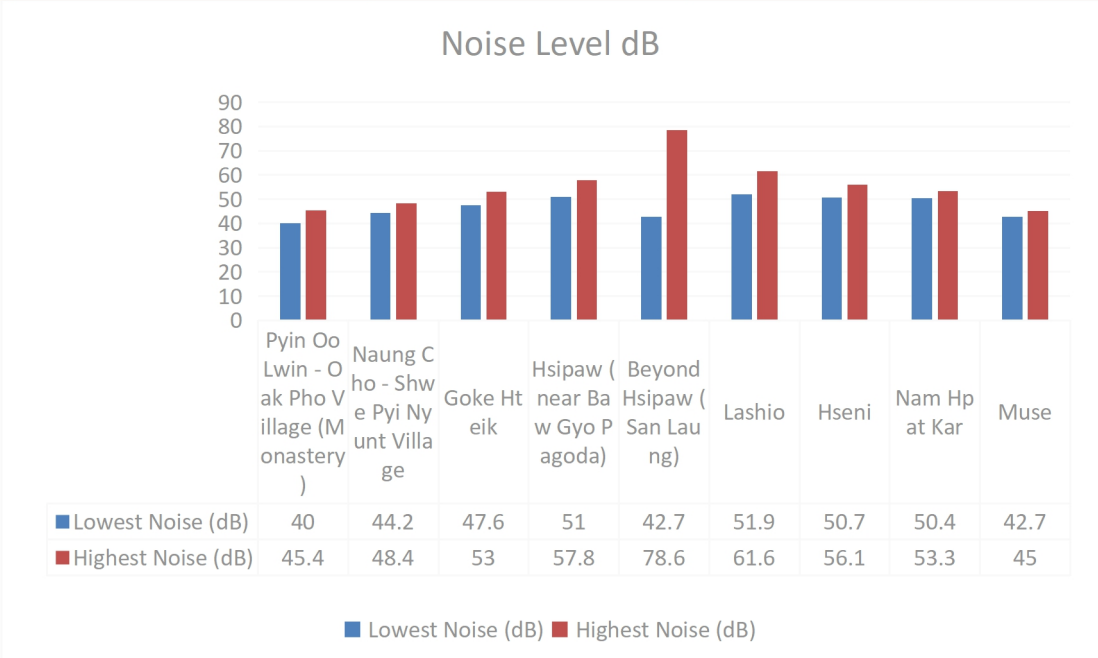


Figure - Recorded photos for noise level monitoring

5.5.8.3. Existing Water Quality Monitoring

Water Quality Sampling Points

Water qualities will be tested in all of the rivers and streams along the railway alignment as follow:

Sample -1, Shweli River

Sample -2, Nant Paung Stream

Sample -3, Nant Khaing Stream

Sample -4, Namtu Stream

Sample -5, Pan Phet Stream
Sample -6, A-T Stream
Sample -7, Sint In Stream
Sample -8, Kho Lone Stream
Sample -9, Dokehtawady River
Sample -10, Kyin Thi Stream
Sample -11, Gok Twin Stream
Sample -12, Yae Ni Stream
Sample -13, Se Taw Gyi Canal,
Sample -14, Myaung Ma Gyi Stream,
Sample -15, Myaing Gyi Stream,
Sample -16, Dokehtawady River

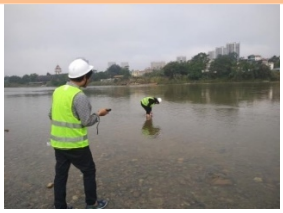
As the total construction period of all of the railway will be 5 years, the water quality will be collected for two seasons to cover the construction period.

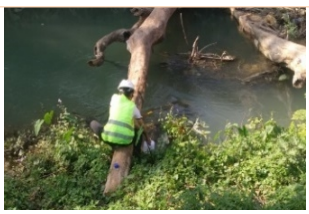
5.4.8.3.1. Water Quality for Dry Seasons

The locations will also be illustrated as shown in the following figures.

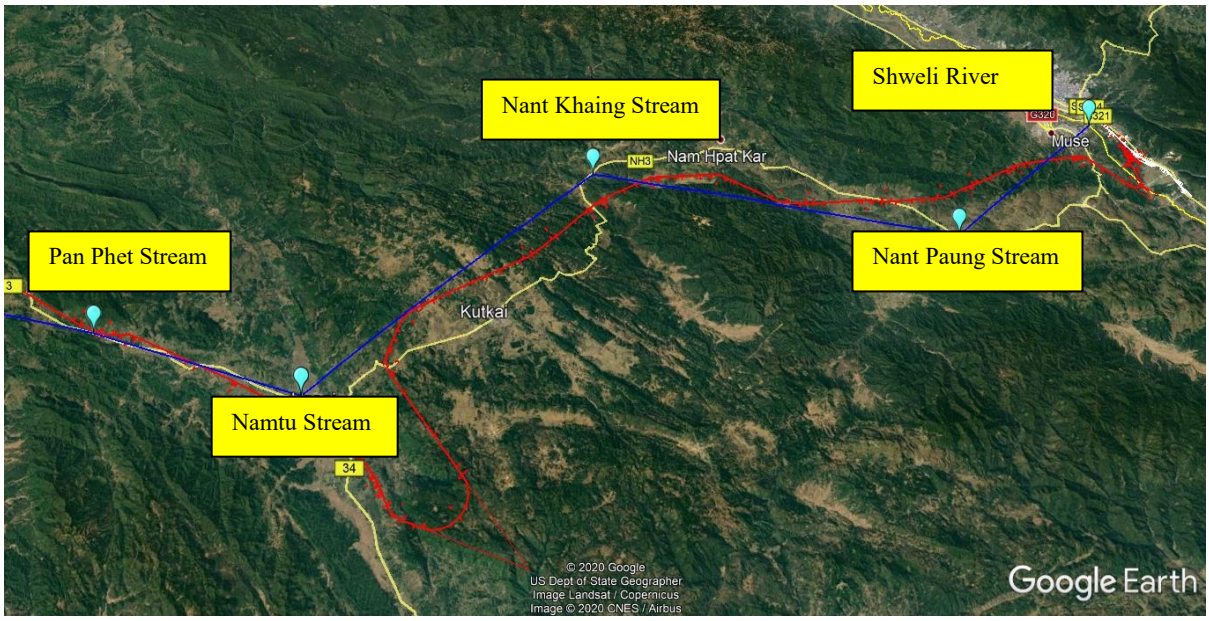
Table - Locations of the Water Quality Sampling

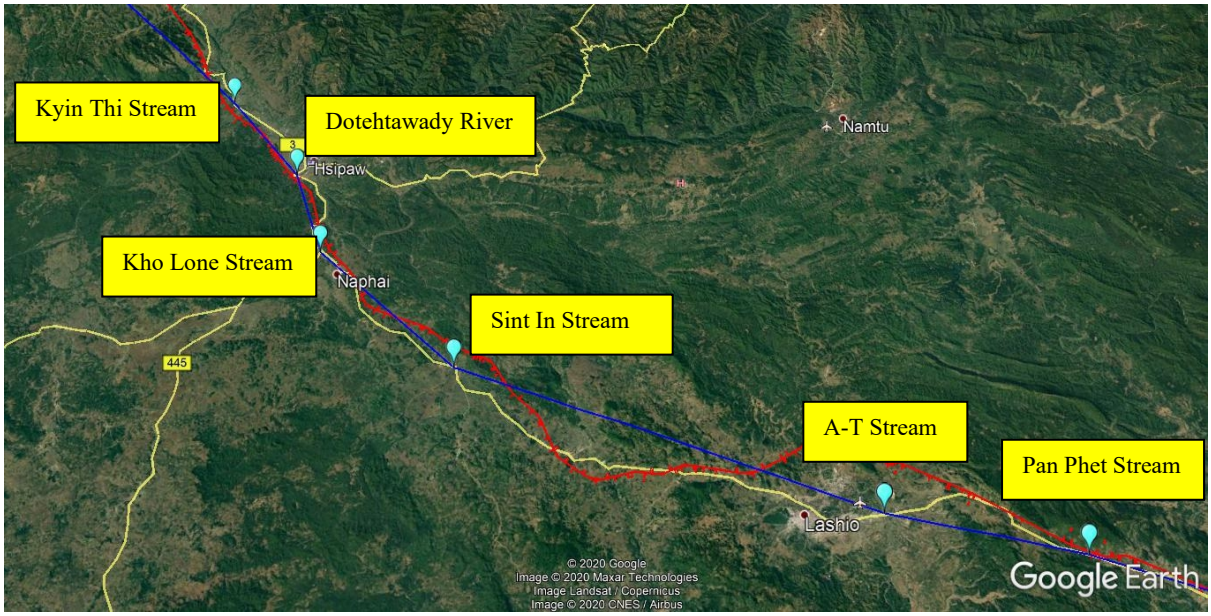
The exact locations and recorded photos during water quality sampling are as follow:

SN	Name	GPS Corrdinate		Collected Water Samples
		Lattitude	Longitude	
1	Shweli River (Muse)	24.01721°	97.90384°	
2	Nant Paung Stream (Muse)	23.85798°	97.97741°	

3	NantKhaing Stream (Kutkai)	23.57058°	97.81950°	
4	Namtu Stream (Thenni)	23.28817°	97.95394°	
5	Pan Phet Stream (Thenni)	23.13200°	97.84320°	
6	A-T Stream (Lashio)	22.99409°	97.76455°	
7	Sint In Stream (Lashio)	22.70178°	97.53847°	
8	Kho Lone Stream (Hsipaw)	22.61445°	97.39456°	
9	Dokehtawady River (Hsipaw)	22.60728°	97.30748°	

10	Kyin Thi Stream (Kyauk Me)	22.56428°	97.20963°	
11	Goke Twin Stream (Naung Cho)	22.35489°	96.83371°	
12	Yae Ni Stream (Pathein Gyi)	21.99596°	96.12399°	
13	SeDaw Gyi Stream (Pathein Gyi)	21.91917°	96.18635°	
14	Myaung Ma Gyi Stream (Amarapura)	21.85159°	96.12443°	
15	Myaing Gyi Stream (Min Village)	21.84470°	96.10187°	
16	Dokehtawady River (Myit Nge)	21.83646°	96.07781°	


Nant Khaing Stream
Shweli River
Nam Hpat Kar
Muse
Pan Phet Stream
Nant Paung Stream
Kutkai
Namtu Stream
© 2020 Google
US Dept of State Geographer
Image Landsat / Copernicus
Image © 2020 CNES / Airbus
Google Earth


Kyin Thi Stream
Dotehtawady River
Namtu
Hsipaw
Kho Lone Stream
Naphai
Sint In Stream
A-T Stream
Pan Phet Stream
Lashio
© 2020 Google
Image © 2020 Maxar Technologies
Image Landsat / Copernicus
Image © 2020 CNES / Airbus
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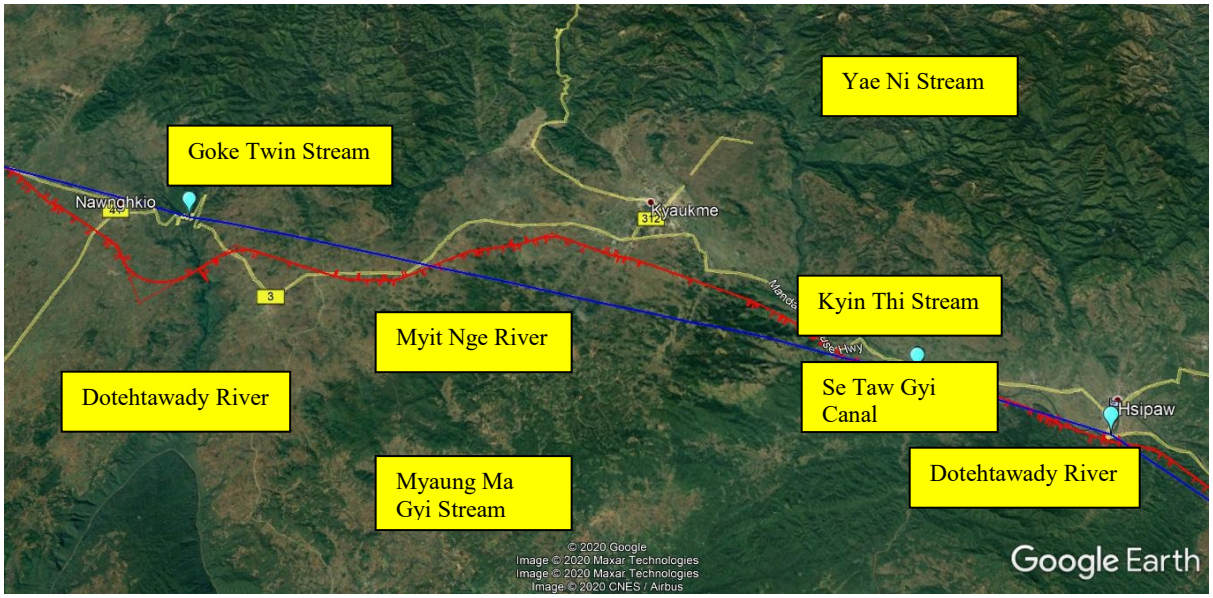

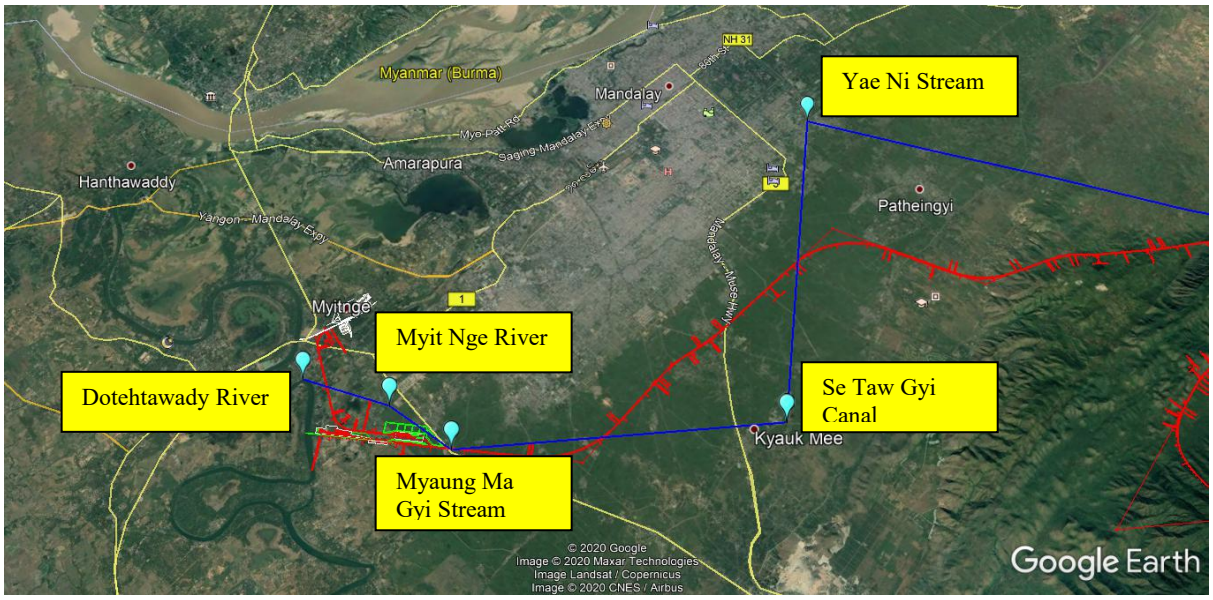

Figure - Locations of Water Quality Sampling for Dry Season

Table 5.6. Water Quality Testing Results for Dry Season

Analyses	Unit	Shwe Li River	Nant Paung Stream	Nant Khaing Stream	Nmatu Stream	Pan Phat Stream	A-T Stream	Sint In Stream	Kho Lone Stream	Dokehtawady River	Kyin Thi Stream	Gok Twin Stream	Yae Ni Stream	Se Taw Gyi Canal	Myaung Ma Gyi Stream	Myaing Gyi Stream	Dokehtawady River	Max. Permissible Limit
Colour (TCU)	Pt-Co	4	38	2	3	2	7	2	1	4	20	5	9	4	30	20	2	20
Turbidity	NTU	1	35	1	2	Nil	2	1	Nil	1	5	2	2	2	5	7	Nil	5
Total dissolved solvents (TDS)	mg/l	74.5	134	185	226	238	197	212	277	176	128	193	92.8	235	125	264	186	1000
Chloride	mg/l	6.75	4.5	11.25	13.5	6.75	9	6.75	6.75	6.75	6.75	9	4.5	99	6.75	18	4.5	250
Total hardness (as Ca CO_3)	mg/l	85	170	200	200	170	260	230	180	210	200	200	90	100	130	170	220	500
Iron	mg/l	0.25	1.95	0.2	0.2	0.2	0.25	0.15	0.1	0.25	0.8	0.3	0.6	0.25	1.1	0.55	0.15	1
pH		7.47	7.79	8.19	8.03	7.43	8.27	7.75	7.46	8.18	7.88	6.87	7.35	7.59	7.65	7.9	7.95	6.5-8.5
Sulphate	mg/l	5	25	5	4	4	6	23	120	20	9	4	10	4	12	9	7	400
Calcium	mg/l	18	24	20	12	10	16	12	8	12	16	10	26	36	12	8	20	200
Magnesium	mg/l	11.2	30.8	42	47.6	40.6	61.6	56	44.8	50.4	44.8	49	7	2.8	28	42	47.6	150
Electrical conductivity	µs/cm	141.4	267	363	447	458	410	427	548	367	243	379	181.8	462	253	538	367	1500

5.5.8.3.2. Water Quality Testing Results for Wet Seasons

Water quality will also be collected for wet seasons as follow:

Location of Water Quality Sampling in Wet Seasons

The following table shows the locations of water quality sampling in wet seasons.

Table - Location of Water Samples in Wet Season

SN	Name	GPS Corrdinate		Collected Water Samples
		Lattitude	Longitude	
1	**Namkhon Monastery (Muse)**	24.00058°	97.940547	
2	**Nam Paw Stream (Muse)**	23.85798°	97.97741°	
3	**Natural Spring Near Nam Paw Stream (Muse)**	23.800891°	97.920002°	

4	**Nam Khaing Stream (Kutkai)**	23.57058°	97.81950°	
5	**Namtu Stream (Theinni)**	23.28817°	97.95394°	
6	**Pan Phet Stream (Theinni)**	23.13200°	97.84320°	
7	**Nant Lam Stream (Hsipaw)**	22.61445°	97.39456°	
8	**Dokehtawady River (Hsipaw)**	22.60728°	97.30748°	
9	**Kyin Thi Stream (Hsipaw)**	22.56428°	97.20963°	

10	**Goke Twin stream (Naung Cho)**	22.35489°	96.83371°	
11	**Wel Laung Stream (Pyin Oo Lwin)**	22.082172°	96.580458°	
12	**Nartaungkya Stream (Pathein Gyi)**	21.880704°	96.226655°	
13	**Sedaw Gyi Cannal**	21.91917°	96.18635°	
14	**Dokehtawady(Myit Nge River)**	21.83646°	96.07781°	

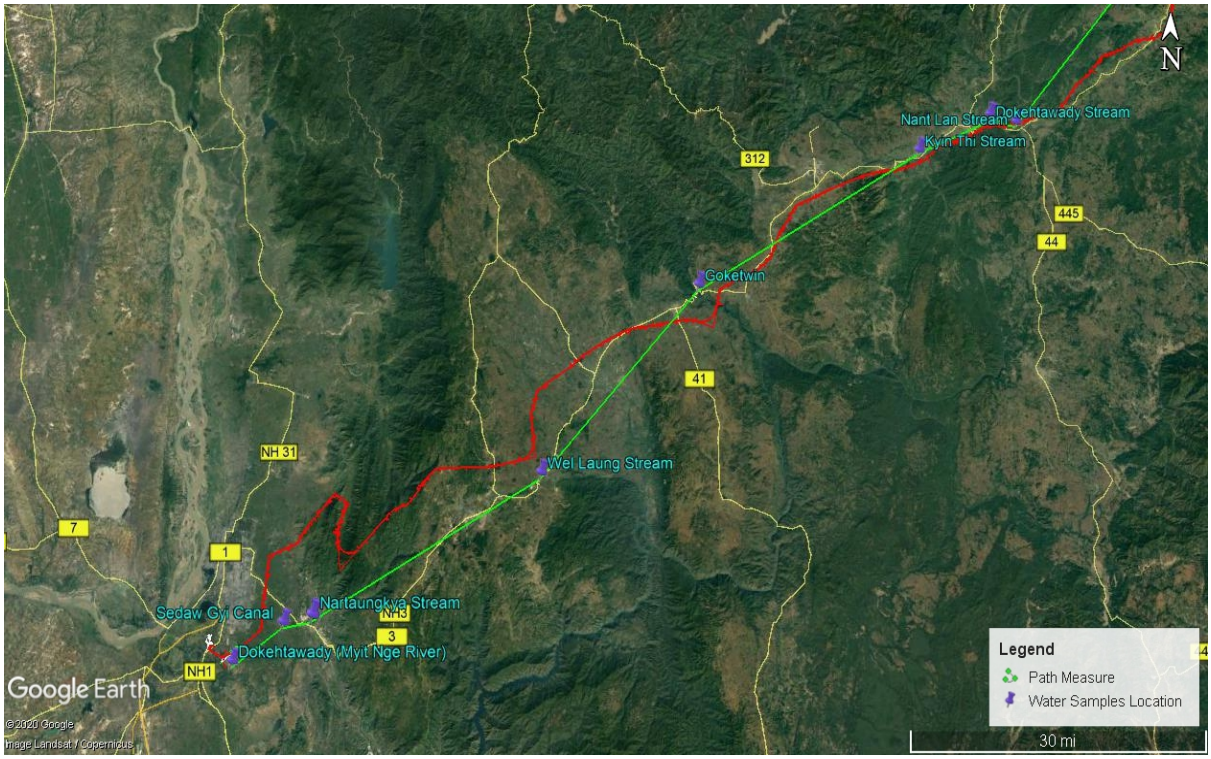

Figure - Locations of Water Quality Sampling for Wet Season

Table 5.7. Water Quality Testing Results for Wet Season

Analyses	Unit	Namkhon Monastery	Nam Paw Stream	Natural Spring Near Nam Paw Stream	Nam Khaing Stream	Namtu Stream	Pan Phet Stream	Nant Lam Stream	Dokehtawady	Kyin Thi Stream	Goke Twin stream	Wel Laung Stream	Nartaungkya Stream	Sedaw Gyi Cannal	Dokehtawady(Myit Nge River)
Calcium	mg/l	24	33	44	49	69	63	73	34	32	42	79	70	29	50
Chloride	mg/l	7.68	7.68	8.65	6.72	12.49	8.65	12.49	8.65	12.49	8.65	21.14	15.37	8.16	9.13
Conductivity	µs/cm	0.244	0.329	0.691	0.447	0.568	0.578	0.658	0.431	0.297	0.377	0.740	0.592	0.258	0.454
Magnesium	mg/l	<5	<5	6	6	9	7	10	<5	5	6	11	9	<5	8
pH	-	7.44	7.36	7.08	7.64	7.24	7.43	7.36	7.2	7.17	7.14	7.1	7.11	7.15	7.2
Sulphate	mg/l	ND	ND	2.1	ND	3.6	ND	46.2	3.9	ND	ND	2.4	2.1	ND	6.6
Total Hardness as $CaCO_3$	mg/l	88.5	157.5	381	328.5	264	412.5	345	200	116	170	403	300	95.5	197
Total Iron	mg/l	0.5	0.2	ND	0.1	0.2	<0.1	0.1	0.5	1	1	ND	0.1	1	<0.1
Total Dissolved Solids	mg/l	95	128	380	280	360	360	258	190	80	172	320	198	103	196
Turbidity	NTU	9.47	36.2	9.29	21.1	24.4	11.5	24.4	35.5	55.6	35.8	10.5	47.6	48.8	14.1

5.5.8.4. Vibration Level Monitoring

Vibration levels were measured at points along the proposed Muse-Mandalay Railway. The measurements are taken in places which are Pyin Oo Lwin-Oak Pho Village (Monastery), Naung Cho- Shwe Pyi Nyunt Village, Goke Hteik, Hsipaw (near Baw Gyo Pagoda), Beyond Hsipaw (San Laung), Lashio, Hseni, Nam Hpat Kar and Muse. The following figures shows the location of vibration level assessment.

Hseni

Testing

Hsipaw (near Baw Gyo Pagoda)

Lashio

Naung Cho (Shwe Pyi Nyunt Village)

Figure - Recorded Photos for Vibration Mea

Figure - Recorded Seismograph Results Along the Proposed Project Muse-Mandalay Railway

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Figure - Location of Vibration Monitoring in Google Map

Table 5.8. Measuring Results for Vibration Level

Place	Location	L(mm/s)	V(mm/s)	T(mm/s)
Pyin Oo Lwin - Oak Pho Village (Monastery)	N 22° 04' 15.87" E 096° 23' 58.30"	1.85	0.475	0.350
Naung Cho - Shwe Pyi Nyunt Village	N 22° 18' 16.29" E 096° 50' 02.16"	-	-	-
Goke Hteik	N 22° 20' 08.94" E 096° 51' 53.42"	-	-	-
Hsipaw (near Baw Gyo Pagoda)	N 22° 34' 59.78" E 097° 13' 59.62"	-	-	-
Beyond Hsipaw (San Laung)	N 22° 40' 33.66' E 97° 30' 17.4"	-	-	-
Lashio	N 22° 59' 05.41" E 097° 42' 23.09"	0.275	0.375	0.275
Hseni	N 23° 18' 23.97" E 097° 58' 28.30"	-	-	-
Nam Hpat Kar	N 23° 41' 21.89" E 097° 49' 02.76"	-	-	-
Muse	N 24° 00' 03.10" E 097° 56' 25.90"	0.250	0.175	0.225

Range of L, V, T – from 0.1 mm/s to 200 mm/s

Range of Air Overpressure – from 100 to 140 dB Linear Peak

L – Love Wave: A major type of surface wave having a horizontal motion that is shear or transverse to the direction of propagation (travel).

V – Peak Particle Velocity (also known as PPV)

T – Travel Time: The time required for a wave train to travel from its source to the point of observation.

5.5.8.5. Existing Soil Quality Monitoring

As the construction of tunnel will impact on soil quality during construction stage, soil quality will be monitored and will have to be tested in laboratory. Soil qualities were collected along the railway line as shown in the following figures.

Sample Point Selection

To determine the chemical composition of soil quality, the sample points are selected at the project site, rivers' bank and inside the farm land.

Table - Locations of Soil Sample Points for Dry Season

SN	Name	GPS Corrdinate		Collected Soil Samples
		Lattitude	Longitude	
1	Phat Man Soil (I)	23.84672°	97.96399°	
2	Lower Nam Phat Loon Soil (I)	23.57058°	97.81950°	

3	Theinni Soil(I)	23.28817°	97.95394°	
4	Hang Lu Soil(I)	23.13200°	97.84320°	
5	Pang Huauk Soil	22.61445°	97.37921°	
6	Hsipaw Soil (I)	22.60728°	97.30748°	
7	Kyin Thi Soil(I)	22.56428°	97.20963°	
8	Goke Twin Soil	22.35489°	96.83371°	

9	Sedaw Gyi Soil	21.91917°	96.18635°	
10	Myit Nge Soil	21.83646°	96.07781°	

Figure - Locations of Soil Quality Sampling along the Railway Line for Dry Season

Table - Locations of Soil Sample Points for Wet Season

SN	Name	GPS Corrdinate		Collected Soil Samples
		Lattitude	Longitude	
1	Phat Man Soil (II)	23.800891°	97.9200002°	
2	Lower Nam Phat Loon Soil (II)	23.569606°	97.819422°	
3	Theinni Soil(II)	23.288344°	97.954061°	
4	Hang Lu Soil(II)	23.119017°	97.836422°	
5	Pang Huauk Soil(II)	22.611375°	97.378211°	

6	Hsipaw Soil (II)	22.621989°	97.334172°	
7	Kyin Thi Soil(II)	22.564178°	97.209489°	
8	Goke Twin Soil(II)	22.354586°	96.833431°	
9	Sedaw Gyi Soil(II)	21.872109°	96.182244°	
10	Myit Nge Soil(II)	21.819177°	96.106333°	

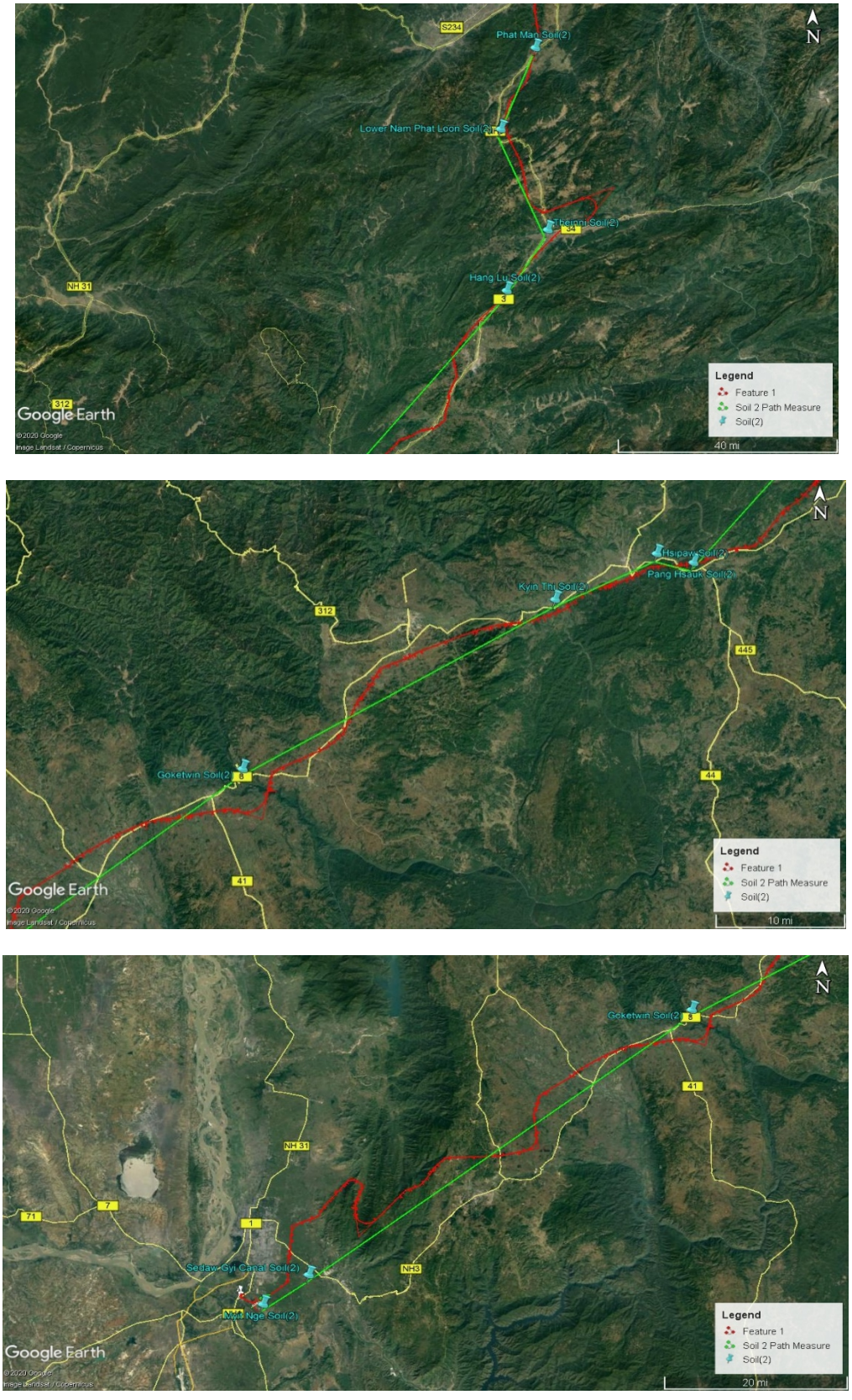


Figure - Locations of Soil Quality Sampling along the railway Line in Wet Season

Table 5.8- Soil Quality Results (Dry Season)

Sr No.	Sample (Soil 1)	pH Soil:Water 1:2.5	Texture	Organic Carbon	Total N	CEC	Available Nutrients		Water Soluble Meq/q100gm		Interpretation of results	
							P	K_2O	Cl^-	$SO_4^=$	Cl^-	$SO_4^=$
1	Hang Lu	Slightly alkaline	Sandy Loam	Low	Medium	High	Low	Medium	0.19	0.37	Low	Low
2	Kyin Thi	Moderately alkaline	Sandy clay loam	Very low	Low	High	Medium	High	0.30	0.14	Low	Low
3	Sedaw Gyi Cannal	Moderately alkaline	Sandy Loam	Medium	Low	Very High	Very High	High	0.19	0.21	Low	Low
4	Hsipaw	Moderately alkaline	Sandy Loam	Very Low	Very low	Medium	Medium	High	0.15	0.18	Low	Low
5	Goke Twin	Moderately alkaline	Loamy sandy	Very Low	Low	Medium	Low	Medium	0.23	0.14	Low	Low
6	Myit Nge	Moderately alkaline	Sandy Loam	Low	Medium	Very high	High	High	0.80	0.25	Low	Low
7	Pang Hsauk	Moderately alkaline	Sandy Loam	Low	Medium	Very high	Medium	Medium	0.23	1.01	Low	Low
8	Phat Man	Moderately alkaline	Sandy Loam	Low	Medium	Medium	Medium	Medium	0.19	0.18	Low	Low
9	Lower Nam Phat Loon	Slightly alkaline	Sandy Loam	Medium	Medium	Medium	Low	Medium	0.23	0.33	Low	Low
10	Theinni	Moderately alkaline	Loamy sandy	Medium	Low	High	Medium	Low	0.15	0.18	Low	Low

Table - Soil Quality Results (Dry Season) Continued

Sr No.	Sample (Soil 2)	pH Soil:Water 1:2.5	Texture	Organic Carbon	Total N	CEC	Available Nutrients		Water Soluble Meq/q100gm		Interpretation of results	
							P	K_2O	Cl^-	$SO_4^=$	Cl^-	$SO_4^=$
11	Phat Man	Slightly alkaline	Clay	Low	Medium	High	Low	High	0.38	0.21	Low	Low
12	Goke Twin	Moderately alkaline	Loam	Very low	Low	Medium	Low	Medium	0.19	0.21	Low	Low
13	Pang Hsauk	Moderately alkaline	Sandy loam	Very low	Low	High	Low	Medium	0.34	0.14	Low	Low
14	Hang Lu	Moderately alkaline	Sandy loam	Very low	Low	Medium	Low	Medium	0.27	0.14	Low	Low
15	Kyin Thi	Moderately alkaline	Sandy loam	Low	Low	Medium	Medium	High	0.30	0.10	Low	Low
16	Myit Nge	Moderately alkaline	Sandy loam	Low	Medium	Very high	Medium	High	0.49	0.25	Low	Low
17	Lower Nam Phat Loon	Moderately alkaline	Sandy loam	Very low	Low	Medium	Medium	Medium	0.34	0.21	Low	Low
18	Sedaw Gyi Canal	Moderately alkaline	Clay loam	Low	Medium	Very high	High	High	0.38	0.10	Low	Low
19	Hsipaw	Moderately alkaline	Sandy loam	Medium	Medium	High	Medium	High	0.23	0.10	Low	Low
20	Theinni	Moderately alkaline	Sandy clay loam	Very low	Low	Very High	Medium	Medium	0.19	0.25	Low	Low

Table 5.9- Soil Quality Results (Wet Season)

Sr No.	Sample (Soil 1)	Moisture	pH soil:water 1:2.5	Texture				Organic Carbon %	Humus %	Total N	CEC	Exchangeable Cations Meq/100gm						Available Nutrients	
				Sand %	Silt %	Clay %	Total %					Ca^{++}	Mg^{++}	K^{+}	Na^{+}	H^{+}	Al^{++}	P ppm Olsen	K_2O Mg/ 100gm
1	Hang Lu	3.54	7.50	69.90	16.72	13.38	100.00	1.77	3.06	0.22	26.98	24.95	1.31	0.36	0.36	-	-	7.47	16.80
2	Kyin Thi	5.35	7.93	48.90	26.72	24.38	100.00	0.82	1.41	0.15	32.09	25.43	1.34	3.99	1.33	-	-	8.46	148.42
3	Sedaw Gyi Cannal	4.08	7.75	62.90	25.72	11.38	100.00	3.35	5.78	0.15	41.67	33.66	4.62	2.28	1.11	-	-	61.31	106.99
4	Hsipaw	1.46	7.81	76.90	10.72	12.38	100.00	0.79	1.35	0.03	21.43	19.92	0.64	0.43	0.44	-	-	10.56	20.10
5	Goke Twin	0.78	8.15	86.90	4.72	8.38	100.00	0.04	0.07	0.18	14.25	11.49	1.91	0.26	0.59	-	-	4.84	12.09
6	Myit Nge	7.66	7.78	56.90	20.72	22.38	100.00	1.10	1.90	0.23	43.67	34.98	6.17	0.94	1.58	-	-	13.87	44.20
7	Pang Hsauk	7.70	7.69	71.90	11.72	16.38	100.00	1.63	2.81	0.21	47.54	43.21	3.43	0.41	0.49	-	-	10.83	19.50
8	Phat Man	10.02	7.91	63.90	13.72	22.38	100.00	1.04	1.80	0.21	19.08	14.08	4.22	0.38	0.39	-	-	10.23	18.02
9	Lower Nam Phat Loon	11.71	7.33	70.90	13.72	15.38	100.00	2.03	3.50	0.24	18.70	14.34	3.58	0.33	0.44	-	-	5.44	15.63
10	Theinni	8.00	8.07	86.90	4.72	8.38	100.00	0.35	0.61	0.15	26.85	24.80	1.38	0.21	0.47	-	-	9.14	9.79

Table - Soil Quality Results (Wet Season) Continued

Sr No.	Sample (Soil 2)	Moisture	pH soil:water 1:2.5	Texture				Organic Carbon %	Humus %	Total N	CEC	Exchangeable Cations Meq/100gm						Available Nutrients	
				Sand %	Silt %	Clay %	Total %					Ca^{++}	Mg^{++}	K^{+}	Na^{+}	H^{+}	Al^{++}	P ppm Olsen	K_2O Mg/ 100gm
11	Phat Man	4.48	7.38	33.9	22.72	43.38	100.00	1.41	2.43	0.22	26.10	16.57	7.95	0.76	0.82	-	-	7.54	35.81
12	Goke Twin	4.54	8.20	46.9	31.72	21.38	100.00	0.17	0.29	0.11	22.11	19.20	1.99	0.24	0.68	-	-	6.27	11.30
13	Pang Hsauk	2.44	8.08	70.9	15.72	13.38	100.00	0.71	1.22	0.18	39.50	36.97	1.03	0.24	1.00	-	-	4.51	11.07
14	Hang Lu	1.36	7.94	66.9	19.72	13.38	100.00	0.95	1.64	0.14	19.78	17.98	1.28	0.23	0.29	-	-	3.65	10.95
15	Kyin Thi	3.45	7.95	66.9	19.72	13.38	100.00	1.01	1.89	0.16	23.91	17.05	5.90	0.48	0.47	-	-	9.53	22.38
16	Myit Nge	2.44	8.01	53.9	30.72	15.38	100.00	1.71	2.94	0.22	51.19	45.45	3.90	0.96	0.89	-	-	11.90	44.92
17	Lower Nam Phat Loon	1.57	8.00	76.9	13.72	9.38	100.00	0.79	1.36	0.16	22.60	19.30	2.57	0.29	0.44	-	-	10.16	13.41
18	Sedaw Gyi Canal	4.63	8.06	36.9	26.72	36.38	100.00	1.54	2.65	0.22	55.20	44.46	6.64	1.81	2.30	-	-	16.35	84.91
19	Hsipaw	3.73	7.82	53.90	34.72	11.38	100.00	2.20	3.79	0.24	34.79	29.58	3.29	0.48	1.44	-	-	10.80	22.43
20	Theinni	1.42	7.77	54.90	24.72	20.38	100.00	0.95	1.64	0.18	49.16	44.94	3.21	0.26	0.75	-	-	10.55	12.17

5.5.9. Biodiversity Environment

Existing Biodiversity Environment

This Environmental Impact Assessment (EIA) report identifies potential environmental impacts associated with the proposed of Mandalay-Muse New Railway Project's Bridges and culverts Construction. The project sites is located that on the route of Mandalay-Muse areas. Study area was divided into two parts, Part I (plain area, Armarapura and Patheingyi) and Part II (hill area, Pyin Oo Lwin to Muse).Study sites were allocated into six study sites in Part I and forty nine study sites in Part II. The biodiversity survey was conducted from May 2019 to November 2019. The base line study and specimen collection of terrestrial fauna, especially as major groups are vertebrate (birds, reptiles, lizards and fishes especially visual observation) and invertebrate (butterflies, dragonflies and damselflies visually during survey). A total of (64) plant species and (89) fauna species were recorded in Part I and (80) plant species and (112) fauna species in Part II. Regarding the population and density: in study Part I, the highest abundance were found in (5) species, as very common, (48) species were found as uncommon in plant species and (7) species, as very common, (13) species were found as uncommon in bird species; (9) species as very common, (2) species as uncommon in insect species. According to surveyed results, the highest density was found as Mimosaceae family (7.81%) species and the lowest was found (24) families (1.56%) in plant species. The highest density was found in Columbidae (10.811%) and the lowest species was found in (18) families (2.703 %) in bird species. In study site Part II, the base line study and specimen collection of terrestrial fauna, especially as major groups are vertebrate (birds, reptiles, lizards and fishes especially visual observation) and invertebrate (butterflies, dragonflies and damselflies visually during survey). According to the survey results, total of 112 fauna species recorded in and around the Mandalay-Muse New Railway Project Area. According to the survey results, about total Mammals fauna 7 species 5 order and 6 families were recorded. According to the survey results, surrounding of the Mandalay-Muse New Railway Project area, about total Avian fauna 59 species 12 order and 30 families were recorded. Surrounding of the Pyin Oo Lwin area, about 39 species of Avian Fauna belonging to 9 order and 23 families were recorded with different population abundance. Surrounding of the Naung Hkio to Kyaukme Survey about 30 species of Avian Fauna belonging to 7 order and 18 families were investigated that the different categorize bird species as insectivore, omnivores and carnivorous. Biodiversity team observed that the surrounding of Lashio to Muse survey, about 22 species of Avian Fauna belonging to 3 order and 12 families were recorded. During

survey period, about 9 species of reptilian species belonging to 2 order and 7 families were recorded at the study site. Biodiversity survey group are observed that there are about total 26 species of Butterfly as well as male and female belonging to 7 families in surrounding of the all project area. The survey team investigated that the surrounding of the site of Project Construction Area, about 13 species Dragonfly and Damselfly species belonging to one order and 2 families (Libellulidae and Coenagrionidae) were recorded with different population abundance. This report is a review of the Environmental Impact Assessment Report (EIAR) for flora, in and around the Mandalay-Muse New Railway Project Area. A total of 80 flora species were recorded during the survey periods. The habit of identified species consists of seven different types, including tree, shrub, herb, climber, bamboo and parasitic shrub. Some of tree species are planted for landscaping beside the rail way yard and some of trees are planted and culturally retained for water resources around the village sites. Most of shrubs and herbs were naturally grow on road sites and understorey layer of tree species. In the conservation point of view: according to IUCN red list, in study Part I, all of plant species are last concern (LC). Almost bird species are last concern (LC) except (1) species (Hooded Treepie) is near threatened (NT) and (1) species (White-vented Myna) is vulnerable (VU). For Part II study area, According to the IUCN Red List, four Least Concerned species and two near threatened status noted from the survey area. The identification of the possible impact of the project recommended mitigation measures for all negative impacts identified. Environmental Impact Assessment is the prediction of consequences to the environment of a proposed project development measures. It could be both positive or negative impacts and one of the most important tools for achieving sustainable development. This report identifies potential environmental impacts associated with the proposed of communication, commercial trades and others. The survey team investigated that four types of impacts as well as negative and positive impacts, reduction of the species diversity (negative impact), loss of habitats(negative impact), noise impact (negative impact), as fauna and flora were observed in these projects. Next, the family income can be improved concerning with the project during the construction and operation period. The result of project can make the working opportunities of local people (both manual laborer and technicians). The impacts on environmental condition will be analyzed statistically and evaluated according to International Association of Impact Assessment-IAIA Guidelines as the impact factors, impacted items and impact degree are determined. As the assumption, by the advantages of the project, it may be support for communication, commercial trades and other factors of developed country. Regarding with EIA Assessment, this report is a review of the

Environmental Impact Assessment Report (EIAR) for flora, in and around the Mandalay-Muse New Railway Project Area. A total of 164 flora species were recorded during the survey periods. The habit of identified species consists of seven different types, including tree, shrub, herb, climber, bamboo and parasitic shrub. Some of tree species are planted for landscaping beside the rail way yard and some of trees are planted and culturally retained for water resources around the village sites. Most of shrubs and herbs were naturally grow on road sites and understorey layer of tree species. According to the IUCN Red List, four Least Concerned species and two near threatened status noted from the survey area. The identification of the possible impact of the project recommended mitigation measures for all negative impacts identified. Environmental Impact Assessment is the prediction of consequences to the environment of a proposed project development measures. It could be both positive or negative impacts and one of the most important tools for achieving sustainable development. This report identifies potential environmental impacts associated with the proposed of communication, commercial trades and others. The survey team investigated that four types of impacts as well as negative and positive impacts, reduction of the species diversity (negative impact), loss of habitats(negative impact), noise impact (negative impact), as fauna and flora were observed in these projects. Next, the family income can be improved concerning with the project during the construction and operation period. The result of project can make the working opportunities of local people (both manual labourer and technicians). The impacts on environmental condition will be analysed statistically and evaluated according to International Association of Impact Assessment-IAIA Guidelines as the impact factors, impacted items and impact degree are determined. As the assumption, by the advantages of the project, it may be support for communication, commercial trades and other factors of developed country.

Biodiversity Survey Team for Mandalay-Muse New Railway Project

Sr.	Biodiversity Survey Team	Official Position	Status (All Technical Specialists)
1.	Dr Nyo Nyo Lwin	Professor Department of Biology, Yangon University of Education	Team Leader Ecology & Biodiversity Senior Consultant
2.	Prof. Weine Nway Nway Oo	Head of Department Department of Biotechnology Technological University (Kyaukse)	Team Leader Ph.D (Biotechnology) Member of NBSAP, 2011

3.	Dr. Nyunt Lwin	Lecturer Department of Zoology Kyuause University	Team Leader Ph.D (Ecology)
4.	Dr Wah Wah Khaing	Associate Professor Department of Botany, Pathein University	Research Member Ph.D (Environmental Science, YU) (Flora Expert)
5.	Dr Theingyi Soe Myint	Lecturer Department of Zoology, University of Yangon	Research Member Ph.D (Ichthyology, YU) Ichthyologist
6.	U Htoo Htoo Aung Lwin	Assistant Lecturer Department of Zoology, University of Yangon	Research Member Ph.D (Candidate, YU) Ichthyologist
7.	Dr. Thein Tun Oo	Lecturer Department of Botany, Yadanabon University	Research Member PhD (Botany) (Flora Expert)
8.	Dr. Ye Ye Win	Lecturer Department of Botany, Yadanabon University	Research Member PhD (Botany) (Flora Taxonomist)
9.	U Shein Htet Aung	sistant Lecturer partment of Zoology, Mandalay University	Research Member PhD Prelim (Zoology); MSc, MRes (Ornithology) (Fauna Expert)
10.	U Kyaw Lwin	Carrier Researcher	Research Member Field specialist, Insect, mammal and herpet
11.	U Naing Oo	Carrier Researcher	Research Member Field Specialist, Plant

(1) Aims and Objectives

To collect and identify of plant and animal species in study area

To record dominant species of plants and animals

To analysis of composition of plants and animals

To assess the potential impacts and to suggest the mitigation measure

(2) Methods

The animals and floristic data, and ecological data collection were conducted by the following methods in the study area.

(i) Study area and study sites

The study area is conducted on Muse-Mandalay Railway from Amarapura Township to Patheingyi Township. Six study sites were allocated by based on habitats in this study area and remarked on Google Earth. Site I (Sauk Taw Wa) I is at Latitude 21°50'31.20"N and Longitude 96° 7'10.68"E; Site II (Sin Bo) is at 21°52'0.33"N and 96° 8'46.74"E; Site III (Ngwe Taung) at 21°53'34.23"N and 96°10'13.57"E; Site IV (Tha Le Kone) at 21°55'16.12"N and 96°11'1.27"E; Site V (Ye Kyi, South) is at 21°57'7.26"N and 96°11'7.77"E and Site VI (Yetagon Taung) is situated at 21°57'50.59"N and 96°12'41.48"E

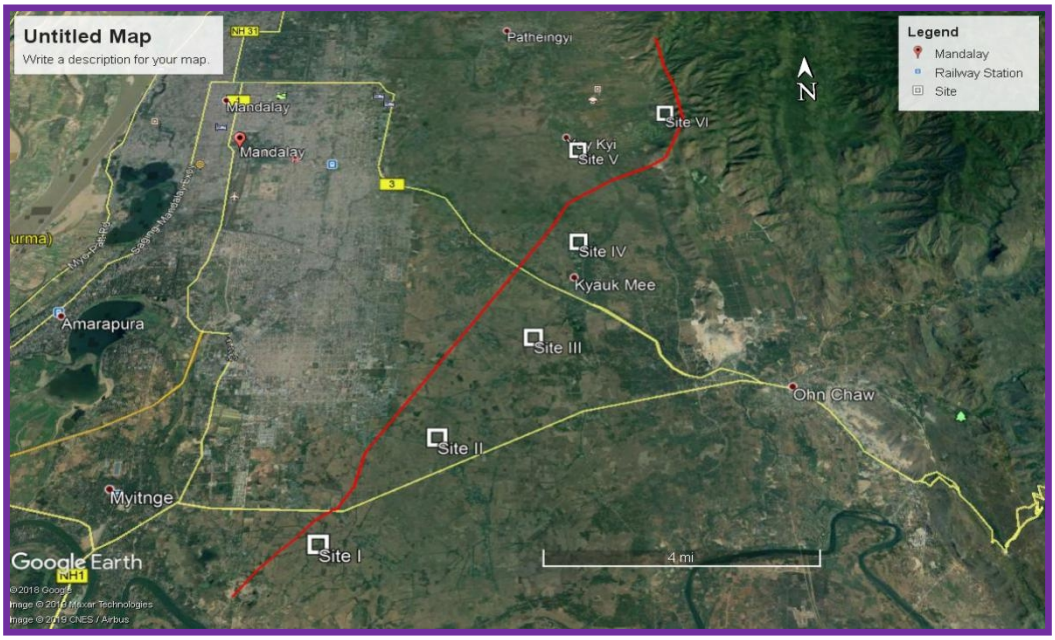


Figure - Map of biodiversity study sites

(ii) Study design

Classification of landscape based on satellite data: is often used to classify the landscape into different vegetation categories and decide about the sampling strategy. We have also followed same strategy of classifying the landscape into discernible units. Further, we have used ground truth points to calibrate the classification of the landscape into distinct units.

At each sampling site, an appropriate data collection line was designated to cover the area of each sampling site. One permanent transect line running from north to south with 50 m width was established in each study site.

Vegetative sampling was made based on plot method. Sampling with quadrat plots were allocated along the either side of each transect line. The minimum distance between two plots was 100m. Each plot was measured a length of 30m and width of 10m. Plants species as well as their total number within each plot were recorded.

(iii) Survey methods

Five kinds (Birds, Fish & Crust, mammals, herpets and insects) animals were surveyed for the diversity assessment. Animals were observed and recorded using a binocular. The photos were taken with digital camera. Most animal species were spotted with binoculars and photographs were taken, some species which could not be recorded on photographs although their occurrence was also recorded were included. The animals were surveyed two times, once in the morning from 7:00 am to 10:00 am and once in the evening from 3:00 pm to 6:00 pm and conducted a month. Line transect count method was carried out, walking along the study points. Data counting were used by direct and estimation methods, followed after Bibby *et al.*(2008). Some mammals and herpets were surveyed as interviewed methods.

Plate 1 Interview (Questionnaires' Survey) and Field survey

(iv) Insects

Insects were caught and taken as voucher specimens. Flying insects were caught by insect net; beetles were collected by digging the grounds, peering the tree barks with the knife. Some beetles in the trees were shaken out and fall down on the ground; these insects were collected by hands and a pairs of forceps.

(v) Fish & Crustacea

Fish & crust were recorded by direct catching method in/near the paddy field.

(vi) Herpet

Snakes, lizards and frogs were caught and taken as voucher species and were identified. Snakes were caught by snake stick, lizards were shot by rubber bands, and frogs were collected in their roosting habitats. Some snakes were surveyed as interviewed methods.

(vii) Birds

Birds were recorded using the watching methods with the help of binoculars. Species identification was examined using the field guide books. Counting of bird number and habitat utilization were observed. Species richness and observed frequency were assessed for species diversity.

(viii) Mammals

Direct count method, remains of animal's body parts such as skin, spines, antlers, etc. Footprints and interviewed methods were used for mammal survey.

(3) Data analysis

Relative abundance

The recorded data was analyzed as follows after Bisht *et al*., 2004:

$$\text{Relative abundance} = \frac{\text{No. of individuals of a species}}{\text{No. of individuals of all species}}$$

The average relative abundance was categorized adopted by Bisht *et al*. (2004)

uC = uncommon having relative abundance of less than 0.0100

C = common having relative abundance of 0.0100 and above but less than 0.0500

vC = very common having relative abundance of 0.0500 and above

Diversity

The relative diversity (RDi) of families was calculated using the following formula (Torre-Cuadros *et al.,* 2007):

$$\text{RDi} = \frac{\text{No. of species in a family}}{\text{Total number of species}} \times 100$$

(4) Identification

Birds were identified following Symthies (2001) and Robson (2015). Mammals were identified followed after by according to mentioned references, U Tun Yin (1993) and Francis C.M, (2008). Identification and classification of herptiles followed after Smith (1935, 1943), Das (2010) and Guraraja (2010). Identification and classification of insect species were classified according to Hill (1983), Ghosh (1940), Pathak and Khan (1994) and Borror and Delong (1964). Plant species were checked against Handley and Chit Ko Ko (1987), Kress *et al*. (2003) and consulted with Department of Botany, Yadanabon University.

Plate 2 Identification for some species

(5) Observation and Results

64 species of flora belong to 54 genera under 40 families were recorded. Among them, 56 species are trees, 6 species are climbers, 4 species are herbs, 3 species are shrub, 1species is bamboo and also 1 species is grass. In fauna recorded, there are 89 species belonging to ; among these, 22 species are insects, 4 species are fishes, 1 species is crab, 10 species are herpet, 37 species are bird and 5 species are mammals.

5.5.9.1. Flora

In the study area, the highest dominant of flora were covered by paddy field and follower after Mango and banana orchards and some are gardens.

Paddy field

Mango orchard

Thapay garden

Banana and Gandama garden

Figure - Occurrence of plant species at study sites

Table - List of flora species and types of plant in study area

No.	Family	Scientific name	Myanmar name	Types
1	I. Anacrdiaceae	*Mangifera india* L.	Thayet	Tree
2		*Lannea coromandelica* L.	Nabe	Tree
3	II. Caesalpiniaceae	Tamarindus indica L.	Magyi	Tree
4		*Cassia fistula*	Ngu	Tree
5		*Delonix regia*	Sein-ban	Tree
6		*Bauhinia acuminata*	Swe-daw	Tree
7	III. Moraceae	*Ficus glomerata*	Thapan	Tree
8		*Ficus sp.*	Nyaung	Tree
9		*Artocarpus heterophyllus*	Peinne	Tree
10		*Streblus asper L.*	Ownne	Tree
11	IV. Combretaceae	*Terminalia oliveri*	Than	Tree
12		*Terminalia belerica*	Thit-Seint	Tree
13		*Terminalia catappa*	Banda	Tree
14	V. Verbenaceae	*Tectona hamiltoniana*	Dahat	Tree
15		*Tectona grandis*	Kyun	Tree
16	VI. Euphorbiaceae	*Phyllanthus emblica*	Zee byu	Tree
17		*Phyllanthus distichus*	Thin baw Zee Pyu	Tree
18		*Ricinus communis*	Kyetsu	Tree
19	VII. Arecaceae	*Cocos nucifera*	Ohn	Tree
20		*Borassus flabellifer L.*	Htan	Tree
21		*Arenga nana*	Yone	Tree
22	VIII. Annonaceae	*Carica papaya*	Thin baw pin	Tree
23	IX. Averrhoaceae	*Averrhoa carambola*	Zaung-yar	Tree
24	X. Meliaceae	*Chukrasia tabularis*	Yinma	Tree
25		*Azadirachta indica*	Tama	Tree
26		*Swietenia macrohyplla*	Mahogany	Tree
27	X. Fabaceae	*Pterocarpus macrocarpus L.*	Paduck	Tree
28	XII. Mimosaceae	*Leucaena Leucocephala*	Bawzagaing Aweya	Tree
29		*Acacia leucophloea L.*	Htanaung	Tree
30		*Albizzia lebbek Benth*	Kokko	Tree
31		*Abarema clypearia L.*	Mezali	Tree
32		*Pithecellobium dulce L.*	Ta yoke mangyi	Tree
33	XIII. Olacaceae	*Hesperethusa crenulata L.*	Thanakhar	Tree
34	XIV. Myrtaceae	*Psidium acidum*	Malaka	Tree
35		*Eugeniapractermissa L.*	Thapyay	Tree
36	XV. Bignoniaceae	*Iroxylum indicum*	Kyaung sha	Tree

37	XVI. Dipterocarpaceae	*Shorea siamensis*	Ingyin	Tree
38	XVII. Moringaceae	*Moringa oleferaa*	Dant tha lon	Tree
39	XVIII. Rhamnaceae	*Zizyphus mauritiana*	Zi	Tree
40		*Ziziphus jujuba L.*	Zi	Tree
41	XIX. Sapotaceae	*Mimusops elengi*	Khayay	Tree
42		*Sideroxylon burmanicum*	Thit-cho	Tree
43	XX. Boraginaceae	*Cordia dichotoma*	Thanat pin	Tree
44	XXI. Oleaceae	*Schrebera swietenioides*	Taw-gwebyu	Tree
45	XXII. Bombacaceae	*Bomasc ceiba L.*	Lappan	Tree
46	XXIII. Tiliaceae	*Corchorus capsularis L.*	Chawphyu	Tree
47	XXIV. Combretaceae	*Combretu acuminatum*	Nabu	Climber
48	XXV. Nyctaginaceae	*Bougainvillea glabra L.*	Sekkupan	Climber
49	XXVI. Papilionaceae	*Abrus precatorius L.*	Zinywe	Climber
50	XXVII. Connaraceae	*Cnestis ramiflora L.*	Kawetout	Climber
51	XXVIII. Cucurbitaceae	*Trichosanthes bracteata*	Kyi-arh	Climber
52		*Momordica dioca*	Kyet-hin-ga	Climber
53	XXIX. Aizoaceae	*Trianthema secandra*	Payan-na-war	Herb
54	XXX. Musaceae	*Musa sapientum*	Taw-nga-pyaw	Herb
55	XXXI. Verbenaceae	*Clerodendrum macrosiphon L.*	Ngayanpadu	Herb
56	XXXII. Euphorbiaceae	*Croton tiglium L.*	Kanaso	Herb
57	XXXIII. Asteraceae	*Ismelia versicolor*	Gandama	Herb
58	XXXIV. Scrophulariaceae	*Scoparia dulcis L.*	Thagar	Shrub
59	XXXV. Malvacea	*Uerna lobata*	Wetchi-pane	Shrub
60	XXXVI. Solanaceae	*Physalis minima L.*	Bauk	Shrub
61	XXXVII. Poaceae	*Bamvusa tuldoides*	War	Bamboo
62	XXXVIII. Muscaceae	*Musa* spp.	Nget-pyaw	Banana
63	XXXIX. Graminae	*Cynodon dactylon*	Myesa-myet	Grass
64	XXXX. Cyperaceae	*Carex nubigena*	Myet-monnyin	

Tree = 56 species; Climber= 6 species; Herb= 5 species; Shrub = 3 species; Bamboo = 1 species; Banana = 1 species Grass =2 species

Composition and Abundance of Plant Species

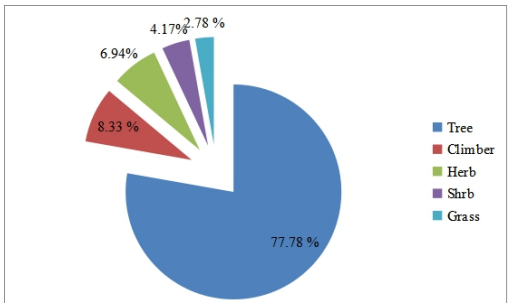


Table - Occurrence and abundance of recorded plant species

No.	Scientific name	Myanmar name	Site I	Site II	Site III	Site IV	Site V	Site VI	Total	Abundance	Relative Abundance
1	*Mangifera india* L.	Thayet	18	200	280	20	40	17	575	0.351	vC
2	*Lannea coromandelica* L.	Nabe	0	0	0	0	12	4	16	0.010	C
3	Tamarindus indica L.	Magyi	8	0	0	2	9	0	19	0.012	C
4	*Cassia fistula*	Ngu	0	0	0	0	0	6	6	0.004	uC
5	*Delonix regia*	Sein-ban	4	0	0	0	8	6	18	0.011	C
6	*Bauhinia acuminata*	Swe-daw	2	0	0	0	6	4	12	0.007	uC
7	*Ficus glomerata*	Thapan	0	0	0	0	1	7	8	0.005	uC
8	*Ficus sp.*	Nyaung	1	2	0	0	2	3	8	0.005	uC
9	*Artocarpus heterophyllus*	Peinne	0	0	0	2	0	6	8	0.005	uC
10	*Streblus asper L.*	Ownne	0	0	0	0	0	3	3	0.002	uC
11	*Terminalia oliveri*	Than	0	0	0	0	0	8	8	0.005	uC
12	*Terminalia belerica*	Thit-Seint	0	0	0	0	0	3	3	0.002	uC
13	*Terminalia catappa*	Banda	3	2	4	0	0	4	13	0.008	uC
14	*Tectona hamiltoniana*	Dahat	0	0	0	0	0	2	2	0.001	uC
15	*Tectona grandis*	Kyun	0	0	0	0	0	8	8	0.005	uC
16	*Phyllanthus emblica*	Zee byu	0	0	0	0	1	3	4	0.002	uC
17	*Phyllanthus distichus*	Thin baw Zee Pyu	0	0	0	0	0	2	2	0.001	uC
18	*Ricinus communis*	Kyetsu	0	0	0	0	0	4	4	0.002	uC
19	*Cocos nucifera*	Ohn	2	1	0	2	1	3	9	0.005	uC
20	*Borassus flabellifer L.*	Htan	0	0	3	2	0	0	5	0.003	uC
21	*Arenga nana*	Yone	0	0	0	0	0	2	2	0.001	uC
22	*Carica papaya*	Thin baw pin	6	5	2	3	0	4	20	0.012	C
23	*Averrhoa carambola*	Zaung-yar	0	0	0	0	0	2	2	0.001	uC
24	*Chukrasia tabularis*	Yinma	0	0	0	0	0	3	3	0.002	uC

25	*Azadirachta indica*	Tama	3	1	5	2	1	8	20	0.012	C
26	*Swietenia macrohyplla*	Mahogany	0	0	0	0	0	1	1	0.001	uC
27	*Pterocarpus macrocarpus L.*	Paduck	3	0	0	0	1	5	9	0.005	uC
28	*Leucaena Leucocephala*	Bawzagaing Aweya	6	2	3	5	1	8	25	0.015	C
29	*Acacia leucophloea L.*	Htanaung	2	0	0	0	1	3	6	0.004	uC
30	*Albizzia lebbek Benth*	Kokko	3	2	1	2	1	4	13	0.008	uC
31	*Abarema clypearia L.*	Mezali	1	2	3	4	1	6	17	0.010	C
32	*Pithecellobium dulce L.*	Ta yoke mangyi	1	2	2	1	0	0	6	0.004	uC
33	*Hesperethusa crenulata L.*	Thanakhar	0	0	0	0	1	0	1	0.001	uC
34	*Psidium acidum*	Malaka	3	0	0	0	0	4	7	0.004	uC
35	*Eugeniapractermissa L.*	Thapyay	3	24	20	80	14	8	149	0.091	vC
36	*Iroxylum indicum*	Kyaung sha	0	0	0	0	0	8	8	0.005	uC
37	*Shorea siamensis*	Ingyin	0	0	0	0	0	4	4	0.002	uC
38	*Moringa oleferaa*	Dant tha lon	2	4	10	18	9	11	54	0.033	C
39	*Zizyphus mauritiana*	Zi	4	1	3	8	2	6	24	0.015	C
40	*Ziziphus jujuba L.*	Zi	0	0	0	0	0	6	6	0.004	uC
41	*Mimusops elengi*	Khayay	0	0	0	0	2	3	5	0.003	uC
42	*Sideroxylon burmanicum*	Thit-cho	0	0	0	0	0	1	1	0.001	uC
43	*Cordia dichotoma*	Thanat pin	0	0	0	0	0	1	1	0.001	uC
44	*Schrebera swietenioides*	Taw-gwebyu	0	0	0	0	0	2	2	0.001	uC
45	*Bomasc ceiba L.*	Lappan	3	2	6	1	4	8	24	0.015	vC
46	*Corchorus capsularis L.*	Chawphyu	2	0	0	6	0	0	8	0.005	uC
47	*Combretu acuminatum*	Nabu	0	0	0	0	3	3	6	0.004	uC
48	*Bougainvillea glabra L.*	Sekkupan	0	0	0	1	0	3	4	0.002	uC
49	*Abrus precatorius L.*	Zinywe	0	0	0	0	2	1	3	0.002	uC
50	*Cnestis ramiflora L.*	Kawetout	0	0	2	1	1	2	6	0.004	uC
51	*Trichosanthes bracteata*	Kyi-arh	0	0	0	0	1	1	2	0.001	uC

52	*Momordica dioca*	Kyet-hin-ga	2	1	1	3	0	1	8	0.005	uC
53	*Trianthema secandra*	Payan-na-war	0	0	0	0	0	3	3	0.002	uC
54	*Musa sapientum*	Taw-nga-pyaw	0	0	0	0	0	2	2	0.001	uC
55	*Clerodendrum macrosiphon L.*	Ngayanpadu	0	0	0	10	0	0	10	0.006	uC
56	*Croton tiglium L.*	Kanaso	0	0	0	0	0	3	3	0.002	uC
57	*Ismelia versicolor*	Gandama	0	0	0	350	0	0	350	0.213	vC
58	*Scoparia dulcis L.*	Thagar	0	0	0	2	1	0	3	0.002	uC
59	*Uerna lobata*	Wetchi-pane	0	0	0	0	0	4	4	0.002	uC
60	*Physalis minima L.*	Bauk	0	0	0	2	0	0	2	0.001	uC
61	*Bamvusa tuldoides*	War	0	0	0	0	0	3	3	0.002	uC
62	*Musa* spp.	Nget-pyaw	8	3	4	40	0	10	65	0.040	vC
63	*Cynodon dactylon*	Myesa-myet								0.000	vC
64	*Carex nubigena*	Myet-monnyin	8	9	0	0	0	0	17	0.010	C
			98	263	349	567	126	237	1640		

Table - Composition of plant species recorded

No.	Scientific name	Myanmar name	Site I	Site II	Site III	Site IV	Site V	Site VI	Total	% Composition
1	*Mangifera india* L.	Thayet	18	200	280	20	40	17	575	35.061
2	*Lannea coromandelica* L.	Nabe	0	0	0	0	12	4	16	0.976
3	Tamarindus indica L.	Magyi	8	0	0	2	9	0	19	1.159
4	*Cassia fistula*	Ngu	0	0	0	0	0	6	6	0.366
5	*Delonix regia*	Sein-ban	4	0	0	0	8	6	18	1.098
6	*Bauhinia acuminata*	Swe-daw	2	0	0	0	6	4	12	0.732
7	*Ficus glomerata*	Thapan	0	0	0	0	1	7	8	0.488
8	*Ficus sp.*	Nyaung	1	2	0	0	2	3	8	0.488
9	*Artocarpus heterophyllus*	Peinne	0	0	0	2	0	6	8	0.488
10	*Streblus asper L.*	Ownne	0	0	0	0	0	3	3	0.183

11	*Terminalia oliveri*	Than	0	0	0	0	0	8	8	0.488
12	*Terminalia belerica*	Thit-Seint	0	0	0	0	0	3	3	0.183
13	*Terminalia catappa*	Banda	3	2	4	0	0	4	13	0.793
14	*Tectona hamiltoniana*	Dahat	0	0	0	0	0	2	2	0.122
15	*Tectona grandis*	Kyun	0	0	0	0	0	8	8	0.488
16	*Phyllanthus emblica*	Zee byu	0	0	0	0	1	3	4	0.244
17	*Phyllanthus distichus*	Thin baw Zee Pyu	0	0	0	0	0	2	2	0.122
18	*Ricinus communis*	Kyetsu	0	0	0	0	0	4	4	0.244
19	*Cocos nucifera*	Ohn	2	1	0	2	1	3	9	0.549
20	*Borassus flabellifer L.*	Htan	0	0	3	2	0	0	5	0.305
21	*Arenga nana*	Yone	0	0	0	0	0	2	2	0.122
22	*Carica papaya*	Thin baw pin	6	5	2	3	0	4	20	1.220
23	*Averrhoa carambola*	Zaung-yar	0	0	0	0	0	2	2	0.122
24	*Chukrasia tabularis*	Yinma	0	0	0	0	0	3	3	0.183
25	*Azadirachta indica*	Tama	3	1	5	2	1	8	20	1.220
26	*Swietenia macrohyplla*	Mahogany	0	0	0	0	0	1	1	0.061
27	*Pterocarpus macrocarpus L.*	Paduck	3	0	0	0	1	5	9	0.549
28	*Leucaena Leucocephala*	Bawzagaing Aweya	6	2	3	5	1	8	25	1.524
29	*Acacia leucophloea L.*	Htanaung	2	0	0	0	1	3	6	0.366
30	*Albizzia lebbek Benth*	Kokko	3	2	1	2	1	4	13	0.793
31	*Abarema clypearia L.*	Mezali	1	2	3	4	1	6	17	1.037
32	*Pithecellobium dulce L.*	Ta yoke mangyi	1	2	2	1	0	0	6	0.366
33	*Hesperethusa crenulata L.*	Thanakhar	0	0	0	0	1	0	1	0.061
34	*Psidium acidum*	Malaka	3	0	0	0	0	4	7	0.427
35	*Eugeniapractermissa L.*	Thapyay	3	24	20	80	14	8	149	9.085
36	*Iroxylum indicum*	Kyaung sha	0	0	0	0	0	8	8	0.488
37	*Shorea siamensis*	Ingyin	0	0	0	0	0	4	4	0.244

38	*Moringa oleferaa*	Dant tha lon	2	4	10	18	9	11	54	3.293
39	*Zizyphus mauritiana*	Zi	4	1	3	8	2	6	24	1.463
40	*Ziziphus jujuba L.*	Zi	0	0	0	0	0	6	6	0.366
41	*Mimusops elengi*	Khayay	0	0	0	0	2	3	5	0.305
42	*Sideroxylon burmanicum*	Thit-cho	0	0	0	0	0	1	1	0.061
43	*Cordia dichotoma*	Thanat pin	0	0	0	0	0	1	1	0.061
44	*Schrebera swietenioides*	Taw-gwebyu	0	0	0	0	0	2	2	0.122
45	*Bomasc ceiba L.*	Lappan	3	2	6	1	4	8	24	1.463
46	*Corchorus capsularis L.*	Chawphyu	2	0	0	6	0	0	8	0.488
47	*Combretu acuminatum*	Nabu	0	0	0	0	3	3	6	0.366
48	*Bougainvillea glabra L.*	Sekkupan	0	0	0	1	0	3	4	0.244
49	*Abrus precatorius L.*	Zinywe	0	0	0	0	2	1	3	0.183
50	*Cnestis ramiflora L.*	Kawetout	0	0	2	1	1	2	6	0.366
51	*Trichosanthes bracteata*	Kyi-arh	0	0	0	0	1	1	2	0.122
52	*Momordica dioca*	Kyet-hin-ga	2	1	1	3	0	1	8	0.488
53	*Trianthema secandra*	Payan-na-war	0	0	0	0	0	3	3	0.183
54	*Musa sapientum*	Taw-nga-pyaw	0	0	0	0	0	2	2	0.122
55	*Clerodendrum macrosiphon L.*	Ngayanpadu	0	0	0	10	0	0	10	0.610
56	*Croton tiglium L.*	Kanaso	0	0	0	0	0	3	3	0.183
57	*Ismelia versicolor*	Gandama	0	0	0	350	0	0	350	21.341
58	*Scoparia dulcis L.*	Thagar	0	0	0	2	1	0	3	0.183
59	*Uerna lobata*	Wetchi-pane	0	0	0	0	0	4	4	0.244
60	*Physalis minima L.*	Bauk	0	0	0	2	0	0	2	0.122
61	*Bamvusa tuldoides*	War	0	0	0	0	0	3	3	0.183
62	*Musa* spp.	Nget-pyaw	8	3	4	40	0	10	65	3.963
63	*Carex nubigena*	Myet-monnyin	8	9	0	0	0	0	17	1.037
			98	263	349	567	126	237	1640	

Diversity of Plants

Table - Diversity of plant species from Armarapura and Patheingyi at Muse-Mandalay Railway

No.	Family	Total no. species	Rdi
1	Anacrdiaceae	2	3.13
2	Caesalpiniaceae	4	6.25
3	Moraceae	4	6.25
4	Combretaceae	3	4.69
5	Verbenaceae	2	3.13
6	Euphorbiaceae	3	4.69
7	Arecaceae	3	4.69
8	Annonaceae	1	1.56
9	Averrhoaceae	1	1.56
10	Meliaceae	3	4.69
11	Fabaceae	1	1.56
12	Mimosaceae	5	7.81
13	Olacaceae	1	1.56
14	Myrtaceae	2	3.13
15	Bignoniaceae	1	1.56
16	Dipterocarpaceae	1	1.56
17	Moringaceae	1	1.56
18	Rhamnaceae	2	3.13
19	Sapotaceae	2	3.13
20	Boraginaceae	1	1.56
21	Oleaceae	1	1.56
22	Bombacaceae	1	1.56
23	Tiliaceae	1	1.56
24	Combretaceae	1	1.56
25	Nyctaginaceae	1	1.56
26	Papilionaceae	1	1.56
27	Connaraceae	2	3.13
28	Cucurbitaceae	1	1.56
29	Aizoaceae	1	1.56
30	Musaceae	1	1.56
31	Verbenaceae	1	1.56
32	Euphorbiaceae	1	1.56
33	Asteraceae	1	1.56
34	Scrophulariaceae	1	1.56
35	Malvacea	1	1.56
36	Solanaceae	1	1.56
37	Poaceae	1	1.56

38	Muscaceae	1	1.56
39	Graminae	1	1.56
40	Cyperaceae	1	1.56
	Total no. of species	64	

Conservation Status

Table - Plant species found in Myanmar assessed on the IUCN Red List of Threatened Species

No.	Scientific name	Common name	Category	Occurrence of study area	
				Present	Absent
1	*Anisoptera scaphula*		CR		-
2	*Dipterocarpus baudii*		CR		-
3	*Dipterocarpus dyeri*		CR		-
4	*Dipterocarpus gracilis*		CR		-
5	*Dipterocarpus grandifloras*		CR		-
6	*Dipterocarpus kerrii*		CR		-
7	*Dipterocarpus turbinatus*		CR		-
8	*Hopea apiculata*		CR		-
9	*Hopea helferi*		CR		-
10	*Hopea sangal*		CR		-
11	*Magnolia gustavii*		CR		-
12	*Nardostachys jatamansi*	Spikenard/muskroot	CR		-
13	*Parashorea stellata*	White Seraya	CR		-
14	*Shorea farinose*		CR		-
15	*Sonneratia griffithii*		CR		-
16	*Vatica lanceaefolia*		CR		-
17	*Afzelia xylocarpa*		CR		-
18	*Anisoptera costata*		EN		-
19	*Cleidiocarpon laurinum*		EN		-
20	*Cypripedium lichiangense*		EN		-
21	*Dalbergia oliveri*		EN		-
22	*Dipterocarpus a latus*		EN		-
23	*Dipterocarpus*		EN		-

	costatus			
24	*Heritiera fomes*		EN	-
25	*Hopea ferrea*		EN	-
26	*Illicium gritfithii*		EN	-
27	*Magnolia rostrata*		EN	-
28	*Paphiopedilum areeanum*		EN	-
29	*Paphiopedilum bellatulum*	Enchanting Paphiopedilum	EN	-
30	*Paphiopedilum charlesworthii*	Charlesworth Paphiopedilum	EN	-
31	*Paphiopedilum concolor*	One Colored Paphiopedilum	EN	-
32	*Paphiopedilum insigne*	Splendid Paphiopedilum	EN	-
33	*Paphiopedilum parishii*	Parish's Paphiopedilum-	EN	-
34	*Paphiopedilum spicerianum*	Spicer's Paphiopedilum	EN	-
35	*Paphiopedilum wardii*	Ward's Paphiopedilum	EN	-
36	*Shorea gratissima*		EN	-
37	*Shorea henryana*	White Meranti	EN	-
38	*Shorea roxburghii*	White Meranti	EN	-
39	*Taxus wallichiana*	East Himalayan Yew, Himalayan Yew	EN	-
40	*Vatica cinerea*		EN	-
41	*Aquilaria malaccensis*	Agarwood, Aloewood, Eaglewood, Lign-aloes	VU	-
42	*Burretiodendron esquirolii*		VU	-
43	*Cayratia pedata*		VU	-
44	*Cephalotaxus mannii*	Mann's Yew Plum	VU	-
45	*Cleidiocarpon cavaleriei*		VU	-
46	*Curcuma candida*		VU	-
47	*Cycas pectinate*		VU	-
48	*Cycas siamensis*		VU	-
49	*Dipterocarpus retusus*		VU	-
50	*Eleiotis rottleri*		VU	-
51	*Halophila beccarii*	Ocean Turf Grass,	VU	-

		Species code: Hb		
52	*Hopea griflithii*		VU	-
53	*Hopea odorata*		VU	-
		Borneo Teak, Moluccan		-
54	*lntsia bijuga*	Ironwood	VU	
55	*Magnolia nitida*		VU	-
	Paphiopedilum	Shaggy		-
56	*hirsutissimum*	Paphiopedilum	VU	
	Paphiopedilum	Villose		-
57	*villosum*	Paphiopedilum	VU	
58	*Picea brachytyla*	Sargent's Spruce	VU	-
59	*Picea farreri*	Farrer's Spruce	VU	-
	Pterocarpus	Amboyna Wood,		-
60	*indicus*	Burmese Rosewood	VU	
	Taiwania	Coffin Tree,		-
61	*cryptomerioides*	Taiwan Cedar, Tai	VU	

- Absent; CR = Critical Endanger , EN = Endanger species; VU = Vulnerable Species

Plate 1 Occurrence of some plant species

Zizyphus mauritiana Zi

Tamarindus indica L. Magyi

Pithecellobium dulce L.,Ta yoke mangyi

Leucaena Leucocephala, Bawzagaing Aweya

Phyllanthus emblica, Zee byu

Bomasc ceiba L. Lappan

Evaluation of Biomass along railway Bridge and Culverts

Forest acts an important part of the global cycle, storing carbon in both trees and soil. The large quantity of woody tissue of a tree in forest can accumulate the highest carbon density of all living things. The world forest is prominent sites to study of climate change, not only in terms of total net carbon emission but also in term of global storage capacity. Therefore this study focuses on carbon emissions but also in terms of aboveground biomass of different species. Aboveground biomass is an essential aspect of studies of carbon stocks and the effects of deforestation and carbon sequestration on the global carbon balance. Selected species that have been assessed were Tectona grandis (Teak), Xyliaxylo carpa (Pyinkadoe), Pterocarpus macrocarpus (Padauk), Pinus kesiya (Htinyu), Gmelina arborea (Yemane), Cassia mimosoides (Mezali), Vernicia fordii (Tansi), Quercus dealbata (Kywatsr), Amoora rohituk (Thitni), Neonauclea excels (Thitpayaung), Shorea obtuse (Thitya), Shorea siamensis (Ingyin), Terminalia crenulata (Taukkyant), Cephalostachyum pergracile (Tin-wa), Thyrsostachys oliveri (Thatnat-wa), Dendrocalamus strictus (Hmyin-wa), Bambusa tulda (Thaik-wa). For estimation of aboveground biomass, the first is to estimate wood volume of each species depending on the diameter at breast height (DBH) and tree height (H).

The mixed forest which has been focused on study area was established on Shan State and Mandalay region such as Kutkai, Hsipaw, Kyaukme, Nawnghkio and Pyin Oo Lwin. Pterocarpus macrocarpus (Padauk) has received the highest value in volume while Bambusa tulda (Thaik-wa) has the lowest value. The DBH, tree height and values of volume for each species was described in the following table .

Table - Volume per stem (m^3) and biomass per stem (kg) of different species

No:	Species		DBH (cm)	Tree Height (m)	Volume/stem (m3)	Biomass (kg/stem)
	Common Name	Scientific Name				
1	Teak	Tectona garndis	25	20	0.412388	409.0059225
2	Pyinkadoe	Xylia xylocarpus	28	20	0.517299	513.0570292
3	Pakdauk	Pterocarpus macrocarpus	32	25	0.84457	837.6441293
4	Pine	Pinus kesiya	20	18	0.237535	235.5874114
5	Yemane	Gmelina arborea	22	18	0.287418	285.0607677
6	Mezali	Cassia mimosoides	25	15	0.309291	306.7544419

7	Tung si	Vernicia fordii	19	18	0.214376	212.6176388
8	Kywatsr	Quercus dealbata	15	25	0.185574	184.0526651
9	Thitni	Amoora rohituk	25	17	0.350529	347.6550341
10	Thitphayaung	Neonauclea excelsa	24	20	0.380056	376.9398582
11	Thitya	Shorea obtuse	23	21	0.366497	363.4917434
12	Ingyin	Shorea siamensis	21	23	0.334628	331.8837658
13	Taukkyan	Terminalia crenulata	28	18	0.465569	461.7513263
14	Bamboo (Tin-wa)	Cephalostachyum pergracile	9.5	18	0.053594	53.15440969
15	Thanat_wa	Thyrsostachys oliveri	7	15	0.024248	24.04954824
16	Hmyin-wa	Dendrocalamus strictus	7	16	0.025865	25.65285146
17	Thaik-wa	Bambusa tulda	6.5	14	0.000462	0.458086633
18	Coffee		2	3.5	0.000462	0.458086633
19	Macadama		3	15	0.004454	4.417263963

Aboveground biomass of above species in which most of them is regarded as commercially important species in Myanmar such as Teak, Pyinkadoe, Padauk, Ingyin and Thitya. Among these species, Pterocarpus macrocarpus (Padauk) has the highest value of aboveground biomass. According to the result, Tectona grandis (Teak), Xyliaxylo carpa (Pyinkadoe), and Neonauclea excels (Thitpayaung) have high aboveground biomass so that they can be regarded as highly prioritized species for reforestation activities for railway projects. Aboveground biomass based on the tree was shown in the following figure.

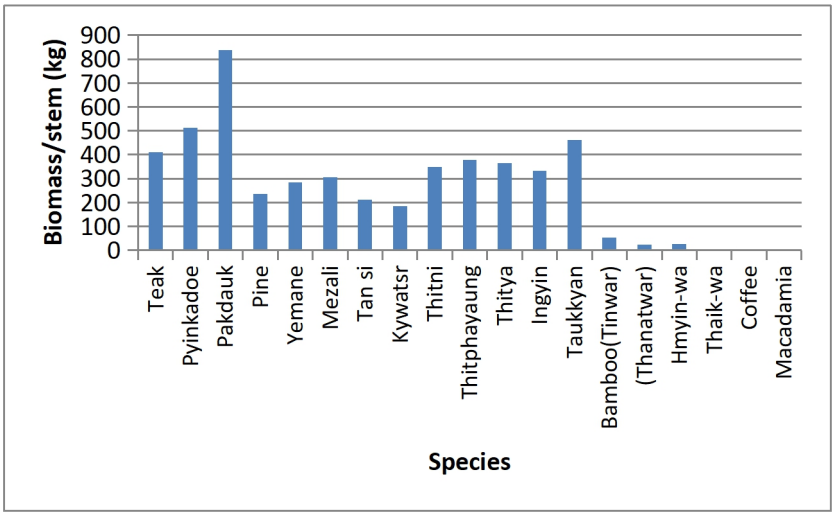


Figure - Comparison of above ground biomass of different species

According to the result, Hsipaw has the highest value of aboveground biomass having 4321kg, followed by Naung Cho has the second largest area having 2279kg, Pyin Oo Lwin has 1314kg, Kutkai has 940kg and Kyaukme has the smallest aboveground biomass 285 kg. In Hsipaw, Tansi, Padauk, Teak, Yemane, Mezali and Pyinkadoe are present and padauk has the largest aboveground biomass compared with the other. So, these species can be regarded as highly prioritized species for reforestation activities for railway project and padauk can be regarded as the most important species. Therefore, this native species can be replanted in appropriate area away from the railway or around the degraded forest and need to be reforestation with approximate amount. Aboveground biomass of bridge and culverts passing through the forest was represented in the following figure.

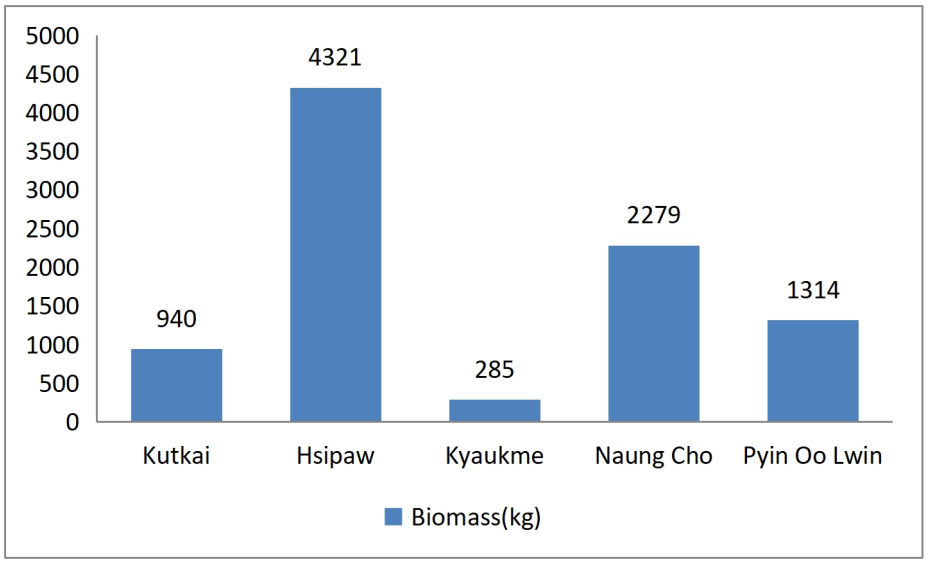


Figure - Comparison of above round biomass of study site passing the bridge and culverts

5.5.9.2. Fauna

Occurrence of fauna species at study sites

Table - List of recorded insect species from study area, Armarapura and Patheingyi at Muse-Mandalay Railway

No.	Order/Family	Species	Common name	Local name
I	**Homoptera**			
1.	Cercopidae	*Philaenus spumarius*	Froghopper	-
2.	Cicadellidae	*Idioscopus nitidulus*	Mango Hopper	-

II	**Hemiptera**			
3.	Lygaeidae	*Graptostethus argentatus*	Graptostethus Bugs	-
4.	Coreinae	*Cletus bipunctatus*	The Squash Bugs	-
5.	Pseudococcidae	*Drosicha mangiferae*	Mango Mealy Bug	-
6.	Diaspididae	*Aulacaspis tuberculis*	Mango Scale	-
III	**Coleoptera**			
7.	Rhysodidae	*Rhysodes taprobanae*	Wrinkled Bark Beetle	-
8.	Cerambycidae	*Batocera rufomaculata*	Red-spotted Longhorn Beetle	-
9.		*Batocera rubus*	White-spotted Longhorn Beetle	-
10.		*Laccoptera quadrimaculata*	Tortoise Beetles	-
11.	Curculionidae	*Hypomeces squamosus*	Gold-dust Weevil	-
IV	**Hymenoptera**			
12.	Formicidae	*Formica rufa*	Wood ant	-
V	**Lepidoptera**			
13.	Papilionidae	*Papilio demoleus*	Lime Butterfly	-
14.		*Papilio polytes romulus*	Common Mormon	-
15.		*Papilio memnon agenor*	Great Mormon	-
16.	Pieridae	*Ixias pyrene*	The Great Orange Tip	-
17.		*Catopsilia pomona*	The Common Emigrant	-
18.		*Eurema hecabe*	The Common Grass Yellow	-
19.		*Eurema laeta*	The Spotless Grass Yellow	-
20.	Nymphalidae	*Junonia lemonias*	The Lemon Pansy	-
21.		*Phalantha phalantha*	The Sun Loving Butterfly	-
VI	**Odonata**			
22.	Gomphidae	*Ictinogonphus rapax*	Dragonfly	-

Table - List of recorded fish and crustacea species from study area, Armarapura and Patheingyi at Muse-Mandalay Railway

No.	Order/Family	Species	Common name	Local name
Fish				
I	**Siluriformes**			
1.	Clariidae	*Clarias batrachus*	Magur	Nga-kun
II	**Perciformes**			
3.	Chanidae	*Channa punctatus*	Spotted snakehead	Nga-yant-pa-naw
4.		*Channa striatus*	Striped or Banded snakehead	Nga-yant-gaung-shay
Crustacea				
III	**Decapoda**			
5.	Parathelphusidae	*Paratelphusa hydrodromus*	Rice field crab	Pa-zun-lone

Table - List of recorded herpet species from study area, Armarapura and Patheingyi at Muse-Mandalay Railway

No.	Order/Family	Species	Common name	Local name
Amphibian				
I	**Anura**			
1.	Bufonidae	*Dusttaphrynus melanostiauts*	Common toad	hpar-pyoke
2.	Dicroglossidae	*Fejervarya greenii boulenger*	Paddy frog	hpar-paung-zin
3.		*Fejervary liconocharis*	Paddy frog	kyaw-san-kay
4.	Microhylidae	*Kaloula pulchra*	Bull frog	hpar-kon-nyin
Reptile				
II	**Squamata**			
5.	Viperidae	*Daboia siamensis*	Viper	mwe-pwe
6.	Elpidae	*Naja* sp.	Cobra	Mywey-hauk
7.	Gekkonidae	*Gekko gecko*	House lizard	Totk-taet
8.		*Hemidactylus frenatus*	Asian House gecko	Eain-myaung
9.	Agamidae	*Calotes mystaceus*	Tree or ground lizard	poke-thin-nyo
10.	Scincidae	*Eutropis macularia*	Skink	king-lekk-shaw

Table - List of recorded bird species from study area, Armarapura and Patheingyi at Muse-Mandalay Railway

No.	Order/Family	Species	Common name	Local name
I	**Ciconiiformes**			
1.	Ardeidae	*Ardeola bacchus*[*]	Chinese Pond-heron	byaing-auk
2.		*Mesophoyx intermedia*[*]	Intermediate Egret	tharrawaddy-byaing
3.	Bubulcus	*Bubulcus coromandus*[*]	Cattle Egret	kywe-kyaung-byaing
4.	Alcedinidae	*Alcedo atthis*[*]	Common Kingfisher	pain-nyin
II	**Suliformes**			
5.	Phalacrocoracidae	*Microcarvbo niger*[*]	Little Commorant	aw-yaw
III	**Falconiformes**			
6.	Columbidae	*Columba livia*	Rock Pigeon	kho
7.		*Streptopelia tranquebarica*	Red-collared Dove	gyo-ni-pu
8.		*Spilopelia chinensis*	Spotted Dove	gyo-le-pyauk
9.		*Treron phoenicoptera*	Yellow-footed Green Pigeon	ngu
IV	**Psittaciformes**			
10.	Sturnidae	*Psittacula krameri*	Rose-ringed Parakeet	kyae-kyute
V	**Cuculiformes**			
11.	Centropdinae	*Centropus sinensis*	Greater Coucal	bok
VI	**Coraciiformes**			
12.	Meropidae	*Merops orientalis*	Green bee-eater	hnet-pa-sin-hto
13.	Upupa	*Upupa epops*	Common Hoopoe	bi-daung-bo
VII	**Piciformes**			
14.	Ramphastidae	*Megalaima haemacephala*	Coppersmith Barbet	hnget-padain
VIII	**Passeriformes**			
15.	Corvidae	*Corvus splendens*	House Crow	kyi-gan
16.	Sturnidae	*Acridotheres tristis*	Common Myna	zayet
17.		*Acridotheres javanicus*	White-vented Myna	Zayet-hpin-phyu
18.		*Acridotheres fuscus*	Jungle Myna	taw-zayet
19.	Pycnonotidae	*Pycnonotus caer*	Red-vented Bulbul	but-phin-ni
20.	Oriolidae	*Oriolus xanthornus*	Black-hooded oriole	hnet-wah

21.	Dicruridae	*Dicrurus macrocercus*	Black-Drongo	lin-me-swae
22.		*Dicrurus leucophaeus*	Ashy Drongo	lin-me-swae
23.	Corvidae	*Dendrocitta vagabunda*	Rufous Treepie	hna-phar-kyuu
24.		*Crypsiprinia cucullata*	Hooded Treepie	hna-phar-kyuu
25.	Aegithinidae	*Aegithina tiphia*	Common Iora	shwe-pyi-soe
26.	Laniidae	*Lanius collurioides*	Burmese Shrike	hnet-be-lue
27.		*Lanius cristatus*	Brown Shrike	wa-yon-hnget
28.	Nectarinidae	*Nectarinia asiatina*	Purple Sunbird	witye-soak-hnet
29.	Dicaeidae	*Dicaeum crueniatum*	Scarlet-backed Flowerpecker	-
30.	Plaeciodae	*Lonchura punctulata*	Scaly-breasted Munia	sar-wati
31.	Passeridae	*Passer domesticus*	House Sparrow	sar kalay
32.		*Passer montanus*	Eurasian Tree Sparrow	thit-pin-sar
33.	Estrildidae	*Lonchura punctulata*	Scaly-breasted Munia	sar-pauk
34.	Motacilla	*Motacilla alba*	White Wagtail	mye-nyaung-hnget
35.	Muscicapidae	*Saxicola caprata*	Pied Bushchat	
36.	Cisticolidae	*Prinia inornata*	Plane Prinia	hnget-let-ma
37.		*Orthotomus sutorius*	Common Tailorbird	hnan-pyi-soak

*Waterbirds; Order 8; Family 26; Waterbirds 5; Terrestrial birds 32

Table - List of recorded mammal species from study area, Armarapura and Patheingyi at Muse-Mandalay Railway

No.	Order/Family	Species	Common name	Local name
I	**Primate**			
1.	Cercopithecidae	*Macaca mulatta*	Rhesus macaque	myaut-sat
II	**Rodentia**			
2.	Sciuridae	*Callosciurus erythreus*	Pallas's squirrel	shin-nga-paw
3.	Muridae	*Rattus rattus*	Black rat	kywet-net
4.	Chrioptera		Microbat	Lin-noe
5.			Macrobat	Lin-swe

Table - Occurrence and abundance of insect species recorded from Armapura and Patheingyi at Muse-Mandalay Railway

No.	Scientific name	Common name	Study sites						Total		
			I	II	III	IV	V	VI			
1	Philaenus spumarius	Froghopper	0	5	3	2	1	0	11	0.049	C
2	*Idioscopus nitidulus*	Mango Hopper	0	6	2	1	0	0	9	0.040	C
3	Graptostethus argentatus	Graptostethus Bugs	0	3	1	2	0	0	6	0.027	C
4	Cletus bipunctatus	The Squash Bugs	0	2	1	0	0	0	3	0.013	C
5	Drosicha mangiferae	Mango Mealy Bug	0	3	2	6	1	0	12	0.054	vC
6	Aulacaspis tuberculis	Mango Scale	0	4	2	6	2	0	14	0.063	vC
7	Rhysodes taprobanae	Wrinkled Bark Beetle	0	1	2	1	0	0	4	0.018	C
8	Batocera rufomaculata	Red-spotted Longhorn Beetle	0	2	1	1	0	0	4	0.018	C
9	Batocera rubus	White-spotted Longhorn Beetle	0	1	0	0	0	0	1	0.004	uC
10	Laccoptera quadrimaculata	Tortoise Beetles	0	1	1	0	0	0	2	0.009	uC
11	Hypomeces squamosus	Gold-dust Weevil	0	5	4	4	0	0	13	0.058	vC
12	Formica rufa	Wood ant	6	7	5	2	1	6	27	0.121	vC
13	Papilio demoleus	Lime Butterfly	2	1	3	4	1	2	13	0.058	vC
14	Papilio polytes romulus	Common Mormon	0	5	4	1	0	0	10	0.045	C
15	Papilio memnon agenor	Great Mormon	2	4	1	3	0	4	14	0.063	vC
16	Ixias pyrene	The Great Orange Tip	0	2	5	3	0	4	14	0.063	vC
17	Catopsilia pomona	The Common Emigrant	0	3	2	1	0	4	10	0.045	C
18	Eurema hecabe	The Common Grass Yellow	0	4	2	1	1	3	11	0.049	C
19	Eurema laeta	The Spotless Grass Yellow	0	2	2	1	1	3	9	0.040	C
20	Junonia lemonias	The Lemon Pansy	0	6	4	1	0	4	15	0.067	vC
21	Phalantha phalantha	The Sun Loving Butterfly	0	7	2	1	0	6	16	0.072	vC
22	*Ictinogonphus rapax*	Dragonfly	3	0	0	2	0	0	5	0.022	C
	Total no. of individuals		10	74	49	41	8	36	218		
	Total no. of species		3	21	20	18	8	9	21		

Table - Occurrence and abundance of fish and crustacea species recorded from Armarapura and Patheingyi at Muse-Mandalay Railway

No.	Scientific name	Common name	Study sites						Total	Abundance	Relative abundance
			I	II	III	IV	V	VI			
1	*Clarias batrachus*	Magur	1	1	0	0	0	0	2	0.154	vC
2	Channa punctatus	Spotted snakehead	1	2	0	0	0	0	3	0.231	vC
3	Channa striatus	Striped or Banded snakehead	2	1	0	0	0	0	3	0.231	vC
4	*Paratelphusa hydrodromus*	Rice field crab	1	2	1	1	0	0	5	0.385	vC
	Total no. of individuals		5	6	1	1	0	0	13		
	Total no. of species		4	4	1	1	0	0	4		

Table - Occurrence and abundance of herpet species recorded from Armarapura and Patheingyi at Muse-Mandalay Railway

No.	Scientific name	Common name	Study sites						Total	Abundance	Relative abundance
			I	II	III	IV	V	VI			
1	*Bufo bufo*	Common toad	1	0	2	0	1	0	4	0.154	vC
2	Fejervarya greenii boulenger	Paddy frog	1	0	0	0	0	0	1	0.038	vC
3	Fejervary liconocharis	Paddy frog	0	1	0	0	0	0	1	0.038	vC
4	Kaloula pulchra	Bull frog	+	+	+	+	-	-		QS	Questionnaires' Survey
5	Daboia siamensis	Viper	+	+	+	+	+	-		QS	-
6	Naja sp.	Cobra	+	+	+	+	+	+		QS	-
7	Gekko gecko	House lizard	2	0	1	0	2	1	6	0.231	vC
8	Hemidactylus frenatus	Asian House gecko	1	2	1	0	1	2	7	0.269	vC
9	Calotes mystaceus	Tree or ground lizard	1	0	0	1	1	1	4	0.154	vC
10	Eutropis macularia	Skink	1	0	0	1	0	1	3	0.115	vC
	Total no. of individuals		7	3	4	2	5	5	26		
	Total no. of species		9	6	6	5	6	5	10		

Table - Occurrence and abundance of bird species recorded from Armarapura and Patheingyi at Muse-Mandalay Railway

No.	Scientific name	Common name	Study sites						Total	Abundance	Relative Abundance
			I	II	III	IV	V	VI			
1	*Ardeola bacchus**	Chinese Pond-heron	3	0	0	3	0	0	6	0.025	C
2	*Mesophoyx intermedia**	Intermediate Egret	0	4	0	2	0	0	6	0.025	C
3	*Bubulcus coromandus**	Cattle Egret	1	0	4	0	0	0	5	0.020	C
4	*Alcedo atthis**	Common Kingfisher	1	0	0	0	0	0	1	0.004	uC
5	*Microcarvbo niger**	Little Commorant	1	0	0	0	0	0	1	0.004	uC
6	*Columba livia*	Rock Pigeon	2	0	0	0	0	5	7	0.029	C
7	*Streptopelia tranquebarica*	Red-collared Dove	0	0	0	0	0	2	2	0.008	uC
8	*Spilopelia chinensis*	Spotted Dove	6	5	3	6	1	15	36	0.148	vC
9	*Treron phoenicoptera*	Yellow-footed Green Pigeon	0	0	0	0	0	1	1	0.004	uC
10	*Psittacula krameri*	Rose-ringed Parakeet	2	0	0	0	0	0	2	0.008	uC
11	*Centropus sinensis*	Greater Coucal	0	0	0	0	1	0	1	0.004	uC
12	*Merops orientalis*	Green bee-eater	4	0	0	0	0	18	22	0.090	vC
13	*Upupa epops*	Common Hoopoe	0	0	0	0	0	3	3	0.012	vC
14	*Megalaima haemacephala*	Coppersmith Barbet	0	0	0	0	0	2	2	0.008	uC
15	*Corvus splendens*	House Crow	17	2	0	0	0	0	19	0.078	vC
16	*Acridotheres tristis*	Common Myna	4	0	0	0	0	0	4	0.016	C
17	*Acridotheres javanicus*	White-vented Myna	3	0	0	0	0	0	3	0.012	C
18	*Acridotheres fuscus*	Jungle Myna	6	0	0	0	0	0	6	0.025	C
19	*Pycnonotus caer*	Red-vented Bulbul	0	3	2	0	2	0	7	0.029	C
20	*Oriolus xanthornus*	Black-hooded oriole	0	0	0	0	0	1	1	0.004	uC
21	*Dicrurus macrocercus*	Black-Drongo	0	1	1	0	0	10	12	0.049	C
22	*Dicrurus leucophaeus*	Ashy Drongo	0	0	0	0	0	9	9	0.037	C
23	*Dendrocitta vagabunda*	Rufous Treepie	0	0	0	0	0	3	3	0.012	C

24	*Crypsiprinia cucullata*	Hooded Treepie	0	0	0	0	0	2	2	0.008	uC
25	*Aegithina tiphia*	Common Iora	0	0	0	1	0	11	12	0.049	C
26	*Lanius collurioides*	Burmese Shrike	0	0	0	0	1	4	5	0.020	C
27	*Lanius cristatus*	Brown Shrike	1	0	0	1	0	0	2	0.008	uC
28	*Nectarinia asiatina*	Purple Sunbird	0	0	0	0	0	0	4	0.016	C
29	*Dicaeum crueniatum*	Scarlet-backed	0	0	0	0	0	2	2	0.008	uC
30	*Lonchura punctulata*	Scaly-breasted Munia	3	0	0	0	0	0	3	0.012	C
31	*Passer domesticus*	House Sparrow	12	10	0	0	0	0	22	0.090	vC
32	*Passer montanus*	Eurasian Tree Sparrow	0	0	0	0	0	0	9	0.037	C
33	*Lonchura punctulata*	Scaly-breasted Munia	0	0	0	0	0	16	16	0.066	vC
34	*Motacilla alba*	White Wagtail	0	0	1	0	0	17	18	0.074	vC
35	*Saxicola caprata*	Pied Bushchat	1	0	0	0	0	0	1	0.004	uC
36	*Prinia inornata*	Plane Prinia	0	2	2	0	0	0	4	0.016	C
37	*Orthotomus sutorius*	Common Tailorbird	0	0	0	0	1	0	1	0.004	uC
	Total no. of individuals		67	27	13	13	6	121	247		
	Total no. of species		16	7	6	5	5	17	37		

* = waterbirds, uC = Uncommon, C = Common, vC = Very common

Waterbirds = 5 species ; Terrestrial birds = 32 species, uC = 13 species; C = 17 species ; vC = 7 species

Table - Occurrence and abundance of mammal species recorded from Armarapura and Patheingyi at Muse-Mandalay Railway

No.	Secific name	Common name	Study sites						Total	Abundance	Relative Abundance
			I	II	III	IV	V	VI			
1	*Macaca mulatta*	Rhesus macaque	0	0	0	0	0	20	20	0.690	vC
2	Callosciurus erythreus	Pallas's	2	1	3	0	0	1	7	0.241	vC
3	Rattus rattus	Black rat	1	1	0	0	0	0	2	0.069	vC
4		Microbat	+	+	+	+	+	+	QS		Questionnaires' Survey
5		Macrobat	+	+	+	+	+	+	QS		-
	Total no. of individuals		3	2	3	0	0	21	29		
	Total no. of species		4	4	3	2	2	4	5		

Composition and diversity

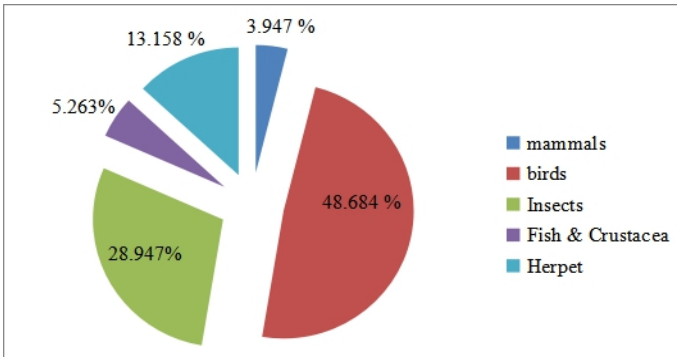


Figure - Species composition of mammals, birds, insects, fish & crustacea and herpet recorded from Armarapura and Patheingyi at Muse-Mandalay Railway

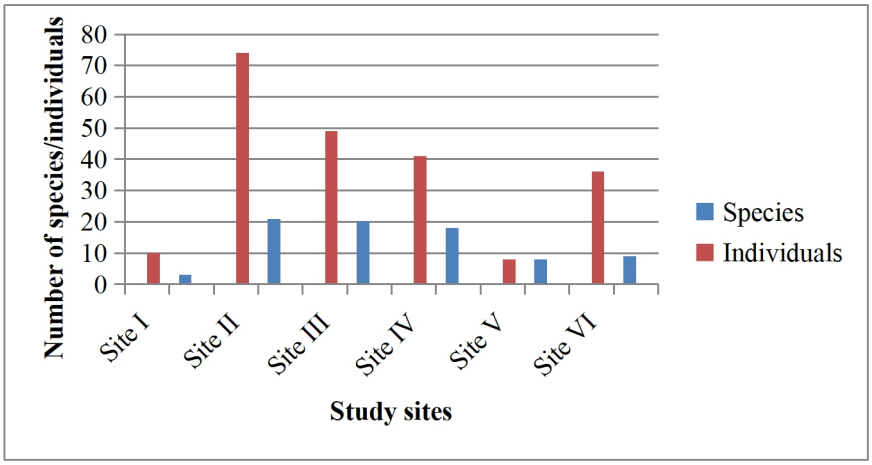


Figure - Composition of insect species recorded in five study sites from Armarapura and Patheingyi at Muse-Mandalay Railway

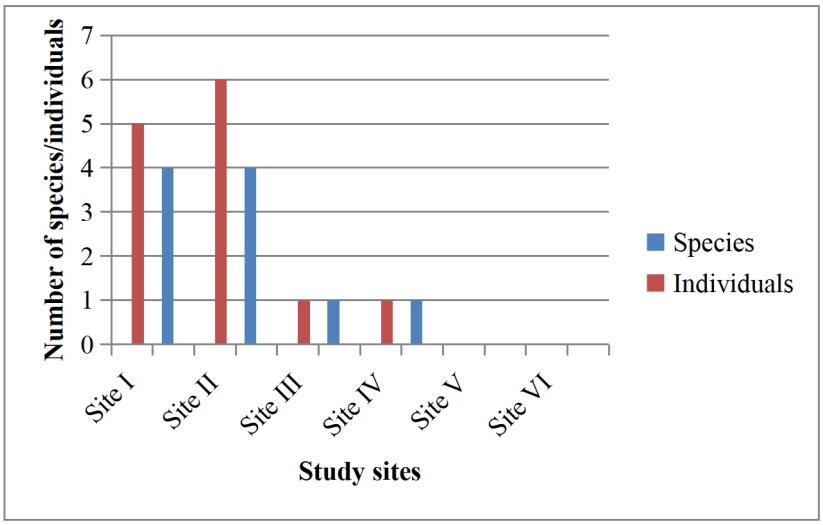


Figure - Composition of fish and crustacea species recorded in five study sites from Armarapura and Patheingyi at Muse-Mandalay Railway

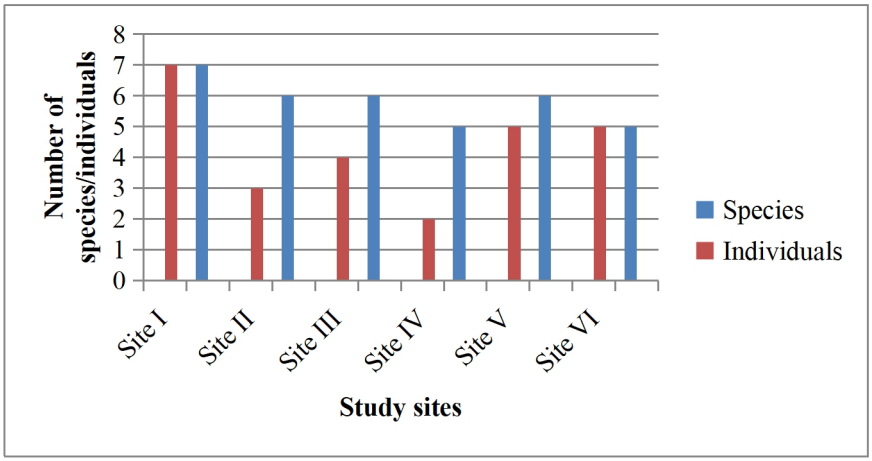


Figure - Composition of herpet species recorded in five study sites from Armarapura and Patheingyi at Muse-Mandalay Railway

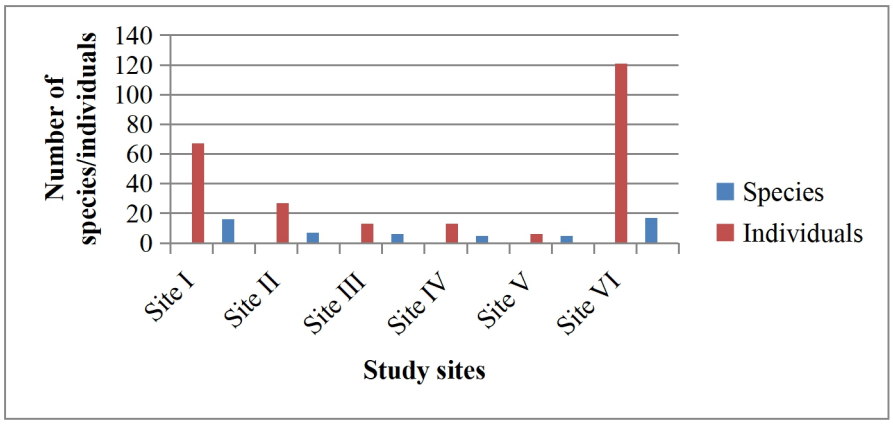


Figure - Composition of bird species recorded in five study sites from Armarapura and Patheingyi at Muse-Mandalay Railway

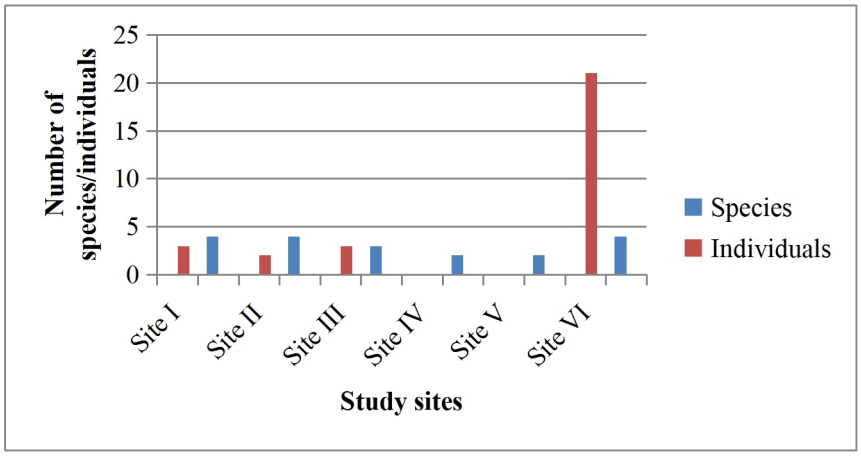


Figure - Composition of mammal species recorded in five study sites from Armarapura and Patheingyi at Muse-Mandalay Railway

Diversity

Table - Diversity of insect species from Armarapura and Patheingyi at Muse-Mandalay Railway

No.	Family	No. of species	RDi (%)
1.	Cercopidae	1	4.545
2.	Cicadellidae	1	4.545
3.	Lygaeidae	1	4.545
4.	Coreinae	1	4.545
5.	Pseudococcidae	1	4.545
6.	Diaspididae	1	4.545
7.	Rhysodidae	1	4.545
8.	Cerambycidae	3	13.636
9.	Curculionidae	1	4.545
10.	Formicidae	1	4.545
11.	Papilionidae	3	13.636
12.	Pieridae	4	18.182
13.	Nymphalidae	2	9.091
14.	Odonata	1	4.545
	Total no. of species	22	

Table - Diversity of insect species from Armarapura and Patheingyi at Muse-Mandalay Railway

No.	Family	No. of species	RDi
1.	Clariidae	1	25
2.	Chanidae	2	50
3.	Parathelphusidae	1	25
	Total no. of species	4	

Table - Diversity of herpet species from Armarapura and Patheingyi at Muse-Mandalay Railway

No.	Family	No. of species	RDi
1.	Bufonidae	1	10
2.	Dicroglossidae	2	20
3.	Microhylidae	1	10
4.	Viperidae	1	10
5.	Elpidae	1	10
6.	Gekkonidae	2	20
7.	Agamidae	1	10
8.	Scincidae	1	10
	Total no. of species	10	

Table - Diversity of bird species from Armarapura and Patheingyi at Muse-Mandalay Railway

No.	Family	No. of species	RDi
1.	Ardeidae	2	5.405
2.	Bubulcus	1	2.703
3.	Alcedinidae	1	2.703
4.	Phalacrocoracidae	1	2.703
5.	Columbidae	4	10.811
6.	Sturnidae	1	2.703
7.	Centropdinae	1	2.703
8.	Meropidae	1	2.703
9.	Upupa	1	2.703
10.	Ramphastidae	1	2.703
11.	Corvidae	1	2.703
12.	Sturnidae	3	8.108
13.	Pycnonotidae	1	2.703
14.	Oriolidae	1	2.703
15.	Dicruridae	2	5.405
16.	Corvidae	2	5.405
17.	Aegithinidae	1	2.703
18.	Laniidae	2	5.405
19.	Nectarinidae	1	2.703
20.	Dicaeidae	1	2.703
21.	Plaeciodae	1	2.703
22.	Passeridae	2	5.405
23.	Estrildidae	1	2.703
24.	Motacilla	1	2.703
25.	Muscicapidae	1	2.703
26.	Cisticolidae	2	5.405
	Total no. of species	37	

Table - Diversity of mammal species from Armarapura and Patheingyi at Muse-Mandalay Railway

No.	Family	No. of species	RDi
1.	Cercopithecidae	1	25
2.	Sciuridae	1	25
3.	Muridae	1	25
4.	Chrioptera	2	50
	Total no. of species	5	

Habitat Utilization and IUCN Conservation Status

Table - Conservation and Habitat utilization of insect species recorded from Armarapura and Patheingyi at Muse-Mandalay Railway

No.	Scientific name	Feeding	Occurrence sites	IUCN status
1	*Philaenus spumarius*	Feeding on the inflorescence and flowers	II, III, IV, V	-
2	*Idioscopus nitidulus*	piercing the tissues and sucking the plant sap	II, III, IV	-
3	*Graptostethus argentatus*	flowers and shoots, feeding on insect egg	II, III, IV	-
4	*Cletus bipunctatus*	Feed by sucking the sap from the leaves of mango	II, III	-
5	*Drosicha mangiferae*	Feed on leaves, especially on the flushes	II, III, IV, V	-
6	*Aulacaspis tuberculis*	suck the sap of leaves and other tender parts reducing vigor of plants	II, III, IV, V	-
7	*Rhysodes taprobanae*	Feed on terminal growth and larvae	II, III, IV	-
8	*Batocera rufomaculata*	Feed on boring long tunnels through branches and stems	II, III, IV	-
9	*Batocera rubus*	Feed and tunnel under the bark or into the wood	II	-
10	*Laccoptera quadrimaculata*	Feed by scraping the surface tissues of the leaves	II, III	-
11	*Hypomeces squamosus*	Feeding on the foliage of plants	II, III, IV	-
12	*Formica rufa*	Eat woody plants	All	-
13	*Papilio demoleus*	Feeding on flowering shrub	All	LC
14	*Papilio polytes romulus*	Feeding on flowering shrub	II, III, IV	LC
15	*Papilio memnon agenor*	Feeding on flowering shrub	I, II, III, IV,	LC

16	*Ixias pyrene*	Feeding on flowering shrub	II, III, IV	LC
17	*Catopsilia pomona*	Feeding on flowering shrub	II, III, IV	LC
18	*Eurema hecabe*	Feeding on flowering shrub	II, III, IV, V, VI	LC
19	*Eurema laeta*	Feeding on flowering shrub	II, III, IV, V, VI	LC
20	*Junonia lemonias*	Feeding on flowering shrub	II, III, IV, V, VI	LC
21	*Phalantha phalantha*	Feeding on flowering shrub	II, III, IV	LC
22	*Ictinogonphus rapax*	Dragonfly	I, IV	LC

Table - Conservation and habitat utilization of fish and crustacea species recorded from Armarapura and Patheingyi at Muse-Mandalay Railway

No.	Scientific name	Feeding	Habitat	IUCN status
1.	*Clarias batrachus*	Aquatic	Paddy field	LC
2.	Channa punctatus	-	-	LC
3.	Channa striatus	-	-	LC
4.	*Paratelphusa hydrodromus*	-	-	-

Table - Conservation and habitat utilization of herpet species recorded from Armarapura and Patheingyi at Muse-Mandalay Railway

No.	Scientific name	Feeding	Habitat	IUCN status
1.	*Bufo bufo*	invertebrates	open countryside, fields, copses, parks and gardens	LC
2.	*Fejervarya greenii boulenger*	Insects	Forest, wetland	-
3.	*Fejervary liconocharis*	Insects	Forest, wetland	-
4.	*Kaloula pulchra*	Insects	Forest, wetland, grassland	LC
5.	*Daboia siamensis*		Burrow or climb into shrubby trees	LC

6.	*Naja sp.*		dense or open forests, plains, agricultural lands (rice paddy fields, wheat crops), rocky terrain, wetlands	LC
7.	*Gekko gecko*	insects	roaming walls and ceilings	LC
8.	*Hemidactylus frenatus*	insects	Savanna, desert, forest and rock areas.	LC
9.	*Calotes mystaceus*	Feeds on crickets, grasshoppers, moths, and other insects.	Forest, trees near city parks	NE, Not Evaluated
10.	*Eutropis macularia*	eating various types of insects		NE, Not Evaluated

Table - Conservation and habitat utilization of bird species recorded from Armarapura and Patheingyi at Muse-Mandalay Railway

No	Secific name	Common name	Feeding	Habitat	IUCN Status
1	*Ardeola bacchus**	Chinese Pond-heron	insects, fish, crustaceans	wetlands, ponds	LC
2	*Mesophoyx intermedia**	Intermediate Egret	insects, fish, frogs, crustaceans	wetlands, ponds	LC
3	*Bubulcus coromandus**	Cattle Egret	insects, spiders, frogs, earthworm	Woodland, near lakes, rivers, in swamps	LC
4	*Alcedo atthis**	Common Kingfisher	aquatic insects, fish, water beetles	slow-flowing streams and rivers, and lakes with well-vegetated banks.	LC
5	*Microcarvbo niger**	Little Commorant	mainly fish	Ponds and lakes	LC
6	*Columba livia*	Rock Pigeon	scavengers, and frequently feed on human garbage	open and semi-open environments	LC
7	*Streptopelia tranquebarica*	Red-collared Dove	scavengers, insects	woodland, semi open environments	LC
8	*Spilopelia chinensis*	Spotted Dove	scavengers, insects	light forests and gardens as well as in urban areas.	LC
9	*Treron phoenicoptera*	Yellow-footed Green Pigeon	mainly fruits	dense forest areas	LC
10	*Psittacula krameri*	Rose-ringed Parakeet	fruits, vegetables, pellets, seeds	forest	LC
11	*Centropus sinensis*	Greater Coucal	insects, eggs	from jungle to cultivation and urban gardens	LC

12	*Merops orientalis*	Green bee-eater	insects, bees, waps and ants	urban and sub-urban neighborhoods	LC
13	*Upupa epops*	Common Hoopoe	insects, small reptiles, frogs and plant matters	lightly vegetated ground on which to forage and vertical surfaces with cavities	LC
14	*Megalaima haemacephala*	Coppersmith Barbet	flower petals	gardens, groves and sparse woodland	LC
15	*Corvus splendens*	House Crow	refuse, small reptiles and mammals	from small villages to large cities	LC
16	*Acridotheres tristis*	Common Myna	insects, arachnids, crustaceans and reptiles, small mammals and seed	open woodland, cultivation and around habitation	LC
17	*Acridotheres javanicus*	White-vented Myna	insects, arachnids, crustaceans and reptiles, small mammals and seed	cities and cultivated areas	VU
18	*Acridotheres fuscus*	Jungle Myna	insects, arachnids, crustaceans and reptiles, small mammals and seed	forest and cultivation	LC
19	*Pycnonotus caer*	Red-vented Bulbul	fruits, petals of flowers	open forest, plains and cultivated lands	LC
20	*Oriolus xanthornus*	Black-hooded oriole	insects and fruit, especially figs	open woodland and cultivation	LC
21	*Dicrurus macrocercus*	Black-Drongo	mainly on insects	open country	LC
22	*Dicrurus leucophaeus*	Ashy Drongo	mainly on insects	tall forest habitat	LC
23	*Dendrocitta vagabunda*	Rufous Treepie	feeding on fruits, nectar and seeds	open forest consisting of scrub, plantations and gardens	LC
24	*Crypsiprinia cucullata*	Hooded Treepie	feeding on fruits, nectar and seeds	lowland forests	EN, NT
25	*Aegithina tiphia*	Common Iora	mainly on insects	trees	LC
26	*Lanius collurioides*	Burmese Shrike		lowland forests	LC

27	*Lanius cristatus*	Brown Shrike	prey on thorns. Small birds and lizards	taiga, forest to semi-desert	LC
28	*Nectarinia asiatina*	Purple Sunbird	feed mainly on nectar	found in gardens with suitable flowers	LC
29	*Dicaeum crueniatum*	Scarlet-backed	the figs of Ficus fistulosa and F. grossularoides	lowland forests and occasionally gardens	LC
30	*Lonchura punctulata*	Scaly-breasted Munia	mainly grass seeds apart from berries and small insects.	tropical plains and grasslands.	LC
31	*Passer domesticus*	House Sparrow	seeds of grains and weeds	in urban or rural settings	LC
32	*Passer montanus*	Eurasian Tree Sparrow	mainly on seeds, invertebrates	lightly wooded open countryside	LC
33	*Lonchura punctulata*	Scaly-breasted Munia			LC
34	*Motacilla alba*	White Wagtail	insects and small vertebrates	near-constant tail wagging, a trait that has given the species	LC
35	*Saxicola caprata*	Pied Bushchat	mainly on insects	open habitats including scrub, grassland and cultivation	LC
36	*Prinia inornata*	Plane Prinia	mainly on insects	open habitats such as long grass or scrub,	LC
37	*Orthotomus sutorius*	Common Tailorbird	eed on a range of beetles and bugs.	in the undergrowth or trees	LC

Table - Conservation and habitat utilization of mammal species recorded from Armarapura and Patheingyi at Muse-Mandalay Railway

No.	Scientific name	Feeding	Habitat	IUCN status
1.	*Macaca mulatta*	leaves, flowers, seeds, and fruit	grasslands to arid and forested areas	LC
2.	*Callosciurus erythreus*	leaves, flowers, seeds, and fruit	Forest habitats	LC
3.	*Rattus rattus*	seeds, fruit, stems, leaves, fungi, and a variety of invertebrates and vertebrate	around fences, ponds, riverbanks, streams, and reservoirs.	LC

Table - Endangered Animals of Myanmar

Rank	Animal Name	Scientific Name	Conservation Status (IUCN)	Occurrence in study area
1	White-bellied heron	*Ardea insignis*	Critically Endangered	Absent
2	Baer's Pochard	*Aythya baeri*	Critically Endangered	Absent
3	Spoon-billed Sandpiper	*Calidris pygmaea*	Critically Endangered	Absent
4	Sumatran Rhinoceros	*Dicerorhinus sumatrensis*	Critically Endangered	Absent
5	Hawksbill turtle	*Eretmochelys imbricata*	Critically Endangered	Absent
6	Fish-eating crocodile	*Gavialis gangeticus*	Critically Endangered	Absent
7	Flatback tortoise	*Geochelone platynota*	Critically Endangered	Absent
8	Irrawaddy river shark	*Glyphis siamensis*	Critically Endangered	Absent
9	Arakan forest turtle	*Heosemys depressa*	Critically Endangered	Absent
10	Slender-billed vulture	*Gyps tenuirostris*	Critically Endangered	Absent
11	White-rumped vulture	*Gyps bengalensis*	Critically Endangered	Absent
12	Sunda pangolin	*Manis javanica*	Critically Endangered	Absent
13	Black ibis	*Pseudibis davisoni*	Critically Endangered	Absent
14	Javan rhinoceros	*Rhinoceros sondaicus*	Critically Endangered	Absent
15	Myanmar snub-nosed monkey	*Rhinopithecus strykeri*	Critically Endangered	Absent
16	Helmeted hornbill	*Rhinoplax vigil*	Critically Endangered	Absent
17	Pink-headed duck	*Rhondonessa caryophyllacea*	Critically Endangered	Absent
18	Red-headed vulture	*Sarcogyps calvus*	Critically Endangered	Absent

(Source: world data; Endanger species of Myanmar)

Plate 1 Occurrence of recorded some fauna species

Mesophoyx intermedia, Intermediate Egret

Bubulcus coromandus, Cattle Egret

Microcarvbo niger, Little Commorant

Corvus splendens, House Crow

Acridotheres javanicus, White-vented Myna

Acridotheres fuscus, Jungle Myna

Lanius cristatus, Brown Shrike

Lanius collurio, Red-backed Shrike

Lanius cristatus, Brown Shrike

Saxicola caprata, Pied Bushchat

Ictinogonphus rapax, Dragonfly

Paratelphusa hydrodromus

5.5.9.3. Impact Assessment, Potential Impacts on Fauna and Flora and Mitigation Measures

(i) Impact Assessment on the Fauna and Flora of the Project Area

The impacts of the fauna and flora on Mandalay-Muse New Railway Project were assessed by the index matrix based on four criteria, Magnitude (M), Duration (D), Extend (E) (area), Probability (P) of the impacts. According to International Association of Impact Assessment-IAIA Guidelines as the impact factors, impacted items and impact degree are determined the following words;

Significant Point (SP)	Impact Significance
< 15	No impact (-)
15-29	Low impact (U)
30-44	Moderate significant (C)
45-59	High significant (B)
> 60	Very high significant (A)

Magnitude

If the impact is only insignificant, the index value is 1
If the impact is only in small and will have no effect, the index value is 2
If the impact is the moderate and will result in minor changes, the index value is 3
If the impact is thehigh and will result in significant changes, the index value is 4
If the impact is very high and will result in permanent changes, the index value is 5

Duration

If the impact is between 0-1 year in limited time of the project duration, index value is 1
If the impact is between 2-5 yearin limited time of the project duration, index value is 2
If the impact is between 6-15 year in limited time of the project duration, index value is 3
If the impact is the life of operation in the project duration, index value is 4
If the impact is over shoot the project duration, index value is 5

Extend (Area)

If the impact is thelimited to the site, the index value is 1
If the impact is the limited to the local area, the index value is 2
If the impact is the limited to the region, the index value is 3

If the impact is the limited to the national, the index value is	4
If the impact is the limited to the international, the index value is	5

Probability

If the impact is the very improbable, the index value is	1
If the impact is the improbable, the index value is	2
If the impact is the probable, the index value is	3
If the impact is the high probable, the index value is	4
If the impact is the definite, the index value is	5

(ii) Current Environmental Aspects

According to the recorded data, plenty of fauna, especially as major groups are vertebrate (mammals, birds, reptiles (Turtle and Tortoise and lizards) and invertebrate (butterflies, dragonflies, damselfly and many kinds of insects visually during survey) about 500 Meter and 1000 Meter surrounding in and around the project area are discovered because of there are enough food sources in these study area.

IUCN and CITES Appendices

(i) Fauna survey

In fauna survey, four fauna species were recorded as threatened species under the IUCN RedList and CITES appendices in this project area at the survey time.According to interview survey results, on the mammals species, Northern Pig-Tailed *Macaca leonine and* Marbled Cat *Pardofelis marmorata* were recorded as VU- Vulnerable status. On reptile's survey, King Cobra *Ophiophagus Hannah* and Yellow-Headed-Tortoise *Indotestudo elongate* were recorded as VU- Vulnerable and EN- Endangered status. Near Threatened (NT) and Least Concern (LC) meanclose to become extinct in the nature without include threatened species.

CITES

The Convention in International Trade in Endangered Species (CITES) is a United Nations Treaty organization, the largest and thus most powerful of the international treaties to protect endangered animals and plants. At present, 177 countries are members (Parties) of CITES.

There is a three species CITES list in the study area. Myanmar as a party country of CITIES we have to follow the rules and regulations of CITIES convention. According to the CITIES Convention

Lists of species that are the most endangered among CITES-listed animals and plants. They are threatened with extinction and CITES prohibits international trade in specimens of these species except when the purpose of the import is not commercial, for instance for scientific research. In these exceptional cases, trade may take place provided it is authorized by the granting of both an import permit and an export permit (or re-export certificate). Article VII of the Convention provides for a number of exemptions to this general prohibition.

Appendix II lists species that are not necessarily now threatened with extinction but that may become so unless trade is closely controlled. It also includes so-called "look-alike species", i.e. species whose specimens in trade look like those of species listed for conservation reasons. International trade in specimens of Appendix-II species may be authorized by the granting of an export permit or re-export certificate. No import permit is necessary for these species under CITES (although a permit is needed in some countries that have taken stricter measures than CITES requires). Permits or certificates should only be granted if the relevant authorities are satisfied that certain conditions are met, above all that trade will not be detrimental to the survival of the species in the wild.

Appendix III is a list of species included at the request of a Party that already regulates trade in the species and that needs the cooperation of other countries to prevent unsustainable or illegal exploitation. International trade in specimens of species listed in this Appendix is allowed only on presentation of the appropriate permits or certificates.

SN	Order/Family	Species	Common Name	Local Name	CITES	Appendix
Reptile						
1	Viperidae	*Daboia siamensis*	Viper	Mwe-pwe	√	III
2	Gekkonidae	*Gekko gecko*	House lizard	Totk-taet	√	II
Mammal						
3	Cercopithecidae	*Macaca mulatta*	Rhesus macaque	myaut-sat	√	II

Wild Life Trade

Wildlife Trade is a global epidemic. The Illegal Wildlife Trade is a multi-million dollar business run by dangerous criminal syndicates that deal in the harvesting and trading of wild species and their body parts. With high demand from a growing Asian middle class stoking the fire, this trade is the biggest threat facing wildlife today.

Myanmar is a global hub for illegal wildlife trade. Because of our remaining wilderness and abundant wildlife our forests are a prime source for some of the most poached species such as tigers, Asian elephants and pangolins. To make matters worse, Myanmar is situated next to the notorious lawless Golden Triangle region, the global illegal wildlife hypermarket.

Each year, hundreds of millions of plants and animals are caught of harvested from the wild and then sold as food, pets, ornamental plants, leather, tourist curios, and medicine. While a great deal of this trade is legal and is not harming wild populations, a worrying large proportion is illegal and threatens the survival of many endangered species. (WWF Myanmar,2020)

According to the UNODC report(2018) , Myanmar is a strategically relevant country in the illegal wildlife trade, nestled between several important source, transit and destination countries. Yet, as transportation infrastructure in the country and the region continues to improve and expand, the importance of Myanmar as a transit location for wildlife smuggling may also increase in the future. We have to consider about wildlife trade and any other smuggling process and have to cooperate with the regional authorities.

While the majority of illegal wildlife trade happens at a commercial level, tourists sometimes participate unknowingly by buying or traveling with illegal items. These are most often bought as souvenirs or gifts for friends and families. When buying souvenirs and gifts, make sure that you are not contributing to the illegal trade in wildlife. That is why the local authorities have to made the awareness program for local communities and tourists.

Summary of globally threatened species in Myanmar

Taxonomic Group	Global Threat Status			
	Critically Endangered	Endangered	Vulnerable	Total
Mammals	4	9	26	39
Birds	4	8	33	45
Reptiles	4	10	7	21
Invertebrates	0	0	1	1
Plants	13	12	13	38
Total	25	39	80	144

Source : Myanmar: Investment Opportunities in Biodiversity Conservation, 2005

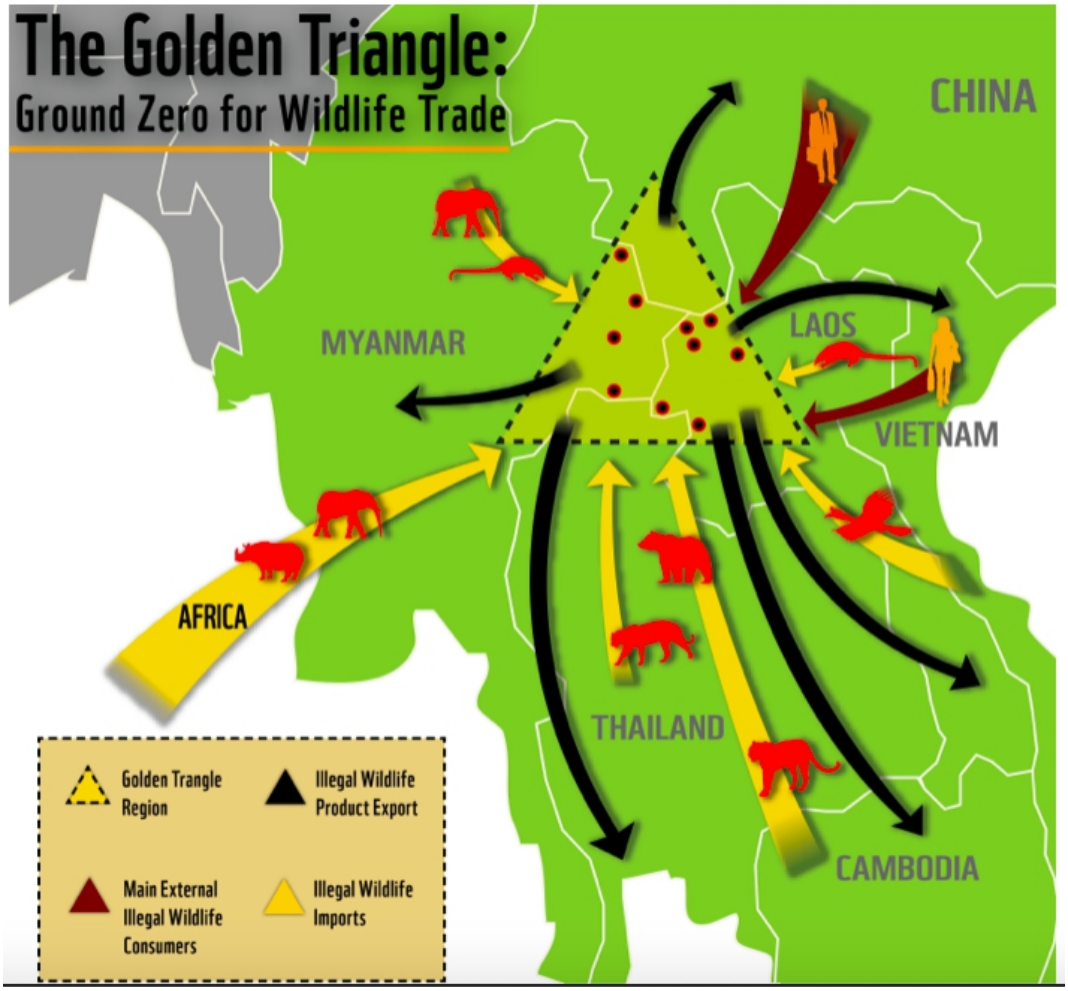


Fig- Showing the Wildlife Trade Path

Overview of available information on species in use or trade and estimates of legal and illegal trade, by taxonomic group

	Species Overview	Legal Trade Estimates	Illegal Trade estimates
Mammals	~ 5,400 species (Wilson and Reeder, 2005); > 1,000 utilized for food and medicine (TRAFFIC, 2010); ~ 900 CITES-listed (UNEP-WCMC (Comps.), 2016).	CITES trade11: ~ 280,000 ‘whole’ 12 wild- sourced mammals annually. Overall, legal international trade, particularly in non-CITES species, appears to be unquantified.	No global estimates, but estimates for some taxa and commodities exist (1,215 rhinos illegally killed in 2014 (TRAFFIC, 2015), 17,000 elephants killed in 2011 at MIKE sites (CITES CoP16 Doc.53.1 Addendum), ~18,750 ivory seizures over the period 1989-2013 recorded in ETIS

			(CITES Standing Committee document SC65 Doc.42.1), ~227,000 pangolins killed in Asia between 2000 and 2013 (Challender et al., 2015)); many reports of instances of ITW.
Birds	~ 10,000 species (BirdLife International, 2013b); ~ 4,500 utilized, for example as pets, food, or for sport hunting (BirdLife International, 2008); ~ 3,300 traded (Butchart, 2008); ~ 1,500 CITES-listed (UNEP-WCMC (Comps.), 2016).	CITES trade: ~ 90,000 ' whole ' wild-sourced birds annually. Several million birds each year in domestic and international trade, particularly finches, weavers, parrots and raptors (BirdLife International, 2015b).	No global estimates although regional estimates for some taxonomic groups exist (25 million birds illegally killed in the Mediterranean per year (BirdLife International, 2015b)); many reports of instances of ITW.
Reptiles	~ 10,000 species (Pincheira-Donoso et al., 2013; Uetz and Hošek, 2015); ~ thousands utilized and traded (e.g. ~3,500 species/subspecies of reptiles and amphibians imported as pets into the EU (Newman, 2014); ~ 800 CITES-listed (UNEP-WCMC (Comps.), 2016).	CITES trade: ~ 1.8 million ' whole ' wild- sourced reptiles annually. Overall, legal international trade, particularly in non-CITES species, appears to be unquantified.	No global estimates, but estimates for some species and commodities exist; many reports of instances of ITW.
Amphibians	~ 7,400 species (Frost, 2014); > 200 utilized for food, > 260 for pet trade and many for medicinal purposes (Carpenter et al., 2007); ~ 150 CITES-listed (UNEP-WCMC (Comps.), 2016).	CITES trade: ~ 15,000 ' whole ' wild-sourced amphibians annually. For example, more than 20 million wild- caught live amphibians (CITES and non-CITES species) legally imported into the United States 2001-2009 (Herrel and van der Meijden, 2014).	No global estimates, but estimates for some taxa and commodities exist; many reports of instances of ITW.

Fish	~ 33,000 species (Froese and Pauly, 2014); > thousands utilized (e.g. 1,200 traded as aquarium fish (Cato and Brown, 2003) , ~ 800 traded for food (Ababouch, 2005); ~ 100 CITES-listed; five species of sharks, one sawfish and the genus Manta were listed at the most recent CoP (UNEP-WCMC (Comps.), 2016).	CITES trade: ~ 40,000 ' whole ' wild-sourced fish annually. Global catch of 90 million tonnes annually (FAO, 2012).	Global illegal and unreported fishing estimated at 11-12 million tonnes annually (Agnew et al., 2009).
Invertebrates	~ 1,000,000 species (Roskov et al., 2014); > thousands utilized (e.g. > 2,000 insect species (Ramos-Elorduy, 2009) and > 300 marine invertebrate taxa are used as food (Anderson et al., 2011)); ~ 2,200 CITES-listed, predominantly corals (UNEP-WCMC (Comps.), 2016).	CITES trade: ~ 2.5 million ' whole ' wild-sourced invertebrates annually. Marine and freshwater mollusc and crustacean catch alone > 13 million tonnes in 2012 (FAO, 2014a). Up to 30- 50 tonnes of red and black13 coral and > 2,500 tonnes of shells also traded each year (Tissot et al., 2010).	No global estimates, but estimates for some taxa and commodities exist; many reports of instances of ITW.
Timber	~ 100,000 species of trees (BCGI, 2007) - not all produce exploitable timber; > 1,600 traded commercially (Mark et al., 2014); ~ 700 CITES-listed trees; five species and two genera were listed at the two most recent CoPs (UNEP-WCMC (Comps.), 2016).	137 million m3 roundwood, 124 million m3 sawnwood, 77 million m3 wood-based panels and 223 million tonnes of pulp/paper products in 2013 (FAO, 2015a).	8-10 per cent of the value of global wood products (Seneca Creek Associates and Wood Resources International, 2004); In 2004, just under half of all tropical logs, sawn timber and plywood in trade were estimated to be illegally sourced (Lawson and MacFaul, 2010).
Plants	~ 300,000 species (BGCI, 2014); > 20,000 traded for medicinal purposes	CITES trade: ~ 24 million ' whole ' wild- sourced plants annually.	No global estimates, but estimates for some taxa and commodities exist; many reports of

	alone (WHO et al., 1993); ~ 30,000 CITES-listed, the majority orchids (UNEP-WCMC (Comps.), 2016).		instances of ITW.

Source: UNEP 2017

(ii) Flora Survey

In flora survey, there are a number of species of flora in the various parts of Mandalay, Pyin Oo Lwin, Naung Hkio, and Lashio, some of which are Least Concerned and Near Threatened species could be found in different parts of the Project area. Potential impacts to flora and fauna include (i) destruction of vegetation for earth works, and (ii) temporary habitat occupation which will disturb fauna movements at certain locations of the alignment.

Potential Impacts on Fauna And Flora

(i) Natural Environment

Muse - Mandalay Segment is Shan plateau topography, most of which are at an altitude of 700m ~ 800m or above, the top of the plateau surface generally presents relatively low and gentle planation surface, the surface fluctuation is generally tens to hundreds of meters, deep valleys are developed. Most of the natural vegetation is secondary evergreen broad-leaved forest with partial residual tropical monsoon rain forest.

Along the railway site area, different forest types were observed accordingly to the elevation, namely: **(1) hill semi evergreen forest (2) tropical mix evergreen and deciduous forest (3) semi-indaing forest (4) Open degraded forest and farmland ecosystem**.

During the survey none of the trees are in the list of threatened plant species. It is expected hundreds of trees along the railway track will be cut or removed. Impacts on flora, fauna and biodiversity are expected to be limited and temporary because trees observed along the railway line are commonly found in public parks, other greenery areas and along the roads in Mandalay to Muse.

Figure - Images Showing Vegetation Scenery Result of the Survey Area

Identification and Assessment/ Analysis Impacts

The following method will be applied to assess the environmental impacts of the Mandalay-Muse Railway New Project mainly on Biodiversity. Conclusively, each source of impact has been assessed by four parameters; Magnitude, Duration, Extend (area) and Probability.

(i) Impact assessments on the fauna and flora of the project area

Table 5.16. Impact index value and categories of fauna and flora in the Mandalay-Muse Railway New Project

No.	Impacts	Magnitude	Duration	Extend (area)	Probability	Total	Category
	Fauna						
1	Reduce Terrestrial Fauna	3	4	2	3	27	Low impact (U)

2	Habitat Loss	3	5	2	3	30	Moderate significant (C)
3	Noise Impact	3	3	2	3	24	Low impact (U)
	Flora						
4	Loss of trees and other plant species	3	5	2	3	30	Moderate significant (C)

(Source: International Association of Impact Assessment-IAIA, 2014, www.iaia.org)

(ii) Impact on Biodiversity and Ecosystem

The most area where the alignment passes has been heavily influenced by human activities of township building and agriculture farmland cultivation. Investigated plants are common species in this area. Due to the influence from local residents, there is a not important fauna and flora resource in the alignment corridor. For this reason, proposed project is little impacts on wild animals in human habitation area. Bats have long been known as the cave-dwellers par excellence. The degree of ecological dependence on caves as shelter is highly variable for bats. Most bats species are able to use multiple kinds of roosts in caves.

From the point of view **of the bats,** caves must be protected to allow species most dependent on this kind of shelter to maintain viable populations. From the point of view of the cave communities, all bat species, independent of their conservation status, must be locally protected in project areas. Even in the case of bat species, the control must be carefully managed, allowing the maintenance of a minimum population size to support the cavernicoles dependent on vampire bat guano. On the other hand, bat guano is an important food source for many subterranean organisms, especially for species restricted to subterranean habitats, totally dependent on the resources present in these habitats and prone to rapid extinction following any ecological disequilibrium. Therefore, protecting bats is a fundamental part of any program or action on project by contractors for conservation of subterranean systems.

Through the field survey, it was observed that biodiversity in the project area was rich because of there are enough food sources and available conditions for wild animals in these areas.Though clearing the vegetation due to the implementation of the project, greening

of the public space along and near the rail -road will help to mitigate the change of biodiversity and ecosystem. Therefore, the development of the project will be able to cause any significant impact on biodiversity and ecosystem of the region. The avoidance is essential to maintain the integrated habitat and is the most effective way to protect local resources.

In the course of construction and operation of tunnel conditions for development of flora and fauna should not be disturbed; deforestation and cutting down of bushes, change of hydrological mode of water objects, deterioration of ways of animals migration, reduction of the sizes of populations, extinction of species are inadmissible.

Construction and operation of the Project will have only a minimal effect on existing flora and fauna. During construction, a short-term impact on ecology is likely to occur in and around the sites, material stockpiling areas, and worksites due to vegetation clearance. A permanent but relatively minor impact on ecology is likely to occur due to the alignment of any unstable section. Vegetative cover stripped from these locations will be kept for landslide and slope protection. Contractors will be responsible for putting new vegetation in removal sites. Construction vehicles should use temporary roads constructed to minimize damage to agricultural land and local access roads. Where local roads are used, they will be repaired to their original condition after the completion of work. Compaction around trees will be performed carefully to avoid damage to the tree drip-line.

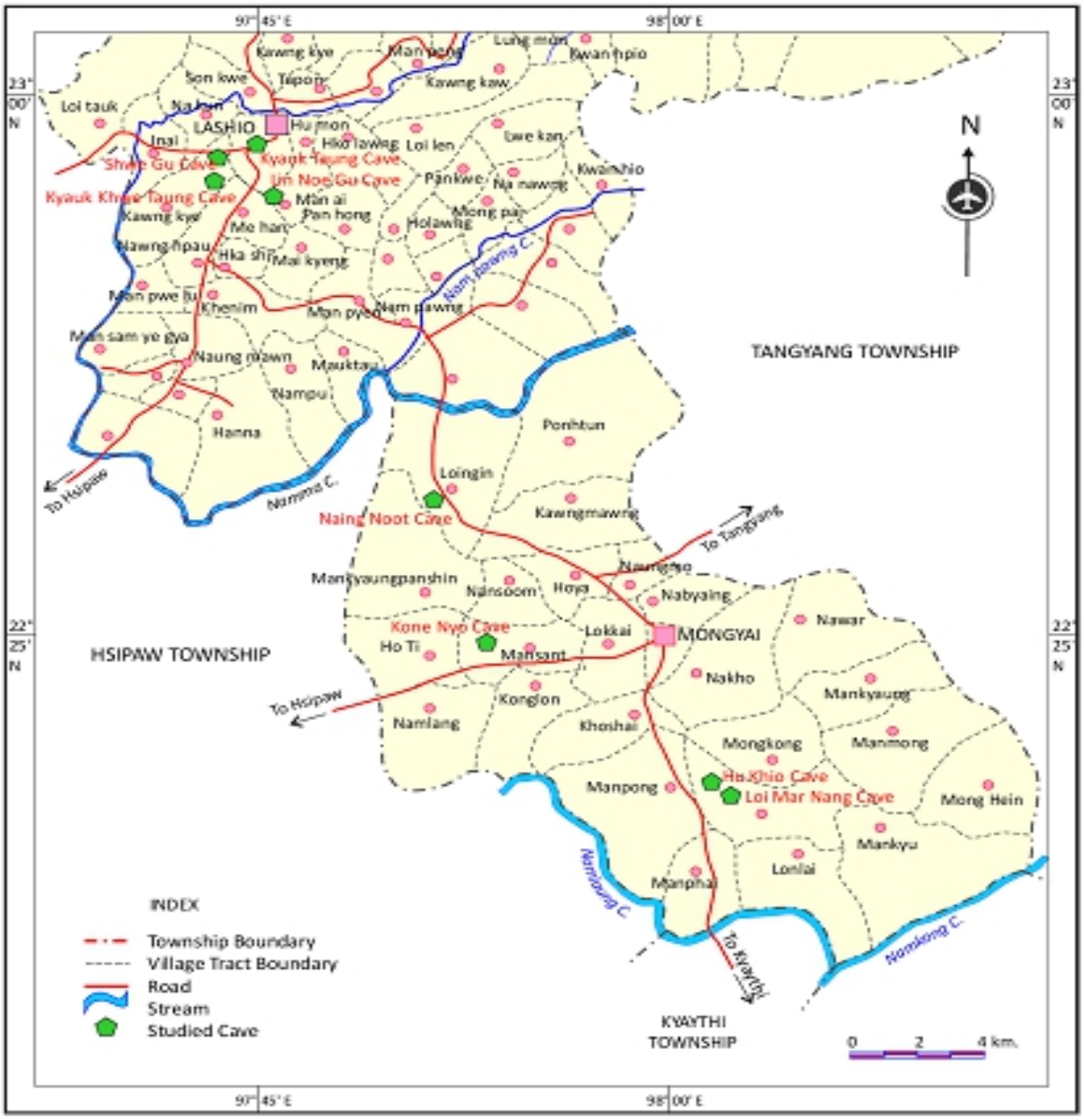
Potential impacts from construction worker camps include poaching of edible animals and birds in the locality, despite prohibitions. The contractors will be responsible for providing adequate knowledge to workers regarding the protection of fauna. Workers will be trained regarding nature protection and the need to avoid cutting down trees during construction. Contractors will be responsible for supplying appropriate fuel in the work camps to prevent fuelwood collection.

Some Limestone Caves near Lashio Area

Shan State covers almost a quarter of Myanmar and is the most mountainous area in the country. This state also constitutes the largest part of the Northern Indo-Chinese biogeographic zone in Myanmar (Tun Yin, 1993). Most caves in the State are important archaeological sites that feature splendid pieces of ancient cultures.

Limestone caves (*Rhinolophus pearsonii* and Malayan Horseshoe bat *Rhinolophus malayanus*are also recorded in Shwe Gu Cave (between 22° 57' 16.0" N and 97° 43' 27.2" E,

elevation 829m), Kyauk Taung Cave (between 22˚ 56' 14.50" N and 97˚ 44' 04.82" E, elevation 825m), Kyauk Khwe Taung Cave (between 22˚ 56' 07.67" N and 97˚ 42' 50.05" E, elevation 875m)) were conducted and bat species use caves for alternate refuge, some species rely on caves for day roosting and protection from predators. According to the survey results, as bats species, about total Mammals fauna 3 species one order and 2 families were recorded in Lashio area. Leschenaulti's Rousette or Fulvous fruit bat *Rousettus leschenaultia*, Pearson's horseshoe bat.



Source: Land Records Department, Lashio

Figure - Location map of studied cave

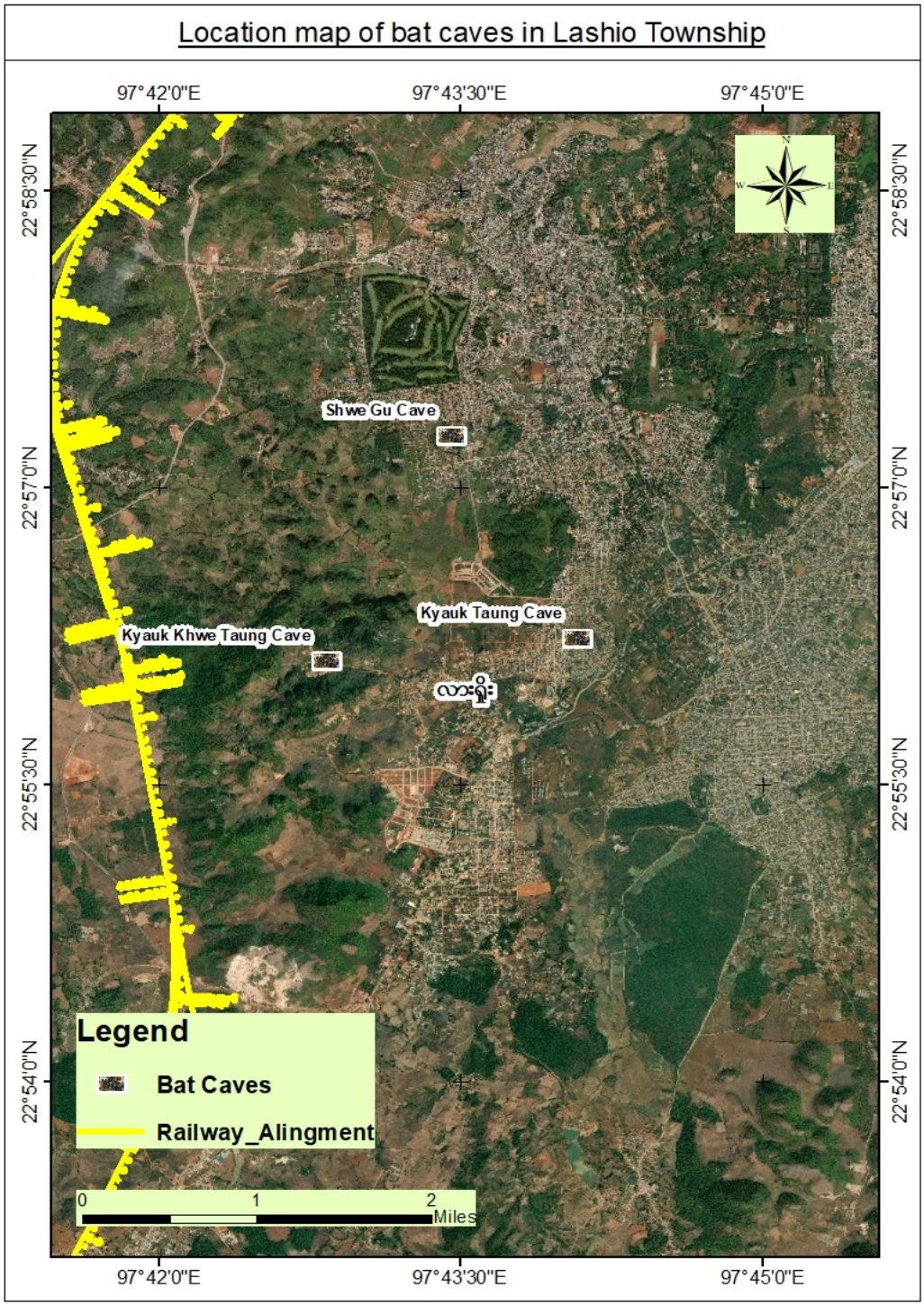


Figure - Map of the study sites of bat caves in Lashio

No	Name	Estimated distance from railway (km)
1	Shwe Gu Cave	3.340
2	Kyauk Taung Cave	3.890
3	Kyauk Khwe Taung Cave	1.745

Figure - Image of Shwe Gu Cave

Figure - Image of Kyauk Taung Cave

Figure - Image of Kyauk Khwe Cave

Disturbance and Destructive Effects on the Protected Area

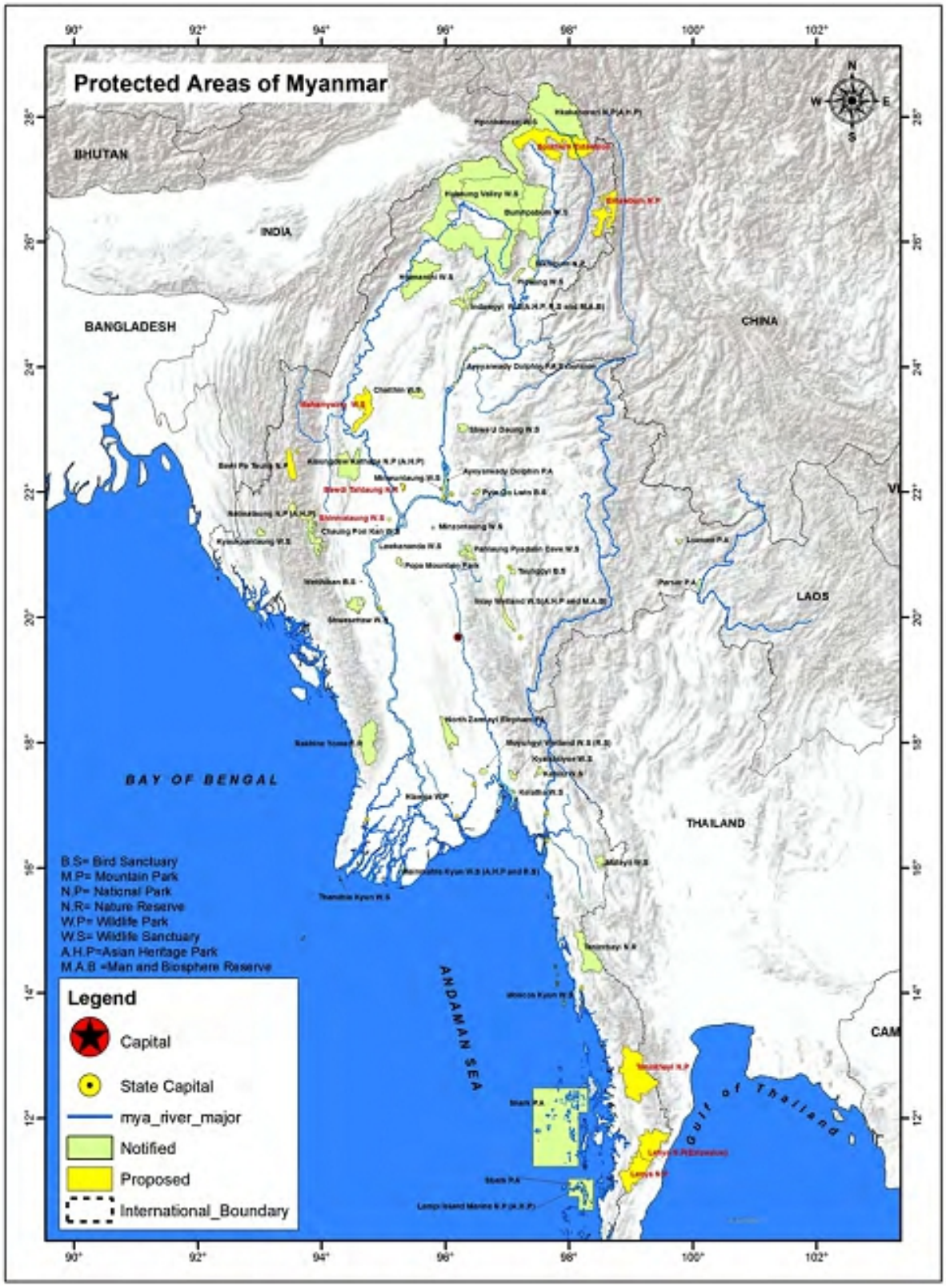


Figure - Map of Protected Areas of Myanmar
(Source: WCS, Protected Areas, 2017)

Protected Areas are one of the most important tools for biodiversity conservation, safeguarding ecosystems services and preserving cultural landscapes. As of 2018, Myanmar has 42 Protected Areas. Seven of the Protected Areas are ASEAN Heritage Parks (AHPs) recognised for their biodiversity value within ASEAN countries; and five are Ramsar Sites (wetlands of international importance).

The above mentioned environmentally sensitive areas (such as Nature Reserve, National Park, Protected Area, National Park and ASEAN Heritage Park, Wildlife Sanctuary, Bird Sanctuary, Wildlife Park, Mountain Park, Wildlife Sanctuary and ASEAN Heritage Park, Elephant Range and Wildlife Sanctuary) are not included along Muse-Mandalay. Among them, totally 4 sensitive areas, Shwe-U-Daung Wildlife Sanctuary (87km away from the line) , Pyin-Oo-Lwin Wildlife Sanctuary (5km away from the line) , Minwuntaung Wildlife Sanctuary (18km away from the line) and Irrawaddy Dolphin P.A are close to Railway with 12.5km away from the line respectively. Shwe U Daung used to be a habitat for critically endangered species of Hairy Rhinoceros (*Dicerorhinus sumatraensis*), and the conservation priority for this site will be critical for restoring this rhinoceros. In addition, Shwe U Daung Wildlife Sanctuary serves as an important habitat for Asian elephant (endangered). Minwuntaung Wildlife Sanctuary serves as Key species protected for Barking deer, Hog deer, Avifauna. Although these areas were not close to the project area, but well planned management should be done for implementation around forest and environment.

Table - Environmentally Sensitive Areas along Muse-Mandalay

Name of sensitive areas	Level	Issuing time	Area (km2)	Competent department	Protection object	Position relationship with the line
Shwe-U-Daung Wildlife Sanctuary	National	1929	117.97	Forest sector	Elephant, gaur, banteng, rusa, serow, bear	About 87km away from the line
Pyin-Oo-Lwin Widlife Sanctuary	National	1927	127.25	Forest sector	Muntjac, birds,	About 5km away from the line
Minwuntaung Wildlife Sanctuary	National	1972	205.88	Forest sector	Muntjac, birds,	About 18km away from the line
Irrawaddy Dolphin P.A	National	2005	327.53	Forest sector	Irrawaddy Dolphin	About 12.5km away from the line

Figure - Location Plan of Railway and Shwe-U-Daung Wildlife Sanctuary

Figure - Location Plan of Railway and Pyin-Oo-Lwin Wildlife Sanctuary

Figure - Location Plan of Railway and Irrawaddy Dolphin P.A

Figure - Location Plans of Railway and Minwuntaung Wildlife Sanctuary

5.5.9.4. Biological Resource Management Plan

The Critical role that biological resources play in sustaining human life has in the last two decades received considerable if belated attention. In 1992 a board framework for the conservation and use of the world's biological resources – The Convention on Biological Diversity (CBD) – was agreed by the United Nations Conference on Environment and Development (the Earth Summit). Despite increasing recognition, however, the worlds' biological resource continues to be lost at an alarming rate, and particularly so in developing countries where many of the remaining resources are concentrated. (World Bank 2002)

The overarching objective of "Biological Resource Management Plan" is to provides strategies and management actions necessary to sustain the country's biological resources.

Recommended biological resource management objectives for proposed railway project are to:

- ✓ Protect species and habitats of along the railway project
- ✓ Maintain and preserve native biological diversity
- ✓ Reduce the spread of invasive species and provide integrated controls of noxious weeds
- ✓ Where and when feasible, improve degraded habitats in a strategic manner to increase landscape connectivity and native diversity
- ✓ Reduce and minimize fragmentation of habitats
- ✓ Maintain landscape that provide regional connectivity to habitats surrounding railway project.
- ✓ To meet these objectives, BRMP provides a set of generally directives for proposed railway project operation.
- ✓ Develop a flora replantation plan particularly for native species
- ✓ Educated employees of environmental responsibilities during inductions including treating all native fauna species as protected.
- ✓ **Biodiversity Richness in Myanmar**

Taxonomic group	Species	Number
Species of vascular plants of Gymnosperms and angiosperms		11,800
Mammals		258
Bird species		1,056
Reptile	Snakes	153
	Lizards	87

	Turtles and tortoise	32
Amphibians	Frogs and toads	79
	Caecilians	2
	Salamander	1
Fresh water fish		310
Marine water fish		465
Medicinal plant		841
Bamboo		96
Rattan		37

Protected Areas & Species

According to the data of Forest Department, there are 36 protected area and 577 wildlife species (completely protected), 318 wildlife species (normally protected), and 914 wildlife species (seasonally species) in Myanmar. Elephant, Indian Bison, Serow, Braking Deer, *Green Pea Fowl Pavo muticus* are protected species in Shan State.

Preventing Wildlife-train Collisions

According to the literature learning railways can be deadly for animals ranging from elephants to deer and frogs. Railway fragment habitat and can affect all kinds of wildlife in varying ways. Collision is the most common cause of mortality, but some animal (especially Avian and Bat) dies from electrocution and collisions which already explain in our report with the IFC guidelines. “The mammal species receiving the most attention are frequently the larger ones, such as moose, bears or elephants as they cause more damage to trains, disrupt the normal operation of the train network, or hold higher conservation and economic status,” according to the editors of the 2017 book Railway Ecology. Although the tracks formed a barrier the herpet species such as toad and some frogs, which can't cross while migrating. Especially toad may not be able to jump or climbs over rails more than 6 inches. Some of the toads appear to have died from desiccation due to extreme heat from the tracks.

Benefits of Animal Crossings

The wildlife animal crossing offers loads of advantages, primarily to help avoid collisions of animals and vehicles. These bridges not only help in reducing collisions but additionally, it aids wildlife species to find resources like food, shelter, mates that are specifically found on the other side. In absence of these wildlife crossings, animals will be left without sufficient

food, reduced reproductivity, or possible extinction. This could be more cost but that is the way to conserve biological resource and a good management plan.

Photo Source: Animal Fact 2009

Sensitive Season

The Ayeyawady Dolphin Protected Area (ADPA) stretches 74 km of river starting from Mingun in the south up to Kyaukmyaung and Singu townships in the north. And Irrawaddy dolphin breed in December through June. The proposed railways project far from Mingun(10.87 miles), Kuaukkmyaung (50.78 miles), and Singu (43.03 miles) respectively. According to the variation of breeding season on difference species, educated employees of environmental responsibilities during inductions including treating all native fauna species as protected.

EHS Guidelines for Electric Power Transmission and Distribution

IBAs – Important Bird & Biodiversity Areas

According to the data of BANCA, there are 57 of IBAs and 5,589,800 ha IBA area in Myanmar. In the other hand one IBAs found in Mandalay region beyond Anesakhan and Pyin

Oo Lwin, The resident bird (season) ***Green Pea Fowl Pavo muticus*** as a protected bird species (IUCN-EN).

IBA in Mandalay region

Source : BANCA & Bird Life International 2020

Avian and Bat Collisions and Electrocutions

Bird and bat deaths from electrocution and collision with power lines are an ongoing environmental issue affecting operation of electrical transmission and distribution lines. When the birds and bats collide with electrical power line infrastructure, their electrocution also can result in electrical outages affects service reliability and cause wildfires.

The combination of the height of transmission towers and distribution poles and the electricity carried by transmission and distribution lines can pose potentially fatal risk to birds and bats through collisions and electrocutions. Avian collisions with power lines can occur in large numbers if located within daily flyways or migration corridors, or if groups are traveling at night or during low light conditions (e.g., dense fog). In addition, bird and bat collisions with power lines may result in power outages and fires.

Recommended prevention and control measures to minimize avian and bat collisions and electrocutions include.

- ❖ Aligning transmission corridors to avoid critical habitats (e.g., nesting grounds, heronries, rookeries, bat foraging corridors, and migration corridors);
- ❖ Maintaining 1.5 meter (60-inch) spacing between energized components and grounded hardware or, where spacing is not feasible, covering energized parts and hardware;

- ❖ Retrofitting existing transmission or distribution systems by installing elevated perches, insulating jumper loops, placing obstructive perch deterrents (e.g., insulated" V's"), changing
- ❖ the location of conductors, and / or using raptor hoods;
- ❖ Considering the installation of underground transmission and distribution lines in sensitive areas (e.g., critical natural habitats);
- ❖ Installing visibility enhancement objects such as marker balls, bird deterrents, or diverters.

We will follow the "Environmental, Health, and Safety Guidelines for Electric Power Transmission and Distribution" for Avian and Bat collisions and electrocutions impacts.

Protected tree species

According to the forest department fact and figure, in total 16 tree species have been declared as protected species in order to prevent their over-utilization. The species are protected either in the whole country or in a specific region. In addition to these tree species, some medicinal plants and orchid species are protected throughout the whole country.

Protected tree species in Myanmar by region (Forest Department Fact and Figure,2006)

Scientific name	Common Name	Region		
		Whole Country	Upper Myanmar	Lower Myanmar
Tectona grandis	Teak	✖		
Pentace burmanica	Thitka	✖		
Xantolis burmanica	Thitcho	✖		
Hopea odorata	Thigan	✖		
Xylia xylocarpa	Pyinkado	✖		
Acacia catechu	Sha	✖		
Pterocarpus macrocarpus	Padauk	✖		
Excoecaria agallocha	Thayaw	✖		
Shorea obtusa	Thit-ya	✖		

Shorea siamensis	Ingyin	✖		
Pinus khasya	Tinshu	✖		
Dipterocarpus alatus	Kanyin			✖
Lindera assamica	Karaway			✖
Cinnamomum pachyphyllum	Hmanthin			✖
Lagerstroemia floribunda	Kamaung			✖
Prunus cerasoides	Cherry		✖	

Invasive Plant Species

According to the Fifth national report to the united nations convention on biological diversity (2014, March) the total number of known species by taxonomic group, is; 11,824 plants, 252 mammals, 1,056 birds, 293 reptiles, 139 amphibian and 775 fish. This is an increase over the Fourth national Report of 24 plant species, one mammal species, 21 reptile species and 57 amphibian species, of which 22 reptiles and 6 amphibian species are believed endemic to Myanmar. However, comprehensive, country wide surveys are still needed to determine the total number of species in the country. In the other hands, Asia-Pacific Forest Invasive Species Network (APFISN) stated that, 32 invasive species of insect, aquatic plant, herb, shrub, vine, grass, tree, microorganism, mammal, bird and fish in Myanmar.

Plant species diversity in Myanmar (Forest Department 2003)

Category	No. of species
Plants	11800
Bamboo	102
Rattan	50
Shrubs	1696
Orchids	841

An invasive species is an organism that causes ecological or economic harm in a new environment where it is not native. Invasive species can harm both the natural resources in an ecosystem as well as threaten human use of these resources. An invasive species can be introduced to a new area via the ballast water of oceangoing ships, intentional and accidental releases of aquaculture species, aquarium specimens or bait, and other means. Invasive species are capable of causing extinctions of native plants and animals, reducing biodiversity, competing with native organisms for limited resources, and altering habitats. This can result in huge economic impacts and fundamental disruptions of coastal and Great Lakes ecosystems. According to our study some invasive species such as *Leucaena Leucocephala* were observed in proposed project area. In our cutting or clearing plants process, we will negotiate and request for approval from Forest Department. Moreover, in cutting or clearing plants process we will avoid native plant species as much as we can and we will be replanting with the guidance of Forest Department. In the replanting process, native plant species are priority.

Ecoregions in Myanmar

Myanmar as a country, one of the richest biodiversity hotspots in the world. MONREC (Ministry of Natural Resources and Environmental Conservation) defined Ecoregions in Myanmar. An ecoregion (ecological region) is an ecologically and geographically defined area that is smaller than a bioregion, which in turn is smaller than a biogeographic realm. Ecoregions cover relatively large areas of land or water and contain characteristic, geographically distinct assemblages of natural communities and species. The biodiversity of flora, fauna, and ecosystems that characterize an ecoregion tends to be distinct from that of other ecoregions. Biodiversity or conservation ecoregions are relatively large areas of land or water where the probability of encountering different species and communities at any given point remains relatively constant, within an acceptable range of variation. According to the WWF, we can take these steps based on ecoregions, - trends in environmental change, - current protection status of key landscapes and habitats. Based on the data of MONREC, Myanmar have the 19 ecoregions all around the country. These are as follow:

Ecoregions

SN	Ecoregion	Area (km^2)	%
1	Central Indochina dry forests	4.0	0.0
2	Chin Hills-Arakan Yoma montane forests	29,810.7	4.4
3	Eastern Himalayan alpine shrub and meadows	5,316.6	0.8
4	Eastern Himalayan broadleaf forests	285.5	0.0
5	Eastern Himalayan Subalpine conifer forests	38.5	0.0
6	Irrawaddy dry forests	35,459.4	5.2
7	Irrawaddy freshwater swamp forests	15,308.8	2.3
8	Irrawaddy moist deciduous forests	139,806.4	20.7
9	Kayah-Karen montane rain forests	56,113.1	8.3
10	Lower Gangetic Plains moist deciduous forests	3.0	00
11	Mizoram-Manipur-Kachin rain forests	71,183.0	10.5
12	Myanmar Coast Mangroves	15,889.0	2.4
13	Myanmar coastal rain forests	66,338.2	9.8
14	Northeast India-Myanmar pine forests	83.0	0.0
15	Northern Indochina subtropical forests	139,582.7	20.6
16	Northern Triangle subtropical forests	54,595.4	8.1
17	Northern Triangle temperate forests	10,813.4	1.6
18	Nujiang Langcang Gorge alpine conifer and mixed forests	4,635.2	0.7
19	Tenasserim-South Thailand semi evergreen rain forests	30,734.1	4.5
	Total	676,000.0	100.0

Source : IFC (2017)

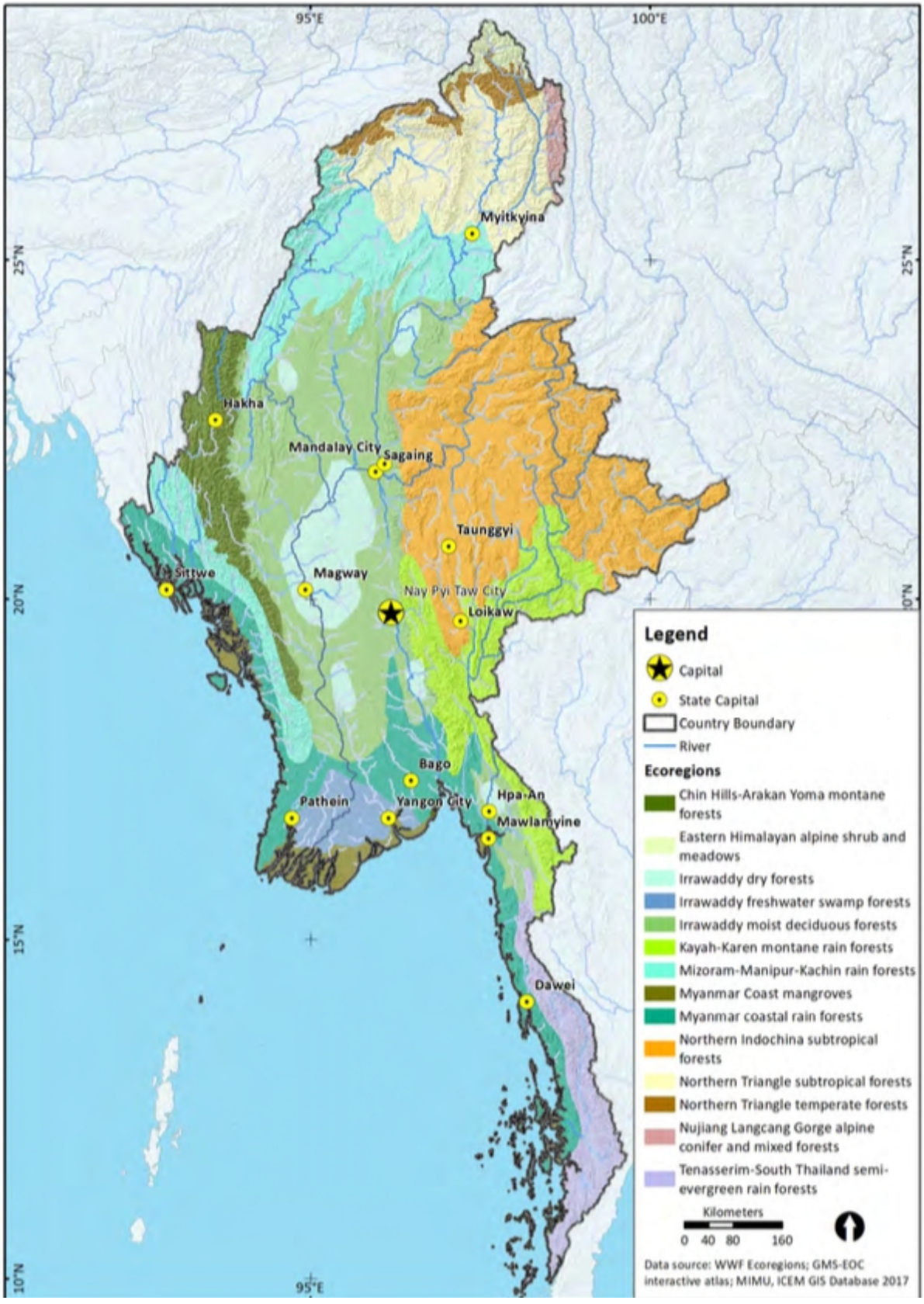


Figure - Ecoregions in Myanmar

Source: IFC (2017)

Thit Ta Pin Taung Protected Forest Area

As the railway route is close to Thit Ta Pin Taung Protected forest area, which is environmental sensitive area of water resources for the local community of surrounding villages and to protect near forest areas in Pyin Oo Lwin Township. As Thit Tapin Taung is massive, it's extremely difficult to carry out conservation work. However locals said there are colonial-era stone posts and fences demarcating the area. So to conduct the project, the old posts and fences may be kept or new ones erected. Either way, the main task is conservation. The area around Thit Tapin Taung is within the forest and the Forestry Department is responsible to conduct conservation work there and has been planting 150 acres of pine trees. There are three lakes at Thit Tapin Taung which have supplied water to Pyin Oo Lwin town since the colonial era. Residents also rely on it for drinking water. Some 16 areas of the lake were recognised as watershed areas. Due to the disappearing forest, the lakes have decreased in size, said an official of the Forestry Department.

Construction of railway line may result in the deterioration of lowered infiltration rate of soil water content, reduction of available water content of soil by the elimination of surface vegetation and thus the construction should avoid to this area.




Image of Thit Ta Pin Taung Area

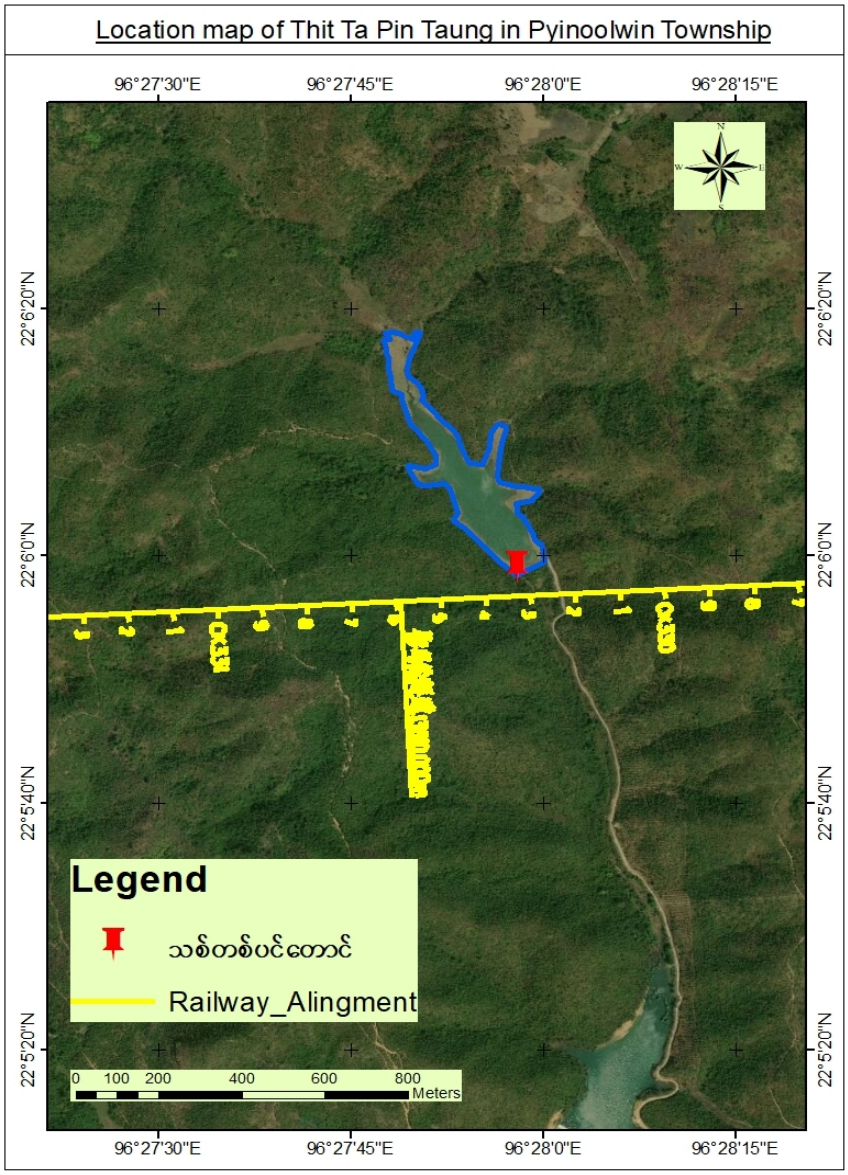


Figure - Location Map of Thit Ta Pin Taung

No	Name	Estimated distance from railway (km)
1	Thit Ta Pin Taung	0.075

Mehon-Doke-hta Wady River key biodiversity area (KBA)

The neighboring predictable area of particular biodiversity importance is the Mehon-Doke-hta Wady River key biodiversity area which found between the Pyin Oo Lwin Wildlife Sanctuary. Although, this area does not have any legal status but it is considered as an International Bird Area (IBA) by Birdlife International.

Overall, the biodiversity recorded in the Project's direct and indirect impact zones was not found to be unique, but, the ecosystems, habitats and species documented are relatively widespread and should considered most important from a conservation perspective.

Overall Suggestions

- The project is huge, long and also will drill into the mountains, underlay soil for the railway track and use a lot of construction materials. It is going to surely affect the ecosystem, original forest areas, water resources and farmlands, even if they use highest technology methods.
- As BRI, large infrastructure project, often have an irreversible environmental impact. If it is implemented in a forested area, it will surely create deforestation, and this contributes tends to climate change in the host country.
- Deforestation will be driven by the conversion of forests into plantations for agricultural commodities like bananas and rubber, supported by authorized investment and these rapidly expanding plantations grow tissue culture bananas, and the clonal genetic material and monoculture production require constant applications of chemical fertilizers and pesticides will be poisoned local communities' water supplies and ecosystems.
- It is important to note that, some areas in Myanmar are environmentally, politically and socially sensitive, so, project implementation needs to be handled carefully and must take those issues into consideration.
- Large areas of near protected forest in the project areas would be cut down to make way for power stations, as the railway line's 100 mph trains and it will be using electricity and thus many hectares of forest would be axed and also a threat to the nature of the Shan

highlands because, the high-speed railway would create a lot of noise and vibration.

- Trees and plants along the planned proposed route may be removed or cut. These may include culturally important and old trees. There is a possibility of impacts due to the management of plants in order to recover trees felled during construction period.
- As for animal ecology, they constitute an important component of the natural ecosystem. The animal communities are important because of their uses as sources of biodiversity conservation and research studies, recreation, and more importantly the provision of protein in the diet of rural communities. The study area is an important habitat for some species of animals. For the present and foreseeable future, this study area is the important vegetation zone as regards conservation and utilization.
- Ecologically, the animal population plays an important role in the transfer of food energy and cycling of essential elements in the ecosystem. The study area is endowed with a large variety of animal species. The Phylum Arthropoda dominated the invertebrate community and is represented by insects, spiders, etc. Occurrence, abundant and diversity butterfly species were depend on the cultivated plant species. In this area was variety of cultivated plants and butterfly species and other insect races are more diverse and abundant.
- Bird species are found in vary habitat and depend on available food, breeding habitat and shelter for them. In this study, the most dominant species were found in bird fauna. On the whole, birds have received more attention than other groups of vertebrates in this area. This, no doubt, is due partly to the efforts of the others ornithologists society and partly to the fact that most birds are conspicuous and easy to observe. The avian population was preponderant in terms of numbers and types. They include Spotted Dove, Green bee-eater, House sparrow and House crow.
- The mammalian community was made up of diverse organisms. The most abundance of mammal species was Rhesus macaque (Monkey) and the small mammals encountered were mainly included Squirrel and Common Rat.
- Animal's habitats are the specific environment or ecological conditions in which species lives. Most habitat descriptions are based on vegetation, which reflects the climate, soil type, and other features of the local environment, and which supports the animal life in a given location. Efforts to measure habitat variables often focus on vegetation structure and attempt to quantify the presence and abundance of different plant species in the habitat.
- It is concluded that the abundance of animal species depend on food availability and

suitable habitat. However habitat can change over time due to the harvesting and utilization of the natural resources by human being and seasonal change. As the habitat changes along multifaceted biological and environmental gradients, a particular animal species can appear increase or decrease in number.

- The construction activities and the changes in traffic during operation are not expected to result in any significant impact on habitats or fauna of conservation importance, . The loss of existing fauna will be mitigated, eg by removing vegetation and felling trees where birds may be nesting outside the nesting period and by planting replacement trees after construction. With these measures the resulting impact on biodiversity and nature conservation interests is considered to be of minor significance.
- Careful implementation of the pre-construction mitigative measure will make the likelihood or scale of the construction period impacts less.
- The railway development projects serves as an important employment generator and provide huge direct and indirect employment opportunity during construction period and operation period.
- The rail connectivity in the Mandalay and Muse region will reduce the traffic load on roads, which will reduce the air pollution in the area. The present proposed rail link will be environmental friendly option of transport.
- During construction and operation of the project, ensure compliance with regulatory environmental requirements, related guidelines and/or recommended control levels.

Mitigation Measure

Mitigation measures are required for items which are expected to cause impact on the environment. By due execution of these mitigation measures, proposed rail way project will be able to become an environmentally friendly mode of transportation. Implementation of appropriate mitigation measures during the construction and operation phases will minimize the negative impacts of the project to acceptable levels.

Mitigation measures at preconstruction/construction stages shall be proposed below.

Table - Mitigation Measures in Preconstruction stage

Item of Impact	Mitigation Measure	Implementation Organization	Responsible Organization
Biota and Ecosystem	- Construction yards shall be planned to keep damages to trees and plants to a minimum.	Contractor	Related state organizations

Human habitation area Reserved forest and Protected area Impact on Geology	- Removed trees and plants shall be replanted at proper locations as exsitu. - Road side trees shall be removed and replanted at proper location as much as possible. - Training of construction workers to raise awareness of environmental protection requirements, - Construction yards shall be planned to keep damages to trees and plants to a minimum. - Construction yards shall be located as far as possible from reserved forest and protected area. - In case of finding of mineralized zones along the tunnel alignment during excavation, it will be brought to the notice of the local authorities for the directions from their end. - Appropriate blasting design will be adopted which will consider safety and for ecology.	Contractor	

Table - Mitigation Measures in Operation Stage

Item of Impact	Mitigation Measure	Implementation Organization	Responsible Organization
Biota and ecosystem Human habitation area Reserved forest and Protected area	- Fences shall be installed at Embankment and Cutting sections in order to prevent animals from entering the railway tracks. - Removed and replanted plants shall be improve - Replenish vegetation at the station regularly - Proper maintenance of trees and other vegetation along the rail way yard	Contractor	Related state organizations

Table – Mitigation Measures in Decommission Phase

Item of Impact	Mitigation Measure	Implementation Organization	Responsible Organization
To Protect Environment Reserved f	The project requires the removal of structure and around stations. Decommission would be carried out by licensed contractors, in accordance with relevant regulatory requirements, and the project environmental management.	Contractor	Related organizations

Construction Mitigation Measures

The mitigation of potential impacts from the Proposed Scheme are as follow. The mitigation strategy for the Proposed Scheme will include standard, best practice approaches for the habitats present and the species they may support including:

- Avoidance of sensitive and/or valuable features;
- Timing of site clearance operations such as felling of trees to avoid the most sensitive periods (this will be dependent on which species are present);
- Creation of replacement habitat to mitigate for habitat losses, through planting and creation of features such as ponds and hibernacula;
- If possible translocation of fauna;
- New planting to reconnect habitats fragmented during construction;
- Minimize lighting during construction;
- Use of lighting types, directional lighting and shields which are of lower impact to bats and some nocturnal
- Removal of invasive plant species for example through application of herbicide in advance of works; and
- Compliance with good practice procedures such as the NEQG/ECD Guidance.

Operational Phase Mitigation Measures

The mitigation of potential impacts from the Proposed are as follow,

- Provision of planting to screen disturbance from trains;

- Use of directional lighting and shields to prevent light spillage;
- Provision of appropriate drainage to prevent run-off of pollutants into adjacent habitats.
- Railway line will be a fragmenting object for some species' populations, since it will impose a burden to the migration. The barrier effect can be reduced by installing adequate animal crossings.

Decommission Phase Mitigation Measure

The project requires the removal of structure and around stations. Decommission would be carried out by licensed contractors, in accordance with relevant regulatory requirements, and the project environmental management.

The following list identifies further measures to reduce or avoid impacts to fauna species and their habitats:

(a) Further habitats should be created to compensate for habitat losses and to improve the landscape and ecological potential for the site.

(b) Ensure there is selective clearing of the vegetation this allows future re-growth and regeneration. This will ensure minimal disruption of wild fauna's natural movement, territoriality, and other ecological processes.

(c) With regards to environmental aspect, the location of project area already occupied with landscape and wild plants of small forest type. Terrestrial organisms may not be affected by the presence of construction of the building by control the habitat loss and noise.

Monitoring

Monitoring initiate a mechanism for implementing mitigation measures for the potential negative environmental impacts and monitor the efficiency of these mitigation measures based on relevant environmental indicators. Monitoring shall be making continuous during construction and operation phases of this project. Furthermore, environmental monitoring of the project will be undertaken regularly through of its operation to ensure that the measures are being implemented properly.

Habitat and Wildlife Population Management

Lower numbers of wildlife species near railways can be achieved by controlling populations (e.g., selective hunting, trapping), or by habitat modification. Changes in habitat structure along railway verges may also increase animals' capability to detect and evade the train.

Population control of a particular species may sometimes be used to reduce its numbers near railways. This method should only be applied on very common species, or those that can

compromise human safety due to collisions. This method has been used to prevent collision with vehicles on roads (Glista et al. 2009), but its use in railways may not be as necessary since most animals will not affect trains' movements.

White Wagtail *Motacilla alba*

Crested Myna *Acridotheres cristatellus*

Common Myna *Acridotheres tristis*

Collared Myna *Acridotheres albocinctus*


Red-Vented Bulbul *Pycnonotus cafer*


Streak-Eared Bulbul *Pycnonotus blanfordi*


Red-Whiskered Bulbul *Pycnonotus jocosus*

Coppersmith Barbet *Megalaima haemacephala*

Grey-Headed Parakeet *Psittacula finschii*

Oriental Magpie Robin *Copsychus saularis*

Vinous-Breasted Starling *Sturnus burmannicus*


Grey Bushchat *Saxicola ferrea*


Siberian Stonechat *Saxicola maura*

Plain Flowerpecker *Dicaeum concolor*


Large-Billed Crow *Corvus macrorhynchos*

Siberian Stonechat *Saxicola maura*

Plain Flowerpecker *Dicaeum concolor*

Large-Billed Crow *Corvus macrorhynchos*

Scaly-Breasted Munia *Lonchura punctulata*

Pied Bushchat *Saxicola caprata* (Male & Female)


Long-Tailed Shrike *Lanius schach*


Burmese Shrike *Lanius collurioides*

Brown Shrike *Lanius cristatus*


Grey-Chinned Minivet *Pericrocotus solaris* (Male)


Green Bee-Eater*Meropus orientialis*


Scarlet Minivet *Pericrocotus flammeus* (Male & Female)


Olive-Backed Sunbird Scarlet-Backed Flowerpecker

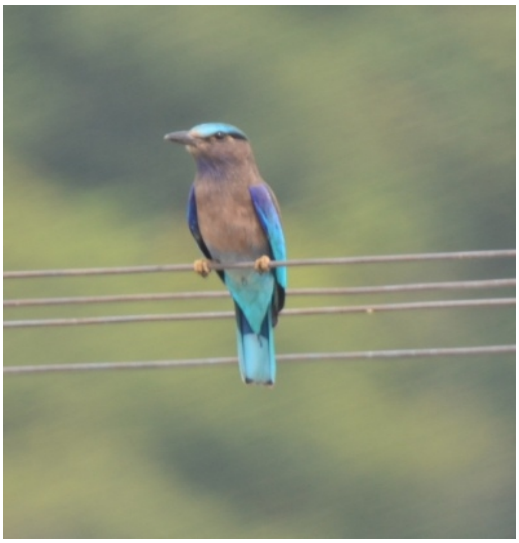
Nectarinia jugularis

Dicaecum cruentatum (Male)

Ashy Drongo *Dicrurus leucophaeus*

Bronzed Drongo *Dicrurus aeneus*

Black-Drongo *Dicrurus macrocercus*



Indian Roller *Coracias benghalensis*

Grey-Headed Canary Flycatcher *Culicicapa ceylonensis*

Plain Flowerpecker *Dicaeum concolor*

Rufous Treepie *Dendrocitta vagabunda*

White-Throated Babbler *Turdoides gularis* Black-Crested Bulbul *Pycnonotus melanicterus*


House Sparrow *Passer domesticus*


Eurasian Tree Sparrow *Passer montanus*


Plain-Backed Sparrow *Passer flaveolus*

Oriental White-Eye *Zosterops palpebrosus* Slender-Billed Oriole *Oriolus tenuirostris*

Spotted-Dove *Streptopelia chinensis*

Oriental Turtle-Dove *Streptopelia orientalis* Greater Coucal *Centropus sinensis*


Plain Martin *Riparia paludicola*


Rock Pigeon*Columba livia*


White Throated Kingfisher *Halcyon smymensis* Lesser Kestrel *Falco naumanni* (Female)


Black-Shouldered Kite *Elanus caeruleus*


Pied Harrier *Circus melanoleucos* Indian Pond Heron *Ardeola* grayii


Lesser Fish Eagle *Ichthypphaga ichthyaetus*

Mountain Hawk Eagle *Spizaetus nipalensis*

Black Kite *Milvus migrans*

Plate 1. Bird Species Recorded from Mandalay-Muse New Railway Project Area

Garden Fence Lizard *Caltoes versicolor*

East Indian Brown Mabuya *Mabuya multifasciata*

Plate 2. Reptile species recorded from Mandalay-Muse New Railway Project Area

Common Grass Yellow *Eurema hecabe*

Gray Pansy *Junonia atlites* (Male)

Lemon Pansy *Junonia lemonias*

Great Eggfly *Hypolimnas bolina* (Male)

Common Rose *Pachliopta aristolochiae*

Blue Tiger *Danaus limniace*

Plained Tiger *Danaus chrysippus*

Psyche *Leptosia nina*

Peacock Pansy *Junonia almanac*


Redbase Jezebel *Delias pasithoe*


Common Sailor *Neptis hylas*

Yellow Pansy *Junonia hierta* (Male)


Chinese Bushbrown *Mycalesis gotama*


Dark-Branded Bushbrown *Mycalesis mineus*


Common Cruiser *Vindula erota*

Common Bush Brown *Mycalesis perseus*


Cabbage White *Pieris canidia*

Redspot Jezebel *Delias descombesi*

Lime Blue *Chilades lajus*

Dark Pierrot *Tarucus ananda*

Common Five Ring *Ypthima baldus*

Lime butterfly *Papilio demoleus*

Plum Judy *Abisara echerius*

Bamboo Treebrown *Lethe Europa*

Tailles Lime Blue/ Small Purple Line Blu

Common Redeye *Caltoris philippina*

Copper Flash *Rapala phertima*

Asian Grizzled Skipper *Spialia galba*

Plate 3. Butterfly Species Recorded from Mandalay-Muse New Railway Project Area

Crocothemis servilia Ruddy Marsh Skimmer (Male & Female)


Ground Skimmer/Chalky Percher *Diplacodes trivilis* (Male & Female)


Slender Skimmer/ Green Marsh Hawk *Orthetrum sabina*

Crimson-tailed Mash Hawk *Orthetrum pruinosum* (Male)


Crimson Mash Glider *Trithemis aurora* (Male)

Scalet March Hawk *Aethriamanta brevipennis* (Male)

Fulvous Forest Skimmer *Neurothemis fulvia*

Yellow-tailed Ashy Skimmer or common chaser *Potamarcha congener* (Male)

Blue Marsh Hawk *Orthetrum glaucaum* (Male)

Plate 4. Dragonfly Species Recorded from Mandalay-Muse Railway New Project Areas

Prunus cerasoides

Bauhinia purpurea

Eucalyptus ovata

Emblica officinalis

Castanopsis tribuloides

Quercus sp.

Quercus helferiana

Diospyros kaki

Schima wallichii

Prunus communis

Gmelina arborea

Senna siamea

Pinus insularis

Prunus persica

Albizia chinensis

Colona floribunda

Dendrocalamus latiflorus

Caryota urens

Colona floribunda

Terminalia bellerica

Albizia odoratissima

Schleichera oleosa

Bombax ceiba

Dillenia pentagyna

Dalbergia cultrata

Millettia macrostachya

Morus indica

Ficus glomerata

Tectona grandis

Dendrocalamus latiflorus

Chukrasia tabularis

Shorea siamensis

Bambusa tulda

Strychnos nux -blanda

Shorea obtusa

Musa itinerans

Plate 5. Investigated Plant Species in Project Area

Paddy field

Cabbage

Metman Yard

Irrigated field

Pineapple

Califlower

Corn

Aster flower

Plate 6. Cultivated Land Areas

ACTIVITIES PHOTOS

Preliminary Survey in the Project Area















Interview (Questionnaires' Survey), Field survey and Study Sites of Mandalay-Muse Railway Project

5.6. Socio-Economic Components

5.6.1. Overview of Important Economic Nodes along the Proposed Railway Line

Myanmar is located in the west of Indo-China Peninsula in Southeast Asia. It is bordered by India and Bangladesh in the northwest, China in the northeast, Thailand and Laos in the southeast, the Andaman Sea in the south, the Bay of Bengal in the southwest and the total length of the coastline is 1930 km. The country has seven provinces, seven states and two central municipalities directly under the Central Government. Its territory area is about 67.65×104 km^2. It is the fortieth largest country in the world and the second largest country in Southeast Asia. In 2017, the total population was 53.39 million, ranking 26th in the world, with an urbanization rate of 34.7%.

In recent years, the government has carried out economic system reform aimed at establishing a market economy, encouraged the development of private enterprises and actively introduced foreign capital. The gross domestic product (GDP) has grown significantly. The total GDP in2015/16 is about 55.813 billion USD, and the per capita GDP is about 1064 USD. Compared with 2014/15, it has increased by 7%, and the average growth rate in recent years is about 7%, which is much higher than the average growth rate of the Association of Southeast Asian Nations (ASEAN) of 4.5%.

This line directly attracts Shan and Mandalay provinces. The main economic data of the two provinces are shown in the table below.

Table - Major Economic Indicators for the Fiscal Year 2015/2016 along the Line

Indicator	Unit	Mandalay Province	Shan State	Total
Area	10^4 km^2	3.7	15.58	19.28
Population	10,000 persons	615	619	1234
Population density	person/km^2	166	40	64
GDP	100 million USD	53.53	61.36	114.89
Per capita GDP	USD	870.48	991.25	931.06

Muse: Muse is located on the northern border of Shan State, with a population of about 450,000 (2014). Muse Port is the largest land trade port between Myanmar and China, with a trade volume of 5.8 billion USD in fiscal year 2017-2018, accounting for 86% of the border trade between Myanmar and China, ranking the first.

Lashio: Lashio is a city in northern Myanmar. It is a military, political, economic and transportation center in northern Shan State. It is also an important gateway to China in northern Myanmar. It is about 130 km away from the border port city Wanding of Yunnan Province in China. It is the end point of the Sino-Myanmar Highway. Lashio is about 280 km away from Mandalay, Myanmar's second largest city, with a population of about 610,000. The main crops are rice, corn, tea, coffee and tobacco. The main minerals are coal, iron, oil, natural gas, rutile and a variety of non-ferrous metals. The meter-gauge railway links Mandalay, and the highway connects Taunggyi, capital of Shan State, in the south, and Yunnan, China, in the north. Rangoon, Myanmar's second largest city can also be reached by airlines.

Mandalay: Mandalay provincial capital, the 2nd largest city in Myanmar, is located at the intersection of the four economic corridors in the country (north-south, east-west, northeast-southwest corridors). It is an economic, educational, transportation and medical center in northern Myanmar. As of October 2017, the total population of Mandalay City was 17.227 million, accounting for 27% of the province. The GDP in fiscal year 2015/2016 was about 2.5 billion USD, accounting for 41% of the province. The industrial structure of agriculture, industry and service industry was 3.5: 38.0: 58.5, mainly in service industry.

5.6.2. Socio-Economic Components

(a) National income

Among the areas passed by Muse -Mandalay Railway, except Muse, Lashio and Mandalay, where the per capita income is higher and the people are richer, the other areas have low per capita income and there are more rural poor people.

Figure - Typical Village Building along the Line

Figure – Agricultural Lands along the Railway Line

(b) Domestic water supply

In the area along Muse-Mandalay Railway, except parts of the city in Muse, Lashio, Mandalay and other cities have good urban water supply, the living water supply in other towns and rural areas along the line mainly relies on the extraction of shallow groundwater. Groundwater is generally buried at a depth of about 2-3 m. Most of the villages along the railway line are used natural spring water as drinking and domestic water.

Figure – Typical Village Well along the Line



Figure – Domestic Use for Natural Spring along the Line

(c) Education

The towns of Sintgaing and Pyinoolwin in Mandalay have good basic and higher education. Other towns are too far away from educational centers and lack good teachers and facilities. There are more rural families in Shan State, and it is difficult for their children to go to middle schools. The main reason is that rural areas are far from cities and towns, and poverty in rural families force children to drop out of school and start working to support their families.

5.6.3 Socio-economic Indicators

Mandalay Region Figures at a Glance

Number of Districts	7
Number of Townships/Sub Townships	30
Total Population	6,165,723
Population Male	2,928,367 (47.49%)
Population Female	3,237,356 (52.51%)

Percentage of urban population	35%
Area (Km^2)	30,888.1
Population density (per Km^2)	199.6
Median age	28.2

Number of private households	1,323,191
Sex ratio	91 males per 100 females
Literacy rate (persons aged 15 years and over)	93.8%

Type of Identity Card (persons aged 10 years and over)	Number	Percent
Citizenship Scrutiny	3,903,980	75.8
Associate Scrutiny	4,394	0.1
Naturalised Scrutiny	14,200	0.3
National Registration	55,423	1.1
Religious	44,273	0.9
Temporary Registration	14,579	0.3
Foreign Registration	1,003	Less than 0.1%
Foreign Passport	4,360	0.1
None	1,104,228	21.4
Labour force participation	Both sexes	Male	Female
Age 10 and over	58.1%	73.2%	44.8%
Age 15 and over	63.9%	81.7%	48.6%
Age 15 – 64	67.9%	85.4%	52.4%
Employment to population ratio	Both sexes	Male	Female
Age 10 and over	56.2%	70.8%	43.3%
Age 15 and over	62.0%	79.3	47.1%
Age 15 – 64	65.7%	82.8%	50.7%
Material for housing	Wall	Floor	Roof
Dhani/Theke/In leaf	2.0%	-	14.0%
Bamboo	72.1%	24.8%	6.7%
Earth	0.1%	23.0%	-
Wood	6.0%	29.5%	0.1%
Corrugated sheet	0.2%	-	74.6%
Tile/Brick/Concrete	18.4%	21.5%	2.0%

Other	1.2%	1.2%	2.6%
Main source of energy for cooking			
Electricity	21.3%		
LPG	0.1%		
Kerosene	Less than 0.1%		
Biogas	0.1%		
Firewood	62.0%		
Charcoal	15.6%		
Coal	0.3%		
Other	0.5%		
Main source of energy for lighting			
Electricity	39.4%		
Kerosene	0.4%		
Candle	14.0%		
Battery	22.4%		
Generator (private)	11.1%		
Water mill (private)	0.7%		
Solar system/energy	8.1%		
Other	3.9%		
Main source of drinking water			
Tap water/piped	11.2%		
Tube well, borehole	46.6%		
Protected well/spring	18.4%		
Bottled/purifier water	9.4%		
TOTAL Improved	*85.6%*		
Unprotected well/spring	2.0%		
Pool/pond/lake	3.5%		
River/stream/canal	5.3%		
Waterfall/rainwater	1.4%		
Other	2.2%		
TOTAL Unimproved	*14.4%*		
Main source of water for non-drinking use			
Tap water/piped	14.9%		
Tube well, borehole	53.8%		
Protected well/spring	15.0%		

Unprotected well/spring	2.0%
Pool/pond/lake	5.3%
River/stream/canal	5.8%
Waterfall/rainwater	1.0%
Bottled/purifier water	0.1%
Other	2.1%

Availability of communication amenities	
Radio	39.6%
Television	52.7%
Landline phone	4.5%
Mobile phone	40.9%
Computer	3.7%
Internet at home	7.8%
% with none of the items	24.0%
% with all of the items	0.5%
Availability of Transportation equipment	
Car/Truck/Van	4.4%
Motorcycle/Moped	58.2%
Bicycle	39.6%
4-Wheel tractor	1.5%
Canoe/Boat	1.7%
Motor boat	0.5%
Cart (bullock)	28.0%

Shan State Figures at a Glance

Number of Districts	14
Number of Townships/Sub-Township	83
Total Population	5,824,432
Population Male	2,910,710 (49.97%)
Population Female	2,913,722 (50.03%)
Percentage of urban population	24%
Area (Km^2)	155,801.38
Population density (per Km^2)	37.4

Median age	24.4

Number of private households	1,169,569		
Sex ratio	100 males per 100 females		
Literacy rate (persons aged 15 years and over)	64.6%		
Type of Identity Card (persons aged 10 years and above)	Number	Percent	
Citizenship Scrutiny	2,754,540	59.9	
Associate Scrutiny	5,805	0.1	
Naturalised Scrutiny	16,043	0.4	
National Registration	141,594	3.1	
Religious	18,259	0.4	
Temporary Registration	22,253	0.5	
Foreign Registration	5,071	0.1	
Foreign Passport	11,249	0.2	
None	1,626,375	35.3	
Labour force participation	Both sexes	Male	Female
Age (10 and over)	67.0%	76.6%	57.4%
Age (15 and over)	74.4%	85.9%	63.1%
Age (15 – 64)	77.5%	88.6%	66.4%
Employment to population ratio	Both sexes	Male	Female
Age (10 and over)	65.5%	74.9%	56.3%
Age (15 and over)	73.0%	84.2%	61.9%
Age (15 – 64)	75.9%	86.8%	65.1%
Material for housing	Wall	Floor	Roof
Dhani/Theke/In leaf	0.5%	-	16.5%
Bamboo	47.9%	30.7%	0.4%
Earth	1.3%	11.2%	-
Wood	20.2%	29.3%	0.1%
Corrugated sheet	0.9%	-	75.3%
Tile/Brick/Concrete	28.4%	27.6%	7.1%
Other	0.8%	1.2%	0.6%

Main source of energy for cooking	
Electricity	15.1%
LPG	0.2%

Kerosene	0.1%
Biogas	0.7%
Firewood	76.7%
Charcoal	6.8%
Coal	0.2%
Other	0.2%
Main source of energy for lighting	
Electricity	33.4%
Kerosene	4.0%
Candle	17.3%
Battery	3.8%
Generator (private)	2.0%
Water mill (private)	10.2%
Solar system/energy	26.6%
Other	2.7%
Main source of drinking water	
Tap water/piped	20.0%
Tube well, borehole	5.6%
Protected well/spring	17.7%
Bottled/purifier water	11.4%
TOTAL Improved	*54.7%*
Unprotected well/spring	9.0%
Pool/pond/lake	4.2%
River/stream/canal	9.9%
Waterfall/rainwater	17.3%
Other	4.9%
TOTAL Unimproved	*45.3%*

Main source of water for non-drinking use	
Tap water/piped	24.2%
Tube well, borehole	6.9%
Protected well/spring	19.9%
Unprotected well/spring	8.6%

Pool/pond/lake	4.8%

River/stream/canal	12.4%
Waterfall/rainwater	17.3%
Bottled/purifier water	0.2%
Other	5.7%
Availability of communication amenities	
Radio	23.3%
Television	54.6%
Landline phone	4.9%
Mobile phone	34.4%
Computer	2.9%
Internet at home	3.9%
% with none of the items	34.1%
% with all of the items	0.4%
Availability of Transportation equipment	
Car/Truck/Van	4.5%
Motorcycle/Moped	63.6%
Bicycle	12.3%
4-Wheel tractor	6.9%
Canoe/Boat	1.6%
Motor boat	0.7%
Cart (bullock)	17.8%

5.6.4. Overview of Important Economic Nodes along the Proposed Project

Myanmar is located in the west of Indo-China Peninsula in Southeast Asia. It is bordered by India and Bangladesh in the northwest, China in the northeast, Thailand and Laos in the southeast, the Andaman Sea in the south, the Bay of Bengal in the southwest and the total length of the coastline is 1930 km. The country has seven provinces, seven states and two central municipalities directly under the Central Government. Its territory area is about 67.65×104 km^2. It is the fortieth largest country in the world and the second largest country in Southeast Asia. In 2017, the total population was 53.39 million, ranking 26th in the world, with an urbanization rate of 34.7%.

In recent years, the government has carried out economic system reform aimed at establishing a market economy, encouraged the development of private enterprises and actively

introduced foreign capital. The gross domestic product (GDP) has grown significantly. The total GDP in2015/16 is about 55.813 billion USD, and the per capita GDP is about 1064 USD. Compared with 2014/15, it has increased by 7%, and the average growth rate in recent years is about 7%, which is much higher than the average growth rate of the Association of Southeast Asian Nations (ASEAN) of 4.5%.

This line directly attracts Shan and Mandalay provinces. The main economic data of the two provinces are shown in the table below.

Table - Major Economic Indicators for the Fiscal Year 2015/2016 along the Line

Indicator	Unit	Mandalay Province	Shan State	Total
Area	10^4 km^2	3.7	15.58	19.28
Population	10,000 persons	615	619	1234
Population density	person/km^2	166	40	64
GDP	100 million USD	53.53	61.36	114.89
Per capita GDP	USD	870.48	991.25	931.06

Muse: Muse is located on the northern border of Shan State, with a population of about 450,000 (2014). Muse Port is the largest land trade port between Myanmar and China, with a trade volume of 5.8 billion USD in fiscal year 2017-2018, accounting for 86% of the border trade between Myanmar and China, ranking the first.

Lashio: Lashio is a city in northern Myanmar. It is a military, political, economic and transportation center in northern Shan State. It is also an important gateway to China in northern Myanmar. It is about 130 km away from the border port city Wanding of Yunnan Province in China. It is the end point of the Sino-Myanmar Highway. Lashio is about 280 km away from Mandalay, Myanmar's second largest city, with a population of about 610,000. The main crops are rice, corn, tea, coffee and tobacco. The main minerals are coal, iron, oil, natural gas, rutile and a variety of non-ferrous metals. The meter-gauge railway links Mandalay, and the highway connects Taunggyi, capital of Shan State, in the south, and Yunnan, China, in the north. Rangoon, Myanmar's second largest city can also be reached by airlines.

Mandalay: Mandalay provincial capital, the 2nd largest city in Myanmar, is located at the intersection of the four economic corridors in the country (north-south, east-west, northeast-

southwest corridors). It is an economic, educational, transportation and medical center in northern Myanmar. As of October 2017, the total population of Mandalay City was 17.227 million, accounting for 27% of the province. The GDP in fiscal year 2015/2016 was about 2.5 billion USD, accounting for 41% of the province. The industrial structure of agriculture, industry and service industry was 3.5: 38.0: 58.5, mainly in service industry.

5.6.5. Population and Nationality

Myanmar has a rich and colorful culture. There are 135 ethnic groups, including Bama and some ethnic minorities, such as Kachin, Kaye, Karen, Mon, Ruokai and Shan. Two states/provinces with different ethnic groups living are passed by this project. Details are as follows:

Shan State: The total population is about 6.19 million. The main ethnic groups are Wa, Shan, Kachin, Lahu, Balang and Chinese.

Mandalay Province: The total population is about 6.15 million. The main ethnic groups are Burmese and Dai. The nations along the line are shown in the table below.

Table -Nationalities Distribution along the Project Area

State/Region	Main nation	Other nations
Mandalay Region	Bamar	Mostly are Han-Chinese, Indians and Shan, etc.
Shan State	Shan	Pa-O, Dai, Dongan Qiao, Danu, Blang, etc.

Generally speaking, the population of Lashio and Ayeyarwady River Plain is denser, while the population of Ruokai Mountains is sparse, and part of it belongs to no-man land.

5.7. Public Health Components

In Myanmar, there are better public health systems in Muse, Lashio and Mandalay urban areas, including municipal hospitals and community (private) medical points. The public health system in other remote areas is incomplete.

Malaria is a major public health problem in Myanmar. In the region where the project is located, the incidence of malaria is ⩽5 cases per 1000 people, and the mortality rate of malaria is the highest in Shan State (6-7 cases per 100,000 people), followed by Mandalay

Province (≤ 1 case per 100,000 people). The main cause of death is the inadequate medical service system.

In addition to malaria, dengue fever is a disease that occurs mainly in high-density cities and towns. The rainy season from May to June is the peak period of dengue fever spreading. The spreading of dengue fever is mainly caused by the bite of Aedes mosquitoes. According to preliminary investigation, more people in Shan State than in Mandalay Province do not use mosquito nets, and the incidence rate is higher.

5.8. Traffic Condition

Since the project is near located in the relatively populated municipal area and the nature of the project is highly interrelated with the traffic conditions especially in daytime, EIA team took a traffic study and prepared vehicle movements summaries at Muse-Mandalay Road. The purpose of the traffic study is to study the counts of vehicle movements through NH3 road and to know the peak period hours. This peak hour will help to reduce the cumulative traffic impacts due to the more vehicles during construction and operation phases of the proposed project.

Materials and Methods

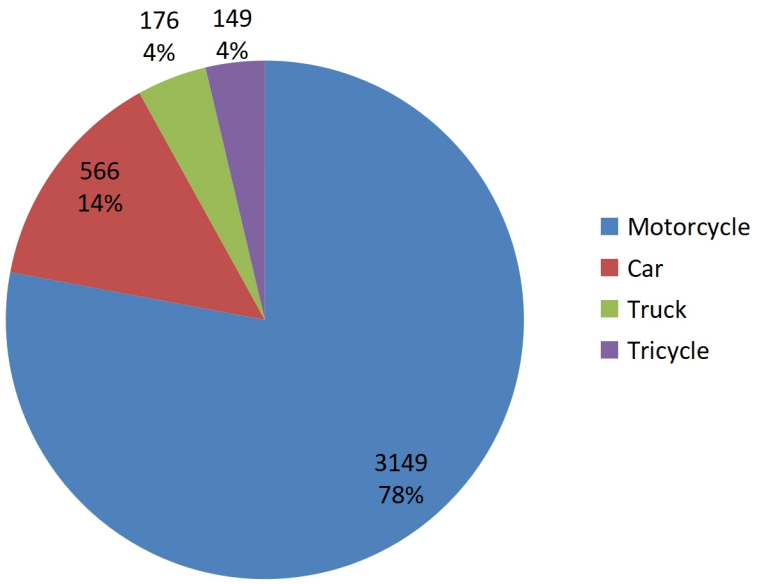
EIA team uses both of the video record and self counted by surveyors to the vehicles entering the NH3 Road. The reason to choose this point for traffic study is to analyse the vehicles entering the NH3 road during working and weekend days.

Summary of Vehicle Movements in Weekend Day

	SUMMARY OF VEHICLE MOVEMENTS				
	LOCATION: NH3 Rd				
TOWNSHIP: Lashio			CITY: Lashio		
OBSERVER: EIA Team			DATE: 20.8.2019 (Sat)		
WEATHER: Clear			Weekend Day		
REMARK:					
	VEHICLE MOVEMENTS				
TIME		Types of Vehicles			Total
BEGIN	Motorcycle	Car	Truck	Tricycle	
7:00(Am) – 10:00 (Am)	850	157	49	47	1103

11:00(Am) – 2:00 (Pm)	561	96	34	27	718
4:00(Pm) – 7:00 (Pm)	986	184	56	51	1277
7:30(Pm) – 9:30 (Pm)	752	129	37	24	942
	Traffic Volume				4040
4:00(Pm) – 7:00 (Pm)	Peak Period Hours	1277			
	Peak Period Traffic Volume				
4:00(Pm) – 7:00 (Pm)	986	184	56	51	

According to the traffic count result in weekend day, morning peak hour occurs at 7:00-10:00 am, midday peak at 11:00 am-2:00 pm, evening peak at 4:00-7:00 pm and night peak at 7:30-9:30 pm. At morning peak hour, peak volume is 1103 vehicles. In this period, vehicles coming from NH3 road as the time is inbound hours at the beginning of weekend day. At midday peak hour, peak volume is 718 vehicles. In this period, vehicles moving in all inbound and outbound directions were about the same amount. At evening peak hour, peak volume is 1277 vehicles. At night peak hour, peak volume is 942 vehicles. Comparing to morning peak volume, the peak volume recorded between 4:00-7:00 pm is significantly high. And weekend day peak volume is 4040 vehicles.

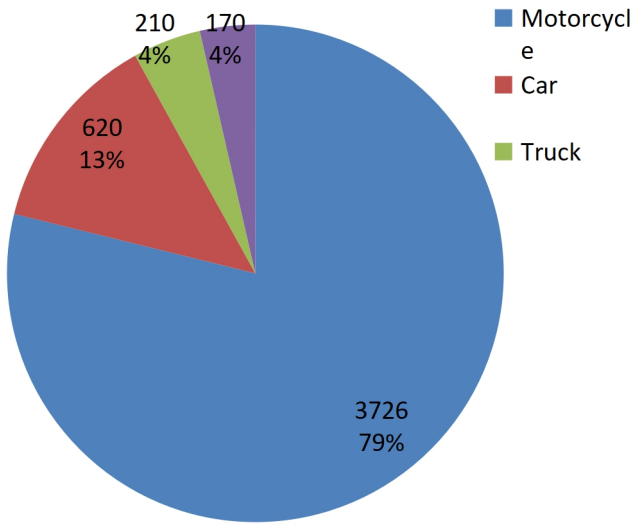


Types of Vehicles Counted in Mandalay-Lashio Road (Weekend Day)

Summary of Vehicle Movements in Working Day

	SUMMARY OF VEHICLE MOVEMENTS				
	LOCATION: NH3 Rd				
TOWNSHIP: Lashio			CITY: Lashio		
OBSERVER: EIA Team			DATE: 19.8.2019 (Fri)		
WEATHER: Clear			Working Day		
REMARK:					
	VEHICLE MOVEMENTS				
TIME		Types of Vehicles			Total
BEGIN	Motorcycle	Car	Truck	Tricycle	
7:00(Am) – 10:00 (Am)	971	163	62	51	1247
11:00(Am) – 2:00 (Pm)	657	108	39	28	832
4:00(Pm) – 7:00 (Pm)	1205	207	67	59	1538
7:30(Pm) – 9:30 (Pm)	893	142	42	32	1109
	Traffic Volume				4726
7:00(Am) – 10:00 (Am)	Peak Period Hours	1538			
	Peak Period Traffic Volume				
7:00(Am) – 10:00 (Am)	1205	207	67	59	

According to the traffic count result in working day, morning peak hour occurs at 7:00-10:00 am, midday peak at 11:00 am-2:00 pm, evening peak at 4:00-7:00 pm and night peak at 7:30-9:30 pm. At morning peak hour, peak volume is 1247 vehicles. In this period, vehicles coming from NH3 road as the time is inbound hours at the beginning of work day. At midday peak hour, peak volume is 832 vehicles. In this period, vehicles moving in all inbound and outbound directions were about the same amount. At evening peak hour, peak volume is 1538 vehicles. At night peak hour, peak volume is 1109 vehicles. Comparing to morning peak volume, the peak volume recorded between 7:00-10:00 am is significantly high.



Types of Vehicles Counted in Mandalay-Lashio Road (Working Day)

Conclusion for Traffic Study

According to the study, the vehicle movements in weekend day is greater 14.5% generation rate of in working day vehicles volume as many visitors coming to Pyin Oo Lwin, Thi Paw and Muse.

5.9. Cultural Components

Myanmar has a rich and colorful culture. There are 135 ethnic groups, including Bama and some ethnic minorities, such as Kachin, Kaye, Karen, Mon, Ruokai and Shan. Two states/provinces with different ethnic groups living are passed by this project. Details are as follows:

Shan State: The total population is about 6.19 million. The main ethnic groups are Wa, Shan, Kachin, Lahu, Balang and Chinese.

Mandalay Province: The total population is about 6.15 million. The main ethnic groups are Burmese and Dai. The nations along the line are shown in the table below.

Table - Nationalities Distribution along Muse-Mandalay Railway

State/Region	Main nation	Other nations
Mandalay Region	Bamar	Mostly are Han-Chinese, Indians and Shan, etc.
Shan State	Shan	Pa-O, Dai, Dongan Qiao, Danu, Blang, etc.

Generally speaking, the population of Lashio and Ayeyarwady River Plain is denser, while the population of Ruokai Mountains is sparse, and part of it belongs to no-man land.

(a) History of Shan

The Shan have already evacuated to Mae Hong Son province for more than a century of years. The evidence has been shown by the elderly the Shan tellers, and from study the history of Mae Hong Son province can see that the Shan, who live in Mae Hong Son, have evacuated from North East of Myanmar which called "Shan State" that comprises of towns along Salween River such as Maung Mog Mai, Maung Nai, Maung Lang Kur, etc. Shan move to live in Mae Hong Son about the year of 1831 B.E. of the third king era, King Pra Nang Klao, of Ratanakosin City.

The Shan will always come to plant the seasonal vegetation and go back to Shan State after finish harvest until the year of 1856, then move to domicile at Baan Pangmoo, Pangmoo subdistrict, Maung district, Mae Hong Son province. They earn their living by planting and farming till the year of 1866 Chao Kaewmaungma has been sent from Chiang Mai to catch the elephants to train to work. He has gathered all the Shan who live scatteringly to come to stay together in the area which is Mae Hong Son at present. In the year of 1874 the ruler of Chiang Mai has seen that Baan Mae Hong Son and Baan Pangmoo are crowded with people which deserve to be upgraded as a town named "Mae Hong Son Town" and has appointed a Shan whose name "Shangale" to be the first ruler and has the title of "Praya Singhanartracha". After that there are 3 more rulers before the management system changed to be Mae Hong Son province.

From the past long period over a hundred year Shan of Mae Hong Son still live with strict traditions and cultures of the time together with the Shan's life style and the belief of Shan. At the same time they still have the brotherly relationship with the Shan who live in Shan State in Myanmar by selling and visiting to each other all the time, though, there will sometime be some political unrest.

The Shan have their own art of dressing which express the unique of culture for a long time. It is the same as the Shan in Mae Hong Son who have their own art of dressing, too. It has just only a little bit of difference in details that depends on the status of living, sex, age, and suitability of dressing such as the women's blouses are like Myanmar's which have both long and short sleeves, the edge of the blouse to which buttons are attached, will be passed from the left to the right and the lower part prefer putting on Thai sarongs. For the Shan men prefer using long sleeves cotton shirts, round collars cut the middle with Chinese buttons, and

putting on wide leg trousers. In the past the Shan men prefer carrying on the shoulder with shoulder bags and nice pattern swords and usually have an ink tattoo all over the bodies. Whenever going out from the houses both men and women usually use turbans or hats which called "Gub Tai".

For the languages, the Shan have their own spoken and written languages. For spoken language or "Gwam Tai" is different from the Myanmar language. However, it is similar to the Thai language; it is only a little bit deviated. For their written language, the alphabets are called "Leek Tai" have been used from the ancient time, which are similar to Mon and Myanmar letters.

(b) Shan Traditions

Shan's traditions are nearly held in every month and because Shan strictly believe in Buddhism therefore most of the traditions are stressed in making merit and giving alms. The details of Shan important traditions are as follow:

Poijati (The Worship of a Sand Pagoda):

Poijati or The Worship of a Sand Pagoda has been inherited by Shan every year for a long time. It is held At Phanon Temple (Reclining Buddha) Mae Hong Son Muang district and other temples in the villages of each district, on the purpose of worship the Buddha and praying for seasonal rainfall. It generally held in June, 7 days before the festival commences in the every evening after finishing working the villagers will help together carrying sand to the temple putting it at the provided area of the temple until there is sufficient to build a sand pagoda. The villagers will help together again to build the pagoda and decorate it with Shan's flags, tiers, colorful of rainbows, and various kinds of flowers, at night the lamps are lit brightly and beautifully. Now when the day, the villagers will dress themselves in Shan style with beautiful colors to join the festival and bring some sweet, bananas, sugarcanes, rice, foods, flowers, candles, incense, and others to offer at the temple. After that, there will be Buddhist preaching or "Thomleek" in the Shan language, after finishing, offering some food to the monks and having a party to all participants. In the afternoon, there will be "Fireballs Procession Contest" before bringing to lit in the field far away from the village. The purpose is to warn all the angles to destine for seasonal rainfall.

Poi Learn Sib Ed:

Poi Learn Sib Ed or "End of Buddhist Lent Day" tradition is a very important tradition of people in Mae Hong Son. In month eleven about thirteenth-fourteenth of waxing moon there will be a fair selling and buying all day and night. The villagers will buy some food or something for making merit at the temple on the fifteenth of waxing moon. In the morning of

the fifteenth of waxing moon there will be giving alms to the Buddhist monks (Tug Bat Tawo) at Phra That Doi Kong Mu temple, which located on the top of the hill, the monks will parade down from the top of the temple to Muay Tor temple which is located at the foothill, thousands of people will be scattered in line along both sides of the road in order to wait for giving alms to the monks. It is very beautiful appearance, at night houses and temples will light very bright lanterns and will also have "Chong Phara Procession" or "Castle Procession" to welcome the Buddha to come from the paradise. The castle will be decorated beautifully, and there will be various local entertainments and "Thousand Candles Procession" (Lu Ten Heng), too.

Ton Gia Tradition:

After end of Buddhist lent day about October each of community will bring pine wood to cut into small pieces and tie them to be a big trunk about 3-5 meters high with beautiful decoration then parade to the temple and light it brightly which regards as making merit and will make the life progress. Moreover, in the procession will comprise with thousand of candles and offerings parade along the various roads, and there will be beauty contest among each community. In the procession will have some shows and competition such as local culture show, Shan music which make fun among the procession.

Poi Lu Kaow Yaku:

The tradition of Poi Lu Kaow Yaku is a tradition that held in every year. It is the tradition that has affiliation with the villagers who do agriculture for a long time. It regards as the tradition that held by Shan. Shan believe that after farming or harvesting there have to be some recall of rice kindness which protects their farms and giving them rice to nourish their lives. After getting some new rice they have to give to the temple to make auspicious for their lives, so on a day of month 3 which is exactly to February of every year Shan will hold the tradition of Kaow Yaku since then.

Way of making Kaow Yaku:

Bringing the sticky rice to steam until it is cooked then put it into the pot and pouring molasses with coconut milk after that mixes it and put some peanut with roast sesame then put it on the tray and put some scratch coconut on top cutting it into pieces and wrapping with banana leave or putting it into a bag to keep to the temple. The left of Kaow Yaku will be donated to the villagers in the past there was a procession of Kaow Yaku by using a nice decorated cart carried Kaow Yaku and went around the village. There were still some entertainments about folk music, and dancing to make more fun.

Gingala (Bird Dance):

It will be performed in the festivals or in the important occasions eg. Welcome the guests or the official foreign visitors, end of Buddhist Lent day, and other traditions. The art performance "Gingala" is a kind of dancing that imitates the bird manner. There will be some teasing according to each dancer style while performing and it is more natural and beautiful when joining together with the rhythm. The way of performance is to dance continuously accordance with the rhythm of the sound of drum and other musical instruments with each dancer's manner until seeing the sign then the performance will be ended in harmony and beautifully. The period of dancing is uncertain and the place has to be big enough to let the dancers have space to perform their dancing style conveniently. Before performance must have teacher worship ceremony.

Gato (To dance):

Gato or Rum To is a kind of performance in Mae Hong Son province. It is like Chinese lion performance which is very enjoyable. There will be two dancers in this show, one of them is in front of the head and the other will be in the back at the tail. Gato has no any certain styles of dancing; most styles of the show will follow the rhythm of the song. Gato will be performed at the festivals or the various important occasions eg. Welcome the official foreign visitors, end of Buddhist Lent day, and other traditions.

Jaad Tai (A Shan musical folk drama):

Jaad Tai performance is a big show which comprises with 20-50 players or over it depends on each of Jaad Tai group. It is the show reflecting Shan's culture. Jaad Tai is alike to a Thai musical folk drama in the central region which comprises with actors, musicians; there are a scene, and a stage, dressing accordance with the story. Jaad Tai is the local Myanmar show but nowadays Shan bring it to apply with their own art called "Lige Tai"

Galaew (Sword Dance):

In the past history Shan is the nationality that often evacuate because of invasion by nearby nationalities. They sometime defeat and sometime lose up to the ability of the leader when they are lost they have to move to set up the new place which make them have to learn and inherit the art of defend continuously. Laew or a sword is the individual weapon of Shan therefore; there is training about using of a sword and sword dance since the ancient time. A sword song has a very attractive dancing style.

Rum Tai:

Rum Tai is an art of dancing that shows the unique of Shan in Mae Hong Son province. It shows about the beautiful gentle culture of Shan together with politeness and humbleness. Showing the way of respect to the visitors, dancing all together accordance with the rhythm

with careful and neat manner. It will be performed in the festivals or the various important occasions eg. Welcome the official foreign visitors, end of Buddhist Lent day, and other traditions.

(c) Shan Handicraft

Tai shirt:

The length of woman's Tai blouse has to be at the waist level and in front of the blouse has passed from one side to another side, with shoulder sleeves and none shoulder sleeves, there is some thick embroidery or engraving around the neck, edge of sleeves, edge of the blouse and some decoration with beads, pearls, spangles. For man' Tai shirt has to sew the stitch inside the shirt and none shoulder sleeves, or sewing by separating the edge of both sides of shirt, in case of long sleeves it may be sew as a trace at the elbow or the edge of sleeves. Sewing with double stitches or single stitch from around the neck of the shirt straight down until the edge of the shirt, the middle back of the shirt sewing with the stitch straight down until the edge of the shirt, too. The button is made of the same cloth of the shirt there are pockets at the both sides of the edge of the shirt and a boring pocket at the left chest of the shirt. The embroidery must be prominent, neat, and nice and correct in accordance with the foundation details. Sewing, the velocity has to be nice not too close or too far. The colors of lining cloth have to be the same color as the shirt.

Tai design:

The feature of Tai design is similar to Thai tribes in the various regions in Indo China Cape especially the Thai details art can deduce that Tai design art has been originated for a long time over thousands of years as same as Thai art, that is in the year around century 9 of Buddha the Asian region has received Buddhist culture from India by bringing the arts and artisan, too. The early era the art of China, Myanmar, Cambodia, Indonesia, and Thai, is the arts which receives the culture from India. Shan is also a branch of Thai nation therefore it is possible to receive the arts religion from India which is the same as the other Thai tribes, too.

Kubtai:

Kubtai is generally called by the local language of Shan or the other name "wickerwork hat" it is used for protecting sunlight and rain and also put on at the various activities such as tradition parade in order to express the unique of the district and some place uses to decorate shops, houses, and the place where has the various exhibitions to show for beauty or to show the unique and the benefit of using. Nowadays, it is very popular for tourists 'souvenir that come to visit Mae Hong Son province.

(d) Shan Agriculture

Mae Hong Son is the province which has the most mountains in Thailand. 90% of the landscape is high sophisticated mountains there is only l0% of plain in all area. Though there is little of plain but the occupation for the most of the people is agricultures such as doing rice farm, doing garlic, onion farm, soya bean, sesame, orchard, other farm crops, and livestock. Most income of the people comes from selling agricultural crops, and a part of the products will be kept for consumption. Works in farms will start in the month of June, it is the early of the rainy season the people will begin to prepare the areas for planting by cutting away all weed, loosening the soil. They will begin planting immediately when there is enough water from the dam it takes also 3 or 4 months in waiting for harvest time. After harvest time it will be cold season in Mae Hong Son the people will prepare the area for planting another vegetation which takes less time and water (2-3 months) such as onion, garlic, soya bean etc. When enters hot season about February every kind of product will be completely harvested and move to be kept in a silo for eating and selling. In hot season the agricultural area looks drought and empty till the rainy season comes then the works in farms will begin again.

(e) Religion and Beliefs

The Candle Worship:

The Candle Worship is the rite which believed by Shan that after finish it can help protecting and getting rid of misfortune or bad luck and escaping all danger. It can make luckiness, and long life. Lighting the candle is very familiar among the Buddhists. The Buddhists believe that “candle” is the symbol of Buddha’s Teaching; therefore, using the candle in the rite has been already used for a long time. In the past the villagers prepare the candle to be lit by hand by using real wax which taking from stewing beehive then separate the wax out and put into the vessel such as a bowl, a plate wait until it becomes cold after that cut it with a knife into pieces. When it will be used to make a candle the wax will be brought to roll on the smooth floor until it becomes a round bar which is ready to be a candle for lighting. Lighting the candle not only the symbol of worship for Buddha’s Teaching but also it is believed that the candle that has been made by the one who knows well about “the Candle Worship” will help to get rid of misfortune, have luckiness, and long life. So The Candle Worship then is one of the rites that Shan prefer doing until now.

Ghost Feeding:

Buddhism is the main religion of Shan only few of them who believe in other religions. In case of the real life style they all still believe about some ghosts’ e.g. Ruler spirit, earth ghost, forest demon, water ghost, farm ghost, household spirit etc. They will be very careful not to

have any insult happen. Then there is the worship and the belief about ghost feeding in each community which is similar, for example, there will be Ruler Spirit Feeding Worship in month 7 of every year which has been called "Country Feeding Worship" because there is the belief that the ruler spirit will take good care to the villagers to stay in peace and happiness. Moreover, there still be another ghost feeding worship in another occasion but it is held in the simple way not too difficult e.g. on Buddhist holy day they will make a small banana leaf bowl which called "Gawg Tang" in Shan put with some food and sweet or betel nut, cigarette etc. then put it at some places such as houses, farms, fields, mines, dams, including spirit house, which they respect, then light the candle and pray. Ghost Feeding is the rite and the belief that held since the ancient time. In case of some community is in town the mentioned worship and the belief may disappear according to the change of the society in globalization world.

(f) Festivals

Normally, there will be several festivals and other traditions celebrated almost throughout the year in Mae Hong Son province. Since the local people still maintain strongly their cultures and ancient traditions. The important festivals are Poi Sang Long (Novice), End of Buddhist Lent (Poi Lern Sib Ed), Buatong Sunflower Festival. In the festival the tourists can see performing arts of Shan and Shan music which are more different from the other places they always joined with other religious ceremonies and parades.

Songkran Festival

Though, Songkran Festival in Mae Hong Son will not be as big as the other provinces. Anyway, Shan's Songkran festival still remains the charm and the uniqueness in itself. Songkran festival or in other words New Year Day will begin on 13th of April, almost on every road in town there will be the youths throwing the water with fun to each other, on 15th of April the Buddha image will be paraded through the streets and let people pour water to welcome the new year or Songkran festival and for the prosperity. After that, there will be Miss Songkran Parades from other communities with beautiful decoration to Nong Jong Kham Park. Along both sides of the street will have a lot of tourists both Thais and foreigners join the festival by pouring water onto the Buddha image, throwing the water to each other and playing Shan's instrument of music along the way. At Nong Jong Kum area there will be Miss Songkran contest, boat racing, local sporting match, and Shan's art and culture shows. Later, there will be pouring water onto the elder relatives or who is respected in order to ask for the apologies or good wishes by tradition. In addition, every district in Mae Hong Son province will organize Songkran Festival, too. The enjoyment and happiness of the festival,

the good and beautiful culture and, including the smile of the people with full hospitality make this festival cannot be forgotten from your memory.

Loy Krathong Festival

Loy Krathong Festival is an ancient ceremony of Shan. It comes on the full moon night of the twelfth lunar month. There is no set date. It depends on the moon and is usually in November every year. People make "krathong" to float in rivers. At Nong Chong Kham, various entertainments, various contests such as Miss Nopamat and krathong, cultural show are held near the central pond. Lamps and candles are lit all around the area. Moreover, at Wat Pra That Doi Kong Mu, there is a ceremony of releasing candle-lit krathong bound with balloons to the sky (known as "Loy Krathong Sawan"). Besides in Mae Hong Son Muang district, the other districts also organize Loy Krathong Festival as great as others, too. The colors of sky and river, the beautiful performing arts will be an experience that impress in your mind forever.

Tea Tasting Festival

Baan Rak Thai village or Baan Mae Aw in the original name, it is a Chinese village evacuating from China at time there was a revolution and change of government. The village is located next to Thai-Myanmar border, 44 kms. far from Mae Hong Son. Planting tea is main occupation of most people in the village it is the place where can produce good quality tea which is also the most famous product of the village. Surrounding village with spectacular views, therefore, during February of every year which is the month matching Chinese New Year there will be a lot of tourists pour to visit Mae Hong Son. So, the people in the village take this opportunity to organize "Tea Tasting Festival" to promote the good quality product of the village and at the same time to welcome all the visitors. Besides tasting good quality tea, during the festival there are the local performing arts to show their own original traditions and cultures. All over the village will be decorated similar to the local area of China and serving you together with good Chinese dishes. Moreover, there is still interesting activity that is to walk or to ride a mule to see and visit tea plantation and beautiful scenery around the village. There are accommodation services to the tourists who want to stay overnight in the village, too.

The journey to Baan Rak Tai Village, the tourists can take about 1 hour from Mae Hon Son to the village by driving along the highway no. 1095 about 8 kms. before reaching Fish Cave turning left to Mog Jum Pae village. This way will pass a lot of interesting places where the tourists can spend some minutes to visit such as Pha Sua Waterfalls, Pang Tong Palace, Hmong village, and Shan village. Anyway, since the road is rather steep the tourists should drive with care.

Chong Phara Tradition

The Chong Phara tradition is the tradition that is concerned making merit of Shan style in Mae Hong Son province. Chong means "a temple or a castle" and the other Para means "Buddha image" or "the Lord Buddha". Chong Phara is the build of castle to welcome the Lord Buddha from the paradise on the end of Buddhist Lent day.

Chong Phara or the Buddha's castle is the art of Shan. The frame is made of bamboo and padded with mulberry paper. It also is decorated with colorful paper which is drilled the holes to make the beautiful patterns then put it on the scaffold. Besides it is hanged with all the local fruits, and the four sides of the scaffold will be tied with banana and sugar cane trees which decorated perfectly with bright lanterns.

Chong Phara will be set for worship in the early evening on the fourteenth day of the waxing moon in the eleventh month, and there will also be inviting and welcoming ceremony in the early morning on the fifteenth day of the waxing moon in the eleventh month which is directly on the same day of the end of Buddhist Lent day. On this day the villagers will bring food in the banana leave cup which is included with steam rice, dessert, and fruit put them inside Chong Phara. Lighting the incense to worship and saying to invite the Lord Buddha to come and stay completely in Chong Phara for seven days for auspiciousness. After ending seven days of worship Chong Phara will be burnt or thrown away. It is unfavorable for keeping and will be rebuilt for the following year use.

The Chong Phara tradition is the tradition to worship the Lord Buddha. It is believed that if this tradition is held by any family, that family will full of happiness and can gain a lot of merit. On the same way it is also believed that if any village makes Chong Phara and keeps worship in the temple of the village entirely for seven days after the end of Buddhist Lent day. The villagers in that village will all be happy, too.

Poi Sang Long Tradition

Poi Sang Long (The Novice Ordination) Tradition:

Shan believe in long years ago that if anyone held Poi Sang Long Tradition that is the novice ordination or the monk ordination in Buddhism will be gained a big merit. Poi Sang Long tradition has been done successively for hundreds of years since the evacuation of Shan into this territory. It is popular held the tradition in the period of March-April which is the period of school vacation and also it is time to free from work in farm. Poi Sang Long is as a great tradition of Shan; it has to take as a month of time in preparing and has many steps, spends a lot of expenses, and has also to require people with knowledge and expertise in various events to help then it will be a success.

Buddhist Lent Festival

Although there are various races settled together in Mae Hong Son, various cultures, beliefs, and traditions, however, the people still respect, and honor in their differences, there is unity and stay with happiness all along. When any festival or tradition, whether it will be of any race the people will unite as one to make the activity always goes smoothly.

End of Buddhist Lent Day Tradition is another one of the most important traditions of Mae Hong Son; it is a tradition and religious belief, held together in every district in October of every year. The districts which held a grand, beautiful, and get much attention from the tourists are Muang Mae Hong Son, Mae Sariang, and Pai districts. Though it is one of the same religious belief but names and ceremonies are a little different.

End of Buddhist Lent Tradition will be called "Poi Lern Sib-ed" in Muang Mae Hong Son district. The villagers begin the ceremony by building "Chong Phara" or castle in front of their houses decorated with beautiful lamps to welcome Buddha back from pleasing his mother in heaven. After that the villagers will buy things preparing to give alms to the monks that always called "Tak Bat Tawo"; monks will walk in a long row from the top of the hill, which located of Pra That Doi Kong Mu Temple, to receive alms from the villagers who line up along the ways. In addition, there still be candle procession, and pine parade by chopping it into small pieces and put together to make a high timber, to offer to the temple finally. There are music and arts performing and many various dances, both sides of the street will be nicely decorated with beautiful candle lamps.

End of Buddhist Lent Tradition will be called "Poi Aok Wa" in Mae Sariang district. The ceremony will be similar "Chong Phara" or castle will be built in front of the villagers' houses decorated beautifully with candle lamps. Things will be prepared to give to the monks by the villagers. However, the difference from the other place is in Mae Sariang district will build the facade which called "Rachawat Facade" or bamboo facade in front of each house with beautiful decoration. Before dawn the villagers will give alms to the monks in front of their houses without any image of the monks walking in a long row to receive the alms like the other places but the image of monks in each temple walking and receiving the alms back and forth along the streets of Mae Sariang town instead. Throughout the duration of the event, at night there will be nice decoration with candle lamps along various streets and also other entertainments.

In Pai district "Poi Kad Lu" will be called for End of Buddhist Lent Tradition. Began by all houses create "Chong Phara" in front of the houses embellished with candle lamps as the other districts do. The quite difference, and bustle from the others is before End of Buddhist Lent day every house will prepare food, sweet, flowers, and other offerings to make a merit at

the temple, give alms to the monks, and put into Chong Phara. Therefore, the villagers from many villages will bring fruits, vegetables, flowers, food, sweet, consumer products, and other products sell in the markets or "Kad Lu" in the Shan language, the villagers will go to buy from dawn until night. In the markets will be brighten with candles and torches, moreover, there still be activities and several performances for tourists to see throughout the event.

The way of life, cultures which have never changed with time, colorful of lamps that embellished along both sides of the streets, the image of people giving alms to the monks dressing in local dresses, great spectacular performing arts believe that will impress visitors unforgettable.

5.9.1. The Distribution of Archaeology and Cultural Heritage in Mandalay Region

The distribution of cultural relics and monuments along the project is as follows:

- **Amarupa Ancient City**: located in the southwest of Mandalay City, the ancient city was built in 1364, and for more than 500 years, it has been the capital for the Awa Dynasty, and Aungzeya Dynasty for several times. The proposed railway line is about 9 km away from the ancient city.

- **Innwa Ancient City**: Located in the southwest of Mandalay, on the west bank of the Ayarwaddy River. Sagaing was built in the 14th century and was the capital of the Shan Kingdom from 1760 to 1764. The proposed railway line is about 13 km away from the ancient city.

Innwa is a major site including a lot of archaeological monuments and sites. In assessment project, these sites must be explored to identify how significant features of archaeological evidences will be come out in making assessment of impacts as well as the appropriate plan for mitigation process.

The existing risk especially disaster risk management is not efficient to protect and preserve the cultural environment of Innwa area. The topographic feature of the site is distinctively risky with the river confluence and erosion as well as the transportation and heavy loading of shipping. The elevation and features of Innwa is facing with the very crowded development plan recently.

The significant feature found nearby the project area is the concrete structure concerning with the ancient warfare and brick monastery concerned with the ancient religious dedication. Furthermore, it is closely related to the area of city walls and moats, which challenged by the river erosion due to the heavy loading of shipping and some other river formation. The earthquake is also the most important risk for this area.

(a) Queen Me Nu Brick Monastery - Maha Aungmye Bonzan Monastery (1822)

It is popularly known as Me Nu Ok Kyaung "Me Nu's Brick Monastery" that was built in 1818 by Nanmadaw Me Nu, the famous Chief Queen of Bagyidaw. For the residence of her religious Preceptor, the Nyaunggan Sayadaw, the Queen Me Nu donated this monastery. The earthquake of 1838, damaged it, and in 1873, it was restored by Sinbyumashin, Queen of Mindon, and a daughter of Nanmadaw Me Nu. The building is markedly different from traditional Burmese monasteries, which are constructed with wood, not masonry.

Figure - Queen Me Nu Brick Monastery

(b) Tha Bye Dan Fortress (1878)

The remain of Thabyedan (Thapyaytan) fortress was built by King Mindon between 1874 and 1878 to defend against the British during the third Anglo-Burmese War. It is near the Innwa Bridge. It could be related to the risk of deterioration such as human threats and development plans. But, the appropriate mitigation plan can provide the preservation of cultural significance of this site and the cultural landscape should also be emphasized in every stages of the development plans in many ways.

Figure - Tha Bye Dan Fortress

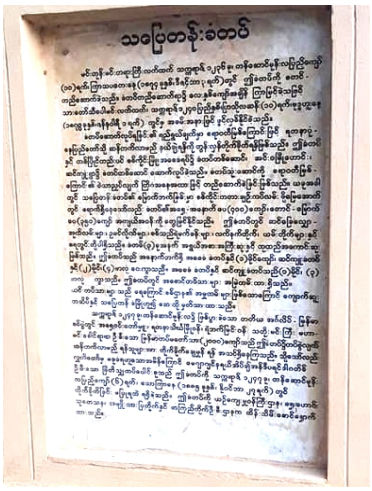


Figure - Description Pillar of Tha Bye Dan Fortress

(c) Innwa Bridge (1934)

Innwa bridge was built by British Colonial Government and it has 16 span cantilever bridge was the only structure to span the Ayeyarwady River until recently. Although now superseded by a parallel 2005 road bridge, it is still in use for railway and local road traffic.

Figure - Innwa Bridge

(d) Innwa City Wall (East and North) (14th -19th Century AD)

The northern part of Innwa is nearby the bank of Ayeyarwady River and the Eastern partis on the bank of Duthavati (Myitnge) River. These two areas are usually eroded by rivers in every rainy season. Because of the water transportation and tourism development, the challenges of this ancient urban landscape are often impacting on the landscape. The most risky impact is wasting sewage and garbage around the cultural heritage monuments.

In both of north and east, there are the places of jetty that the local and tourist can enter into the ancient cultural area by waterway. These jetties should be measured to get the loading of using the waterway to be accessible. In the time of heavy rain, these parts were usually flooded not to be accessible by car or some vehicles. Therefore, the flash flood is also the major risk for cultural heritage. The development plan can frighten the cultural landscape by their preparedness of construction and operation processes. But, it is depending on their respective types of plan. As for oil storage tanks project, even though it may be considered the various types of risks for the cultural heritage, there can be drawn out these possible impacts of visual and cumulative aspect.

(e) U-bein Bridge

Also known as the "Valentine Bridge", located in the southwest side of Mandalay City, spanning across Taungthaman Lake, built in 1851, with a 160-year history. The bridge is built of 1086 pieces of teak trees, the length of which is 1.2 km. The whole bridge is built of teak. It is the most precious treasure in Myanmar with its ancient color and rich local characteristics. The proposed railway line is about 7 km away from the bridge.

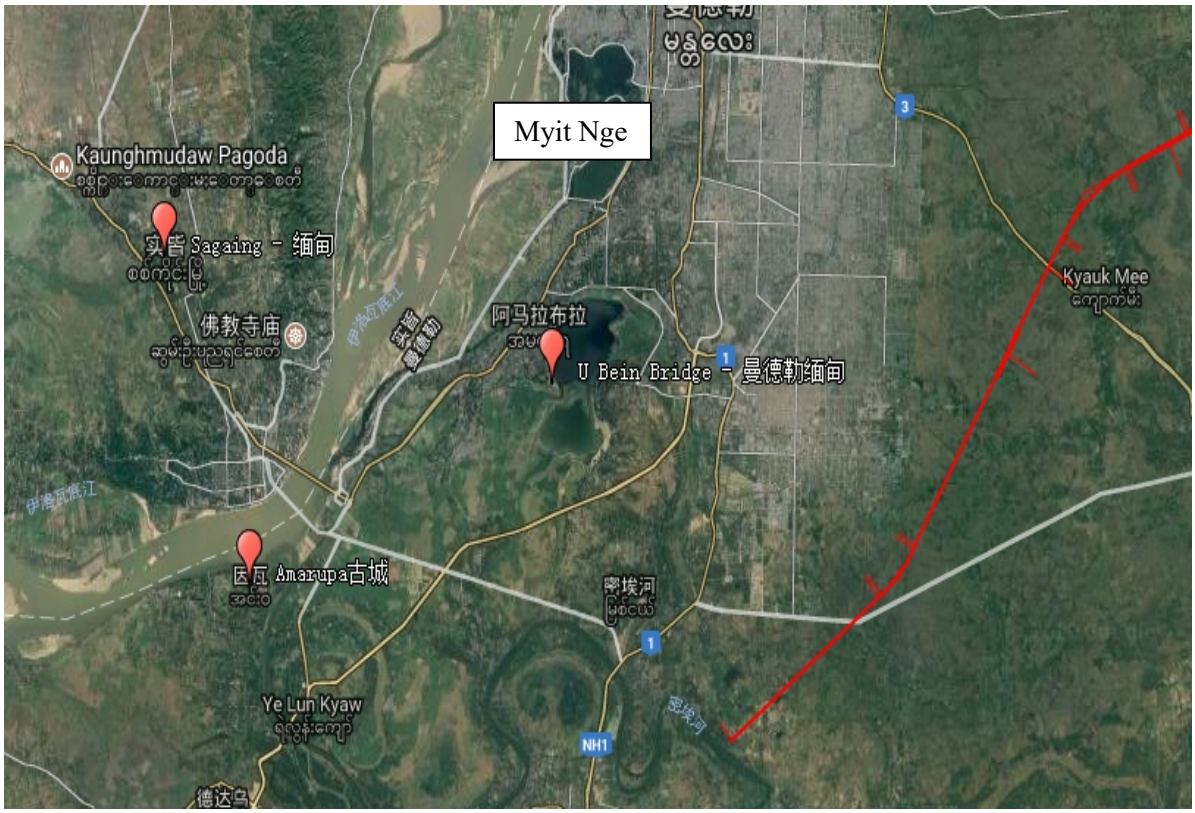


Figure - Location Plan of Railway and Cultural Relics

Consideration of Potential Impact to Cultural and Heritage in Mandalay Region

Although the tunneling will use drilling and blasting process that will impact on archeological site, there will no tunnel construction in Mandalay Region and the nearest archeology and cultural heritage site is 7km away from the railway alignment. So there will be no impact on cultural and heritage in Mandalay Region due to railway tunnels construction.

5.9.2. The Distribution of Archeology and Cultural Heritage in Shan State

Being a mountainous region, most of the Pagodas as well as some shrines are found in mountains as shown in the following figures.

Figure – Some Pagodas in Mountain

Some Shan people worship 'Guardian Spirits' by enshrining as their traditional belief as shown in the following figures.

Figure – Some Shrines beside the Road and in Mountain

5.9.3. Key Archaeology and Cultural Heritage along the Railway Line

The archaeological and cultural heritage along the railway includes:

1. Archaeological remains
2. Historic buildings
3. Historic Landscape

The study area that has been used for the current desk based data collection is defined by the route alignment of the Proposed Scheme, and an area extending 300m in all directions, sufficient to capture any features likely to be directly affected by the Proposed Scheme and taking into account any future minor design/route changes. A second study area of 500m in all directions of the route alignment has been considered to establish potential impacts on the setting of designated heritage assets.

Name of cultural heritage	Approximate distance to nearest part of proposed route (meter)	Latitude	Longitude	Category	Description	Location
Yan Tine Aung Pagoda	3278.95	22° 55.986'N	97° 43.809'E	Pagoda	Yan Tine Aung Pagoda is located at the entrance of Lashio city. The Pagoda is very famous in Lashio city.	**Lashio**
Lashio Hot spring	5707.79	22° 59.453'N	97° 46.477'E	Landscape	Lashio Hot Spring is famous tourist attraction in northern Shan State. This natural hot spring is made with the multiple swimming pool and the private bathrooms for the visiting people.	
Mansu Shan Buddhist Monastery	7107.79	22° 57.270'N	97° 45.802'E	Building	Thiri Mingalar Mansu Monastery, which has gained prominence as the home of Sayadaw Maha Thaddamma Zawtika Zay Baddanda Ponnya Nanda, who is known for anyone who needs it, regardless of religion or race stands in the big compound in downtown Lashio in Shan State.	
Hu Mon Dam	10363.75	22° 55.969'N	97° 48.020'E	Dam	Hu Mon Dam is special for whom want to relax and swim. The well-known activity is that the visitors can ride the water slide with their own along the flowing water slope.	
Sasana Year 2500 Pagoda	5568.79	22° 57.035'N	97° 44.945'E	Pagoda	-	
Baw Kyo Pagoda	1079.05	22° 35.030'N	97° 14.025'E	Pagoda	Built in the 12th century, the temple is located in Bawgyo village, several miles from the town of Hsipaw. Every march, the temple is the site of a Buddhist festival that commemorates the pagoda's founding.	**Hsipaw**
Haw Sao Pha (Shan Palace)	2458.94	22° 37.650'N	97° 18.247'E	Building	Haw Sao Kya Seng with the age of 96 years was built in 1924 for Saopha Sao Kya Seng (1947 to 1959) who was a politician, a mining engineer, an agriculturalist and the last Saopha of Hsipaw State, Myanmar, and Inge Sargent, known as Maha Devi. Sao Kya Seng was considered by the Shan people as one of the Shan national leaders who promoted federalism and democracy, together with Sao Shwe Thaik and Sao Hkun Hkio.	
Hsipaw Hot Spring	4939.53	22° 38.204'N	97° 16.281'E	Landscape	It is situated in Kyankhin Village, Hsipaw Township, Northern Shan State. Organizer normally stores the hot water from the spring to 30 foot long, 15 foot wide and 4 foot deep concrete tank and collects 200MMK per vistor to raise funds for preservation of the natural hot spring. People who want to	

					take a hot spring bath can swim at two concrete tanks within the area. Hot spring bathing assists with cardiovascular disease and nervous system imbalance. An average of 200 people visits the hot spring in each day.	
Gokhteik	981.83	22° 20.612'N	96° 51.566'E	Landscape	The Gohteik viaduct is between the two towns of Pyin Oo Lwin, the summer capital of the former British colonial administrators of Burma, and Lashio, the principal town of northern Shan State. It is the highest bridge in Myanmar and when it was completed, the largest railway trestle in the world. The bridge was constructed in 1899 by the Pennsylvania and Maryland Bridge Construction Company, and opened in 1900. The viaduct measures 689 metres (2,260 ft) from end to end. The Viaduct is described as "a monster of silver geometry in all the ragged rock and jungle, its presence was bizarre".	**Nawng Hkio**
Inn Wine Waterfall	11935.17	22° 10.657'N	96° 43.384'E	Landscape	Naung Cho City's Inn Wine waterfall is known to be one of the most beautiful waterfalls in Myanmar and has become one of the top places interested by tourist to visit along with the peaceful nature of Naung Cho City. It is situated near Sin Shwe Le (2) Sugar Manufacturing Industry.	
Upper Yeywa Hydropower Plant	23395.31	22° 14.596'N	97° 5.846'E	Dam	The construction of 280-megawatt Upper Yeywa hydropower project is planned to finish in 2022 and it will produce 1.409 billion kilowatts hours of electricity annually, according to Ministry of Electricity and Energy. Hydropower Implementation Department is developing Upper Yeywa hydropower project on Dotawady River about 20 miles away from Kyaukme in northern Shan State. The electricity generated from the dam project will be accessed to national grid and it will be provided 2.7 million people (about 6.6 per cent of total population) more, announced the ministry.	
Pwe Kouk Waterfall	4460.77	22° 4.142'N	96° 33.383'E	Landscape	The water fall is located suburb of Pyin Oo Lwin, and small waterfall and park, and it is the type of multiple waterfall. This sightseeing spot is almost for Myanmar people, and there is a pagoda, close to the waterfall, MaharAnhtoo Kanthar Pagoda. This pagoda is famous for Myanmar people.	**Pyin Oo Lwin**
Pate Chin Myaung Cave	6261.10	22° 5.757'N	96° 37.216'E	Landscape	Peik Chin Myaung is a limestone stalactite cave situated south of Wetwun village, 23 km from Pyin Oo Lwin, Myanmar. The cave was firstly developed by local Nepalese or Gakhar and later co-opted by the Myanmar government as a tourist attraction in 1990. The cave covers an area of 45 acres, where local plants named Peik Chin, alike long pepper vine used to grow by the mouth of the cave. It is estimated to be 230 million to 310 million years old from the formation of limestone and hillocks. After the establishment of shrines with many Buddhist stupas inside the cave, it has also been called Maha Nadamu cave.	

Shwe Myin Tin Pagoda	6790	22° 2.319'N	96° 28.906'E	Pagoda	Shwe Myin Tin Pagoda is located 0.42 kilometer from Mandalay-Muse Highway.
Dat Taw Gyaint Waterall	7242.92	21° 58.817'N	96° 23.216'E	Landscape	Dat Taw Gyaint is a tufa waterfall formed by limestone rich water from a karst spring. It, also commonly known as Anesakan Falls, is a magical waterfall with a blue, natural and refreshing swimming hole. Nestled at the bottom of a jungle canyon, this waterfall sits beside a small temple and is one of the best hidden gems in Myanmar. Dat Taw Gyaint Waterfall is located along the road from Mandalay to Pyin Oo Lwin near a small village known as Anesakhan
Purcell Tower	7960.58	22° 1.603'N	96° 27.846'E	Building	Purcell Tower stands in the heart of the town, Pyin Oo Lwin. The clock was one of the few made in 1934 by Gillete and Johnson Co. of England in commemoration of the Silver Jubilee of the reign of King George V of Britain.
Taung Kyaung Gyi Monastery	8150	22° 1.485'N	96° 27.867'E	Building	-
Orchid Nan Myaing Hotel	8464.88	22° 0.928'N	96° 27.035'E	Building	Orchid Hotel Nan Myaing is a hotel in a good neighborhood, which is located at Pyinoolwin. Not only well positioned, but Orchid Hotel Nan Myaing is also one of hotels near the following Atumashi Monastery within 34.77 km and Kuthodaw Pagoda within 34.82 km. 24-hours front desk is available to serve from check-in to check-out, or any assistance what is needed.
Candacraig Hotel	9037.58	22° 1.073'N	96° 28.694'E	Building	It is a historic building in Pyin Oo Lwin. Dating from 1904 and formerly the British Club, this colonial pile comes complete with side turrets and is set in attractively manicured gardens. There's a slightly spooky air to the place – many locals believe it's haunted and it has been closed for long-delayed renovations for a while. But the gates are normally open, so cycle in for a look.
National Kandawgyi Botinical Garden	11097.99	21° 59.637'N	96° 28.168'E	Landscape	The National Kandawgyi Botanical Gardens (formerly National Botanical Gardens) is a 177 hectare botanical garden located in the Alpine town of Pyin Oo Lwin, situated at an elevation of 1000 meters (3,605 ft) and 69 km (43 mi) by road from Mandalay. It was first established in 1915 as the Maymyo Botanical Gardens by Alex Roger, a Forest Officer. The original site was 30 acres and was modelled after the Kew Gardens of England with the help of an amateur gardener called Lady Cuffe. The Botanical Gardens has three museums. The Fossils Museum houses fossils of mammals, reptiles, and invertebrates, and the

					Petrified Wood Museum displays fossils of plants, colorful stones, toddy-palm roots, as well as things made from fossils of plants. The Butterfly Museum has various species of butterflies from Nepal, Taiwan, South America, Japan and South East Asia.	
Thitsar Myaing (Tapsy Villa)	8924.87	22° 1.111'N	96° 28.309'E	Building	These are the representatives of architecture, town planning, and infrastructure introduced by British Colonial Regime during the period of the end of Second World War. Nowadays most of these buildings is changed to hotels, restaurants, and tourist attractions.	
Cherry Myaing (Linduden)	9872.51	22° 0.592'N	96° 28.536'E	Building		
Hinthar Myaing (Jacobstowe)	9696.14	22° 0.689'N	96° 28.277'E	Building		
Thazin Myaing	9584.93	22° 0.741'N	96° 28.455'E	Building		
Gandamar Myaing (Croxton)	9116.12	22° 1.004'N	96° 28.218'E	Building		
Htinshu Myaing	9155.99	22° 0.974'N	96° 28.516'E	Building		
Yuzana Myaing (Knowle)	10273.76	22° 0.369'N	96° 28.421'E	Building		
Maha Ganda Yone Monastery	5594.70	16° 51.189'N	96° 9.586'E	Building	The monastery is known for its strict adherence to the Vinaya, the Buddhist monastic code. The monastery was first established by Agatithuka Sayadaw, a Thudhamma-affiliated monk around 1908, as a meditation monastery for forest-dwelling monks. A thousand Buddhist monks and novices line up every morning, at 10 o'clock, to receive their meal of the day at Mahar Gandar Yone Monastery.	**Mandalay**
Shwenandaw Monestery	5870.45	22° 0.040'N	96° 6.821'E	Building	Shwenandaw Monastery (Golden Palace Monastery) was built in 1878 by King Thibaw Min, who dismantled and relocated the apartment formerly occupied by his father, King Mindon Min, just before Mindon Min's death, at a cost of 120,000 rupees. The building was originally part of the royal palace at Amarapura, before it was moved to Mandalay, where it formed the northern section of the Hmannan (Glass Palace) and part of the king's royal apartments. The building was heavily gilt with gold and adorned with glass	

					mosaic work. The monastery is known for its teak carvings of Buddhist myths, which adorn its walls and roofs. The monastery is built in the traditional Burmese architectural style. Shwenandaw Monastery is the single remaining major original structure of the original Royal Palace today.	
Maha Atulawaiyan (Atumashi) Kyaungdawgyi	5980.14	22° 0.064'N	96° 6.756'E	Building	The Atumashi Monastery (formally Maha Atulaveyan Kyaungdawgyi) was built in 1857 by King Mindon at a cost of 500,000 rupees. The original structure burned down in 1890 after a fire in the city destroyed both the monastery and the 30 feet (9.1 m) tall Buddha image, as well as complete sets of the Tipitaka. During the fire, a 19.2-carat diamond, which adorned the Buddha image (originally given to King Bodawphaya by Maha Nawrahta, the Governor of Arakan) disappeared as well. In 1996, Burma's Archaeological Department reconstructed the monastery with prison labor.	
Kuthodaw Pagoda	6193.64	22° 0.281'N	96° 6.774'E	Pagoda	Kuthodaw Pagoda (formally titled Mahalawka Marazein) contains the world's largest book lied at the foot of Mandalay Hill and was built during the reign of King Mindon. In the grounds of the pagoda are 729 kyauksa gu or stone-inscription caves, each containing a marble slab inscribed on both sides with a page of text from the Tripitaka, the entire Pali Canon of Theravada Buddhism. In 2013, UNESCO plaque indicating that the Maha Lawkamarazein or Kuthodaw Inscription Shrines at Kuthodaw Pagoda, were inscribed on to the Memory of the World Register.	
Sanda Muni Pagoda	6369.83	22° 0.211'N	96° 6.587'E	Pagoda	Sandamani Pagoda is a Buddhist stupa located southwest of Mandalay Hill and was commissioned by King Mindon Min in 1874 as a memorial to Mindon Min's younger brother, Kanaung Mintha. This pagoda contains the graves of the Kanaung, Sagu Mintha, Malun and Maingpyin Princes. It also contains an iron image of the Buddha cast by Bodawpaya of the Konbaung dynasty in 1802. The statue reportedly weighs 40,924.8 pounds (18,563.2 kg).	
Kyauktawgyi Pagoda	6708.50	22° 0.268'N	96° 6.396'E	Pagoda	Kyauktawgyi Pagoda in Amarapura was built in 1847 by King Bagan Min on the model of the Ananda Pagoda at Bagan. It exemplifies a type of architecture, which though borrowed from the Indian designs at Pagan, was constructed entirely by Burmese architects. The artistic interest of the temple lies in the numerous frescoes with which its four porches are adorned. The pagoda is crowned with a five-tiered pyatthat roof.	
Mahawizayayanthi Pahtoedawgyi	6879.92	21° 54.677'N	96° 3.390'E	Pagoda	Pahtodawgyi is a Buddhist pagoda located in Amarapura, north of the Taungthaman Lake. It was built in 1819 by King Bagyidaw.	**Manadalay**

Mandalay Palace	6960.92	21° 59.579'N	96° 5.772'E	Building	The Mandalay Palace known as The Famed Royal Emerald Palace is the last royal palace of the last Burmese monarchy. The palace was constructed between 1857 and 1859 and was the primary royal residence of King Mindon and King Thibaw, the last two kings of Myanmar. The palace is famous for Great Audience Hall, Lion Throne Room, Watch Tower, Royal Mausoleums and Glass Palace. Throughout the British colonial era, the palace was seen by the Burmese as the primary symbol of sovereignty and identity. Much of the palace compound was destroyed during Second World War by allied bombing; only the royal mint and the watch tower survived. A replica of the palace was rebuilt in the 1990s with some modern materials. Today, Mandalay Palace is a primary symbol of Mandalay and a major tourist destination.	
Su Taung Pyae Pagoda	7340.74	22° 0.892'N	96° 6.449'E	Pagoda	Su Taung Pyae Pagoda is located at the top of the Mandalay Hill. Mandalay Hill is known for its abundance of pagodas and monasteries, and has been a major pilgrimage site for Burmese Buddhists for nearly two centuries. A panoramic view of Mandalay from the top of Mandalay Hill alone makes it worthwhile to attempt a climb up its stairways.	
Bagaya Monastery	7663.28	21° 55.144'N	96° 3.537'E	Building	This magnificent monastery is also known as Maha Waiyan Bontha Bagaya Monastery. During King Hsinbyushin's reign (1763–1776), Maha Thiri Zeya Thinkhaya, town officer of Magwe built the monastery in the Bagaya monastic establishment and dedicated to Shin Dhammabhinanda. The monastery, which was built with 267 gigantic teak wood posts, has a structure of great dimensions: 188 feet (57 m) high in length and 103 feet (31 m) in width. The monastery is decorated with splendid Burmese architectural works such as carvings, floral arabesques, the ornamentation with curved figurines and the reliefs of birds and animals as well as small pillars decorated on the wall, the artistic works of Inwa Era. . It is one of the famous tourist attractions in Myanmar.	
Mahar Myat Muni Pagoda	7855.09	21° 57.111'N	96° 4.707'E	Pagoda	The Mahamuni (literal meaning; The Great Sage) Buddha Temple is a Buddhist temple and major pilgrimage site, located southwest of Mandalay. Ancient tradition refers to only five likenesses of the Buddha, made during his lifetime; two were in India, two in paradise, and the fifth is the Mahamuni Buddha image in Myanmar. The temple has a central shrine and is framed by an extensive grass lawn. A major annual pagoda festival is held in early February, at the end of the Buddhist Lent to celebrate the history of the pagoda.	

U-bein Bridge	7000	21° 53.495'N	96° 3.471'E	Landscape	U Bein Bridge is a crossing that spans the Taungthaman Lake near Amarapura. The 1.2-kilometre (0.75 mi) bridge was built around 1850 and is believed to be the oldest and once longest teakwood bridge in the world. It features 1,086 pillars that stretch out of the water, some of which have been replaced with concrete.	
Maha Aungmye Bonzan Monastery	8963.03	21° 51.502'N	95° 59.070'E	Building	Maha Aungmye Bonzan Monastery is commonly known as the Me Nu Brick Monastery. The monastery was built by Queen Nanmadaw Me Nu in 1818. This monastery is one of the finest specimens of Myanmar architecture during the Konbaung Period (19th century). Its architecture is in simulation of wooden monasteries with multiple roofs and a prayer hall of seven-tiered superstructure.	
Amarapura Ancient City	9000	21° 54.228'N	96° 2.966'E	Archaeological Remains	Amarapura is a former capital of Myanmar during the Konbaung period (1783–1821 and 1842–1859). It is historically referred to as Taungmyo (Southern City) in relation to Mandalay. Amarapura today is part of Mandalay, as a result of urban sprawl. The township is known today for its traditional silk and cotton weaving, and bronze casting. It is a popular tourist day-trip destination from Mandalay.	
Shwe In Bin Monastery	9256.34	21° 57.972'N	96° 3.956'E	Building	Shweinbin Monastery was built in the tradition of Burmese teak architecture in 1895 by a Sino-Burmese merchant married to a Burmese woman of royal extraction. The monastery's construction strictly adheres to traditional rules of Burmese monastic architecture and includes all of the designated pyatthat-crowned pavilions.	
Soon U Ponya Shin Pagoda	9863.10	21° 54.121'N	95° 59.547'E	Pagoda	One of the most tourist attraction places on Sagaing Hills is Soon U Pon Nya Shin Pagoda and is connected by a set of covered staircases that run up the 240 meters hill and is one of the oldest temples on Sagaing Hills. It was built in 1312 by Minister Pon Nya. An annual Pagoda festival is held on Full Moon Day of Warso, the fourth month of the Myanmar Calendar, which falls in July of each year. It is famously known to have the earliest Soon (food) offered by angels before any human	**Sagaing**
Uminkoeze	9850.68	21° 54.298'N	95° 59.697'E	Pagoda	Uminkoeze pagoda is situated in Sagaing Hill, Sagaing.	
Sagaing City	13000	21° 54.952'N	95° 57.728'E	Landscape	Sagaing is the capital of the Sagaing Region and is located in the Irrawaddy River, 12 mi to the south-west of Mandalay on the opposite bank of the river. Sagaing with numerous Buddhist monasteries is an important religious and monastic centre. The pagodas and monasteries crowd the numerous hills along the ridge running parallel to the river. The central pagoda, Soon U Ponya Shin Pagoda, is connected by a set of covered staircases that run up the 240 m (790 ft) hill.	

Mingun Pahtodawgyi	17206.57	22° 3.051'N	96° 1.055'E	Archaeological Remains	The Mingun Pahtodawgyi is an incomplete monument stupa in Mingun. The ruins are the remains of a massive construction project begun by King Bodawpaya in 1790 which was intentionally left unfinished. The pahtodawgyi is seen as the physical manifestations of the well-known eccentricities of Bodawpaya. The completed stupa would have been the largest in the world at 150 metres (490 ft). Huge cracks are visible on the structure from the earthquake of 23 March 1839.	
Mingun Bell	17319.29	22° 3.180'N	96° 1.070'E	Archaeological Remains	King Bodawpaya also had a gigantic bell cast to go with his huge stupa. The Mingun Bell, weighing at 90 tons, is today the second largest ringing bell in the world. The weight of the bell in Burmese measurement, is 55,555 viss or peiktha (1 viss = 1.63 kg), handed down as a mnemonic "Min Hpyu Hman Hman Pyaw", with the consonants representing the number 5 in Burmese astronomy and numerology.	
Mya Thein Tan Pagoda	17609.28	22° 3.351'N	96° 0.992'E	Pagoda	Mya Thein Tan Pagoda also known as Hsinbyume Pagoda is a large pagoda on the northern side of Mingun in Sagaing Region and was built in 1816 by Bagyidaw. It is dedicated to the memory of his first consort and cousin, Princess Hsinbyume. The pagoda's design is a great departure from Burmese pagoda design norms. It is based on descriptions of the mythical Sulamani pagoda on Mount Meru, and the lower parts of the pagoda represent the mountain. Seven concentric terraces represent the seven mountain ranges going up to the Mount Meru according to Buddhist mythology.	

There are no well-known cultural heritage such as Archaeological remains, Historic buildings and Historic landscapes within the 500 meters of EIA study area. Pagoda, monasteries and religious areas will also be avoided although it does not consider as historical places.

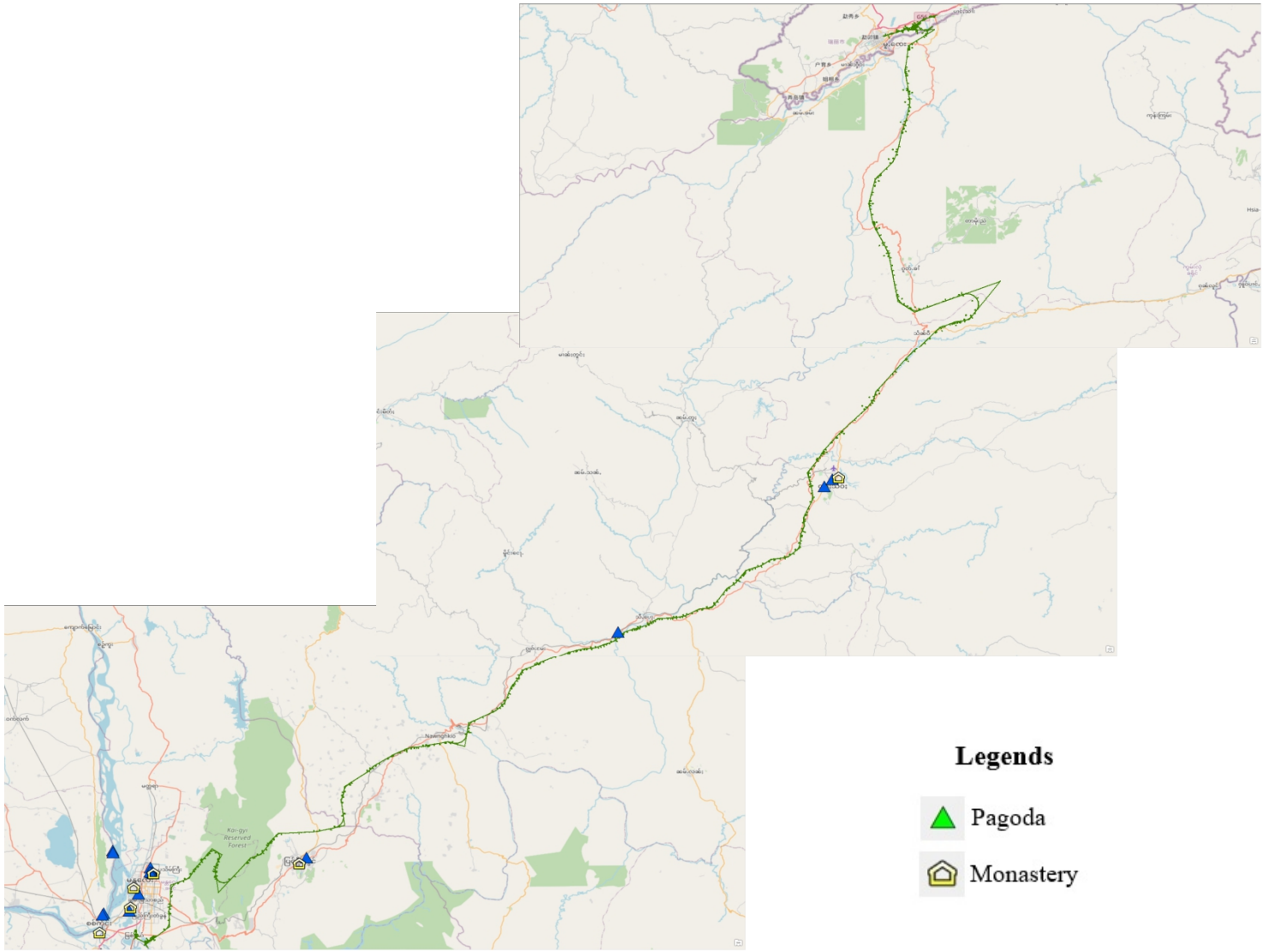


Figure - Pagodas and Monastries within 500 km along the Alignment

5.10. Existing Infrastructure and Services

5.6.1. Transportation

(1) Mandalay Province

Mandalay is located in the central part of Myanmar. Compared with other places, Mandalay has a better transportation system, including roads, aviation, railways and waterways. The main mode of transportation in central Myanmar is highway. Three of the six main highways in Myanmar are located in Mandalay Province and adjacent Magwe Province, with Mandalay as the main hub. Starting from Mandalay, the network extends northward through Muse in northern Shan State to Kachin State and China, westward to western Myanmar and India, and southward toYangon.

The existing railway in Myanmar is basically in north-south direction, the branch line is in east-west direction, and the central railway station in Mandalay is the main hub. The main railway lines for passenger and freight transport are located between Rangoon and Mandalay. Starting from Mandalay, the railway branch lines extend eastward to Shan State, westward to Magwe Province and northward to Kachin State.

Mandalay has an international airport and serves as the central hub of central Myanmar. Most flights fly to Shan State in the East and Kachin State in the north. In addition, there are a few international flights, including direct flights to Kunming, China. Mandalay has a major port where passengers and goods are frequently transported to towns along the Ayarwaddy River.

(2) Shan State

Shan State's road network is not as developed as Mandalay Province. The most common transport route into northern Shan State is National Highways NH3 Highway, 450 km long. Lashio and Muse, which are major cities in northern Shan State, are connected to Mandalay through the NH3 Highway.

NH3 Highway

NH3 highway, also known as "Stilwell Highway" in history, has the part in Chinese border, as No. 320 National Highway Western-Yunnan Section. The length in China is 850 kilometers long; it starts from Kunming to Shwe Li Wanding Port, the length from the Wanding port to the destination Lashio, Myanmar is 603 kilometers. It is an important

transportation route connecting Southeast Asian countries. At present, it can reach Yangon, Bangkok, the capital of Thailand, to India in the west and Singapore in the southeast. There is onlyNH3 highway along the line, which is a two-way two-lane road with an existing width of 8m and asphalt concrete pavement.

The line also crosses NH3 Highway several times, and some sections are parallel with the existing highway, so the traffic is relatively convenient. For the purpose of not affecting ground traffic, this project adopts girder bridge and frame bridge for railway crossing highway, and adopts road relocation or interchange culvert for lower grade roads.

Table - Individual Situation of Main Crossed Roads along the Line

S/N	Mileage	Crossing method and engineering measures	Remarks	S/N
1	CK9+880	CK9+560 Muse Station 2#frame bridge 2-10m	NH3	Highway underpass
2	CK31+650	CK31+330Kawng wing super major bridge(33×32)m simply supported girder bridge	NH3	Railway overcrossing highway
3	CK62+290	CK62+290 Pang nin Road-over bridge 5×32m	NH3	Highway overcrossing railway
4	CK88+100	Man peng1# tunnel	NH3	Highway overcrossing railway
5	CIK133+665	CKI133+990Sam lou super major bridge5×32m simply supported girder bridge	NH3	Railway overcrossing highway
6	CK151+630	Hang lu tunnel	NH3	Highway overcrossing railway
7	CK154+900	Hang lu tunnel	NH3	Highway overcrossing railway

8	CK153+200 (After broken chain）	CK152+453Hka shi super major bridge 49×32m simply supported girder bridge	NH3	Railway overcrossing highway
9	CK164+559	CK164+599 Kawng has super major bridge 25×32m simply supported girder bridge	NH3	Railway overcrossing highway
10	CK198+180	CK198+040 Hsup lang major bridge 12×32m simply supported girder bridge	NH3	Railway overcrossing highway
11	CK266+560	Tunnel	NH3	Highway overcrossing railway
12	CK272+880	Tunnel	NH3	Highway overcrossing railway
13	CK273+680	CK273+680 2-16m rigid frame bridge	Road under construction	Highway underpass
14	CK279+884	CK279+884 2-16m rigid frame bridge	Road under construction	Highway underpass
15	CK291+050	CK291+519 Hu ka1#super major bridge 25×32m simply supported girder bridge	NH3	Railway overcrossing highway
16	CK394+550	Mandalay Road-over bridge 9×25m	NH3	Highway overcrossing railway

Highway Bus Station

No.	Existing Bus Station	Location	Relation with the project
1	Chan Mya Shwe Pyi Highway Station	Mandalay	Existing Mandalay-Muse Highway
2	Thiri Pa Day Thar Highway Station	Pyin Oo Lwin	Existing Mandalay-Muse Highway
3	Lashio Bus Station	Lashio	Existing Mandalay-Muse Highway
4	Kyaukme Highway Bus Terminal	Kyaukme	Existing Mandalay-Muse Highway
5	Muse Highway Bus Station	Muse	Existing Mandalay-Muse Highway

Underground Pipelines

According to the survey data, there are many crossings between the newly built railway and the existing oil and gas pipelines, which have certain influence on the railway route. The main underground pipeline is the Myanmar-China oil and gas pipeline, with the diameter of 813mm-1,016mm. The starting point of Myanmar-China oil pipeline is located in Maday Island on the west coast of Myanmar. They enter China from Shwe Li, Yunnan Province, via

Rakhine, Magwe, Mandalay and Shan State of Myanmar. The total length of crude oil and natural gas pipelines is 793km. Among them, the design capacity of Myanmar-China crude oil pipeline is 22 million tons/year, and the gas transmission capacity of Myanmar-China natural gas pipeline is 12 billion cubic meters/year. On July 28, 2013, gas transmission to China started.

The line is also intersected with a small number of local water supply and drainage pipelines, underground communication cables, oil and gas pipelines and other pipelines. When the railway crosses the underground pipeline, in principle, the method of relocation, reconstruction, in-situ protection are adopted. On the premise of meeting the relevant provisions regarding pipeline protection, railway culverts or railway bridges can be adopted for passing.

Path of Myanmar-China Oil and Gas Pipeline

Table- Summary table of intersections between Myanmar-China oil and gas pipelines and the Project

No.	Intersection Mileage	Measure Taken	Remarks
1	CK229+100	Pass through by Kyankme tunnel	Railway underpass
2	CK239+500	CK239+193Pawk ang1#super major bridge 25×32m simply supported girder bridge	Railway overcrossing highway
3	CK266+725	Pass through by Kyaunggon tunnel	Railway underpass
4	CK274+350	Gohteik Nam ban ton River super major bridge 2(6×32+(1×48+2×36) steel-concrete composite girder+(148+2×260+148m)steel-concrete double-layer composite rigid frame+2×50msteel-concrete composite girder+18×32)	Railway overcrossing highway

5.11. Visual Components

It can be a nuisance to local people since the railway may also pass through their houses and fields. It can also be unpleasant to see since the train may pass through beautiful mountains and fields of the Shan State.

Before Project

After Project

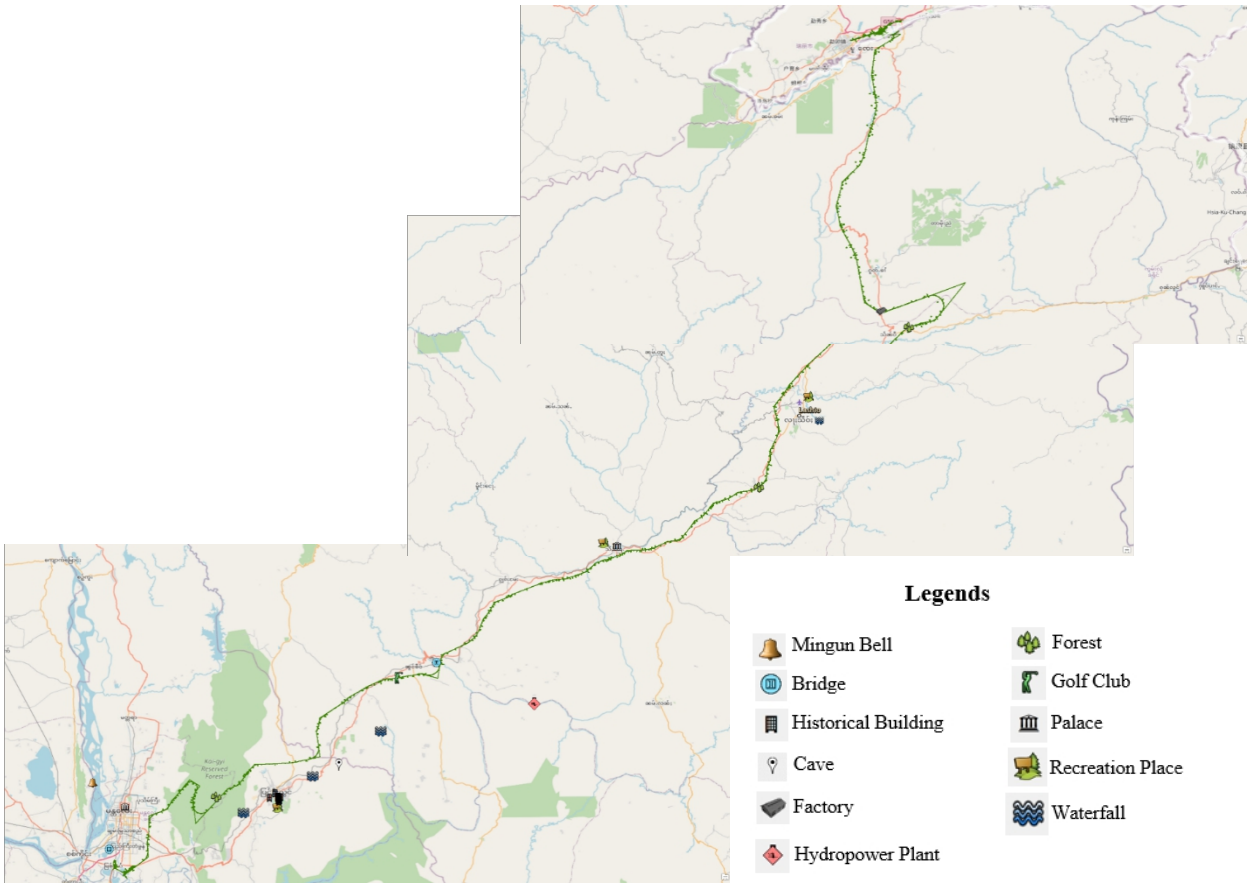


Figure - Visually Sensitive Areas along the Railway

5.12. Environmental Protection Zone

Myanmar has published 59 environmental protection zones. Among them, 11 types of sensitive zones defined by the state are Nature Reserve, National Park, Protected Area, National Park and ASEAN Heritage Park, Wildlife Sanctuary, Bird Sanctuary, Wildlife Park, Mountain Park, Wildlife Sanctuary and ASEAN Heritage Park, Elephant Range and Wildlife Sanctuary, there are 52 sensitive areas in total. There are 2 types of environmentally sensitive zones defined by international organizations, namely, biosphere protected areas issued by UNESCO and important wetlands published by the International Wetland Convention, with a total of seven sensitive zones. The list of sensitive areas is shown in the table below.

Table - Environmental Sensitive Areas in Myanmar

S/N	Sensitive area name	Level	Promulgation time	Area (km2)	Administra-tive Authority	Relation with line location
Nature Reserve						
1	Bawdi Tahtaung N.R	National	2008	73	Forest Department	Not involve
2	Taninthayi Nature Reserve	National	2005	1699.99	Forest Department	Not involve
National Park						
1	Emawbum	National	2017	1603.25	Forest Department	Not involve
2	In Khaing Bum National Park	National	2017	300.52	Forest Department	Not involve
3	Lenya N.P	National	2002	1761	Forest Department	Not involve
4	Taninthayi N.P	National	2003	2072	Forest Department	Not involve
5	Lenya N.P(Extension)	National	2004	1864.39	Forest Department	Not involve
6	Bawi Pa Taung	National	2017	581.05	Forest Department	Not involve
Protected Area						
1	Shark P.A	National	2004	11836.17	Forest Department	Not involve
2	Irrawaddy Dolphin P.A	National	2005	327.53	Forest Department	Not involve
3	Loimwe Protected Area	National	1996	42.84	Forest Department	Not involve
4	Parsar Protected Area	National	1996	77.03	Forest Department	Not involve
National Park and ASEAN Heritage Park						
1	Lampi Marine National Park	National	1996	204.84	Forest Department	Not involve
2	Alaungdaw Kathapa National Park	National	1989	1402.79	Forest Department	Not involve
3	Natmataung National Park	National	2010	713.54	Forest Department	Not involve
4	Hkakabo Razi National Park	National	1996	3812.46	Forest Department	Not involve
Wildlife Sanctuary						
1	Pidaung Wildlife Sanctuary	National	1927	122.07	Forest Department	Not involve
2	Bumhpabum Wildlife Sanctuary	National	2004	1854.43	Forest Department	Not involve

3	Htamanthi Wildlife Sanctuary	National	1974	2150.73	Forest Department	Not involve
4	Shinpinkyetthauk W.S	National	2006	72	Forest Department	Not involve
5	Minwuntaung Wildlife Sanctuary	National	1972	205.88	Forest Department	Not involve
6	Mulayit Wildlife Sanctuary	National	1939	138.54	Forest Department	Not involve
7	Thamihla Kyun Wildlife Sanctuary	National	1970	0.88	Forest Department	Not involve
8	Kyaikhtiyoe Wildlife Sanctuary	National	2001	156.23	Forest Department	Not involve
9	Minsontaung Wildlife Sanctuary	National	2001	22.61	Forest Department	Not involve
10	Kyauk Pan Taung Wildlife Sanctuary	National	2001	130.61	Forest Department	Not involve
11	Shwe-U-Daung Wildlife Sanctuary	National	1929	117.97	Forest Department	Not involve
12	Lawkananda Wildlife Park	National	1995	0.47	Forest Department	Not involve
13	Mahamyaing W.S	National	2002	1180	Forest Department	Not involve
14	North Zarmayi Elephant PA	National	2012	983.21	Forest Department	Not involve
15	Moscos Islands Wildlife Sanctuary	National	1927	49.18	Forest Department	Not involve
16	Moeyungyi Wetland Sanctuary	National	1988	103.6	Forest Department	Not involve
17	Meinmahla Kyun Wildlife Sanctuary	National	1993	136.7	Forest Department	Not involve
18	Kelatha Wildlife Sanctuary	National	1942	23.93	Forest Department	Not involve
19	Panlaung-Pyadalin Cave Widlife Sanctuary	National	2002	333.8	Forest Department	Not involve
20	Hponkanrazi Wildlife Sanctuary	National	2003	2703.95	Forest Department	Not involve
21	Shinmataung	National	2012	24.44	Forest Department	Not involve

22	Chatthin Wildlife Sanctuary	National	1941	269.36	Forest Department	Not involve
23	Kahilu Wildlife Sanctuary	National	1928	160.55	Forest Department	Not involve
24	Shwesettaw Wildlife Sanctuary	National	1940	464.28	Forest Department	Not involve
25	Hukaung Valley Wildlife Sanctuary (Extension)	National	2010	6669.22	Forest Department	Not involve
26	Southern Extension	National	2017	3550.7	Forest Department	Not involve
27	Hukaung Valley Wildlife Sanctuary	National	2004	6371.37	Forest Department	Not involve
28	Chung Pon Kan Wildlife Sanctuary	National	2013	2.2	Forest Department	Not involve
Bird Sanctuary						
1	Wethtikan Wildlife Sanctuary	National	1939	4.4	Forest Department	Not involve
2	Taunggyi Wildlife Sanctuary	National	1920	16.06	Forest Department	Not involve
3	Pyin-Oo-Lwin Widlife Sanctuary	National	1927	127.25	Forest Department	Not involve
Wildlife Park						
1	Hlawga Park	National	1989	6.24	Forest Department	Not involve
Mountain Park						
1	Popa Mountain Park	National	1989	128.54	Forest Department	Not involve
Wildlife Sanctuary and ASEAN Heritage Park						
1	Inlay Lake Wildlife Sanctuary	National	1985	640.91	Forest Department	Not involve
2	Indawgyi Wildlife Sanctuary	National	2004	814.99	Forest Department	Not involve
Elephant Range						
1	Rakhine Yoma Elephant Range	National	2002	1755.7	Forest Department	Not involve

Table - International Environmental Sensitive Zone in Myanmar

S/N	Sensitive area name	Level	Promulgation time	Area (km2)	Administrative Authority	Relation with line location
Biosphere Protected Areas						
1	Inlay Lake Wildlife Sanctuary	National	2015	640.91	Forest Department	Not involve
2	Indawgyi Wildlife Sanctuary	National	2017	814.99	Forest Department	Not involve

Wetland of International Importance						
1	Moeyungyi Wetland Widlife Sanctuary	National	2004	103.59	Forest Department	Not involve
2	Inlay Lake Ramsar Site	National	2018	57.98	Forest Department	Not involve
3	Meinmahla Kyun Wildlife Sanctuary	National	2017	500	Forest Department	Not involve
4	Indawgyi Wildlife Sanctuary	National	2016	478.84	Forest Department	Not involve
5	Gulf of Mottama	National	2017	425	Forest Department	Not involve

The above mentioned environmentally sensitive areas are not included in the railway. Totally 4 sensitive areas, Shwe-U-Daung Wildlife Sanctuary, Pyin-Oo-Lwin Wildlife Sanctuary, Minwuntaung Wildlife Sanctuary and Irrawaddy Dolphin P.A are close to Railway. Please refer to the following table for the details.

Table - Environmentally Sensitive Areas along Muse-Mandalay

Name of sensitive areas	Level	Issuing time	Area (km2)	Administrative Authority	Protected object	Position relationship with the line
Shwe-U-Daung Wildlife Sanctuary	National	1929	117.97	Forest Department	Elephant, gaur, banteng, rusa, serow, bear	About 87km away from the line
Pyin-Oo-Lwin Widlife Sanctuary	National	1927	127.25	Forest Department	Muntjac, birds,	About 5km away from the line
Minwuntaung Wildlife Sanctuary	National	1972	205.88	Forest Department	Muntjac, birds,	About 18km away from the line
Irrawaddy Dolphin P.A	National	2005	327.53	Forest Department	Irrawaddy Dolphin	About 12.5km away from the line

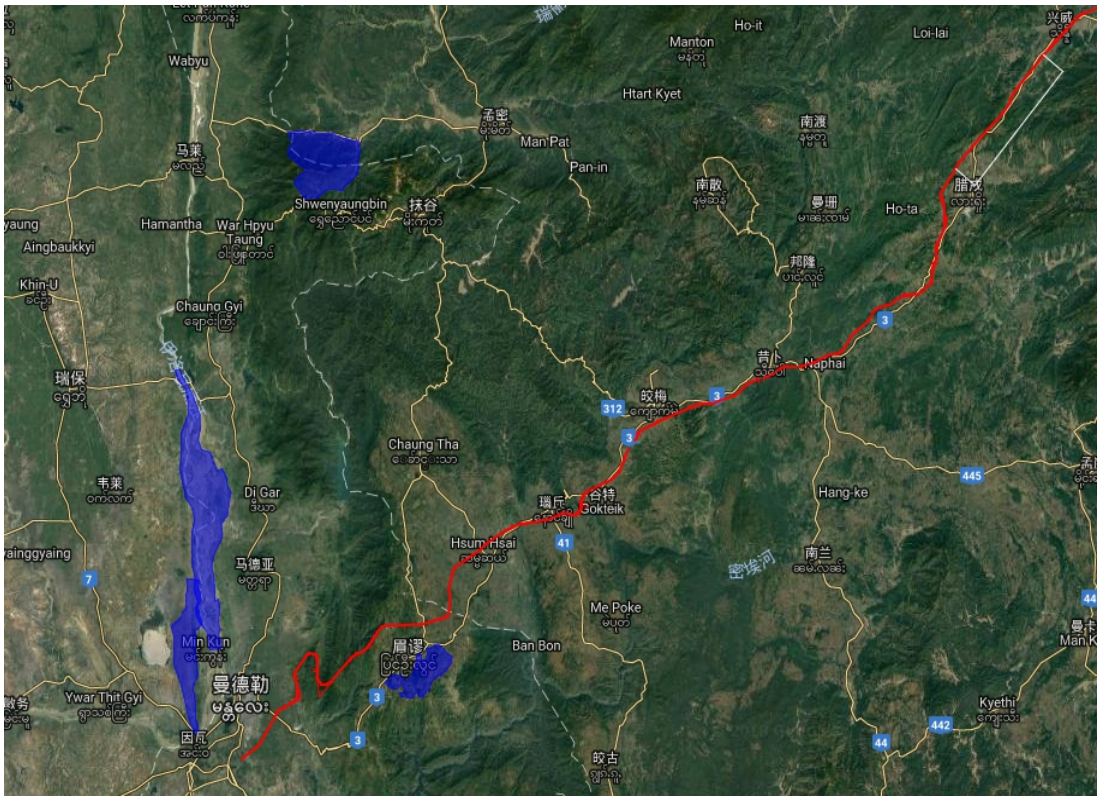


Figure - Distribution Map of Environmentally Sensitive Areas along the Railway

Figure - Location Plan of Railway and Shwe-U-Daung Wildlife Sanctuary

Figure - Location Plan of Railway and Pyin-Oo-Lwin Wildlife Sanctuary

Figure - Location Plan of Railway and Irrawaddy Dolphin P.A

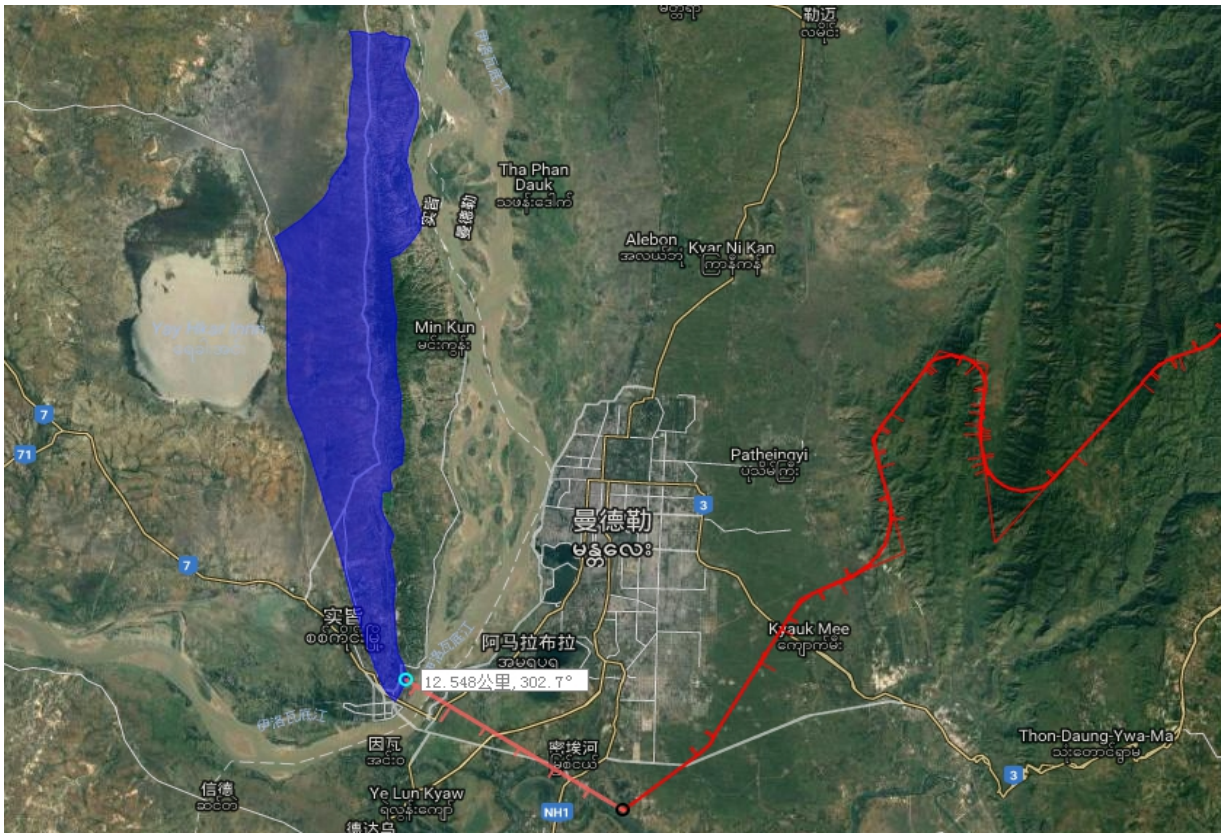


Figure - Location Plan of Railway and Minwuntaung Wildlife Sanctuary

5.13. Consideration of Environmental Sensitive Areas by Overlay Mapping System

Environmental sensitive areas within 500m beside the railway alignment will be study by overlay mapping technique as follow.

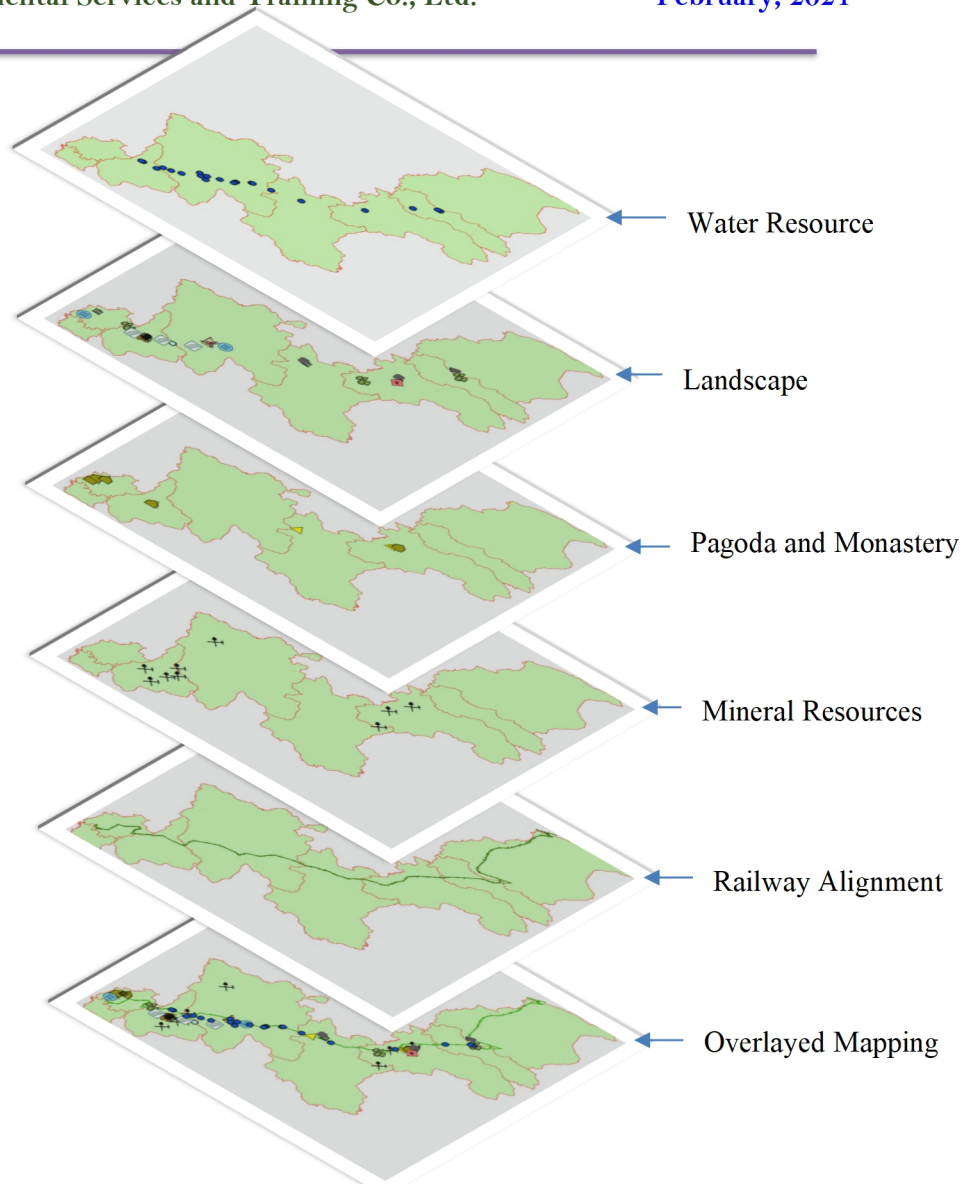


Figure - Overlayed Mapping of Sensitive Zones along the Muse-Mandalay Railway Alignment

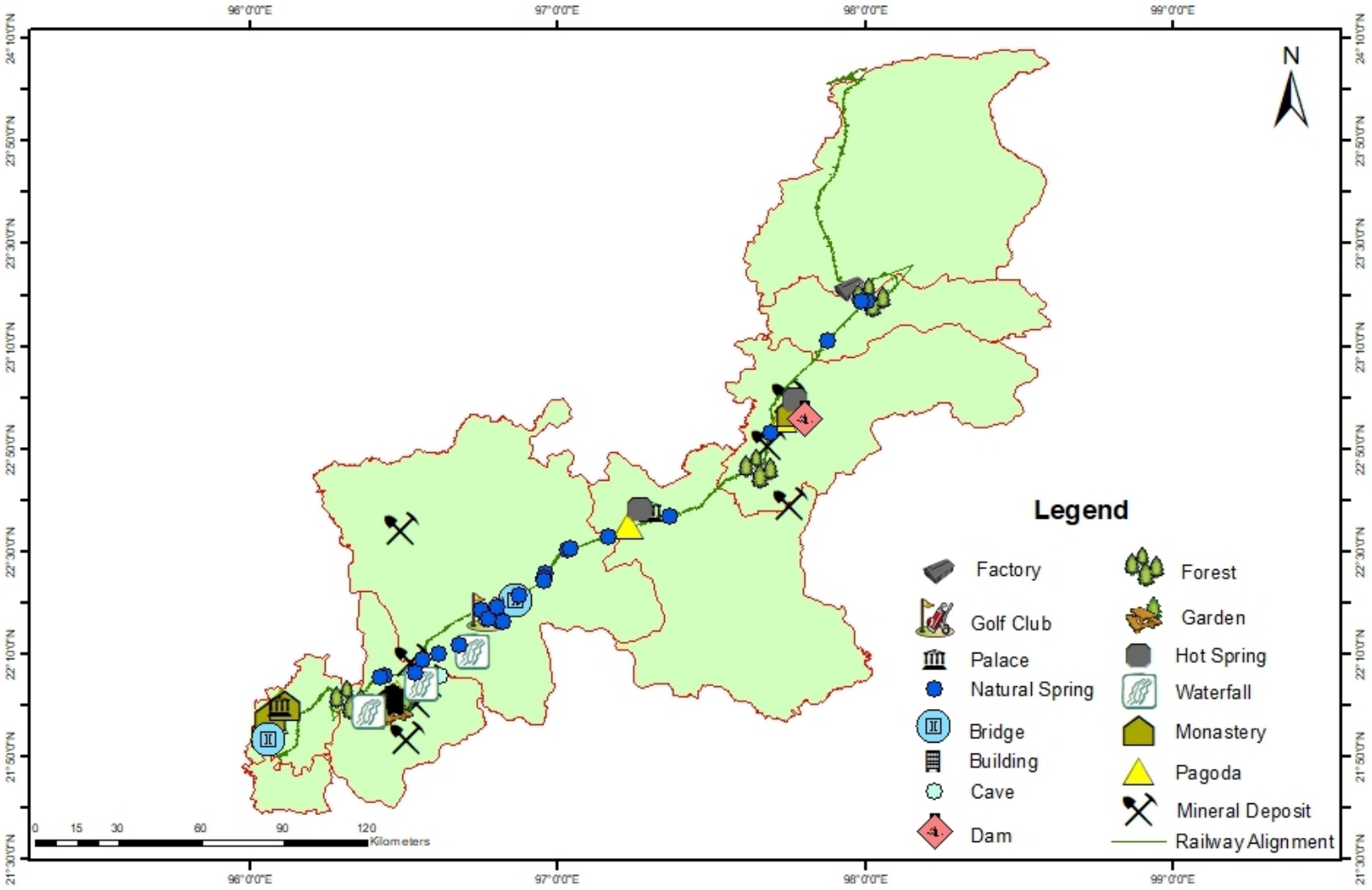


Figure - Overlayed Map of Sensitive Areas along the Muse-Mandalay Railway Alignment

Table – Environmental Sensitive Areas within 500m beside the Railway Alignment by Overlay Mapping

		Residential Area		Ecologically Important Area		Historical, Archaeological, Cultural and Heritage		Mineral Abundance Areas		Surface Water Resources		Landscape and Visual	
		Village	Location	Protective Area	Location	Sensitive Zone	Location	Resources Area	Location	Source	Location	Source	Location
Border to Muse Station (24.006486°, 97.954332°)	1	Nam Sonn	24.030702, 97.982782	-	-	-	-	-	-	-	-	-	-
	2	Nan Pann	24.014952, 97.957032	-	-	-	-	-	-	-	-	-	-
Muse Station (24.006486°, 97.954332°) to Pang Hkam Station (23.924275°, 97.930225°)	3	Wane Mine	24.002076, 97.939476	-	-	-	-	-	-	-	-	-	-
	4	Kaung Khan	23.989151, 97.927925	-	-	-	-	-	-	-	-	-	-
Man Hwang Station (23.840273°, 97.935907°) to Na Hpai Station (23.735083°, 97.907042°)	5	Nan Om	23.826240, 97.935353	-	-	-	-	-	-	-	-	-	-
	6	Phat Mhan	23.977210, 97.916416	-	-	-	-	-	-	-	-	-	-
	7	Mhan Haunn	23.777568, 97.908184	-	-	-	-	-	-	-	-	-	-
Na Hpai Station (23.735083°, 97.907042°) to Nan Hpak Ka Station (23.660356°, 97.852678°)	8	Mine Mine	23.719454, 97.898163	-	-	-	-	-	-	-	-	-	-

Nan Hpak Ka Station (23.660356°, 97.852678°) to Pang Nin Station (23.570530°, 97.851733°)	9	-	-	-	-	-	-	-	-	Nam Khai River	23.604513°, 97.841143°	-	-
Pang Nin Station (23.570530°, 97.851733°) to Kutkai Station (23.469516°, 97.894684°)	10	Nam Phat Loon	23.560408, 97.851887	-	-	-	-	-	-	-	-	-	-
	11	Mang Lon	23.532197, 97.872483	-	-	-	-	-	-	-	-	-	-
	12	Lwal Pal	23.480092, 97.894311	-	-	-	-	-	-	-	-	-	-
Kutkai Station (23.469516°, 97.894684°) to Mang Peng Station (23.371909°, 97.931348°)	13	Ho Nar	23.468220, 97.892402	-	-	-	-	-	-	-	-	-	-
	14	Nam Khone	23.439460, 97.895019	-	-	-	-	-	-	-	-	-	-
	15	Man Nawng	23.418225, 97.902488	-	-	-	-	-	-	-	-	-	-
	16	Par Gyo	23.370266, 97.929377	-	-	-	-	-	-	-	-	-	-
Mang Peng Station (23.371909°, 97.931348°) to Nwang Yen Station (23.399132°, 98.055187°)	17	-	-	Factory	23.365911, 97.948227	-	-	-	-	-	-	-	-
Laban Pa Station (23.333072°, 98.059699°)	18	-	-	-	-	-	-	-	-	-	-	Forest area near Mu Loot	23.324428, 98.016133

to Theinni Station (23.293231°, 97.985080°)												
	19	Man Chat	23.313305, 98.008298	-	-	-	-	-	-	Natural Spring	23.313305, 98.008298	-	-
	20	Mang Sar Tone	23.309274, 97.999011	-	-	-	-	-	-	-	-	-	-
	21	Wane Line	23.309188, 97.988722	-	-	-	-	-	-	Natural Spring	23.309188, 97.988722	-	-
Theinni Station (23.293231°, 97.985080°) to Sam Lou Station (23.201112°, 97.894590°)	22	-	-	-	-	-	-	-	-	Nam Tu River	23.289810° 97.976761°	-	-
	23	Naung On	23.278872, 97.969783	-	-	-	-	-	-	-	-	-	-
	24	Pan Sone	23.259018, 97.938860	-	-	-	-	-	-	-	-	-	-
	25	-	-	-	-	-	-	-	-	Nam Pang Stream	23.257000° 97.943131°	-	-
	26	Kungmyaung	23.233243, 97.913675	-	-	-	-	-	-	-	-	-	-
	27	Nan Onn	23.206558, 97.902174	-	-	-	-	-	-	-	-	-	-
Sam Lou Station (23.201112°, 97.894590°) to Hang Lu Station (23.127267°, 97.840565°)	28	Nar Chat	23.181866, 97.877292	-	-	-	-	-	-	Natural Spring	23.181866, 97.877292	-	-
	29	Pan Kham	23.171638, 97.872338	-	-	-	-	-	-	-	-	-	-
	30	Nam Maw Hate	23.164425, 97.869158	-	-	-	-	-	-	-	-	-	-
	31	Pan Phat	23.144800, 97.854208	-	-	-	-	-	-	-	-	-	-
Hang Lu Station (23.127267°, 97.840565°) to Lashio	32	Nam Hu	23.085759, 97.798375	-	-	-	-	-	-	-	-	-	-
	33	Pan Hat	23.071928,	-	-	-	-	-	-	-	-	-	-

North Station (23.048538°, 97.759070°)			97.779249										
Lashio North Station (23.048538°, 97.759070°) to Lashio West Station (22.981536°, 97.705398°)	34	-	-	-	-	-	-	-	-	Lake near Lashio North Station	23.047041, 97.758620	-	-
	35	Ho Pate	23.044302, 97.756349	-	-	-	-	-	-	-	-	-	-
	35	-	-	-	-	-	-	-	-	Nam Yao River	23.011512°, 97.722750°	-	-
Lashio West Station (22.981536°, 97.705398°) to Mehan Station (22.870083°, 97.688677°)	36	Naung Laing	22.975586, 97.694733	-	-	-	-	-	-	-	-	-	-
	37	Khar Shi	22.950894, 97.695643	-	-	-	-	-	-	-	-	-	-
	38	Kaung Ma Kyan	22.938349, 97.694631	-	-	-	-	-	-	-	-	-	-
	39	Mal Han	22.883921, 97.694954	-	-	-	-	-	-	Natural Spring	22.883921, 97.694954		
	40	Lwin Lount	22.870793, 97.688123	-	-	-	-	-	-	-	-	-	-
Mehan Station (22.870083°, 97.688677°)to Nam Un Station (22.771006°, 97.656280°)	41	-	-	-	-	-	-	Quarry near Mehan Station	22.849777, 97.689589	-	-	-	-
	42	San Pyat	22.814816, 97.667802	-	-	-	-	-	-	-	-	-	-
	43	Khay Ninn	22.794086, 97.675568	-	-	-	-	-	-	-	-		
Nam Un Station	44	-	-	-	-	-	-	-	-	-	-	Forest area	22.770808, 97.652135

(22.771006°, 97.656280°)												Nam Un Station	
to Sint Eng Station (22.733224°, 97.555773°)	45	Naung Mon	22.764907, 97.637856	-	-	-	-	-	-	-	-	-	-
Sint Eng Station (22.733224°, 97.555773°) to San Lau Station (22.673916°, 97.487782°)	46	-	-	-	-	-	-	-	-	Nam Paung Stream	22.708126°, 97.521687°	-	-
San Lau Station (22.673916°, 97.487782°) to Kong Tha Station (22.627581°, 97.411773°)	47	Ho Nwang	22.631058, 97.418032	-	-	-	-	-	-	-	-	-	-
Kong Tha Station (22.627581°, 97.411773°)	48	Soot Lan	22.619744, 97.363305	-	-	-	-	-	-	-	-	-	-
	49	Pan Hsauk	22.611549, 97.367325	-	-	-	-	-	-	-	-	-	-
to Hsipaw Station (22.597323°, 97.300881°)	50	Nwang Eain	22.602100, 97.302230	-	-	-	-	-	-	-	-	-	-
Hsipaw Station (22.597323°, 97.300881°)	51	Ton Kar	22.587546, 97.252104	-	-	-	-	-	-	-	-	-	-
to Hsipaw South	52	-	-	-	-	-	-	-	-	Nam Tu Myi Nge-R	22.565116°, 97.227588		

Hsipaw South Station (22.570027°, 97.237676°) to Chaung Chauk Station (22.539479°, 97.144750°)										River	°		
	53	Kyin Thi	22.564065, 97.222827	-	-	-	-	-	-	-	-	-	-
	54	Nam Onn	22.555872, 97.187512	-	-	-	-	-	-	-	-	-	-
	55	Ngon Sai	22.543566, 97.181939	-	-	-	-	-	-	-	-	-	-
	56	Nwang Ann	22.546527, 97.166665	-	-	-	-	-	-	Natural Spring	22.546527, 97.166665	-	-
Chaung Chauk Station (22.539479°, 97.144750°) to Kyaukme Station (22.492722°, 97.020461°)	57	Pang Ywang	22.508405, 97.039741	-	-	-	-	-	-	Natural Spring	22.508405, 97.039741	-	-
	58	Mway Taw	22.503216, 97.033525	-	-	-	-	-	-	Natural Spring	22.503216, 97.033525	-	-
Kyaukme Station (22.492722°, 97.020461°) to Myin Gwin Station (22.422319, 96.966095)	59	Na Ai Hkant	22.425912, 96.961091	-	-	-	-	-	-	Natural Spring	22.425912, 96.961091	-	-
Myin Gwin Station (22.422319, 96.966095) to Nam Ba Ton River Station (22.341234, 96.871000)	60	Khite Tone Home	22.414476, 96.957989	-	-	-	-	-	-	Natural Spring	22.414476, 96.957989	-	-
	61	Kone Kaw	22.405297, 96.957967	-	-	-	-	-	-	Natural Spring	22.405297, 96.957967	-	-
	62	Kyaung Kone	22.358234, 96.877519	-	-	-	-	-	-	Natural Spring	22.358234, 96.877519	-	-
	63	-	-	-	-	-	-	-	-	Nam Ba Ton River	22.339885 °, 96.867818	-	-

											°		
Nam Ba Ton River Station (22.341234, 96.871000) to Nawng Hkio Station (22.310013, 96.801553)	64	Myat Chae Nu	22.306392, 96.836849	-	-	-	-	-	-	-	-	-	-
	65	Kone Gyi Ma	22.315804, 96.828690	-	-	-	-	-	-	-	-	-	-
Nawng Hkio Station (22.310013, 96.801553) to Ommakha Station (22.275012, 96.677853)	66	Taung Quarter	22.313778, 96.803853	-	-	-	-	-	-	Natural Spring	22.313778, 96.803853	-	-
	67	Ngoke Ka Lay	22.310301, 96.771796	-	-	-	-	-	-	-	-	-	-
	68	-	-	-	-	-	-	-	-	-	-	Nawng Hkio Golf Club	22.306280 °, 96.765162 °
	69	Ban Bway	22.305213, 96.737448	-	-	-	-	-	-	-	-	-	-
	70	Ommakha	22.282294, 96.689727	-	-	-	-	-	-	-	-	-	-
Ommakha Station (22.275012, 96.677853) To Gangaw Station (22.216818, 96.590718)	71	Kyin Ganai	22.268749, 96.658752	-	-	-	-	-	-	-	-	-	-
	72	Samasal	22.247475, 96.641875	-	-	-	-	-	-	-	-	-	-
Gangaw Station	73	Lone Yone	22.188979, 96.568363	-	-	-	-	-	-	-	-	-	-

(22.216818, 96.590718) To Pyinoolwin Station (22.105295, 96.540374)	74	Anauk Kyu Inn	22.148223, 96.563513	-	-	-	-	-	-	Natural Spring	22.148223, 96.563513	-	-
Pyinoolwin Station (22.105295, 96.540374) To Sin Byu In Station (22.082622°, 96.403790°)		East Pin Lain	22.104714, 96.549211	-	-	-	-	-	-	-	-	-	-
	75	Middle Pin Lain	22.105234, 96.539294	-	-	-	-	-	-	Natural Spring	22.105234, 96.539294	-	-
	76	Myawt Taw	22.100343°, 96.495723°	-	-	-	-	-	-	-	-	-	-
	77	-	-	-	-	-	-	-	-	Reservoir near That Kan Gone	22.099917°, 96.466268°	-	-
	78	Kone Kaw	22.095427°, 96.435934°	-	-	-	-	-	-	Natural Spring	22.095427°, 96.435934°	-	-
	79	Pan Oo Taung	22.092211°, 96.423717°	-	-	-	-	-	-	Natural Spring	22.092211°, 96.423717°	-	-

To Sin Byu In Station (22.082622°, 96.403790°) To Sakangyi Station (22.024931°, 96.339346°)	80	-	-	-	-	-	-	-	-	-	-	Kai Gyi Reserved Forest	22.017399°, 96.295682°
Sakangyi Station (22.024931°, 96.339346°) To Taung Kyun Station (22.004728°, 96.259483°) Taung Kyun Station (22.004728°, 96.259483°) To Tok Kha Taung Station (22.016022°, 96.220754°)	81	-	-	-	-	-	-	-	-	-	-	Kai Gyi Reserved Forest	22.017399°, 96.295682°
Tok Kha Taung Station (22.016022°, 96.220754°) to Mandalay East Station (21.945631°, 96.157707°)	82	-	-	-	-	-	-	-	-	Sedawgyi Canal	21.981115°, 96.178485°	-	-
	83	Lain Pin	21.976874, 96.177334	-	-	-	-	-	-	-	-	-	-
	84	Yankin Taung	21.978723, 96.165871	-	-	-	-	-	-	-	-	-	-
Mandalay East Station (21.945631°,	85	Bo Tat Gone	21.926714, 96.150118	-	-	-	-	-	-	-	-	-	-
	86	Shin Taw	21.935598,	-	-	-	-	-	-	-	-	-	-

96.157707°) to Mandalay South Station (21.840919°, 96.115836°)		Gone	96.148471											
	87	Thant Zin Gone	21.923191, 96.148111	-	-	-	-	-	-	-	-	-	-	-
	88	Lat Kaung	21.922025, 96.158469	-	-	-	-	-	-	-	-	-	-	-
	89	Thale Gone	21.915023, 96.155310	-	-	-	-	-	-	-	-	-	-	-
	90	Ywar Shay	21.910429, 96.155531	-	-	-	-	-	-	-	-	-	-	-
	91	Sauk Taw Wa	21.852743, 96.115185	-	-	-	-	-	-	-	-	-	-	-
	92	War Yone Pin	21.844165, 96.128938	-	-	-	-	-	-	-	-	-	-	-
Mandalay South Station	93	Sin Bo	21.876957, 96.152982	-	-	-	-	-	-	-	-	-	-	-
	94	Min Su	21.858199, 96.128463	-	-	-	-	-	-	-	-	-	-	-
	95	Pauk Chine	21.868409, 96.142784	-	-	-	-	-	-	-	-	-	-	-
	96	Min Ywar	21.843224, 96.099868	-	-	-	-	-	-	-	-	-	-	-
	97	Nyaung Pin Ni	21.835055, 96.086749	-	-	-	-	-	-	-	-	-	-	-
	98	Nyaung Pin Zout	21.827731, 96.095464	-	-	-	-	-	-	-	-	-	-	-
	99	Sar Toe	21.847448, 96.076049	-	-	-	-	-	-	-	-	-	-	-
	100	Sat Kway	21.842036, 96.071457	-	-	-	-	-	-	-	-	-	-	-
	101	Myo Pyin Gyi	21.837322, 96.075945	-	-	-	-	-	-	-	-	-	-	-
	102	Myit Laung	21.852678, 96.079742	-	-	-	-	-	-	-	-	-	-	-
	103	Danone	21.865502, 96.075499	-	-	-	-	-	-	-	-	-	-	-

	104	Pyauk Sake Kone	21.863664, 96.097978	-	-	-	-	-	-	-	-	-	-
	105	Ashay Thar Yar Gone	21.855179, 96.065068	-	-	-	-	-	-	-	-	-	-

According to the above table, most of the environmentally sensitive areas along the railway alignment are residential areas, natural springs, rivers, Si Daw Gyi and Paw Daw Mu canals, factory, quarry, Nawng Hkio golf club and Kai Gyi Reserved Forest.

Table – Environmental Sensitive Areas within 1km around the Railway Stations by Overlay Mapping

No.	*Station Name*	*Location*	*Residential Area*		*Ecologically Important Area*		*Historical, Archaeological, Cultural and Heritage*		*Surface Water Resources*		*Land Use Type within 1km*	
			Village	*Location*	*Industrial Area*	*Location*	*Sensitive Zone*	*Location*			*Forest Area*	*Agricultural Land*
1.	Muse	24.006486, 97.954332	Nan Pann	24.014952, 97.957032	-	-	-	-	-	-	Forest	Agricultural Land
2.	Pang Hkam	23.924275, 97.930225	-	-	-	-	-	-	-	-	Forest	Agricultural Land
3.	Man Hawng	23.840273, 97.935907	Nan Om	23.826240, 97.935353		-	-	-	-	-	Forest	Agricultural Land
4.	Na Hpai	23.735083, 97.907042	-	-	-	-	-	-	-	-	Forest	Agricultural Land
5.	Nam Hpak Ka	23.660356, 97.852678	-	-	-	-	-	-	-	-	Forest	Agricultural Land
6.	Pang Nin	23.570530, 97.851733	Nam Phat Loon	23.560408, 97.851887	-	-	-	-	-	-	Forest	Agricultural Land
7.	Kutkai	23.469516, 97.894684	Ho Nar	23.468220, 97.892402	-	-	-	-	-	-	Forest	Agricultural Land
8.	Man Peng	23.371909, 97.931348	Par Gyo	23.370266, 97.929377	-	-	-	-	-	-	Forest	Agricultural Land
9.	Nawng Yen	23.399132, 98.055187	-	-	-	-	-	-	-	-	Forest	-

10.	Laban Pa	23.333072, 98.059699	-	-	-	-	-	-	-	-	Forest	Agricultural Land
11.	Theinni	23.293231, 97.985080	-	-	-	-	-	-	Nam Tu River	23.289810, 97.976761	-	Agricultural Land
12.	Sam Lou	23.201112, 97.894590	Nan Onn	23.206558, 97.902174	-	-	-	-	-	-	Forest	Agricultural Land
13.	Hang Lu	23.127267, 97.840565	-	-	-	-	-	-	-	-	Forest	Agricultural Land
14.	Lashio North	23.048538, 97.759070	Ho Pate	23.044302, 97.756349	-	-	-	-	-	-	Forest	Agricultural Land
15.	Lashio West	22.981536, 97.705398	-	-	-	-	-	-	-	-	Forest	Agricultural Land
16.	Mehan	22.870083, 97.688677	Lwin Lount	22.870793, 97.688123	-	-	-	-	-	-	Forest	Agricultural Land
17.	Nam Un	22.771006, 97.656280	Naung Mon	22.764907, 97.637856	-	-	-	-	-	-	Forest	Agricultural Land
18.	Sint Eng	22.733224, 97.555773	-	-	-	-	-	-	-	-	Forest	Agricultural Land
19.	San Lau	22.673916, 97.487782	-	-	-	-	-	-	-	-	-	Agricultural Land
20.	Kong Tha	22.627581, 97.411773	Ho Nwang	22.631058, 97.418032	-	-	-	-	-	-	-	Agricultural Land
21.	Hsipaw	22.597323, 97.300881	Nwang Eain	22.602100, 97.302230	-	-	-	-	Myit Nge River	22.599445, 97.295479	Forest	Agricultural Land
22.	Hsipaw South	22.570027, 97.237676	-	-	-	-	-	-	-	-	Forest	Agricultural Land
23.	Chaung Chauk	22.539479, 97.144750	-	-	-	-	-	-	-	-	Forest	Agricultural Land
24.	Kyaukme	22.492722, 97.020461	-	-	-	-	-	-	-	-	-	Agricultural Land
25.	Myin Gwin	22.422319, 96.966095	Na Ai Hkant	22.425912, 96.961091	-	-	-	-	Natural Spring	22.425912, 96.961091	Forest	Agricultural Land
26.	Namban Ton River	22.341234, 96.871000	-	-	-	-	-	-	-	-	Forest	Agricultural Land

27.	Nawng Hkio	22.310013, 96.801553	Taung Quarter	22.316893, 96.803754	-	-	-	-	Natural Spring	22.316893, 96.803754	-	Agricultural Land
28.	Om Maka	22.275012, 96.677853	-	-	-	-	-	-	-	-	-	Agricultural Land
29.	Gan Gaw	22.216818, 96.590718	-	-	-	-	-	-	-	-	-	Agricultural Land
30.	Pyinoolwin	22.105295, 96.540374	East Pin Lain	22.104714, 96.549211	-	-	-	-	-	-	Forest	Agricultural Land
			Middle Pin Lain	22.105234, 96.539294	-	-	-	-	Natural Spring	22.105234, 96.539294	Forest	Agricultural Land
31.	Sin Byu In	22.082622, 96.403790	-	-	-	-	-	-	-	-	Forest	Agricultural Land
32.	Sakangyi	22.024931, 96.339346	-	-	-	-	-	-	-	-	Forest	-
33.	Taung Kyun	22.004728, 96.259483	-	-	-	-	-	-	-	-	Forest	-
34.	Tok Hka Taung	22.016022, 96.220754	-	-	-	-	-	-	-	-	Forest	-
35.	Mandalay East	21.945631, 96.157707	-	-	-	-	-	-	Paw Taw Mu Canal	21.944724, 96.154545	-	Agricultural Land
36.	Mandalay South	21.840919, 96.115836	Min Ywar	21.843224, 96.099868	-	-	-	-	-	-	-	Agricultural Land
			Sauk Taw Wa	21.852743, 96.115185								

According to the above table, most of the environmentally sensitive areas around the stations are residential areas (villages), natural springs, rivers and Paw Daw Mu canals, agricultural lands and forest areas including Kai Gyi Reserved Forest.

Table – Environmental Sensitive Areas within 1km around the Railway Stations by Overlay Mapping

No.	Type of Project	Station Name	Location	Residential Area		Surface Water Resources		Landscape and Visual	
				Village	Location			Forest Area	Agricultural Land
1.	Access Road	Muse	24.006486, 97.954332	Nan Pann	24.014952, 97.957032	-	-	Forest	Agricultural Land
				Wane Mine	24.002076, 97.939476				
2.		Nam Hpak Ka	23.660356, 97.852678	-	-	-	-	Forest	Agricultural Land
3.		Kutkai	23.469516, 97.894684	Ho Nar	23.468220, 97.892402	-	-	Forest	Agricultural Land
4.		Theinni	23.293231, 97.985080	-	-	Nam Tu River	23.289810, 97.976761	-	Agricultural Land
5.		Lashio West	22.981536, 97.705398	-	-	-	-	Forest	Agricultural Land
6.		Nam Un	22.771006, 97.656280	Naung Mon	22.764907, 97.637856	-	-	Forest	Agricultural Land
7.		Hsipaw	22.597323, 97.300881	Nwang Eain	22.602100, 97.302230	Myit Nge River	22.599445, 97.295479	Forest	Agricultural Land
8.		Kyaukme	22.492722, 97.020461	-	-	-	-	-	Agricultural Land
9.		Nawng Hkio	22.310013, 96.801553	Taung Quarter	22.316893, 96.803754	Natural Spring	22.316893, 96.803754	-	Agricultural Land
10.		Pyinoolwin	22.105295, 96.540374	East Pin Lain	22.104714, 96.549211	-	-	Forest	Agricultural Land
				Middle Pin Lain	22.105234, 96.539294	Natural Spring	22.105234, 96.539294	Forest	Agricultural Land
11.		Mandalay East	21.945631, 96.157707	Bo Tat Gone	21.926714, 96.150118	Paw Taw Mu Canal	21.944724, 96.154545	-	Agricultural Land
				Shin Taw Gone	21.935598, 96.148471				
				Thant Zin Gone	21.923191, 96.148111				

				Lat Kaung	21.922025, 96.158469				
				Thale Gone	21.915023, 96.155310				
				Ywar Shay	21.910429, 96.155531				
12.		Mandalay South	21.840919, 96.115836	Sauk Taw Wa	21.852743, 96.115185	-	-	-	Agricultural Land
				Min Su	21.858199°, 96.128463°				
				Pauk Chine	21.868409°, 96.142784°				
				War Yone Pin	21.844165, 96.128938				

According to the above table, most of the environmentally sensitive areas along the access roads are residential areas, natural springs, rivers and canals, agricultural lands and forest areas including Kai Gyi Reserved Forest.

5.14. Forest Area and Forest Plantation in or neare Railway Project

All of the alternative analysis was done within 1km beside the proposal alignment except for household that were accounted based on 100m beside the railway alignment. Alternative analysis for bridges and culverts will be based on the type of land use that the bridge will pass through the sensitive forest areas. The land use type will be studied by GIS and remote Sensing Method based on buffer width 1km around the rail track center. There are five different portions at which area calculation of land over classes are as follows:

(1) Shweli East – Man Hawang Section
(2) Nam Hpak Ka to Lashio West Section
(3) San-Lau Myin Gwin
(4)Myin Gwin Om Ma Ka
(5) Om Ma Ka Mandalay East

(1) Shweli East – Man Hawang Section

In this section, the geological conditions of the proposed main line is good, the amount of demolition will be small and the project implementation and resettlement will be relatively simple. After that, the alignment in this section did not pass the sensitive forest area.

(2) Nam Hpak Ka to Lashio West Section

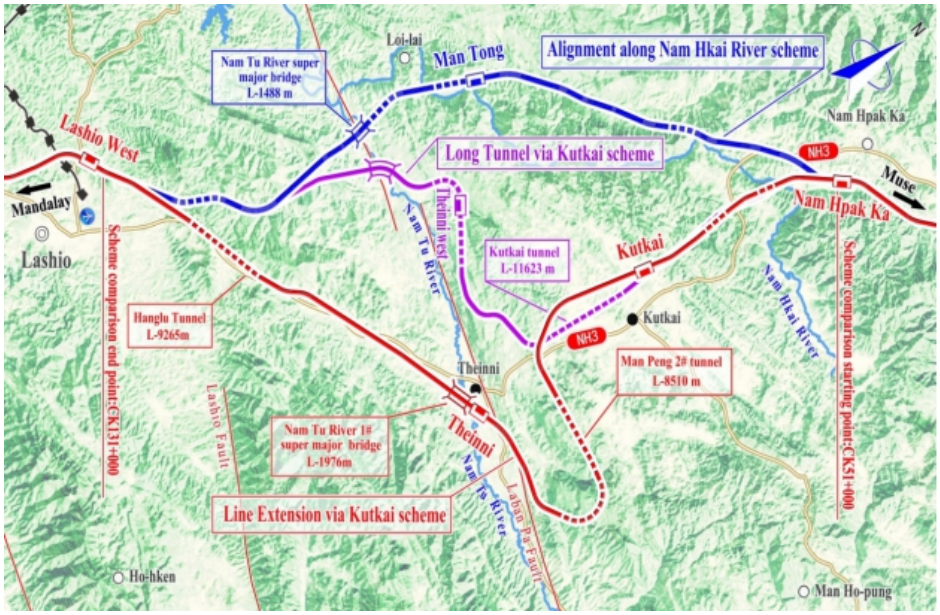


Figure - Schematic Map for Alignment Scheme of Nam Hpak Ka-Lashio West Section

The proposal main line will pass through the two economic centers of Kutkai and Theinni,and it will promote local economic development. Furthermore, the Ministry of Transport and Communicaitons of Myanmar attaches great importance to the economic development of Kutkai area and hopes that the route will pass through Kutkai. In this section Man Peng 2 Super Major Bridge is needed to be considered for alternatives because it has the largest land used area or passing forest areas. And Kutkai1 Super Major Bridge has the longest bridge but smallest land used area. Therefore Kutkai 1 Super Major Bridge is not needed to consider for location alternative. The bridges passed through the sensitive forest and land used area are shown below.

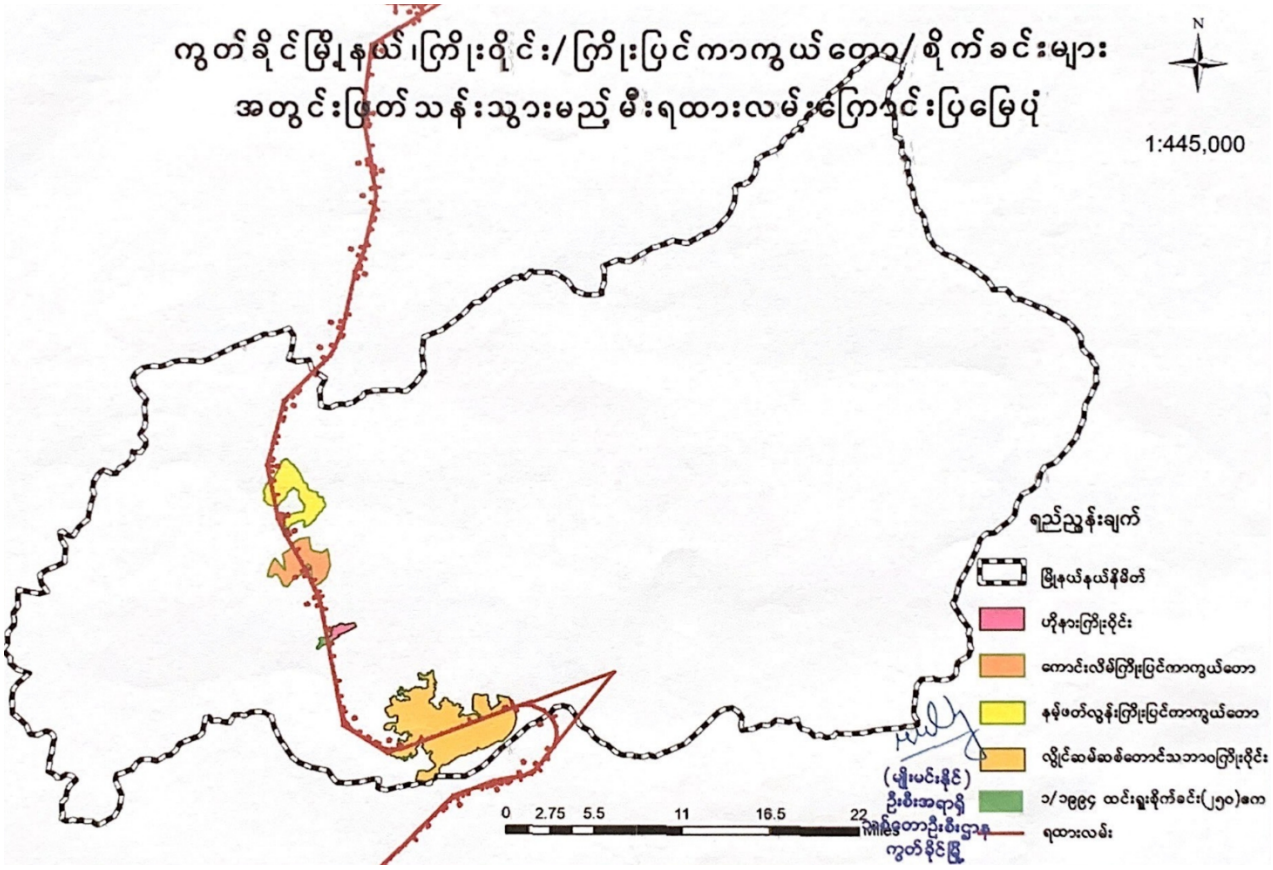


Figure - Forest Area and Forest Plantation that the Railway will Pass in Kuit Kai Region

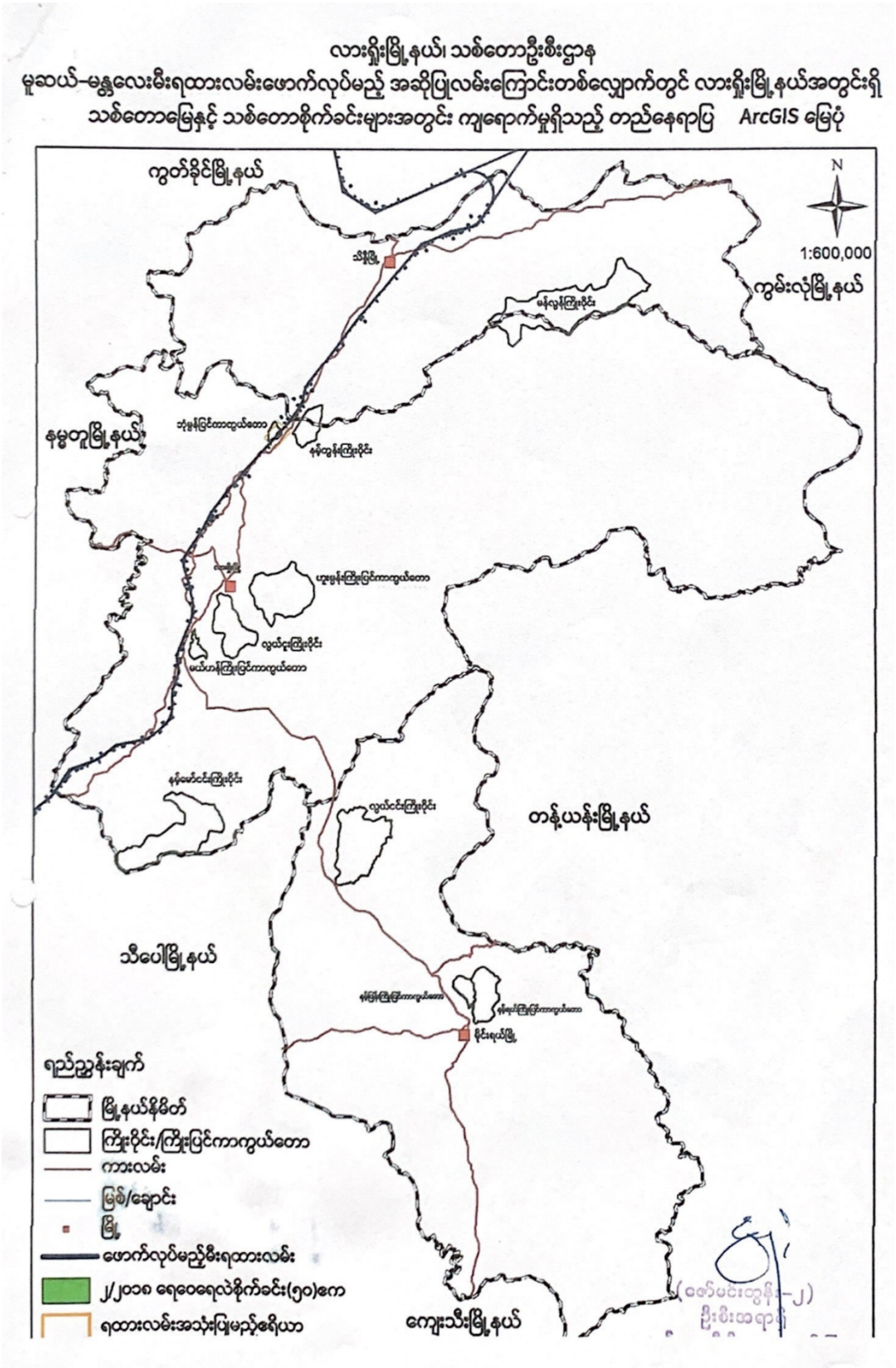
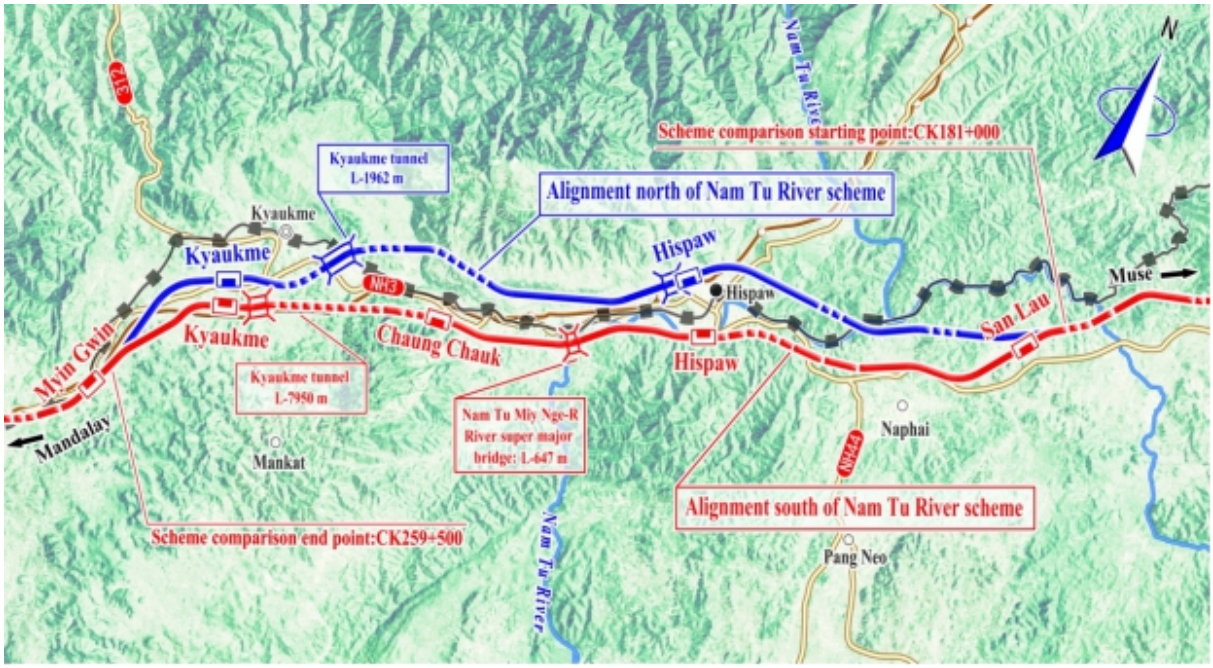


Figure - Forest Area and Forest Plantation that the Railway will Pass in Lashio Region

(3) San-Lau Myin Gwin



Schematic Map of the alignment scheme of San lau-Myin Gwin Section

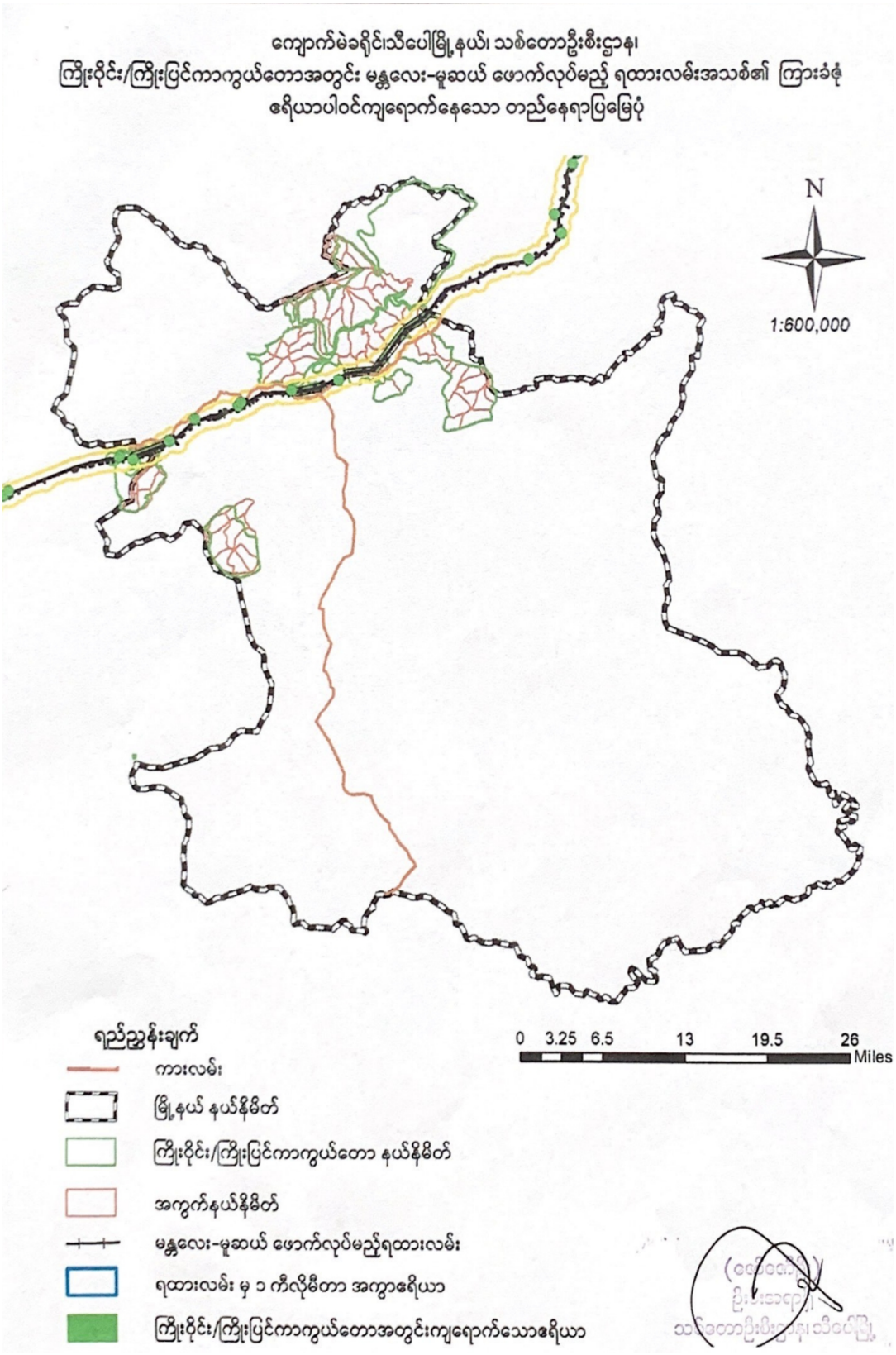


Figure - Forest Area and Forest Plantation that the Railway will Pass in Thipaw Region

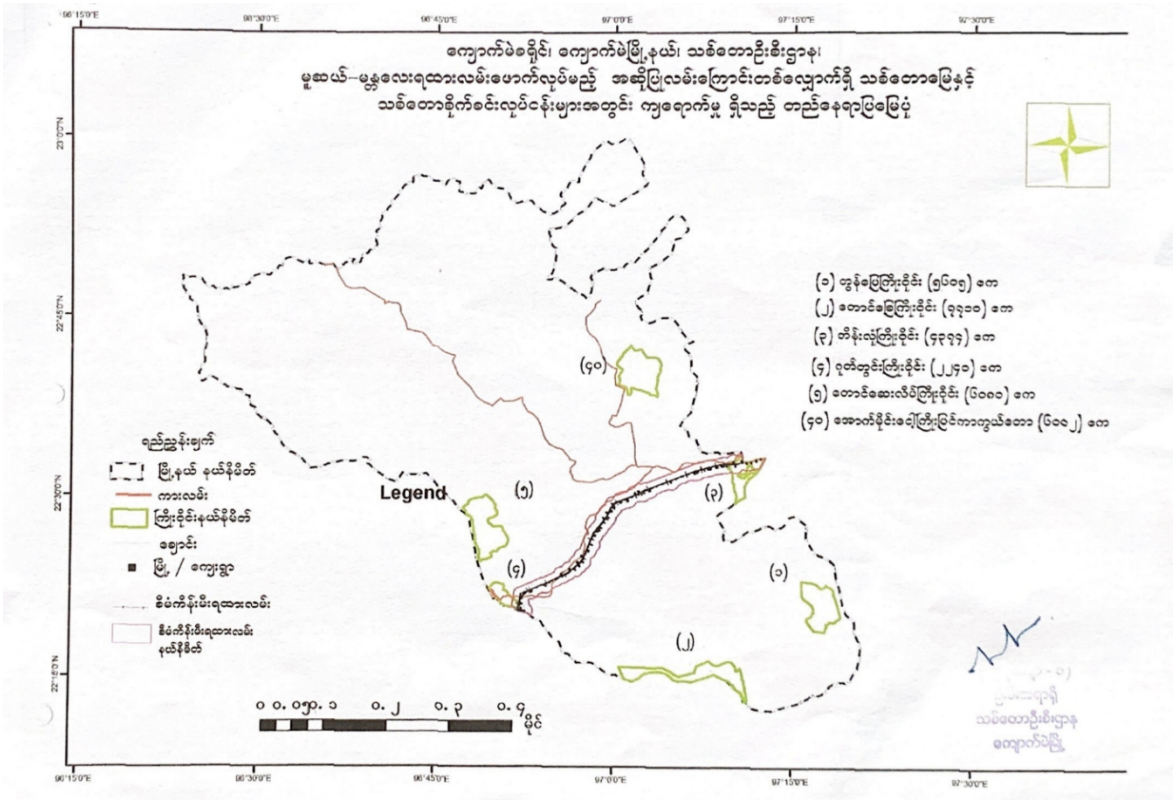
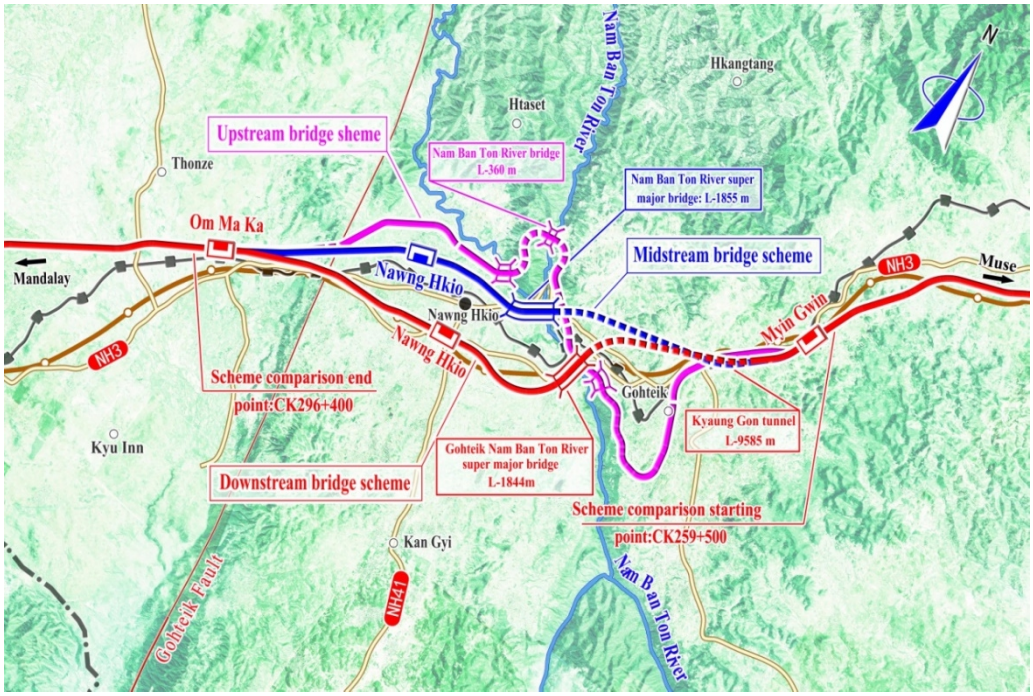


Figure - Forest Area and Forest Plantation that the Railway will Pass in Kyauk Mae Region

(4) Myin Gwin - Om Ma Ka



Schematic Map for the alignment scheme of Myin Gwin-Om Ma Ka section

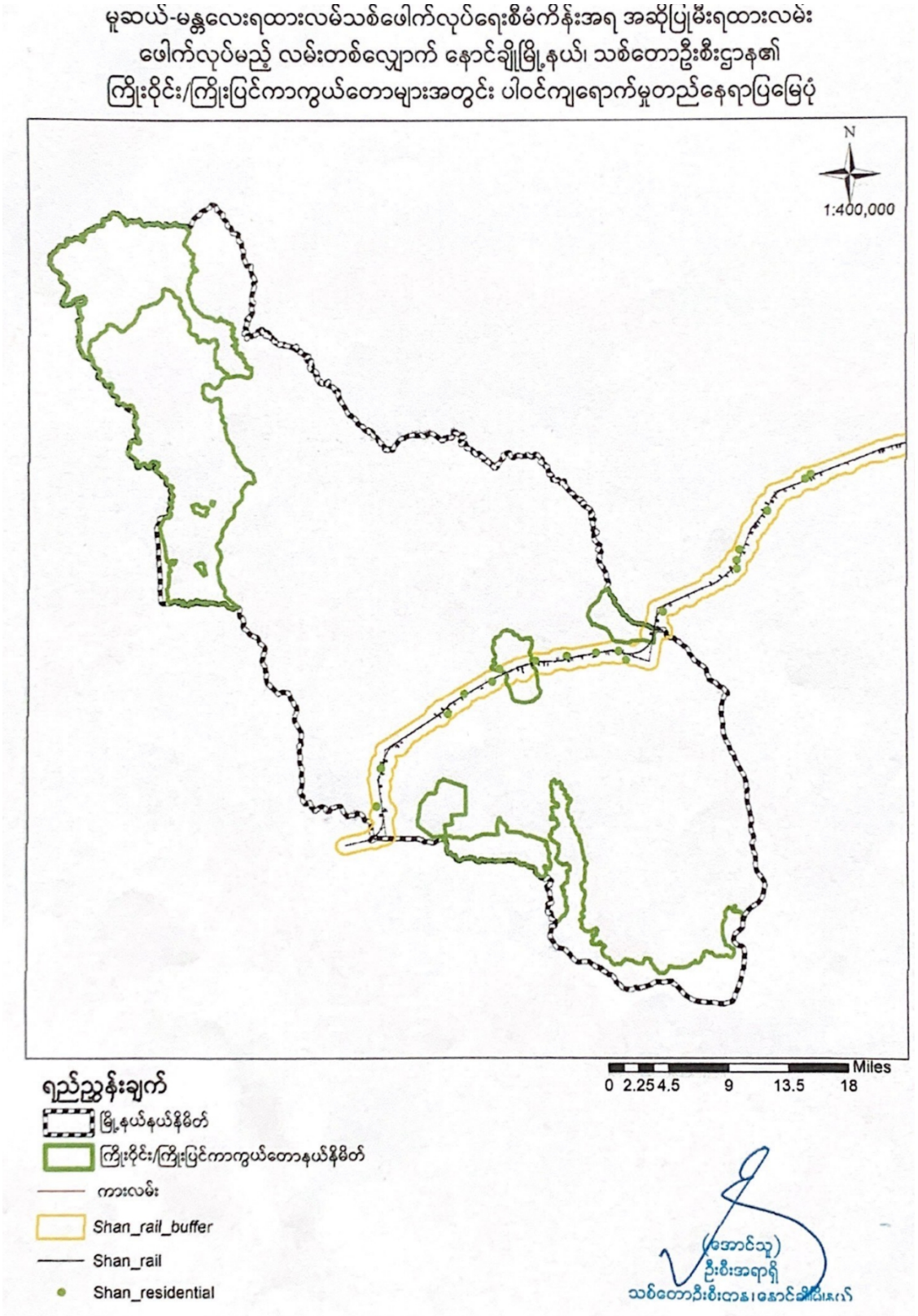
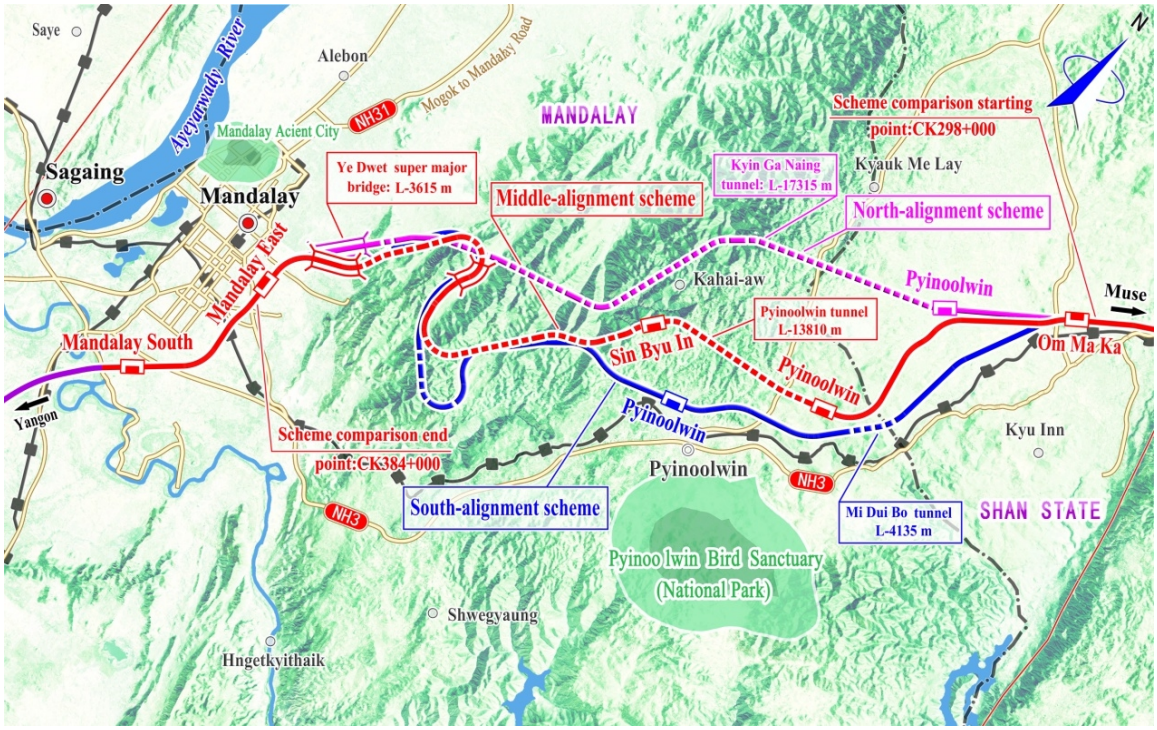
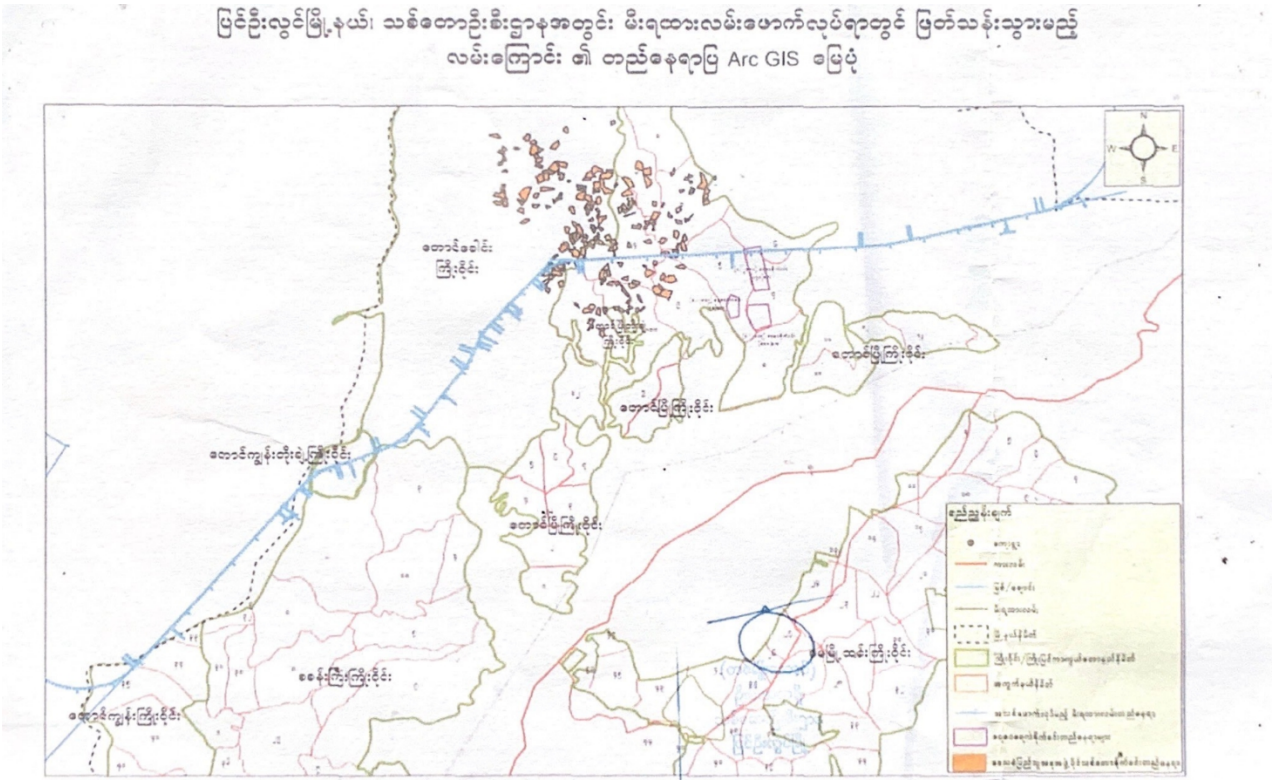


Figure - Forest Area and Forest Plantation that the Railway will Pass in Naung Cho Region

(5) Om Ma Ka - Mandalay East



Schematic Map for the alignment scheme of Om ma ka–Mandalay section



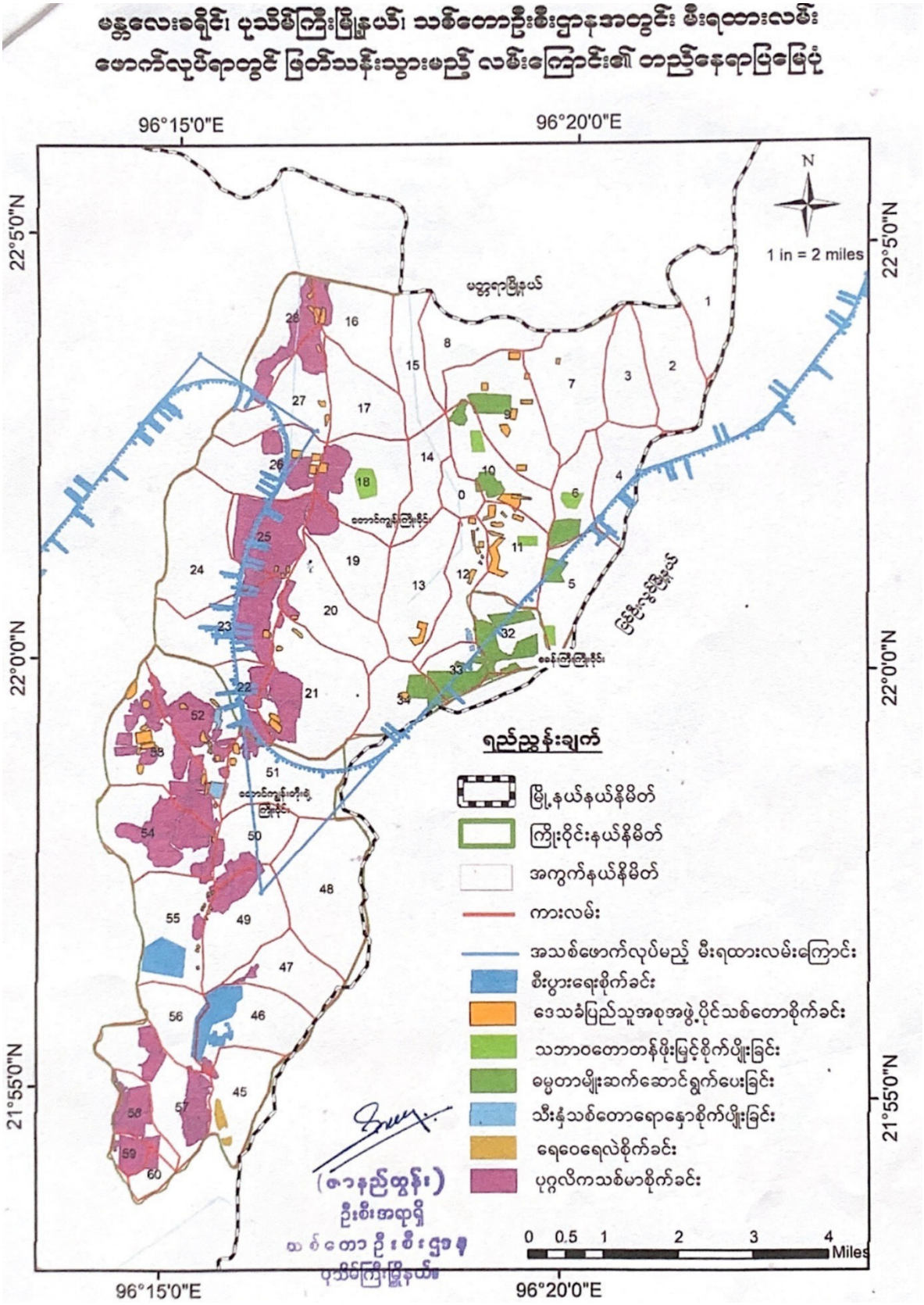


Figure - Forest Area and Forest Plantation that the Railway will Pass in Pathein Gyi Region

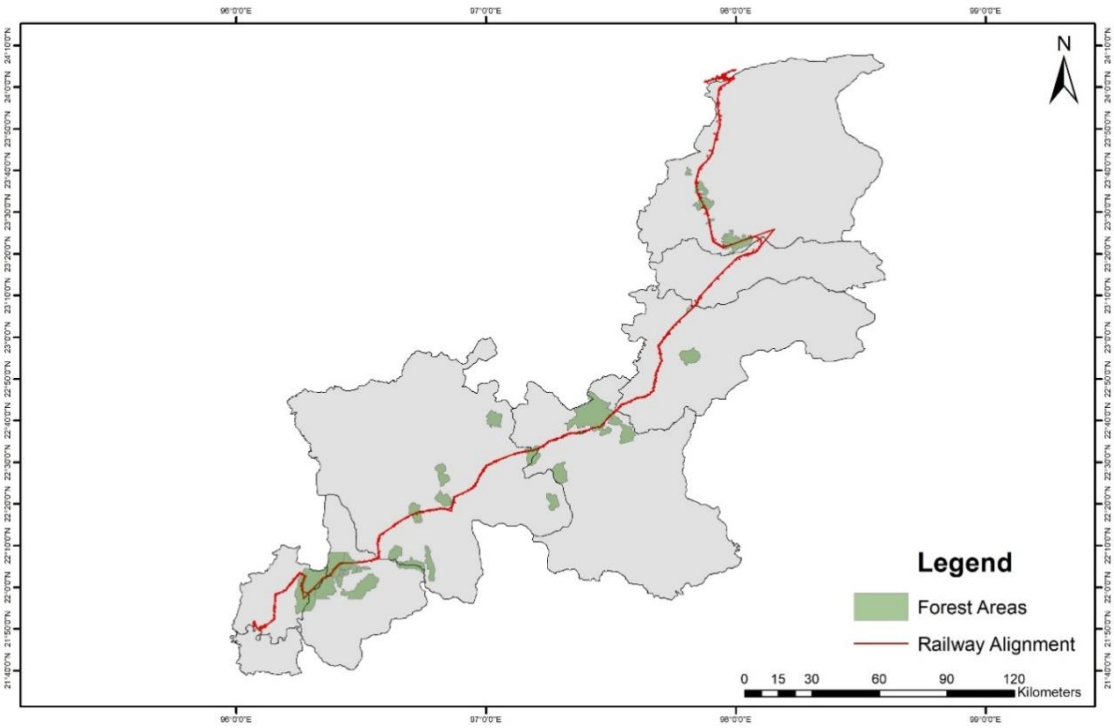


Figure – Forest Area and Forest Plantation along MMR in Argic Map

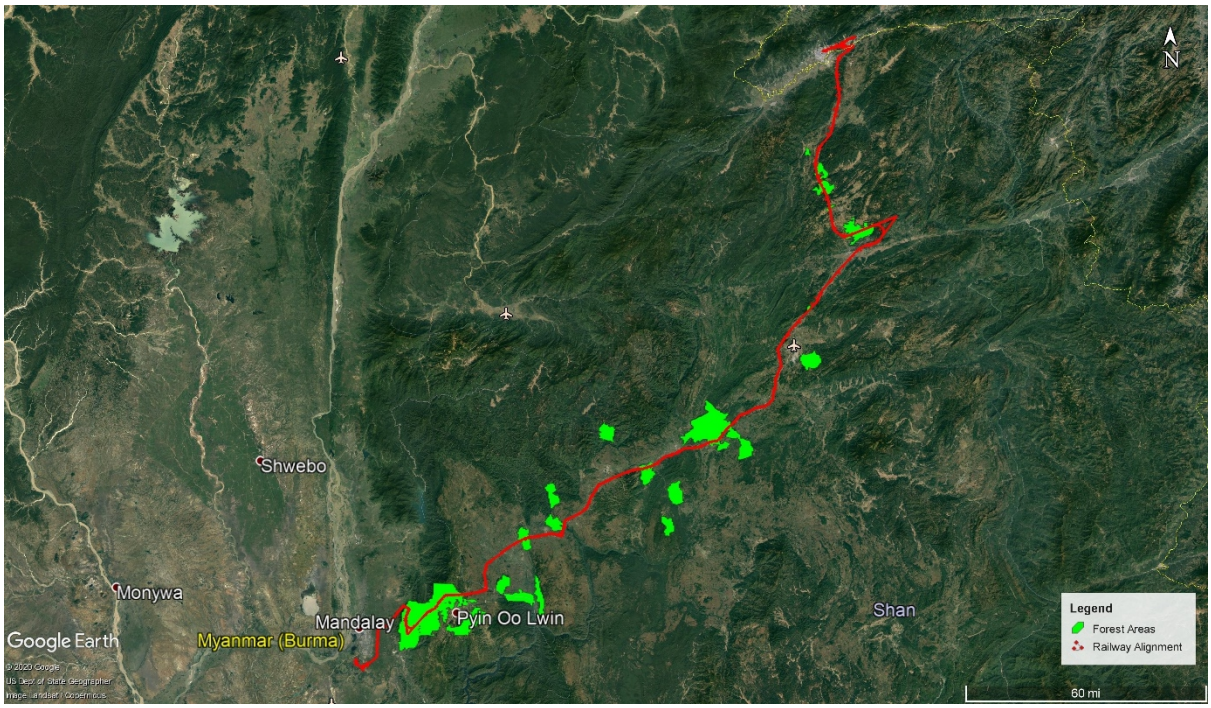


Figure – Forest Area and Forest Plantation along MMR in Google Map

TABLE -

S/N	Railway Passing Region	Forest		Forest Plantation		Private Plantation		CF Plantation	
		Name	Area (Acres)	No. of owners	Area (Acres)	No. of owners	Area (Acres)	No. of owners	Area (Acres)
1.	**Muse**	-	-	-	-	-	-	-	-
2.	**Kutkai**	Ho Nar Reserved Forest	217	2	217	-	-	-	-
		Nam Hpak Loon Protected Forest	892	-	-	-	-	-	-
		Kaung Lain Protected Forest	1510	-	-	-	-	-	-
		Loi Sam Sit Natural Protected Forest	5352	-	-	-	-	-	-
3.	**Hseni**	-	-	-	-	-	-	-	-
4.	**Lashio**	Bone Mon Protected Forest	540	1	50	-	-	-	-

5.	**Hsipaw**	Tein Lon Reserved Forest	611	47	5530	3	32	6	678.47
		Namma Reserved Forest	2590	-	-	-	-	-	-
		Pang Hsauk Protected Forest	815	-	-	-	-	-	-
6.	**Kyaukme**	Tein Lon Reserved Forest	1702	-	-	-	-	35	189.79/20
		Goketwin Reserved Forest	15	-	-	1	15	-	-
7.	**Nawnghkio**	Nawnghkio Reserved Forest	2300	13	2370	15	1357	-	-
		Goketwin Extended Reserved Forest	653	-	-	-	-	-	-
8.	**Pyinoolwin**	Taung Kyun Reserved Forest	-	-	-	-	-	-	-
		Taung Kyun Extended Reserved Forest	-	-	-	-	-	-	-

6.0 IMPACT ASSESSMENT AND MITIGATION MEASURES

6.1. Impact Assessment Methodology

6.1.1. Environmental Impact Assessment Methodology

Impacts will be assessed using information gathered during the baseline assessment in combination with previously collected data and the detailed project plan. The significance of the identified impacts will be determined using the approach outlined in Table 6.1. This incorporates two aspects for assessing the potential significance i.e. occurrence and severity, which are further sub-divided as indicated. The impact ranking will be described for both pre and post implementation of mitigation/management measures conditions.

An impact can be defined as any change in the physical-chemical, biological, cultural and/or socio-economic Environmental system that can be attributed to human activities. The significance of the aspects/impacts of the process was rated by using a Matrix Method modified by Green Tech EIA Team. The significances of the impacts were determined through a synthesis of the criteria below:

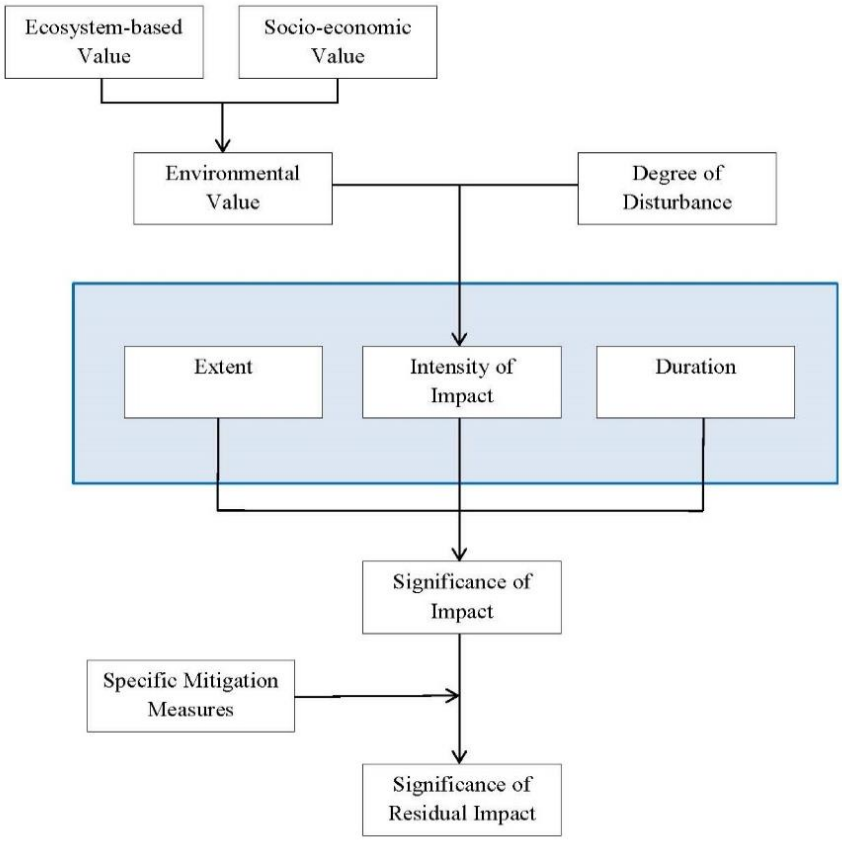


Figure 6.1. Methodological Framework for Impact Assessment

The significances of the impacts were determined through a synthesis of the criteria below:

1. Scale

No.	Description	Rating	Score
1.	Impact will be affected (Distance = 100 m or Area =1000 m^2)	Site	1
2.	Impact will be affected (Distance = 1000 m or Area = 10 km^2)	Limited	2
3.	Impact will be affected (Distance = 1000 m to 10 km or Area = 10 km^2 to 100 km^2)	Local	3
4.	Impact will be affected (Distance = 10 km to 100 km or Area = 100 km^2 to 1000 km^2)	District	4
5.	Impact will be affected (to the distance exceeding 100 km or Area = 1000 km^2)	Regional	5

Note: For linear objects areal gradations are used. If the area cannot be evaluated, the linear distance is used.

2. Duration

No.	Description	Rating	Score
1.	One day to one month	Very short term	1
2.	One month to two years	Short term	2
3.	Two years to ten years	Medium term	3
4.	Ten years to the whole life of operation	Long term	4
5.	Permanent and irreversible impact on nature	Permanent	5

3. Severity for the Environment

No.	Description	Rating	Score
1.	Isolated parts will be damaged and easy to mitigate/restore	Very low	1
2.	Isolated parts will be damaged and hard to mitigate/restore	Low	2
3.	Large parts will be damaged and easy to mitigate/restore	Low to Medium	3
4.	Large parts will be damaged and hard to mitigate/restore	Medium	4
5.	Large parts will be permanently destroyed	High	5

4. Frequency

No.	Description	Rating	Score
1.	Less than twice a year	Rare	1
2.	3 to 4 times per year	Intermittent	2
3.	Once a month	Regular	3
4.	1-3 times per week	Very Often	4
5.	More than 3 times per week	Continuous	5

5. Probability

No.	Description	Rating	Score
1.	Impact is very unlikely to occur under normal conditions but may occur in exceptional circumstances	Very Seldom	1
2.	Impact is unlikely to but may occur at some time under normal operating conditions	Seldom	2
3.	Impact is likely to occur at some time under normal conditions	Probable	3
4.	Impact is very likely to occur at some time under normal conditions	Highly probable	4
5.	Impact will occur under normal operating conditions	Certain	5

Table- Impact Rating Table

Consequence

Likelihood														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2	4	6	8	10	12	14	16	18	20	22	24	26	28	30
3	6	9	12	15	18	21	24	27	30	33	36	39	42	45
4	8	12	16	20	24	28	32	36	40	44	48	52	56	60
5	10	15	20	25	30	35	40	45	50	55	60	65	70	75
6	12	18	24	30	36	42	48	64	60	66	72	78	84	90
7	14	21	28	35	42	49	56	63	70	77	84	91	98	105
8	16	24	32	40	48	56	64	72	80	88	96	104	112	120
9	18	27	36	45	54	63	72	81	90	99	108	117	126	135
10	20	30	40	50	60	70	80	90	100	110	120	130	140	150

Very Low (0- 25)

Low (26- 50)

Low to Moderate (51-75)

Moderate (76-100)

Moderate to High (101-125)

High (126 to 150)

Mitigation Requirement for Impact Significance

No.	Impact Significance	Mitigation Requirement
1	Very Low (Negligible)	No mitigation required
2	Low	Required a small number of additional mitigations
3	Low to Moderate	Require more or less additional mitigations
4	Moderate	Require a number of additional mitigations
5	Moderate to High	Require a number of additional mitigation or modification of the project design
6	High	Require additional mitigations plus modification of the project design or alternative action may be required

Prediction Confidence

Although not explicitly included in the criteria tables, there is uncertainty associated with the information and methods used in an ESIA because of its predictive nature. The certainty with which an impact analysis can be completed depends on a number of factors including:

- Understanding of natural/ecological and socio-economic processes at work now and in the future; and
- Understanding of present and future properties of the affected resource.

The level of prediction confidence for an impact analysis will be discussed when there are questions about the factors reviewed above. Where the level of prediction confidence makes a prediction of the impact problematic, a subjective assessment is made based on the available information, the applicability of information on surrogates and on professional opinion.

The level of prediction confidence is sufficiently low in some cases that an estimate of Environmental consequence cannot be made with a sufficient degree of confidence. Undetermined

ratings are accompanied by recommendations for research or monitoring to provide more data in the future.

Development of Mitigation Measures

A common approach to describing mitigation measures for critical impacts is to specify a range of targets a predetermined acceptable range and an associated monitoring and evaluation plan. To ensure successful implementation, mitigation measures will be unambiguous statements of actions and requirements that are practical to execute. The following summarize the different approaches that may be used in prescribing and designing mitigation measures:

- Avoidance: e.g. mitigation by not carrying out the proposed action on the specific site, but rather on a more suitable site;
- Minimization: mitigation by scaling down the magnitude of a development, reorienting the layout of the project or employing technology to limit the undesirable Environmental impact;
- Rectification: mitigation through the restoration of Environments affected by the action;
- Reduction: mitigation by taking maintenance steps during the course of the action; and Compensation: mitigation through the creation, enhancement or acquisition of similar Environments to those affected by the action.

Prediction Confidence

Although not explicitly included in the criteria tables, there is uncertainty associated with the information and methods used in an ESIA because of its predictive nature. The certainty with which an impact analysis can be completed depends on a number of factors including:

- Understanding of natural/ecological and socio-economic processes at work now and in the future; and
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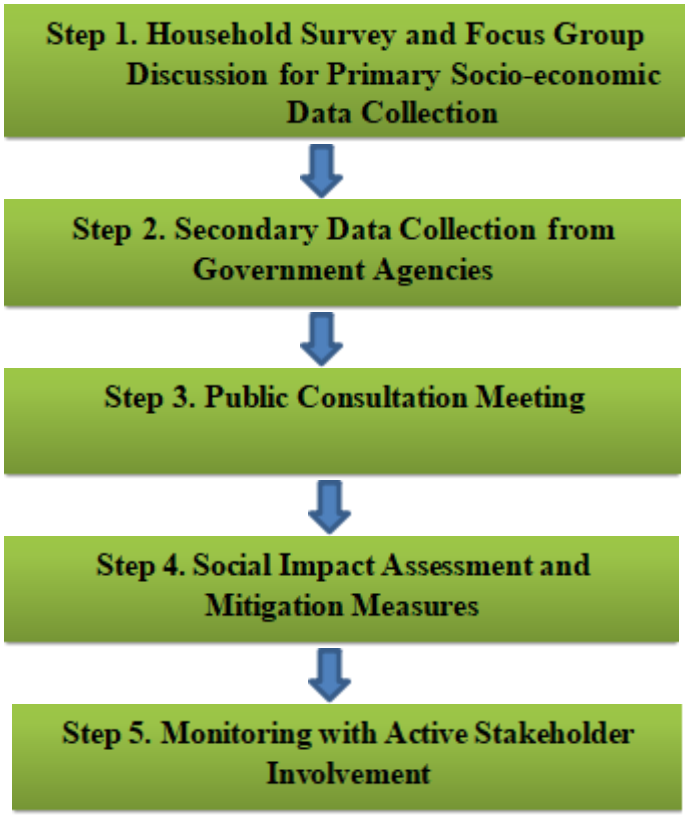
- Rectification: mitigation through the restoration of Environments affected by the action;
- Reduction: mitigation by taking maintenance steps during the course of the action; and Compensation: mitigation through the creation, enhancement or acquisition of similar Environments to those affected by the action.

6.1.2. Social Impact Assessment (SIA) Methodology

The first phase of the Social Impact Assessment (SIA) will provide a baseline description of the study area, specifically focusing on the communities living and working in close proximity to the proposed development. The potential impacts of the proposed development on the social environment will be identified and assessed in terms of an agreed assessment methodology in the EIA phase. Mitigation measures will be proposed to enhance the positive impacts and reduce the significance of the negative impacts. SIA study area was considered after the discussions with key informers project managers from Myanma Railways (MR) and China Railway Eryuan Engineering Group Co., Ltd. (CREEC). and the heads of Village General Administrative Offices of nearest villages that the railway pass or cross nearby. Google Map and census are also used for the determination of SIA study area during pilot survey. To assess the baseline socio-economic

conditions that may result from the development of the proposed project, the SIA team employed both quantitative and qualitative approaches as follow:Socioeconomic impact assessment for proposed project was conducted by the following procedures.



Main Steps in SIA Study

Step I: Household Survey and Focus Group Discussion

The collection of primary data will consist of focus group discussions and household surveys in the target study areas. Household sample survey will conduct to evaluate primary socio-economic conditions of the project area and to understand the mood, perceptions and extent of preparedness of the people towards the proposed project. The household survey will carry out to tap the baseline socio-economic conditions of project area and to assess project perceptions and attitudes of the local people. To get the accurate data, primary data collection will conduct by social specialist, social consultants, local authorities and local people.

(a) Survey Team

The team was formed with researchers from social, medical, and engineering sciences having research experiences in the field of social impact assessment and social management planning.

(b) Development of Survey Questionnaire

Socioeconomic aspects to be included in questionnaire will base on site visits and issues identified by interviews with local people and village heads during pilot survey. Items will formulate by the consultants and reviewed by social assessment team members as to clarity of item wordings and relevance to the socioeconomic domains measured. The survey questionnaire will designed to collect information as to the following household characteristics:

- household composition (age, gender, educational status, religion, ethnicity, language used and marital status);
- occupations;
- ownership of agricultural fields and livestock;
- energy sources and facilities;
- agricultural and other economic activities;
- daily movement patterns;
- income and expenditure patterns;
- access to and use of community services/facilities and natural resources;
- health and nutrition; and
- views/concerns/suggestions on the proposed project.

(c) Recruitment and Training

The enumerators will receive a training program prior to commencing with the fieldwork. The training program will include a briefing on the objectives of the survey, socioeconomic aspects to be measured, interview techniques as well as a detailed explanation of each question and its relevance to the survey objectives, how to pose the question and how to code the answer. Discussions will also held among participants about the socioeconomic conditions and initial questionnaire items will revise based on the discussion results. A set of guidelines will give to each enumerator for administration of survey questionnaire. In the field data collection activities, the enumerators will supervise by experienced supervisors with household survey.

(d) Data Collections

The project related data, factory layout plans and design parameter will be provided by China Railway Eryuan Engineering Group Co., Ltd. (CREEC). Primary data for public concerns, socio-economic and health profiles will be conducted by household survey.

(e) Data Analysis

In household survey data collection period, field supervisors will check and ensure the control of data quality. During field surveys, information obtained through household survey and interviews will corroborate through direct observation by the study team aiming at assessing social and cultural infrastructure existed in the project area, physical assets of people, and living conditions. Observations will back up by photographic records. Quantitative data will be coded and processed using SPSS statistical package. Qualitative data will be coded using standard methods.

6.1.3. Health Impact Assessment Methodology

There is no universally agreed formula for assessing public health significance, although assessments are mostly based on a subjective judgment about the magnitude of the potential health impacts (size of the affected population and scale of the positive or negative health impact); its likelihood of occurrence; and the degree of confidence in the impact actually occurring (based on scientific and other evidence of the health impact occurring in similar circumstances elsewhere). The following table shows a Health Impact Significance Rating Methodology of Green Tech EIA Team.

Table - Health Impact Significance Rating Methodology

	Likelihood of Occurrence of Health Impact			**Health Impact Rating**
	Low	Medium	High	
Magnitude of Health Impact	Unlikely to occur	Likely to occur sometimes	Likely to occur often	
None	No significance	No significance	No significance	0
Low	Very Low	Low	Medium	1
Medium	Low	Medium	High	2
High	Medium	High	Very High	3

When analyzing health impacts, it is important to consider the magnitude, likelihood and public health significance of the potential impacts. This analysis will involve expert judgment based on a consideration of the evidence gathered and its applicability to the local context and the specific project.

Distributional, health equity and inequality impacts will be analyzed by examining how particular sub-groups within a population, particularly vulnerable groups, are likely to be affected by the project. The scoping and community profiling steps are likely to have already identified potentially vulnerable groups through existing local information on these individuals/groups or through community surveys and meetings with key informants e.g. community leader, community health worker or local NGO.

Health equity/inequality impacts occur when the projects benefits and harms are unevenly distributed. This includes where the risk is equally distributed, such as air pollution, but the impact is disproportionate – affecting particularly children, older people and those with existing ill health. Analysis of health impacts will involve systematically determining the range of potential impacts, their relative importance and where, when and how likely they are to occur. The information for the HIA will be obtained from the primary data collection (household survey), literature review, community profile and Health Data from Pubic Health Department as well as knowledge and expertise of the HIA Consultant.

6.1.4. Risk Assessment

The following procedure should be used to reduce risks to a tolerable level (see figure 6.2):

a) Identify the likely users for the product or system, including vulnerable consumers and others affected by the product;
b) Identify the intended use, and assess the reasonably foreseeable misuse, of the product or system;
c) Identify each hazard (including reasonably foreseeable hazardous situations and events) arising in the stages and conditions for the use of the product or system, including installation, operation, maintenance, repair and destruction/disposal;
d) Estimate and evaluate the risk to the affected user group arising from the hazard(s) identified: consideration should be given to product s or systems used by different user groups; evaluation can also be made by comparison with similar products or systems;
e) If the risk is not tolerable, reduce the risk until it becomes tolerable.

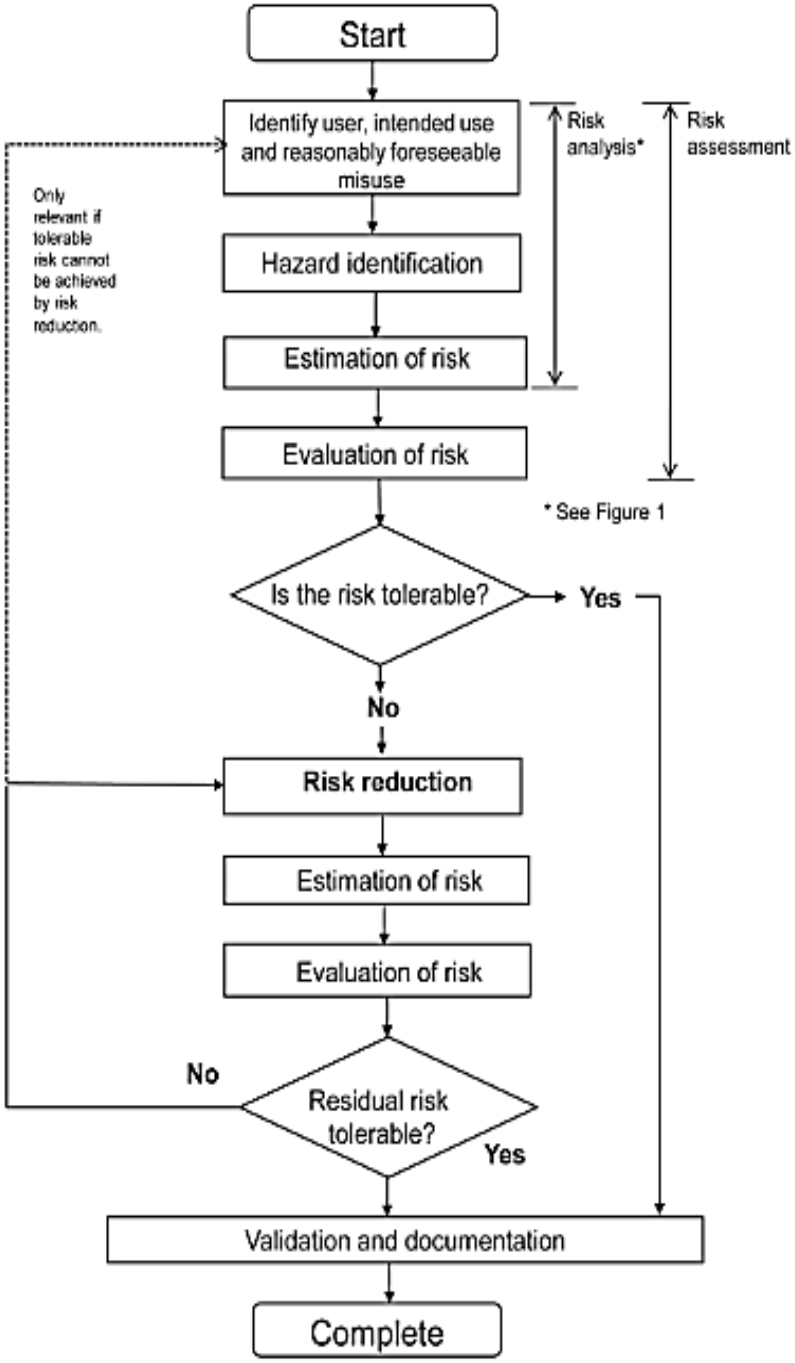
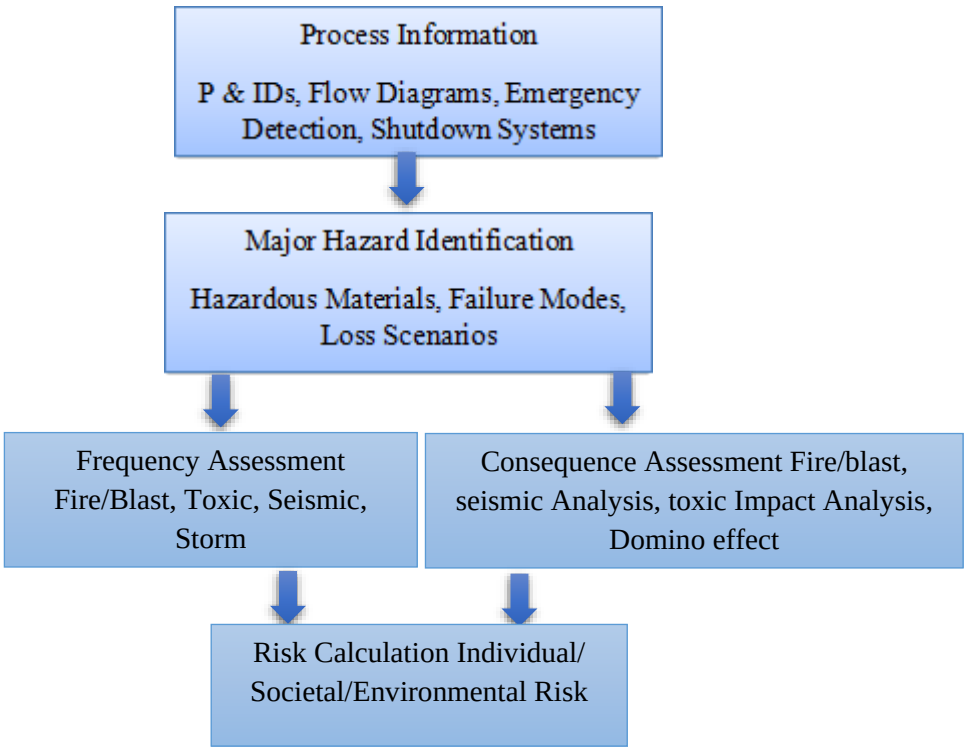


Figure 6.2 - Iterative Process of Risk Assessment and Risk Reduction

Risk Assessment Flow Diagram

Objectives

The following is the flow chart for risk assessment procedure.



Risk Calculation

Risk due to hazards at a storage tank terminal and its surroundings is composed of summation of all risks given no escalation (i.e. no domino effects) of undesired events and all risks given an escalation (i.e. domino effects) of undesired events:

$$Risk = \Sigma\ Risk\ |No\ Escalation + \Sigma Risk\ |Escalation$$

Table - Tolerability of Environmental Risk (Category Definitions) – Loss of Containment

Category	Definitions	
6	Catastrophic	- Major airborne release with serious off-site effects - Site shutdown - Serious contamination of ground water or water course with extensive loss of aquatic life
5	Major	- Serious toxic effect on beneficial or protected species - Widespread but not persistent damage to land - Evacuation of local populace - Temporary disabling and hospitalization - Serious toxic effect on beneficial or protected species - Widespread but not persistent damage to land - Significant fish kill over 5-mile range

4	Serve	- Hospital treatment required - Public warning and off-site emergency plan invoked - Hazardous substance releases into water course with 1/2-mile effect
3	Significant	- Severe and sustained nuisance, e.g. strong offensive odors or noise disturbance - Major breach of permitted emissions limits with possibility of prosecution - Numerous public complaint
2	Noticeable	- Noticeable nuisance off-site, e.g. discernible odors - Minor breach of permitted emission limits, but no environmental harm - One or two complaints from the public
1	Minor	- Nuisance on site only (no off-site effects) - No outside complaint.

UK HSE, "Safety and environmental standards for fuel storage sites", Process Safety Leadership Group, 2009. Environment Agency for England and Wales, "Integrated Pollution Prevention and Control (IPPC) Environmental Assessment and Appraisal of BAT", July 2003

Table - Tolerability Criteria of Environmental Risk

Category	Definition	Acceptable if frequency less than	Acceptable if reduced as low as is reasonably practical and frequency	Unacceptable if frequency above
6	Catastrophic	1.0E-06 per year	1.0E-04 to 1.0E-06 per year	1.0E-04 per year
5	Major	1.0E-06 per year	1.0E-04 to 1.0E-06 per year	1.0E-04 per year
4	Serve	1.0E-06 per year	1.0E-04 to 1.0E-06 per year	1.0E-02 per year
3	Significant	1.0E-04 per year	1.0E-04 to 1.0E-06 per year	1.0E-01 per year
2	Noticeable	1.0E-02 per year	□1.0E+01 to 1.0E-02 per year	□1.0E+01 per year
1	Minor	All shown as acceptable	-	-

Earthquake and Flood Risk Assessment Methodology

LIKELIHOOD (probability) How likely is the event to occur at some time in the *(Linear Scale time specific matrix)*	**CONSEQUENCES** What is the Severity of injuries /potential damages / financial impacts (if the risk event actually occurs)? *(Logarithmic Scale, property industry specific matrix)*				
	Insignificant	Minor	Moderate	Major	Catastrophic
	No Injuries First Aid No Envir Damage << $1,000 Damage	Some First Aid required Low Envir Damage << $10,000 Damage	External Medical Medium Envir Damage <<$100,000 Damage	Extensive injuries High Envir Damage <<$1,000,000 Damage	Death or Major Injuries Toxic Envir Damage >>$1,000,000 Damage
Almost certain - expected in normal circumstances (100%)	MODERATE RISK	HIGH RISK	HIGH RISK	CRITICAL RISK	CRITICAL RISK
Likely – probably occur in most circumstances (10%)	MODERATE RISK	MODERATE RISK	HIGH RISK	HIGH RISK	CRITICAL RISK
Possible – might occur at some time. (1%)	LOW RISK	MODERATE RISK	HIGH RISK	HIGH RISK	CRITICAL RISK
Unlikely – could occur at some future time (0.1%)	LOW RISK	MODERATE RISK	MODERATE RISK	HIGH RISK	HIGH RISK
Rare - Only in exceptional circumstances 0.01%)	LOW RISK	LOW RISK	MODERATE RISK	MODERATE RISK	HIGH RISK

Figure - 5x5 Risk Matrix
Source: kevinian.com

Fire Risk Assessment Methodology

Six-Step Method

This method entails a two-fold process:

1. Identifying the fire hazards (i.e. readily combustible or highly flammable materials, sources of heat, and unsatisfactory structural features).

2. Assessing the fire risk (i.e. the likelihood that a fire will occur and the consequences of such a fire on the people in the workplace).

The overall process may be carried out in six steps:

Step 1: Identify hazards,
Step 2: Identify people at risk,
Step 3: Remove/reduce hazards,
Step 4: Assign the risk category,
Step 5: Decide if existing fire safety arrangements are OK or need improving,
Step 6: Record findings.

Step 1: Identification of Hazards

Identifying hazards entails noting readily combustible materials or highly flammable substances. These would include such things as paints and thinners, flammable solvents, solvent-based adhesives, flammable gases, some plastic foams, large areas of bare hardboard, highly flammable and/or reactive chemicals etc.

It also entails noting sources of heat such as flames or sparks from processes, sources of frictional heat, ovens, kilns, incinerators, oil or gas fired equipment or heaters, matches and lighters, ducts or flues, light bulbs close to flammable materials, electrical wander leads, any electrical equipment, faulty wiring, portable heaters, etc.

Structural features that would constitute hazards by promoting the rapid spread of fire should therefore be identified. These would include such things as ducts and flues, unstopped holes that have been cut into fire resisting walls for the provision of services such as cables and pipe work, large areas of hardboard, chipboard, or blockboard, un-compartmented roof spaces. Excessively long escape routes and dead-end conditions that would prejudice the means of escape should also be identified.

Step 2: Identification of People at Risk

In identifying people who would be especially at risk in a fire, consideration should be given to any who are asleep, any who are present in large numbers, any who are unfamiliar with the layout of the premises and/or the exit routes, those who may be exposed to a particular or specific fire risk, those who have impairments such as sight, hearing, or mobility and young people or children. Also taken into consideration should be any people who would be unable to react quickly enough or are unaware of the danger of fire because they are in remote areas, because they have learning difficulties, or because they are outside contractors who are unaware of the fire risks.

Step 3: Removal/Reduction of Hazards

The removal or reduction of hazards entailed in this stage of the risk assessment can have enormous benefits insofar as, at the end of the process, it will have produced a much safer environment.

For each of the hazards that have been identified in step 1, the question should be asked, "could it be removed, reduced, replaced, separated, protected, repaired, or cleaned?"

For example, the removal of excessive amounts of combustibles, the reduction in the areas of combustible wall linings, replacement of tungsten filament bulbs with fluorescent light fittings and solvent based adhesives being replaced with water-based ones, separating sources of heat from combustibles, protecting electrical equipment with thermostats, repairing damaged electrical flexes and damaged furniture, cleaning dirty flues and ducts.

At this stage it should be decided whether any of these removals or reductions are to be undertaken immediately, in the medium term, or in the long term.

Step 4: Assignment of Risk Category

On completion of step three, depending upon what hazards still remain it should be possible to assign a risk category to the workplace or, more likely, to individual parts of it.

The risk categories could be 'Low', 'Normal' and 'High': -

Low: There is hardly any risk from fire, few combustibles materials, no highly flammable substances, and virtually no sources of heat.

Normal: There are sufficient quantities of combustible materials and sources of heat to be of greater than low fire risk but that a fire would be likely to remain confined, or to spread but slowly.

High: There is a serious risk to life from fire, or there are substantial quantities of combustible materials, or there are any highly flammable substances, or there exists the likelihood of the rapid spread of fire, heat or smoke.

Step 5: Adequacy or Improvement of Fire Precautions

In this step, it is necessary to decide whether the existing fire safety measures are adequate or are in need of improvement. Possible improvements could include such steps as:

- Reduction of evacuation times/escape route lengths,
- Protection of escape routes,
- Provision of additional escape routes,
- Installation of a fire alarm system or more fire alarm call points,
- Provision of more fire signs,
- Installation of fire detection systems,
- Installation of a sprinkler system,

- Installation of an emergency lighting system,
- Institution of better programmes of fire safety training,
- Provision of, or increasing the number of fire extinguishers
- Provision of regular training and practice of fire and evacuation drills.

Step 6: Recording Findings

This simply entails recording the findings of the fire risk assessment, and should include the significant hazards found to be present, the details of any staff who are especially at risk, and the date on which the assessment was made.

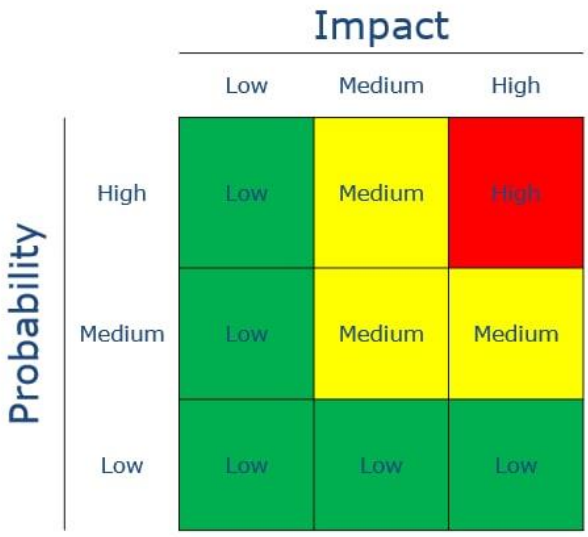


Figure: Classification of Fire Risk Level

Based on the fire incidents from 1983-2007, the States and Divisions have been categorized into the probability of High, Medium and Low level. Following criteria has been used:

High Probability: More than 100 average annual fire cases

Medium Probability: Between 100 and 50 average annual fire cases

Low Probability: Less than 50 average annual fire cases

Property loss level	Criteria
High Property Loss	Less than 100 Million Kyats
Medium Property loss	Between 100 to 200 Million Kyats
Low Property loss	More than 200 Million Kyats

Potential Risk and their Sources

Category	Potential Risk	Source
Risk in Culvert (Construction Phase)	Structural Collapse	- Structural overload of culvert - deterioration of culvert leading to loss strength
	Slope instability	- water leakage of the culvert leading to saturation of fill or foundation material - headwall has been subjected to erosion and collapses taking with it a portion of the road pavement
	Erosion by overtopping flows	- flow over the road
	Cross catchment flooding	- blockage or insufficient hydraulic capacity of the culvert
Risk in Bridge	Bridge structure risk by human factor	- due to terrorist such as explosion
Occupational and Community Health and Safety Risk	Slips and trips	- Spill and oil in the workplace - equipment used in site
	Electricity	- direct or indirect touch of electric wire
	Airborne fibres and toxins	- The erosion of the already installed, improperly taken down or stored asbestos as well as from the products that contain it.
	Asbestos	- demolition process
	Unintended collapse	- demolition process
	Material handling	- use of excavators and dump trucks
	Hand and vibration syndrome	-piling activity
	Noise	- piling activity
	Moving objects	- transport of material
	Working from height	- fall from height and from the installation of pier and beam
Disaster Risk	Earthquake	- seismic waves and fault zone near the working site
	Earthquake induced liquefaction risk	- high excess pore-water pressure generated by and accumulated during strong earthquake ground shaking or other rapid loading

	Flood risk	- high flow or overflow of water from a river or similar source of water occurring over a period of time - heavy rain spell - climate change - blocking of river channels by landslides
	Fire risk	- fire incidents from temporary facilities - flammable materials used on site - vehicle collision due to derailment -overheating due to high speed - electrocution - overheating of roof-mounted compressor heating and air conditioner units - burning locomotives - flammable materials carried on train

6.2. Anticipated Environmental Impacts and Mitigation Measures

An impact can be defined as any change in the physical-chemical, biological, cultural and/or socio-economic environmental system that can be attributed to human activities. Environmental impacts for the proposed railway facilities will include in all different phases of the project. The process flow chart of the proposed project is shown in the following figure.

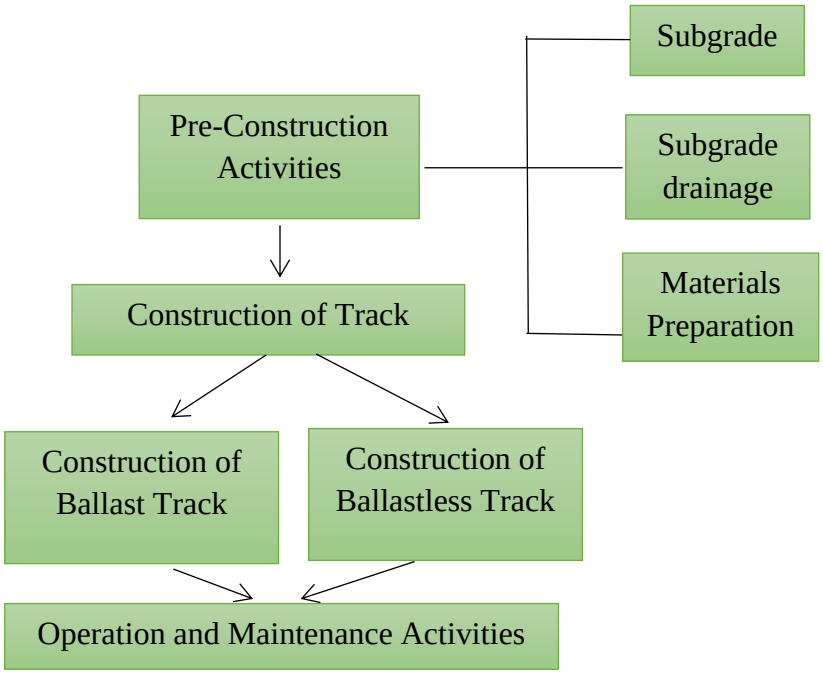


Figure – Process Flow Chart of the Proposed Project

To cover the environmental impacts in the entire life of the project, it is necessary to conduct impact assessment for four major phases as follow:

(a) Phase I: Pre-construction Phase (during the pre-construction period),
(b) Phase II: Construction Phase (during the construction period),
(c) Phase III: Operation Phase (during the operation period), and
(d) Phase IV: Decommissioning Phase (after the operation period).

The impact assessment will identify all of the potential positive and negative impacts (both biophysical and social) associated with the proposed project.

6.2.1. Anticipated Impacts and Mitigation Measures during Pre-construction Phase

Pre-construction activities will involve site clearing and ground leveling. The consideration of the anticipated impacts during pre-construction phase includes the site clearing activities for the stations, the construction site area for the railway alignment and for the worker camps. It will include some tree cutting and minor earth working activities. Some of the impacts related to the above pre-construction activities will be as following.

6.2.1.1. Anticipated Impacts and Mitigation Measures on Air Environment during Pre-construction Phase

The major impacts on air quality during the pre-construction phase will be fugitive dust generation, vehicular emissions and increased in noise level due to the site clearing and sand filling activities.

(a) Fugitive Dust Generation (Particulate Matter Emission)

During pre-construction phase, the main source of air pollution will be dust generation (PM) due to the movement of dozer and trucks for site clearing activities. Short-term impacts will be experienced by the workers, pedestrians passing near the project site and local residents nearby.

Significant of Impacts on Air Environment due to Fugitive Dust Generation before mitigation measures

The nature of impact on air quality during pre-construction phase will be as follow:

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Fugitive dust generation	Site clearing and ground leveling	Negative (-)	Limited (-2)	Short term (-2)	Very Low (-1)	Very Often (-4)	Highly Probable (-4)	Low (-40)

Consideration of Mitigation Requirement for Air Environment

The intensity of mitigation required for air environment according to the consideration of impact evaluation and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation required considered by EIA team	Intensity of Mitigation Required	Responsibility
1.	Fugitive Dust Generation	Low (-40)	No	Yes	Minor	Pre-construction service provider(s)

Mitigation Measures for Dust Generation

Due to the minor mitigation requirement, dust will be countered by sprinkling of water during pre-construction phase. It is also the most cost-effective dust suppressant. Water will not use that may have pressure on water available of local people especially for seasonal streams or natural springs. Water will be sprayed by using handheld spray. Before leaving the construction site, wheels will be cleaned and goods carried should be covered. Vehicles delivering materials will be covered to reduce spills and dust blowing off the load.

Significant of Impacts on Air Environment due to Fugitive Dust Generation after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Fugitive dust generation	Site clearing and ground leveling	Negative (-)	Limited (-2)	Short term (-2)	Very Low (-1)	Very Often (-4)	Seldom (-2)	Low (-30)

Residual impact

After mitigation measures, there will be no residual impact for fugitive dust generation.

(b) Vehicular Emissions

Site clearing and earth working vehicle and delivery vehicles used in site produced gaseous emissions such as CO_2, CO, NO_x and SO_2 during the operation of vehicles and machineries during the pre-construction phase including both on-site and the public.

Significant of Impacts on Air Environment due to Vehicular Emissions before mitigation measures

The nature of impact on air quality during pre-construction phase will be as follow:

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Vehicular emission	Site clearing and ground leveling	Negative (-)	Local (-3)	Short term (-2)	Very Low (-1)	Very Often (-4)	Highly Probable (-4)	Low (-48)

Consideration of Mitigation Requirement for Vehicular Emissions

The intensity of mitigation required for air environment according to the consideration of impact evaluation and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation required considered by EIA team	Intensity of Mitigation Required	Responsibility
1.	Vehicular Emission	Low (-48)	No	Yes	Minor	Pre-construction service provider(s)

Mitigation Measures for Vehicular Emission

Due to the minor mitigation requirement on vehicular emission, there will require a plan to reduce in loading and unloading time and plan to reduce in idle time during working hours. Vehicles used during pre-construction phase will avoid local traffic time and will also reduce vehicular emission. Moreover, pre-construction services provider(s) will have to use good engines conditions for every machinery used and low sulphur content fuel oil to reduce gaseous emission. Generator with good engine conditions should be used.

Significant of Impacts on Air Environment due to Vehicular Emissions after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Vehicular emission	Site clearing and ground leveling	Negative (-)	Local (-3)	Short term (-2)	Very Low (-1)	Very Often (-4)	Probable (-3)	Low (-42)

Residual impact

After mitigation measures, there will be no residual impact for vehicular emission.

(c) Increased in Noise Level

Site clearing and earth working vehicle (5 dozer) and delivery vehicles (8 trucks) traveling to and from the site produced noise which will increase existing noise level in pre-construction phase. All of the calculation of predicted noise level during pre-construction phase will be based on Patrick Breysse, and Peter S.J. Lees., School of Public Health, Johns Hopkins University, Bloomberg, 2006. The required data for calculation of the noise levels will be used typical construction equipment prepared by "Handbook of Noise Control" as follow:

Typical Construction Equipment Noise Emission Levels

Equipment Type	Noise Level (dBA at 50 Feet)
Dozer	87
Truck (Medium and Heavy)	84

Source: Harris, C.M. "Handbook of Noise Control," McGraw Hill, New York, 1979

Since the number of vehicles used in pre-construction phase is very few, the impacts will not be significant.

Significant of Impacts on Air Environment due to Noise before mitigation measures

The nature of impact on air quality during pre-construction phase will not be significance due to minor earth working activities and pre-construction period as follow:

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Noise	Noise from dozer and trucks	Negative (-)	Limited (-2)	Short term (-2)	Very Low (-1)	Very Often (-4)	Highly Probable (-4)	Low (-40)

Consideration of Mitigation Requirement for Air Environment

The intensity of mitigation required for air environment according to the consideration of impact evaluation and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation required considered by EIA team	Intensity of Mitigation Required	Responsibility
1.	Noise	Low (-40)	No	Yes	Minor	Pre-construction service provider(s)

Mitigation Measures for Noise

According to the requirement of minor mitigation measures for noise during pre-construction phase, the following mitigation measures will do:

- Limit working at night and avoid the operation of noisy equipment and machineries at night if it is necessary to make operation at night;
- Use vehicle with good engines;
- Use phase wise construction (not to running noisy equipment at the same time); and
- Regular maintenance of machineries.

Significant of Impacts on Air Environment due to Noise after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Noise	Noise from dozer and trucks	Negative (-)	Limited (-2)	Short term (-2)	Very Low (-1)	Very Often (-4)	Probable (-3)	Low (-32)

Residual impact

After mitigation measures, there will be no residual impact for noise.

6.2.1.2. Anticipated Impacts and Mitigation Measures on Surface Water Environment during Pre-construction Phase

During pre-construction phase, impacts on surface water environment will be described as follow.

(a) Liquid Wastes

The temporary water pollution in nearest water sources due to earth working activities (soil erosion and sedimentation). The mobilization and transport of soil particles may, in turn, result in

sedimentation of surface drainage networks, which may result in impacts to the water quality. In addition, improper handling of fuel oil and lubricants may constitute a risk for pollution of surface water.

Significant of Surface Water Pollution due to Liquid Wastes before mitigation measures

Impact on nearby surface water bodies and natural water spring will be low probability and not significant due to the volume of earth work in pre-construction phase as follow:

Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Liquid wastes	Site clearing and earth working activities	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Intermittent (-2)	Highly probable (-4)	Low (-36)

Consideration of Mitigation Requirement for Surface Water Environment

The intensity of mitigation measures for surface water environment according to the consideration of impact evaluation and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern during Public Consultation	Mitigation Requirement by Impact Evaluation	Intensity of Mitigation	Responsibility
1.	Increase in turbidity, oil and grease in nearest surface water bodies	Low (-36)	No	Yes	Minor	Pre-construction service provider(s)

Mitigation Measures for Liquid Wastes

Although impact rating is very low, pre-construction service provider(s) will have to do the following mitigation measures to protect the surface water quality during the pre-construction phases of the proposed project. All stacking and loading areas will be provided with proper drains to prevent runoff from the site to enter any water body. The temporary retention ponds and other waste water facilities with suitable drainage system around the dumping sites should be used. The oil and grease and other chemicals should be handled as per MSDS.

Significant of Surface Water Pollution due to Liquid Wastes after mitigation measures

Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Liquid wastes	Site clearing and earth working activities	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Intermittent (-2)	Seldom (-2)	Very Low (-23)

Residual Impact

After mitigation measure, there will be no residual impact for liquid waste.

(b) Solid Wastes

Solid wastes of unsuitable soil materials from site clearing activities and domestic solid wastes from pre-construction workers.

Significant of Surface Water Pollution due to Solid Wastes before mitigation measures

Impact on nearby surface water bodies and natural water spring will be low probability and not significant due to the volume of earth work in pre-construction phase as follow:

Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Solid wastes	Site clearing and earth working activities	Negative (-)	Limited (-2)	Short term (-2)	Low to medium (-3)	Rare (-1)	Highly probable (-4)	Low (-35)

Consideration of Mitigation Requirement due to Solid Wastes

The intensity of mitigation measures for surface water environment according to the consideration of impact evaluation and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern during Public Consultation	Mitigation Requirement by Impact Evaluation	Intensity of Mitigation	Responsibility
1.	Increase in turbidity, oil and grease in nearest water spring	Low (-35)	No	Yes	Minor	Pre-construction service provider(s)

Mitigation Measures for Solid Wastes

The following prevention measures will do to reduce surface water pollution during pre-construction phase.

(a) Limit unnecessary earthworks;
(b) All stacking and loading areas will be provided with proper drains to prevent run off from the site to enter any water body;
(c) Prevent over-excavation;
(d) Working in a small area at a point of time (phase wise construction);
(e) Reduce, reuse, and recycle of domestic wastes; and
(f) Vegetation of bare areas after the pre-construction state.

Significant of Surface Water Pollution due to Solid Wastes after mitigation measures

Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Solid wastes	Site clearing and earth working activities	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Rare (-1)	Probable (-3)	Very Low (-24)

Residual Impact

After mitigation measure, there will be no residual impact for solid waste.

6.2.1.3. Anticipated Impacts and Mitigation Measures on Soil Environment during Pre-construction Phase

Impacts on soil and ground water environment during pre-construction phase will include the followings:

Impacts of Soil Quality

A small amount of domestic wastes will be produced from pre-construction workers. Moreover, some biomass- unsuitable soil materials-were generated from site clearing and tree cutting (bushes and small trees) activities during pre-construction phase. Some earth soil will also be produced from earth cutting activities. All of these solid wastes will have more or less impact on soil quality especially for agricultural land farmland.

Significant of Impacts on Soil Quality before mitigation measures

Domestic wastes from pre-construction workers will be large quantity along the railway. Amount of scrub produced will also be large quantity along the railway line especially in deep forest area because there will be large number of trees to fell down. Earth and soil materials will also be produced from earth cutting activity, So, impacts on soil and ground water environment during pre-construction phase will be high as shown in the following table.

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Soil contamination for railway construction	Domestic wastes and unusable materials in soil	Negative (-)	Limited (-2)	Short term (-2)	Medium (-4)	Very often (-4)	Probable (-3)	Low to moderate (-56)
Soil contamination for station construction	Bio-mass waste and construction wastes	Negative (-)	Site (-1)	Short term (-2)	Low to moderate (-3)	Very often (-4)	Probable (-3)	Low (-42)

Consideration of Mitigation Requirement for Soil Environment during Pre-construction Phase

The intensity requirement of mitigation measures for soil and ground water environment according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern during Public Consultation	Mitigation Requirement by Impact Evaluation	Mitigation Scale	Responsibility
1.	Soil contamination for railway construction	Low to moderate (-56)	No	Yes	Minor	Pre-construction service provider(s)
2.	Soil contamination for station construction	Low (-42)	No	Yes	Minor	Pre-construction service provider(s)

Mitigation Measures for Impact on Soil Quality

The following measures are to be practiced to mitigate impact on soil and ground water quality:

1. Decrease the amount and/or toxicity of waste that must be disposed of by producing less waste.
2. Increase recycling of materials such as paper, glass, and plastic, thus recovering these materials rather than discarding them.

3. Provide safer disposal capacity by improving the design and management of incinerators and landfills.

Accordingly, pre-construction services provider(s) will follow CDC rules and regulations for solid waste management during the pre-construction phase. Moreover, MR will take special care on handling of diesel and lubricants to avoid leakage.

Significant of Impacts on Soil Quality after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Soil contamination for railway construction	Domestic wastes and unusable materials in soil	Negative (-)	Limited (-2)	Short term (-2)	Low to medium (-3)	Intermittent (-2)	Seldom (-2)	Low (-28)
Soil contamination for station construction	Bio-mass waste and construction wastes	Negative (-)	Site (-1)	Short term (-2)	Low (-2)	Intermittent (-2)	Seldom (-2)	Very low (-20)

Residual Impact

After mitigation measure, there will be no residual impact for soil environment.

6.2.1.4. Anticipated Impacts and Mitigation Measures on Biodiversity Environment during Pre-construction Phase

Anticipated impacts on biodiversity environment during pre-construction phase will be as follows:

(a) Impacts on Flora Diversity

There will have too much tree cutting for the railway project and for the construction of stations, and so there will have high impact on flora diversity. By clearing the construction site and greening both sides of the line and the station, the impact on the ecological environment will be greatly reduced. Most of the subgrade areas are located in the areas of secondary vegetation types and artificial vegetation types (including farmland vegetation, etc.), thus, the loss of vegetation and plant resources caused by the site clearance of railway construction will not have a significant adverse impact on the integrity of local ecosystem and the diversity of plant species, and will not lead to the disappearance of any plant species.

Impact index value and categories of flora in the Mandalay-Muse Railway New Project

No.	Impacts	Magnitude	Duration	Extend (area)	Probability	Total	Category
	Flora						
1	Loss of trees and other plant species	3	5	2	3	30	Moderate significant (C)

Consideration of Mitigation Requirement for Flora Diversity

The intensity requirement of mitigation measures for biodiversity environment according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern during Public Consultation	Mitigation Requirement by Impact Evaluation	Mitigation Scale	Responsibility
1.	Impact on flora diversity from alignment construction	Moderate (-30)	Yes	Yes	Moderate	Pre-construction service provider(s)
2.	Impact on flora diversity from station construction	Moderate (-30)	Yes	Yes	Moderate	Pre-construction service provider(s)

Mitigation Measures for Impacts on Flora Diversity

Clearing of vegetation should be kept to a minimum, keeping the width and length of the earth works to a minimum and the floodplain / wetlands habitats identified should be retained within the development footprint in its current state. According to the consideration of intensity of mitigation measures (major scale), it is necessary to avoid tree cutting of road side plants and fence plants and re-planting the trees at twice of cutting and re-planting at other place for IUCN red list trees. So, MR will do or will force pre-construction service provider(s) to avoid tree cutting as much as possible at project site and no tree cutting beside the railway road construction. MR also limit operation of noisy machineries and working at night during pre-construction phase.

(b) Impacts on Fauna Diversity

Increase in noise during pre-construction phase may affect the feeding, breeding and movement of wildlife in near construction site.

Mitigation Measures for Impacts on Fauna Diversity

It is necessary to avoid working at night for fauna species and cutting the fence plants. Sound proof measurement shall be constructed surrounding the construction site as needed. Borrow pit will be away from fauna diversity abundance area.

Impacts on Human Environment during Pre-construction Phase

The job opportunities and used machinery and equipment are shown in the following table.

Duration	Job Opportunity for pre-construction phase	Machinery and Equipment	Quantity	Total site clearing area (acres)
6 months	3000	Dozer	5	For alignment including transmission line – width (11m), length (188491 m) Total site clearing – approximately 512 acres For stations – approximately 82acres
		Trucks	8	

6.2.1.5. Anticipated Impacts and Mitigation Measures on Socio-economic during Pre-construction Phase

Impacts on socio-economic during pre-construction phase will be both positive and negative as follow:

(a) Positive Socio-economic Impacts

The positive socio-economic impact during pre-construction will be job creation. The proposed railway project will provide temporary employment opportunities at least 3000 workers for local people during pre-construction period.

Significant of Impacts on Socio-economic Environment during Pre-construction Phase

Job Creation without Enhancement Measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Potential to Increase in household income	Jobs opportunities in pre-construction site	Positive (+)	Limited (+2)	Short term (+2)	Low (+2)	Regular (+3)	Probable (+3)	Low (+36)

Consideration of Mitigation Requirement for Job Opportunities during pre-construction phase

The intensity of mitigation requirement for job opportunities according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1	Job Opportunities	Low (+36)	Yes	Yes	Moderate	Pre-construction service providers

Enhancement Measures for Job Creation

Although this kind of positive impact will not benefit to local people in nearest villages, MR will make agreement with pre-construction contractor and sub-contractor to use local labor force as part of tender requirement.

Impact Significance of Job Creation after Enhancement Measures

The impact will rise into very low to low after enhancement actions as follow:

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Reduce jobless people	Job creation	Positive (+)	Local (+3)	Short term (+2)	Low (+2)	Regular (+3)	Highly Probable (+4)	Low (+49)

(b) Negative Socio-economic Impacts

The negative socio-economic impacts for the proposed project are as follows:

(i) Visual Impact

The negative socio-economic impacts during pre-construction phase will be visual impact. Visual impacts during pre-construction phase are mainly from the visual pollutants like construction materials and waste from site clearance and also from the tree cutting for the station construction and construction site for railway alignment.

Significant of Impacts on Visual Impact before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Visual impact	Construction material and waste from site clearance	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Intermittent (-2)	Probable (-3)	Low (-30)

Consideration of Mitigation Requirement for Visual Impact

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Visual impact	Low (-30)	No	Yes	Minor	Construction Service Provider(s)

Mitigation Measures for Visual Impacts

The efficient and timely removal of all demolition and construction wastes as per requirement. Proper disposal of soil materials and other wastes. Roads providing access to the site should be maintained free of dust and mud.

Significant of Impacts on Visual Impact after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Visual impact	Construction material and waste from site clearance	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Intermittent (-2)	Seldom (-2)	Very low (-24)

Residual Impact

After mitigation measure, there will be no residual impact for visual impact.

Mitigation Measures for Negative Socio-economic Impact

The efficient and timely removal of all demolition and construction wastes as per requirement.

(ii) Land Acquisition and Involuntary Resettlement

The proposed alignment is very extensive and has sections of very large curve radii to enable high speed train operation. Due to these factors, relocation of a large number of residences cannot be avoided. The construction could result due to influx of migrant workers and associated induced development. The influx may cause a rise in the consumption of consumer goods in the local area, which will tend to boost up the local economy. Resettlement or/and relocation of buildings and other assets, involving some changes in livelihood of PAPs. Loss of income opportunity of some PAPs due to resettlement and shop owners, vendors or farmers to be affected by construction works.

Table – Land Use along the Main Line

Land use item		Land use quality (m^2)			Land use specifications (m^2/km)		
		New land use	Temporary land use	Sub-total	New land use	Temporary land use	Sub-total
Total for main line from Muse to Mandalay South	Section subgrade	9262532	2793158	12055690	68025	20513	88538
	Including land use of other disciplines	25951997	11368515	37320512	63304	27731	91035
Total for Muse-Mandalay South	Section subgrade	9425986	2893158	12319144	67168	20616	87784
	Including land use of other disciplines	26141696	11471725	37613421	63124	27701	90825

Source: Feasibility study from CREEC

Significant of Impacts on Land Acquisition and Involuntary Resettlement before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Land acquisition and involuntary resettlement	Temporary Land use	Negative (-)	Local (-3)	Permeant (-5)	Low to medium (-3)	Regular (-3)	Highly probable (-4)	Low to Moderate (-77)

Consideration of Mitigation Requirement for Land Acquisition and Involuntary Resettlement

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Land acquisition and involuntary resettlement	Low to Moderate (-77)	Yes	Yes	Moderate	Pre-construction Service Provider(s)

Mitigation Measure for Land Acquisition and Resettlement

The proposed project has provided compensation to the affected persons irrespective of their legally tenable ownership rights for the affected land. As local labours will be hired, initial conflict is not envisaged. To the extent possible, local labour shall be utilized for the construction purpose and all the activities related to construction worker shall be confined to the project site only to minimize conflict. Avoid agricultural land, historical places, archaeological places, forest area and ecologically sensitive area as much as possible. The impact shall be avoided and/or mitigated as much as possible. The acquisition of land and private property shall be carried out in accordance with the RAP. Compensation for affected structures and standing crops and assistance of livelihood restoration and assistance package will be planned in RAP. If there will have indigenous local people, conduct indigenous people's plan (IPP) for the indigenous people.

Significant of Impacts on Land Acquisition and Involuntary Resettlement after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Land acquisition and involuntary resettlement	Temporary Land Use	Negative (-)	Local (-3)	Permeant (-5)	Low to medium (-3)	Intermittent (-3)	Probable (-3)	Low (-66)

Residual Impact

After mitigation measures, there will be residual impact on land acquisition and involuntary resettlement.

6.2.2. Anticipated Impacts and Mitigation Measures during Construction Phase

Construction of proposed project will include (1) preparation of construction materials (2) constructions of railway (3) construction of stations, and (4) constructions of internal road and drainage system. The construction phase is expected to be about five years. The major activities during construction phase will include:

(a) Vehicular movement,
(b) Loading and unloading construction materials,
(c) On site storage of construction materials,
(d) Connection of power supply system,
(e) Maintenance of construction machinery, and
(f) Disposal of solid wastes from both construction site and workers etc.

Some of the impacts related to construction of the proposed project are as follow:

(a) Impacts on Air Environment;
(b) Impacts on Surface Water Environment;
(c) Impacts on Soil and Ground Water Environment;
(d) Impacts on Biodiversity Environment; and
(e) Impacts on Human Environment.

Construction related impacts (noise, fugitive dust emission and traffic) will impact on people in nearest residents and workers in workplace.

6.2.2.1. Anticipated Impacts and Mitigation Measures on Air Environment during Construction Phase

Impacts on air quality during construction phase will be as follow:

(a) Fugitive dust generation from transportation of construction materials and construction activities,
(b) Vehicular emissions related to the transportation of personnel and construction materials, and
(c) Noise from construction activities.

(a) Fugitive Dust Generation

The construction phase will mainly result in nuisance impacts in the form of dust. Large uncertainties are associated with emission estimates for these types of activities, resulting mostly in fugitive emissions. It will include emissions from on-site heavy-duty off-road vehicles, other light-duty vehicles and dust emissions as a result of the construction activities. Particulate matter (PMs) were released from transportation of construction materials and construction activities such as during excavation, movement of earth materials, unloading and mixing of construction materials, contact of construction machinery with bare soil, traffic movement on unpaved roads and the public roads, transport of demolition waste, and exposure of bare soil and soil piles to wind. Although construction is not a long time, construction activities will affect particularly in dry season.

Evaluation of Dust Generation

Dust Generation during construction phase will be mainly resulted in nuisance impacts. Dust emissions as a result of the construction activities will include emissions from on-site heavy-duty off-road vehicles, other light-duty vehicles. Particulate matter (PMs) were released from transportation of construction materials and construction activities such as during excavation, movement of earth materials, unloading and mixing of construction materials, contact of construction machinery with bare soil, traffic movement on unpaved roads, transport of demolition waste, and exposure of bare soil and soil piles to wind. Short-term impacts will be experienced by the workers, pedestrians passing near the project site and local residents nearby.

The impact of fugitive dust sources on air quality depends upon the quantity as well as the drift potential of the dust particles emitted into the atmosphere. Large dust particles (i.e. over 100 mm in diameter) will settle close to the source and particles that are between 30 and 100 mm in diameter would likely undergo impeded settling.

The main dust impacts are likely to arise from particles with less than 30 mm in diameter, which have a greater potential to disperse over greater distance. Dust emissions vary substantially from day to day depending on the level of activity, the specific operations, and the prevailing weather.

According to USEPA AP-42, construction dust particles are grouped into various particle sizes. Their size ranges are 1.25 mm, 3.75 mm, 7.5 mm, 12.5 mm, 22.5 mm, and the percentage

of particles in each class was estimated to be 7%, 20%, 20%, 18% and 35%, respectively. Based on field measurements of suspended dust emissions from heavy construction projects like building and road construction, an approximate emission factor for construction operations is: 1.2 tons per acre of construction per month of activity. This value applies to construction operations with: (1) medium activity level, (2) moderate silt content (30%), and (3) semiarid climate (50 % of precipitation-evaporation (PE) index.

Normally, the particles (greater than 10 microns) will disperse following wind direction and will fall off in the distance of 6-9 meters from construction site. Moreover, for particulate matter smaller than 10 microns, the dispersion distance could be greater than a radius of (200-700) m from project site and the sensitive receptors are considered to be those within a 2 km radius of proposed site. The following tables shows the estimated distance travelled between the relationship of wind speed and dust size particles.

Table 1: 10-micron particle

Wind Speed (mph)	Distance Traveled (miles)
3.1	.55
6.2	1.1
12.4	2.3
24.8	4.6
37.3	6.9
49.7	9.2

Table 2: 5-micron particle

Wind Speed (mph)	Distance Traveled (miles)
3.1	2.2
6.2	4.5
12.4	9
24.8	18
37.3	27
49.7	36.1

Emission Rate (Q)

The dust emission rate will be estimated according to equation (1):

$$Q(mg/s) = \frac{0.04\,(tons/acre/day) \times area \times 10^6 (mg/kg)}{24 \times 60 \times 60 (s/d)}$$ Equation (1)

$$Q(mg/s) = \frac{40\,(kg/acre/day) \times area \times 10^6 (mg/kg)}{24 \times 60 \times 60 (s/d)}$$ Equation (1)

The land use for main line of Muse-Mandalay Railway will be 37, 320,512 m^2 (9222 acres) during project life. By calculation of dust emission with above equation, it will be resulted Q = 4269444 mg/s

Dust Concentration (C)

The dust concentration is estimated by using equation (2):

$$C(mg/m^3) = \frac{Q(mg/s)}{d(m)*W(m/s)*M(m)}$$ Equation (2)

Where,

C = Dust Concentration (mg/m3)

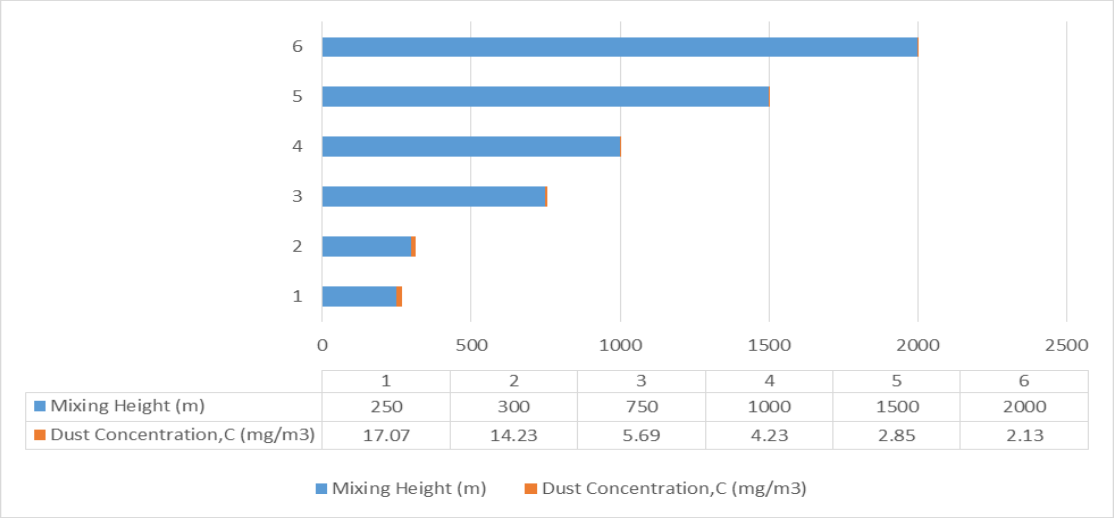
Q = Emissions at Source (mg/s)

d = Width (the smallest dimension is used for worst case scenario) (m) = 500 m

W = Average maximum wind speed (m/s)

M = Mixing Height (m)

According to the wind speed condition, wind speed during a year is about 1m / s ~ 3m / s in Myanmar. Thus, assume that average maximum wind speed will be 2 m/s in the calculation. However, the mixing height data is not available in the Meteorology Department. Therefore, the measurement of mixing height data is adopted from the atmospheric simulation models (EU) in which the default mixing height vary from very unstable stage to extremely stages in total six stages with default values of mixing height values (2000m, 1500m, 1000m, 750m, 300m, 250m).



	1	2	3	4	5	6
Mixing Height (m)	250	300	750	1000	1500	2000
Dust Concentration,C (mg/m3)	17.07	14.23	5.69	4.23	2.85	2.13

The above chart shows the estimated results of dust concentration at source varying mixing heights. In construction time, the whole alignment would be carried out part by part with different sub-contractors. Thus, the same whole amount of dust emission could not generate at all sections.

Significant of Impacts on Air Environment during Construction Phase before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Dust generation	Dust from earth working activities	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Very Often (-4)	Highly Probable (-4)	Low (-48)

Consideration of Mitigation Requirement for Air Environment during Construction Phase

The intensity of mitigation measures for air environment according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by Impact Evaluation	Mitigation Scale	Responsibility
1.	Dust generation	Low (-48)	No	Yes	Minor	Construction service providers

Mitigation Measures for Dust Generation

Like pre-construction phase, dust will be efficiently countered by sprinkling of water during construction phase for minor mitigation measures. Water can be sprayed by using handheld spray. The Safeguards during construction related to dust control will include:

- Minimizing dust from material handling sources by using covers or control equipment;
- Minimizing dust from open area sources, including storage piles by using enclosures or covers, or increasing moisture content;
- Use of dust suppression techniques such as applying water or non-toxic chemicals to minimize dust from vehicle movements Other mitigation measures include maintaining good housekeeping practices throughout the construction phase. These low-cost measures include:
- Properly enclosing the site through use of appropriate hoarding and screening.
- Perform mixing and unloading operations of solid materials on-site (to minimize off-site impacts).
- Proper handling of cement material.
- Requiring and monitoring for minimal traffic speed on-site
- Covering the loads of all vehicles hauling materials likely to give off dust emissions.
- Ensuring adequate maintenance and repair of demolition and construction machinery and vehicles.
- Prohibiting burning of material for and resulting from site clearance.
- Covering excavated soils and demolition wastes with impervious sheeting.
- Ensuring the timely removal of demolition waste to local authorities approved site for landfilling or reclamation and reuse.
- Applying water as a dust suppressant as needed.
- Identifying periods where site activities may create higher levels of dust (e.g. at times of demolition, heavy traffic or excavation) and planning accordingly to have adequate water supply available and implement dust suppression techniques to decrease emissions into the atmosphere and to ensure maximum efficiency, facility trucks and equipment will be inspected on a regular basis and have a regular maintenance schedule. Trucks and machinery will be turned off when not in use to reduce power consumption as well as the emission of pollutants.

Moreover, the construction services provider(s) will do the following activities to control dust during construction phase are shown in the following table.

Recommended Actions for Dust Control during Construction Phase

Fugitive Dust Source Category	Dust Control Actions
Earth-moving	▪ For any earth moving which is more than 30 m from all property lines, conduct watering as necessary to prevent visible dust emissions from exceeding 100 cm in length in any direction. ▪ Physical barrier is required to install to prevent dust moving to the surrounding. ▪ Facial masks need to be provided to the construction workers during potentially dusty operations
Disturbed surface areas (except completed grading areas)	▪ Apply dust suppression in a sufficient quantity and frequency to maintain a stabilized surface; ▪ Areas, which cannot be stabilized, as evidenced by wind driven dust, must have an application of water at least twice per day to at least 80 percent of the unstabilized area. Damping down shall take place on a continual basis.
Disturbed surface areas (completed grading areas)	▪ Apply water to at least 80 percent of all inactive accessible disturbed surface areas on a daily basis when there is evidence of wind driven fugitive dust.
Inactive disturbed surface areas	▪ Apply dust suppressants in sufficient quantity and frequency to maintain a stabilized surface.
Unpaved roads	▪ Water all roads used for any vehicular traffic at least twice per day of active operation; or ▪ Water all roads used for any vehicular traffic once daily and restrict vehicle speed to 15 mph.
Track-out control	▪ Downwash of trucks (especially tyres) prior to departure from site.

Significant of Impacts on Air Environment during Construction Phase after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Dust generation	Dust from earth working activities	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Very Often (-4)	Seldom (-2)	Low (-36)

Residual Impact

After mitigation measure, there will be no residual impact for dust generation.

(b) Impacts of Gaseous Emissions

Some gases such as carbon monoxide (CO), Carbon dioxide (CO_2), nitrogen oxides (NOx), and sulfur oxides (SOx) were emitted from the operation of generator, concrete mixer, vehicles and construction machineries into the atmosphere during the construction phase (including both on-site and the public roads). Air emissions are expected to be limited due to the short duration and scope of construction operations. The impact is negative, direct, temporary, intermittent, reversible, localized and short-term.

Methodologies for Prediction of Gaseous Emission

Methodologies to Predict Gaseous Emissions during Construction Phase

Emission of pollutants will be estimated by using the simple estimation method (e.q 1). The method is to multiply relevant emission factor by activity rate.

$$Em = EF \times AR \qquad \text{(e.q 1)}$$

Where,

Em = Emission load

EF = Emission factor

AR = Activity data (can also be expressed in terms of production rate)

However, gaseous emission from the vehicular moments at the project site will be used the equation (2).

$$Em = Fc \times EF \qquad \text{(e.q 2)}$$

Where,

Em = Emission rate

Fc = Fuel consumption

EF = Emission factor

Emission Factors of Pollutants

Activity	Pollutant	Emission factor	Unit
Bulldozing (activities include land clearing, site excavation, levelling, road and drainage construction)	PM_{10}	$E = \frac{18.6\ (s)^{1.5}}{(M)^{1.4}}$	lb/hr
	CO	36[a] , 18[b]	g/kg
	CO_2	3090[a] , 3090[b]	g/kg
	NO_x	42[a], 16[b]	g/kg
Loading of excavated materials	PM_{10}	$E = k\ (0.0032)\ \frac{(\frac{U}{5})^{1.3}}{(\frac{M}{2})^{1.4}}$	lb/ton
Vehicles traveling on unpaved road	PM_{10}	$E = k\ (^{s}/_{12})^{a}\ (^{W}/_{3})^{b}$	*lb/VMT*
	CO	36[a] , 18[b]	g/kg
	CO_2	3090[a] , 3090[b]	g/kg
	NO_x	42[a], 16[b]	g/kg

Source: Adapted from USEPA

[a] Heavy Duty Vehicles-HDV that use diesel engine with moderate emission control system

[b] Light Duty Vehicles-LDV that use gasoline engine with moderate emission control system

where,

s = material silt content (%)

k = particle size multiplier (dimensionless, <10µm = 0.35),

M = material moisture content (%)

U = mean wind speed, meters per second (m/s) (miles per hour [mph])

W = mean vehicle weight (tons)

k = constant value for vehicles traveling on unpaved road (for industrial road-1.5, for public road- 1.8)

a = constant value for vehicles traveling on unpaved road (for industrial road-0.9, for public road- 1)

b = constant value for vehicles traveling on unpaved road (for industrial road-0.45, for public road- ND)

Examples of silt content of various soil types are given below (EPA, 1999).

Soil type	Silt content (%)
Silt loam	52
Sandy load	33
Sand	12
Loamy sand	12
Clay	29
Clay loam	29
Loam	40

k = particle size multiplier (dimensionless, <10µm = 0.35),

M = material moisture content (%)

U = mean wind speed, meters per second (m/s) (miles per hour [mph])

W = mean vehicle weight (tons)

Vehicle Type	Average Fuel Economy (mpg) miles-per-gallon
Passenger Cars	23.3
Motorcycles	43.5
Diesel Buses (Diesel Heavy-Duty Vehicles)	7.2
Other 2-axle, 4-Tire Vehicles	17.1
Single unit 2-Axle 6-Tire or More Trucks	7.3
Combination Trucks	5.8

Source: EPA

Assumptions for combustible emissions according to machines

Assumptions for Combustible Emissions					
Type of Construction Equipment	Num. of Units	HP Rated	Hrs/day	Days/yr	Total hp-hrs
Water Truck	1	300	8	240	576000
Diesel Road Compactors	1	100	8	90	72000
Diesel Dump Truck	2	300	8	90	432000
Diesel Excavator	1	300	8	15	36000
Diesel Hole Trenchers	1	175	8	15	21000
Diesel Bore/Drill Rigs	1	300	8	15	36000
Diesel Cement & Mortar Mixers	1	300	8	240	576000
Diesel Cranes	1	175	8	240	336000
Diesel Graders	1	300	8	90	216000
Diesel Tractors/Loaders/Backhoes	2	100	8	90	144000
Diesel Bull Dozers	1	300	8	90	216000
Diesel Front End Loaders	1	300	8	90	216000
Diesel Fork Lifts	2	100	8	90	144000
Diesel Generator Set	6	40	8	240	460800

Emission factors (EF) with type of construction equipment (g/hp-hr)

Emission Factors							
Type of Construction Equipment	VOC g/hp-hr	CO g/hp-hr	NOx g/hp-hr	PM-10 g/hp-hr	PM-2.5 g/hp-hr	SO2 g/hp-hr	CO2 g/hp-hr
Water Truck	0.440	2.070	5.490	0.410	0.400	0.740	536.000
Diesel Road Compactors	0.370	1.480	4.900	0.340	0.330	0.740	536.200
Diesel Dump Truck	0.440	2.070	5.490	0.410	0.400	0.740	536.000
Diesel Excavator	0.340	1.300	4.600	0.320	0.310	0.740	536.300
Diesel Hole Trenchers	0.510	2.440	5.810	0.460	0.440	0.740	535.800
Diesel Bore/Drill Rigs	0.600	2.290	7.150	0.500	0.490	0.730	529.700
Diesel Cement & Mortar Mixers	0.610	2.320	7.280	0.480	0.470	0.730	529.700
Diesel Cranes	0.440	1.300	5.720	0.340	0.330	0.730	530.200
Diesel Graders	0.350	1.360	4.730	0.330	0.320	0.740	536.300
Diesel Tractors/Loaders/Backhoes	1.850	8.210	7.220	1.370	1.330	0.950	691.100
Diesel Bull Dozers	0.360	1.380	4.760	0.330	0.320	0.740	536.300
Diesel Front End Loaders	0.380	1.550	5.000	0.350	0.340	0.740	536.200
Diesel Fork Lifts	1.980	7.760	8.560	1.390	1.350	0.950	690.800
Diesel Generator Set	1.210	3.760	5.970	0.730	0.710	0.810	587.300

Emission Calculations Results with type of construction equipment (tons/yr)

Emission Calculations							
Type of Construction Equipment	VOC tons/yr	CO tons/yr	NOx tons/yr	PM-10 tons/yr	PM-2.5 tons/yr	SO2 tons/yr	CO2 tons/yr
Water Truck	0.279	1.314	3.485	0.260	0.254	0.470	340.227
Diesel Road Compactors	0.029	0.117	0.389	0.027	0.026	0.059	42.544
Diesel Dump Truck	0.209	0.985	2.614	0.195	0.190	0.352	255.170
Diesel Excavator	0.013	0.052	0.182	0.013	0.012	0.029	21.276
Diesel Hole Trenchers	0.012	0.056	0.134	0.011	0.010	0.017	12.399
Diesel Bore/Drill Rigs	0.024	0.091	0.284	0.020	0.019	0.029	21.014
Diesel Cement & Mortar Mixers	0.387	1.473	4.621	0.305	0.298	0.463	336.228
Diesel Cranes	0.163	0.481	2.118	0.126	0.122	0.270	196.318
Diesel Graders	0.083	0.324	1.126	0.079	0.076	0.176	127.657
Diesel Tractors/Loaders/Backhoes	0.294	1.303	1.146	0.217	0.211	0.151	109.669
Diesel Bull Dozers	0.086	0.328	1.133	0.079	0.076	0.176	127.657
Diesel Front End Loaders	0.090	0.369	1.190	0.083	0.081	0.176	127.633
Diesel Fork Lifts	0.314	1.231	1.358	0.221	0.214	0.151	109.622
Diesel Generator Set	0.614	1.909	3.032	0.371	0.361	0.411	298.232
Total Emissions	**2.599**	**10.034**	**22.811**	**2.005**	**1.952**	**2.931**	**2125.647**

Significant of Impacts on Gaseous Emissions before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Gaseous emissions	Gaseous emission from vehicles and generators	Negative (-)	Local (-3)	Short term (-2)	Low (-2)	Continuous (-5)	Highly Probable (-4)	Low to moderate (-63)

Consideration of Mitigation Requirement for Gaseous Emissions

The intensity of mitigation measures for gaseous emissions according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by Impact Evaluation	Mitigation Scale	Responsibility
1.	Gaseous emissions	Low to moderate (-72)	No	Yes	Minor	Construction service providers

Minimizing of Gaseous Emissions during Construction Phase

For minor mitigation requirement, certain mitigation measures will be adopted to limit atmospheric impacts to as great an extent as possible during construction phase. For instance, the transportation of personnel and materials will be scheduled such as to avoid periods of peak flow where congested conditions are more likely, and to reduce the overall number of vehicular movements. In addition to careful traffic management, close adherence to the recommended maintenance regime will be applied to both on-site and off-site vehicles.

Improved Maintenance: Recognizing that significant emission reduction will be achieved through regular equipment maintenance.

Reduction of On-site Construction Time: Rapid on-site construction will reduce the duration of traffic interference and therefore, reduce emissions from traffic delay. Off-site fabrication of structural components can also enhance the quality of work, as the production takes place in controlled settings and external factors such as weather and traffic do not interfere.

Significant of Impacts on Gaseous Emissions after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Gaseous emissions	Gaseous emission from vehicles and generators	Negative (-)	Local (-3)	Short term (-2)	Low (-2)	Very Often (-4)	Probable (-3)	Low (-49)

Residual Impact

After mitigation measure, there will be no residual impact for gaseous emission.

(c) Increased in Noise Level

For the proposed project, the major noise generating sources during the construction phase will be caused by the earth moving and excavation equipment, generators, concrete mixers, as well as piling process in some places. The increased noise level can impact local residents in nearest villages near the project site and will become a nuisance to the public and sensitive receptors in the area.

The predicted noise level at nearest villages during construction phase can be predicted as follow:

Predicted Noise Levels during Construction Phase

Receptors and distances from project	Existing noise levels monitored by integrated noise level meter (dBA)		Calculated noise level at site (dBA)		Reduced noise level at receptors due to Distance (dBA)	Predicted cumulative noise level at receptors (dBA)		Allowable noised level (existing noised level + 3dBA) (dBA)	
	Day Time	Night Time	Day Time	Night Time		Day Time	Night Time	Day Time	Night Time
Nearest villages within 1km radius	50.7	43.4	99.7	-	64.4	64.6	43.4	53.7	46.4

According to the above table, there will be impacts of noise on nearest residents (within 1km radius) and all of the predicted noise levels during day time are relatively higher than the allowable limit (existing noise level plus 3dB). Moreover, noise will also impact on travelers who travel along the road near the proposed railway project. Although all of the predicted noise levels are based on calculations and the actual noise level may a little change due to the other factors (seasonal wind direction and wind speed), these changes will not affect the calculations.

All kinds of machinery and equipment at the construction site, including loaders, excavators, bulldozers, concrete mixers and heavy-duty mixers, etc, are the most important sources of construction noise. Secondly, in the process of railway engineering construction of this section, there is a need to demolish existing buildings within the land expropriation area, mainly residential buildings along the line, and to build new railway buildings at the same time. In the process of demolishing and building new structures, construction noise will also be generated; large temporary construction facilities will radiate noise outward in the process of working, mainly intermittent noise such as percussion collisions, and equipment noises from crane, concrete mixer, internal machinery and other equipment noise. These noises will have a certain impact on nearby residential areas, schools, hospitals and other sensitive points. Due to construction work, the operation of construction machinery and running of construction vehicles is expected, and noise will be produced as a result, and impact to residences in the vicinity is expected. Although the specific number of construction vehicles is not yet determined, the amount of noise from construction machinery shall be assumed per below. The U.S. Federal Transit Administration (FTA) standards shall be used as reference. Table below shows the FTA noise assessment criteria for construction. The last column applies to construction activities that extend over 30 days near

any given receiver. Day-night sound level, Ldn, is used to assess impacts in residential areas and 24-hr Leq is used in commercial and industrial areas. The 8-hr Leq and the 30-day average Ldn noise exposure from construction noise calculations use the noise emission levels of the construction equipment, their location, and operating hours. The construction noise limits are normally assessed at the noise-sensitive receiver property line edge.

Table - Construction Noise Assessment Criteria

Land Use	8-Hour L_{eq} dBA		Noise Exposure, L_{dn} dBA
	Day	Night	30-day Average
Residential	80	75	75*
Commercial	85	85	80**
Industrial	90	90	85**

* In urban areas with very high ambient noise levels (L_{dn} greater than 65 dB), L_{dn} from construction operations should not exceed existing ambient noise levels + 10 dB.
**Twenty-four-hour L_{eq}, not L_{dn}.
Source: FTA (2006).

Methodologies for Construction Noise Level Prediction

Construction noise mainly comes from the construction machinery working and construction materials transportation, the construction noise will seriously affect the neighboring residents work and rest, especially at night. According to the limit of noise at boundary of construction and its measuring method in different construction stage.

The equivalent sound pressure level of noise averaged over 8 hours (the length of a typical work shift) can be calculated by the following equation.

$$L_{ex,8} = 10\ Log_{10}\left(\frac{\left[\sum_{i=1}^{n}(t_i \times 10^{0.1\ SPL_i})\right]}{8}\right)$$

in which,

$L_{ex,8}$ is the equivalent sound exposure level in 8 hours,

$\sum$ is the sum of the values in the enclosed expression for all activities from i = 1 to i = n,

i is a discrete activity of a worker exposed to a sound level,

t_i is the duration in hours of i,

SPL_i is the sound level of i in dB(A),

n is the total number of discrete activities in the worker's total workday.

Construction Noise Restriction

Construction Stage	Main noise sources	Noise Limitation LeqdB(A)	
		Daytime	Night
Earth work	Bulldozer, excavator, loader	75	55
Piling	Pile driver	8.5	Ban
Structure	Concrete mixer, vibrator, electric saw etc.	70	55
Fixture	Crane, elevator	65	55

The forecast noise value of the main construction equipment is as follows:

S/N	Equipment	No. of Equipment	Noise values at 50m distance dB(A)
1.	Truck	6	84
2.	Bulldozer	2	85
3.	Excavator	2	85
4.	Concrete mixer	2	85
5.	Compactor	1	80
6.	Motor Graders	1	85
7.	Generator	1	82
8.	Paver	1	85

The equivalent noise level for 8 hours ($L_{eq.8}$) for every machinery running at the same time with discrete duration of 1 hour measured at 50m away is calculated by the above equation and results in **87.2992 dB(A)**.

In order to determine an estimate of a sound pressure level at a distance the **Inverse Square Law** can be used. According to the inverse square law, it can be shown that for each doubling of distance from a point source, the sound pressure level decreases by approximately 6 dB(A).

The formula to calculate sound attenuation over distance for a **point source** is:

$Lp(R2) = Lp(R1) - 20 \cdot Log_{10}(R2/R1)$

Where:

Lp(R1) = Known sound pressure level at the first location (typically measured data or equipment vendor data)

Lp(R2) = Unknown sound pressure level at the second location

R1 = Distance from the noise source to location of known sound pressure level

R2 = Distance from noise source to the second location

By using the Inverse Squared Law, the same sound pressure level at 500 m and 1000 m away are determined. At the distance of **500 m** away the sound level pressure will be dropped to **67.2992 dB(A)** and at **1000 m**, it will be **61.2786 dB(A)**.

Significant of Impacts on Noise before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Noise	Noise from heavy machineries and generator	Negative (-)	Limited (-2)	Short term (-2)	Low to moderate (-3)	Continuous (-5)	Highly Probable (-4)	Low to Moderate (-63)

Consideration of Mitigation Requirement for Noise during Construction Phase

The intensity of mitigation measures for noise according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by Impact Evaluation	Mitigation Scale	Responsibility
1.	Noise	Low to Moderate (-63)	Yes	Yes	Minor to Moderate	Construction service providers

Mitigation Measures for Noise during Construction Phase

To reduce noise level during construction phase, the construction service provider(s) will do to the following:

- not running noisy construction machineries at the same time;
- Limit operation of heavy machinery at night;

- The use of hearing protection actively when noise levels exceed 70dB(A);
- Installing warning signs in areas of high noise levels.
- Considering the use of acoustic insulating materials, isolation of the noise source, and other engineering controls to minimize noise impact;
- Effectively utilizing material stockpiles and other structures, where feasible; to reduce noise from on-site construction activities;
- Choosing inherently quiet equipment with mufflers;
- Operating only well-maintained mechanical equipment on-site and only operated it according to manufacturer's gratification;
- Keeping equipment speed as low as possible;
- Shutting down or throttling down to minimum equipment that may be intermittent in use, between work periods;
- Restricting access to the site for truck traffic outside of normal working hours;
- Routing trucks away from noise sensitive areas where feasible;
- Utilizing proper site logistics and planning;
- Scheduling noisy activities during the morning hours;
- Consulting with local communities prior to beginning work and inform the communities when especially noisy activities are planned;
- Developing grievance mechanism for communities to voice concerns over noise;
- Developing and implementing noise monitoring program.

Significant of Impacts on Noise after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Noise	Noise from heavy machineries and generator	Negative (-)	Limited (-2)	Short term (-2)	Low to medium (-3)	Very Often (-4)	Probable (-3)	Low (-49)

Residual Impact on Air Environment during Construction Phase

Dust emission and particulate matter emission from on-site vehicles, gaseous emission from vehicles and operation of generator, and construction activities would not be a residual impact on air environment. And these can be controlled by the described mitigation measures during the construction phase. Noise emission caused by the earth moving, excavation equipment and

constructional used machinery would not be a residual impact after conducting the mitigation measures. The main source of vibration is from the strong vibration construction machinery. So after the construction is over, there would be no residual impact due to vibration. In conclusion, there would be no residual impact on air environment during construction phase.

6.2.2.2. Anticipated Impacts and Mitigation Measures on Surface Water Environment during Construction Phase

Potential construction-induced impacts to surface water quality will be soil erosion and sedimentation resulting from excavation and grading activities necessary for the construction of subgrade during rainy seasons. Drainage and seepage from construction waste dumping site will have potential to surface water pollution. Mobilization and transport of soil particles due to construction activities may result in sedimentation of surface drainage networks, which may result in impacts to the water quality in nearest rivers via drains. In addition, handling of fuel oil, other oil products, chemicals and lubricants may constitute a risk for pollution of surface water. It will be more evidence in rainy seasons (June to September). Waste generated from construction activity will also have potential to surface water pollution and will include construction debris and waste from construction workers.

(a) Construction Debris

Waste materials (pallets, packing crates, steel structure off-cuts, and waste concrete from station construction) will be generated during construction period. The construction of subgrade and station yard works will destroy the surface vegetation and produces bare surface. The earth working activities during construction of subgrade and station will cause the soil erosion, and it will increase the suspended matter of the water body when entering into the water body. The construction camp of the project is mainly located at the portal of tunnel, both ends of the bridge and the working points of each concentrated subgrade section. Some construction camps are arranged in combination with the beam yard, track-laying base, sleeper precast yard, concrete mixing station, filling centralized mixing station and other temporary works, and some construction camps are solved by renting local houses. The specific location and number of construction camps will be determined in the construction stage. The construction personnel have relatively simple lives; thus, their sewage discharges are relatively less with simple pollution

behavior, mainly including fecal sewage, kitchen sewage, bath wastewater and other domestic sewage. The unsuitable soil material from foundation preparation will also produce. All of the construction wastes will have potential to surface water pollutions if they are not properly managed. Drainage and seepage from construction waste dumping site will have potential to surface water pollution during rainy season.

Significant of Impacts on Surface Water Environment due to Construction Debris before mitigation measures

Impact on water environment during construction phase will not be significant due to the amount of wastewater produced during construction phase (the volume of nearest water bodies is very much greater than the volume of wastewater disposed by construction site) and the time of construction phase.

Anticipated Impacts	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Surface Water Pollution	Construction Debris from alignment construction	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Very Often (-4)	Highly probable (-4)	Low (-48)
	Construction Debris from station and yard construction	Negative (-)	Site (-1)	Short term (-2)	Low (-2)	Regular (-3)	Highly probable (-4)	Low (-35)

Consideration of Mitigation Requirement for Surface Water Environment due to Construction Debris

The intensity of mitigation measures for surface water environment according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by Impact Evaluation	Required Mitigation Scale	Responsibility
1.	Construction Debris from alignment construction	Low (-48)	No	Yes	Minor	Construction Service Providers
2.	Construction Debris from station and yard construction	Low (-35)	No	Yes	Minor	Construction Service Providers

Mitigation Measures for Construction Debris

According to the above impact identification and evaluation, there will need minor mitigation measures for impact on water environment during construction phase. Construction period should not start in rainy seasons. If construction will have to start in rainy seasons, it is necessary to construct temporary settling pond inside the project compound. All stacking and loading areas should be provided with proper drains to prevent run off from the site to enter any water body. The following mitigation measures will be conducted.

(a) Working in a small area at a point of time (phase wise construction),
(b) Minimize the time of exposure of any waste and erodible land exposed to stormwater runoff.
(c) Minimize land clearing activities to those of required work areas.
(d) Using sediment controls, with special care taken during the rainy season.
(e) Use sediment controls when pumping rainwater from trenches or foundation excavations into storm drains and not directly to the aquatic environment.
(f) Cover open stockpiles of construction materials with tarpaulin or similar fabric during rainstorm events to prevent erosion and resultant sedimentation of receiving waters.
(g) Paving roads wherever possible.
(h) Upstream downstream and downstream erosion protection.
(i) The soil material removed from the construction process should be recycled;
(j) Segregate the wastes according to the requirements; and
(k) Storage of fuel, oils and chemicals should be on an impermeable base, away from drains and watercourses.

Significant of Impacts on Surface Water Environment due to Construction Debris after mitigation measures

Anticipated Impacts	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Surface Water Pollution	Construction Debris from alignment construction	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Very Often (-4)	Seldom (-2)	Low (-36)
	Construction Debris from station and yard construction	Negative (-)	Site (-1)	Short term (-2)	Low (-2)	Regular (-3)	Seldom (-2)	Low (-25)

(b) Oil and Grease

Trucks and vehicles can leak fuel oil during transportation of construction materials and workers during construction phase. Another impact during the construction phase is the accidental spillage of fuels and hydraulic fluids from construction plant. Moreover, lubricants and grease from construction machineries can also leak during construction phase. All of the fuel oil and lubricants can cause surface water pollution (increase in oil and grease content in nearest water bodies) for a while.

Significant of Impacts on Surface Water Environment due to Oil and Grease before mitigation measures

Impact on water environment due to oil and grease during the construction phase is as follows:

Anticipated Impacts	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Surface water pollution	Oil and Lubricants	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Intermittent (-2)	Probable (-3)	Low (-30)

Consideration of Mitigation Requirement for Surface Water Environment due to Oil and Grease

The intensity of mitigation measures for surface water environment according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by Impact Evaluation	Required Mitigation Scale	Responsibility
1.	Oil and Grease	Low (-30)	No	Yes	Minor	Construction Service Providers

Mitigation Measures for Oil and Grease

The following mitigation measures will be conducted for oil and grease generation during construction phase.

(a) Avoid construction works during the rainy season;
(b) Store the oil and lubricants on impermeable floor like concrete floor;
(c) Regular maintenance of the machineries and the vehicles;
(d) Avoid any leakage of oil and lubricant from vehicles and machineries used in construction phase.

Significant of Impacts for Surface Water Environment for Oil and Grease after mitigation measures

Impact on water environment due to oil and grease during the construction phase is as follows:

Anticipated Impacts	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Surface water pollution	Oil and Lubricants	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Intermittent (-2)	Seldom (-2)	Very Low (-24)

(c) Impacts of Domestic Wastes from Construction Workers

A certain amount of domestic waste will be generated from construction workforce. The establishment of labor camps will also affect on environment through improper waste (solid & garbage /sewage) disposal.

Significant of Impacts on Surface Water Environment due to Domestic Wastes before mitigation measures

Anticipated Impacts	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Surface water pollution	Domestic Wastes	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Very Often (-4)	Highly probable (-4)	Low (-48)

Consideration of Mitigation Requirement for Surface Water Environment due to Domestic Wastes

The intensity of mitigation measures for surface water environment according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by Impact Evaluation	Required Mitigation Scale	Responsibility
1.	Domestic Wastes	Low (-48)	No	Yes	Minor	Construction Service Providers

Mitigation Measures for Domestic wastes from Construction Workers

The domestic wastes from construction workers can be mitigated by the following measures.

(a) Waste water channels from the site should be connected to septic tank during construction to prevent wastewater from entering the nearest water bodies. Temporary sedimentation pond on the waterway to nearest river at construction site,

(b) Vegetation of bare areas after the construction state, and

(c) Compact soil as soon as building foundations are formed to prevent erosion, especially during the wet season.

Significant of Impacts on Surface Water Environment due to Domestic Wastes after mitigation measures

Anticipated Impacts	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Surface water pollution	Domestic Wastes	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Very Often (-4)	Seldom (-2)	Low (-36)

Residual Impact on Surface Water during Construction Phase

Construction debris and oil and grease leaked from the vehicles and construction machinery can be controlled by silt traps, and natural weirs and small lakes. So there would be no residual impact because of the construction debris, and oil and grease from the construction activities. Since the intensity of mitigation for the impact on surface water environment during construction phase is minor, there would be no residual impact on surface water environment.

6.2.2.3. Anticipated Impacts and Mitigation Measures on Soil and Ground Water Environment during Construction Phase

Impact of soil and groundwater environment during construction phase will be leakage of fuel oil, leakage of lubricants and disposal of wastes.

Accidental Spills of Fuel Oil and Lubricants: Potential contamination of soil and groundwater during construction phase could possibly occur as a result of accidental spills of lubricants, oils, solvents and degreasers during construction can infiltrate and contaminate the soil. This can occur from poorly maintained or improperly operated on-site vehicles and construction

equipment, as well as due to improper storage or handling of equipment or hazardous materials. Wastewater from repair shops and washing places contaminated with hydrocarbons (oil, lubricants and solvents) can enter the soil if spilled. Liquid contaminants that enter the soil can then percolate further and result in soil contamination and groundwater pollution.

Construction Debris and Domestic Wastes: During construction phase, construction debris such as concrete waste, packing materials and domestic wastes from construction workers will produce. The construction debris from alignment construction would be much larger than the station construction but the impact on the soil quality is not that significant in construction phase. There will have potential to soil contamination and ground water pollution if these solid wastes are not properly disposed. Moreover, seepage from construction waste dump site will also impact on soil and ground water qualities. But these impacts on ground water quality is insignificant.

Impacts Significance on Soil and Ground Water Environment during Construction Phase before mitigation measures

Construction related impacts to soil and groundwater in project site will be as follow:

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Soil and Ground Water Pollution	Leakage of fuel oil and lubricants	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Regular (-3)	Probable (-3)	Low (-36)
	Construction debris from alignment construction	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Very Often (-4)	Probable (-3)	Low (-42)
	Construction debris from station construction	Negative (-)	Site (-1)	Short term (-2)	Low (-2)	Very often (-4)	Probable (-3)	Low (-35)
	Domestic Wastes	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Very Often (-4)	Highly probable (-4)	Low (-48)

Consideration of Mitigation Requirement for Soil and Ground Water Quality

The requirement of mitigation measures for soil and ground water environment according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Leakage of fuel oil and lubricants	Low (-36)	No	Yes	Minor	Construction Service Provider(s)
2.	Construction debris from station construction	Low (-42)	No	Yes	Minor	Construction service provider(s)
3.	Construction debris from alignment construction	Low (-35)	No	Yes	Minor	Construction Service Provider(s)
4.	Domestic wastes	Low (-48)	No	Yes	Minor	Construction Service Provider(s)

Mitigation Measures for Impacts on Soil and Ground Water Environment during Construction Phase

The mitigation measure for the groundwater quality is that MR should take responsibility for the shortage of groundwater to the affected area (the nearest villages) by digging the new deep wells, tube well and supporting water requirement to those areas if they suffer the shortage of groundwater. According to the above consideration for required mitigation measures, there will be minor mitigation measures such as disposed of solid wastes according to the rules and regulations of CDCs to reduce impacts of solid wastes during construction phase. Care should be taken not to leak during the handling of fuel oil and lubricants. All of the fuel tank and lubricants container have to store over concrete floor or impermeable pad. Machinery used in construction phase have to be in good conditions. Construction wastes need to be transported in an orderly manner that ensures that no material escapes from the trucks during transport, and that the waste is then deposited in MCDC approved landfill locations to ensure that the surrounding environment does not become contaminated with the waste material generated. Wherever possible, steel scraps, metals, and other construction wastes should be recovered for re-use, recycling and reclamation after the adequacy of the physical and chemical properties of such material is ascertained and the absence of contamination is ensured.

Domestic effluent will be collected and contained in septic tanks on site. The contents will be removed for disposal as and when necessary by an MCDC licensed contractor.

During the construction phase, there will be generation of debris as a result of various construction activities. An agreement will be drafted with solid waste collectors and schedule set for demolition and construction wastes to be delivered to an CDC approved site appropriate for landfilling for:

- Contaminated and hazardous material,
- Non-hazardous material,
- Where feasible, for reclamation and reuse.

The generated materials will also be used for reclamation purposes whenever applicable on site in the project. Sorting of construction wastes will be encouraged, as well as, adoption of a re-use/recycle program on site whenever deemed feasible.

Construction wastes will also be minimized through careful planning during the design stage, whereby reducing or eliminating over-ordering of construction materials to decrease waste generation and reduce project costs (cost of surplus materials).

Chemical wastes have to be generated including containers that were used for storage of chemical wastes on site, the chemical residue as well as contaminated material. These materials have to be segregated as hazardous and non-hazardous and properly labeled, stored and disposed of. Storage be located in a separate area that has an impermeable floor, adequate ventilation and a roof to prevent rainfall from entering.

In addition, all chemical wastes must be clearly labeled in Myanmar, stored in corrosion resistant containers and arranged so that incompatible materials are adequately separated. There will be a prior agreement with the MCDC for the disposal of any hazardous waste generated.

General refuse generated during project activities will be stored in enclosed bins or compaction units separate from construction and chemical wastes. An agreement will be drafted with a solid waste collector certified by the MCDC to identify collection sites and schedule the removal to minimize odor, pest infestation and litter buildup. The burning of refuse on the construction site will be strictly prohibited and penalized. General refuse is generated largely by food service activities on site, so reusable rather than disposable dishware will be promoted if feasible. Aluminum cans will be recovered from the waste stream by individual collectors if they are segregated and made easily accessible, so separate, labeled bins for their storage should be provided if feasible.

Impacts Significance on Soil and Ground Water Environment during Construction Phase after mitigation measures

Construction related impacts to soil and groundwater in project site will be as follow:

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Soil and Ground Water Pollution	Leakage of fuel oil and lubricants	Negative (-)	Limited (-2)	Short term (-2)	Very Low (-1)	Regular (-3)	Very Seldom (-1)	Very Low (-20)
	Construction debris from alignment construction	Negative (-)	Limited (-2)	Short term (-2)	Very Low (-1)	Very Often (-4)	Very Seldom (-1)	Low (-25)
	Construction debris from station construction	Negative (-1)	Site (-1)	Short term (-2)	Very low (-1)	Very often (-4)	Very seldom (-1)	Very low (-20)
	Domestic Wastes	Negative (-)	Limited (-2)	Short term (-2)	Very Low (-1)	Very Often (-4)	Seldom (-2)	Low (-30)

Impact on Soil Quality due to Hazardous Wastes

If the construction of station is with the concrete structure, the oil-based paint is the most common. Oil-based paints are consisted of volatile organic compounds (VOC), so these paint cans can be hazardous to the environment if they are not properly disposed. Aerosol cans containing paints are also regulated as hazardous waste when disposed. This can be due to the oil-based paints in the can. The lead-based paints are used, if the steel structure is used for the construction of the stations.

Impacts Significance on Soil Quality due to Hazardous Wastes before mitigation measures

Construction related impacts to soil quality in project site will be as follow:

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Impact on soil quality	Leakage of fuel oil and lubricants	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Intermittent (-2)	Seldom (-2)	Very Low (-24)

Consideration of Mitigation Requirement for Impact on Soil Quality

The requirement of mitigation measures for soil quality according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Impact on soil quality	Verry Low (-24)	Yes	Yes	Sensible	Construction Service Provider(s)

Mitigation Measures for Impacts on Soil Quality due to Hazardous Wastes

The project developer will do the following mitigation measures to reduce the impact on soil quality

(a) Where possible, substitute water-based paint for oil-based paints;

(b) Never discharge any oil-based paint or residuals down the drain;

(c) All wastes that are hazardous must be clearly identified as "hazardous waste" on the label; and

(d) Disposal of hazardous wastes should be made according to the rules and regulations of CDC.

Impacts Significance on Soil Quality due to Hazardous Wastes after mitigation measures

Construction related impacts to soil quality in project site will be as follow:

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Impact on soil quality	Leakage of fuel oil and lubricants	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Rare (-1)	Very Seldom (-1)	Very Low (-12)

Residual Impact on Soil and Ground Water Environment during Construction Phase

The impact on soil and ground water environment during the construction phase would not be residual by conducting the described mitigation measures.

6.2.2.4. Anticipated Impacts and Mitigation Measures on Biodiversity Environment during Construction Phase

The impacts on biodiversity and the activities causing to the impact is shown in the following table.

Table - Biodiversity Impact and Activities causing to the Impact

Impact	Activities Causing to The Impact
Habitat damage, fragmentation and loss Species disturbance and loss	▪ Wildlife disturbance and relocation through increased noise, light and human ▪ Unexpected clearance of land, deforestation and conversion of habitats providing important ecosystem services for tourism developments or supporting infrastructure ▪ Construction of access rail road and other infrastructure that open up previously inaccessible areas to development ▪ Poor construction practices leading to soil erosion

The anticipated impacts on the biodiversity environment during construction phase of proposed project will be as follow:

(a) Impact on Flora Diversity

During construction phase, clearing natural vegetation for the alignment construction and station construction can cause impacts on flora diversity. But the impact due to station construction is not significant compared to that of alignment construction.

Significant of Impacts on Flora Diversity

Unmanaged grassland is a frequent habitat in the area and is not of any particular conservation importance. The project site is near the settlement area; therefore, there will be no concerns for wild life disturbance as there is no suitable habitat in terms of suitable natural flora cover and related fauna. The various areas of improved grassland do not have any conservation value. The total carbon sequestration of herbs and grass communities in proposed factory will be very little. So that loss of carbon stock by proposed project is very low.

Affected plant species

Engineering land occupation will affect individual plant species, but will not change the floristic composition of plants in the evaluation scope. Affected plant species are common local species. Affected trees are mainly Eucalyptus, Pterocarya stenoptera, black locust, Melia azedarach, cedrela sinensis, alder, paper mulberry, Excoecaria sebifera, coconut palm, banyan, etc.; other shrubs affected are mainly mulberry, lantana, Rumex hastatus, Coriaria sinica, Reinwardtia trigyna, HollygreenBarberry, raspberry, linden viburnum, Maesa doraena, sweet potato vine,

Siberian Cocklebur, mountain loquat, Glochidion puberum, etc.; affected grasses are mainly crofton weed, Heteropogon contortus, Herba Euphorbiae, Euphorbia officinalis, Urtica japonica, Lotus philoxeroides, Echinacea, Poa pratensis, Snakeberry, Carpesium abrotanoides L., Lysimachia christinae Hance, Eupatorium odoratum, etc.

(1) Influences on vegetation (Flora)

The implementation of the project will occupy part of the farmland and forest land, and have a certain impact on the surface vegetation on both sides of the railway.

Comparative analysis of the influence of highway project on vegetation

The land occupation of the project will have a disturbing impact on the integrity of the surface ecosystem and the diversity of habitat and plant. The two engineering forms of bridge and tunnel occupy less land and have fewer disturbances to biodiversity than subgrade work. Through the preliminary statistics, the permanent land area of the subgrade on the main line of the project is 9,262,532m^2, and the permanent area of the subgrade for the construction of a two-way six-lane highway equivalent to the transportation capacity of the project is about 19,680,000m^2, and the occupying area of the highway subgrade is about twice as much as that of the railway. As a result, the impact of railways on vegetation biodiversity is far less than that of highways with the same transportation capacity. Due to the nature of the project, vegetation will be cleared and replaced with rail infrastructure, service roads and storm water management systems. This will have the greatest impact in areas where no lines are in place and within the areas earmarked as biodiversity hotspots.

Significance of Impacts with mitigation

The construction phase would have the greatest impact on the surrounding vegetation. This will definitely result in the disturbance of the vegetation and soils within the site especially when considering the linear aspects of the project such as the rail lines and ancillary works mentioned above. Due to the site scale of disturbance in the construction period on the surrounding vegetation when compared to its current state, i.e. the magnitude would be Medium, the overall significance of would be rated as Medium with mitigation (Table below).

The operational phase of the project would have limited impact on the surrounding vegetation once the plants are allowed to re-establish themselves in any remaining areas; thus, the overall intensity would remain be Very Low as the species assemblages would have altered from natural. It is also anticipated that the grazing and agricultural pressure on the vegetation would also continue but would be equitable to the present state and thus similar to the No-Go option.

Mitigation:

- Construction activities should not exceed the proposed construction boundaries by more than 15 m to avoid the secondary impact of construction and increasing the areas that would require clearing and rehabilitation.
- A search and rescue operation for both plants and fauna (particularly reptiles) must be initiated prior to the commencement of any construction once the required permits are in place. Applications must be submitted to the applicable authority for the removal of any protected floral or faunal specie.
- Re-vegetation as part of a rehabilitation plan is always advocated, however due the nature of the vegetation, this may not be practical. It is suggested that the shallow topsoil layer be stockpiled separately from the subsoil layers, should the excavation exceed 0.5 m. When the construction has been completed, then the topsoil layers, which contain seed and vegetative material, should be reinstated last thus allowing plants to rapidly re-colonise the bare soil areas.
- Alien plant regrowth should also be monitored, and any such species should be removed during the construction phase.

Plant Protection Measures (Managements Control)

The permanent land occupied by subgrade, tunnel portal, bridge pier and temporary land occupied by abandoned ballast yard and construction site need to adopt vegetation restoration measures, and all kinds of construction sites formed, such as excavation surface, construction site and temporary road, need to be restored by artificial vegetation. Moreover, the main species planted should be native trees, and a small number of native shrubs should be planted appropriately.

During the construction process, the vegetation along the line should be protected as far as possible. Strict planning of construction roads, construction sites, dump sites and construction camps and strict delineation of construction scope and routes of personnel and vehicles shall be made while limiting the scope of construction activities to a certain extent on both sides of the railway line, to prevent the treading and destruction of vegetation in areas beyond the scope of construction; in the construction process, trees and shrubs within the area occupied should be carried out as far as possible and provide transplanting and nurturing management. After the completion of the project, according to the requirements of the local government, the construction roads will be used as permanent roads, hardened ground, living camps and production sites will be dismantled to restore topsoil and create conditions for the restoration of vegetation.

After the operation of the railway, some greening measures shall be taken to promote the natural restoration of vegetation along the railway. A total of 907.84 hectares of area will be restored along the whole line (including spoil area). Because the climate along the railway is humid, light and heat are abundant and suitable for plant growth, it is expected that vegetation along the railway will be restored to a certain extent within 3-5 years of operation, which can effectively alleviate the impact of the implementation of the project on vegetation.

Mitigation Measures for Flora Diversity

According to the minor mitigation requirement, it is necessary to avoid tree cutting, dispose wastes properly and avoid working at night to reduce impacts on flora diversities during construction phase.

(b) Impact on Fauna Diversity

Clearing away trees and natural vegetation can cause hazards to the habitats of birds and butterflies. Noise due to construction activities at the site involving human and vehicular movement will disturb aril and wild animals in the area. If waste disposal during construction are not properly done, there will be increased in the habitat loss of native species. Terrestrial micro flora and fauna at the site are also affected. Although the project is adjacent to Ayarwadi River, there will be no impact on aquatic lives in Ayarwadi River because waste water produced from construction site will be little amount from small area (about two acres). During construction period, clearing

habitats for project plant is the principal cause of habitat destruction. The loss of the habitats during the construction period is expected to have indirect impacts on surrounding habitat areas and associated biota. The vegetation also supports good shelter for many wildlife species. Habitat destruction is currently ranked as the primary cause of species extinction worldwide. Clearing of existing vegetation which may leads to loss of habitat. Some places in the construction area are likely to be lost due to direct and indirect construction activities for resident animals.

Impact index value and categories of fauna in the Mandalay-Muse Railway New Project

No.	Impacts	Magnitude	Duration	Extend (area)	Probability	Total	Category
	Fauna						
1	Reduce Terrestrial Fauna	3	4	2	3	27	Low impact (U)
2	Habitat Loss	3	5	2	3	30	Moderate significant (C)
3	Noise Impact	3	3	2	3	24	Low impact (U)

Consideration of Mitigation Requirement for fauna impact during construction phase

The intensity of mitigation requirement for fauna according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Reduce terrestrial fauna	Low (-27)	No	Yes	Minor	Construction Service Provider(s)
2.	Habitat loss	Moderate (-30)	Yes	Yes	Moderate	Construction service provider(s)
3.	Noise impact	Low (-24)	No	Yes	Minor	Construction service provider(s)

Significance of Impacts on Fauna Diversity

Influences on animal resources (Fauna)

(i) Analysis of the influence on mammals

The influence of engineering construction on mammals mainly occurs in the construction area along the railway: the living activities of construction personnel will cause the interference and destruction to the habitat of mammals; the noise of construction machinery will drive away the mammals; these effects will cause most mammals to migrate elsewhere, away from the construction area. As the mammals will migrate to avoid the damage caused by the project construction, the direct impact of the project construction on the mammals is not significant.

(ii) The influence on birds

Construction activities will cause disturbance and destruction to bird habitat. Construction cutting-down trees, construction machinery noise and so on, will directly or indirectly destroy bird habitat and bird nests, and interfere with shrub habitat of birds. Or their daily living activities will also cause interference and destruction to bird habitats. As a result of these effects, most birds will migrate elsewhere, away from the construction area; a small number of terrestrial and shrub forest birds will disappear from the construction area as a result of habitat loss; and some bird population will be reduced as a result of the destruction of nests, especially when the construction period is in the breeding season of birds (in summer). The overall result will be a reduction in the species and number of birds in the project area. As most birds will fly away and migrate in a short distance to avoid the damage caused by the project construction, the project construction has little impact on birds.

(iii) The influence on amphibians and reptiles

The influence of engineering construction on amphibians and reptiles mainly include the disturbance and destruction to their habitat, especially on the mating activities of amphibians, oviposition and hatching of eggs, and the growth of tadpoles. The noise of construction machinery will drive away amphibians and reptiles, and the excavation and filling of streams, ponds and ditches during construction will cause damage to amphibians and reptiles, especially to amphibian habitat. These effects will cause most reptiles to migrate elsewhere, away from the construction

area; some amphibians and reptiles will be reduced by the destruction of their nests. The overall result is that their types and numbers within the project area will be reduced. However, as most reptiles will migrate to avoid the damage caused by project construction, the influence of project construction on reptiles will not be too great.

As noted above, the implementation of the project has little direct impact on mammals and birds and will have a certain direct impact on amphibians and reptiles. The main reason is that the construction excavation and filling of the project will destroy the natural water body necessary for amphibian reproduction activities, so that the area of natural water body will be reduced and the quality of the natural water body will be reduced. It has a certain indirect impact on mammals and birds, and has a greater indirect impact on amphibians and reptiles. The main impact on birds is that the occupation of forests will reduce the suitable habitat for birds.

(iv) The influence on animal activity barriers

For the animals distributed in the areas along the railway, the railway has formed a barrier to the animal activity due to its complete closure, which may limit the range of animal activities and have a potential impact on their foraging and mating. In the route selection stage, the project bypasses all wildlife reserves along the route, increases the number of bridges, tunnels and culverts. For sections close to the Pyinoolwin Wildlife Reserve, whole tunnel mode is adopted. Therefore, the barrier effect of the project on animal activities is not obvious.

(v) The influence of traffic on animal death

The line is near the river, mainly in the form of bridges and tunnels. Amphibians can migrate through the space below the span of the bridge hole and the original surface at the top of the tunnel, and will not have a significant impact on their normal migration. In addition to the bridge section, the subgrade work section has also set up more culverts to ensure the migration of animals on both sides of the line. Thus, the probability of traffic death is relatively less.

(vi) Comparative analysis of the influences of highway projects on animals

In the project, the ratio of bridge to tunnel is as high as 54%, and the bridge and tunnel have little impact on animal activity barrier. The subgrade section is completely closed, which effectively reduces the fatality rate of animals in the traffic and improves the safety of railway operation. A

total of 729 culverts have been set up on the whole line. With an average of 42 horizontal linear meter/ Nr., the barrier effect of the project on animal activities is greatly reduced.

Compared with the construction of a two-way six-lane highway with the same transport capacity as that of the project, the area of the highway is about twice that of the railway, and the ratio of bridge to tunnel is relatively low, and the highway cannot be completely closed. As a result, the impact of railways on animals is far less than that of highways with the same transport capacity.

Animal Protection Measures (**Managements Control)**

(i) ***Publicizing wildlife protection laws and regulations and prohibiting the killing of wildlife***

It is strictly forbidden to hunt wild animals, especially rare and endangered animals, in and around the construction area.

(ii) ***Reasonable arrangement of construction time and mode shall be arranged to reduce the impact on animals***

The disturbance of blasting noise to wildlife should be prevented during construction. Wild birds and animals mostly go out in the morning and dusk or at night to forage, and noon is the bird's rest time. In order to reduce the disturbance of blasting noise to wildlife in engineering construction, the blasting mode, quantity and time should be planned well, and the blasting in the morning and noon should be avoided.

(iii) ***Measures to improve animal passing***

Through the environmental analysis on route selection, the project avoided all wildlife along the line, and ensured that the animal traffic was not significantly affected by increasing the bridge-tunnel ratio (53.9%) and adding culverts (835 in totals, with an average length of 42.9 m/pic). In view of the sections close to the Pyinoolwin wildlife reserve, the project form was optimized and the whole-tunnel passage was adopted, which effectively reduced the impact of the project to the animal passing.

(3) Aquatic environment impact assessment – loss of habitat and removal of vegetation

Due to the nature of the project, vegetation will be cleared and replaced with rail infrastructure, service roads and stormwater management systems. The increase in rail footprint would have an impact on the valley head seeps with regard physical loss of catchment, wetland area and changes to the local hydrology.

Significance of impacts with mitigation

The bridge pier in the water is constructed by high pile bearing platform, bored pile foundation and double-wall suspension box-cofferdam. During the construction process, pile driving and steel pile casing insertion may lead to the release of underwater sediment into the water, but the scope of influence is small. The bottom cleaning and pouring are carried out in the cofferdam, and the influence on the water environment is not obvious.

According to the construction scheme of the bridge, the construction of the bridge foundation may have a certain impact on the aquatic ecological environment, but the construction disturbance range is only limited to about 20m around the pier, so the overall impact on the aquatic ecological environment is not obvious. Benthonic habitats can be gradually restored.

In the whole process of major bridge construction, the noise which has a great impact on the water ecosystem mainly comes from the pile driving and steel pile casing insertion in the construction link of bridge foundation cofferdam, and in the influence range of the major bridge, the aquatic organisms sensitive to the noise are all kinds of fishes. Most fishes will instinctively avoid the area during construction, so construction noise has no significant impact on fish habitats.

The construction phase would have the greatest impact on the surrounding wetland and aquatic areas. This will definitely result in the disturbance of the vegetation and soils within the site. Due to the site scale of disturbance in the construction period on the surrounding vegetation when compared to its current state, i.e. the magnitude would be moderate, the overall significance of would be rated as Low, with mitigation (Table below).

The operational phase of the project would have limited impact on the surrounding wetland areas once the plants are allowed to re-establish themselves in any remaining areas; thus the overall intensity would remain be Low as the species assemblages would have altered from natural. It is also anticipated that the grazing pressure on the vegetation would also continue but would be equitable to the present state and thus similar to the No-Go option.

Mitigation:

- All designs should include means to protect or maintain the current hydrological regime, thus maintaining and not impeding or diverting any surface water flows.
- Stormwater management systems should include energy dissipation structures to minimise the potential impact of erosion and sedimentation.
- Clearing of vegetation should be kept to a minimum, keeping the width and length of the earth works to a minimum and the floodplain / wetlands habitats identified should be retained within the development footprint in its current state.
- Construction activities should not exceed the proposed construction boundaries by more than 15 m to avoid the secondary impact of construction and increasing the areas that would require clearing and rehabilitation
- A search and rescue operation for both plants and fauna (particularly reptiles) must be initiated prior to the commencement of any construction once the required permits are in place. Applications must be submitted to the applicable authority for the removal of any protected floral or faunal specie.
- Re-vegetation as part of a rehabilitation plan is always advocated, however due the nature of the vegetation, this may not be practical. It is suggested that the shallow topsoil layer be stockpiled separately from the subsoil layers, should the excavation exceed 0.5 m. When the construction has been completed, then the topsoil layers, which contain seed and vegetative material, should be reinstated last thus allowing plants to rapidly re-colonise the bare soil areas.
- Alien plant regrowth should also be monitored, and any such species should be removed during the construction phase.

Aquatic Organism Protection Measures (Managements Control)

(i) ***Adjusting construction progress and construction period***

In order to minimize the impact of bridge construction on fish, the construction schedule and construction period should be reasonably arranged to avoid underwater drilling, cofferdam lowering and cofferdam pumping during the fish breeding season.

(ii) *Optimizing construction technology*

The construction technology in the process of bridge construction should be optimized as far as possible, especially in the water-related work. Firstly, low noise machinery should be selected to reduce the impact of construction noise on water environment; secondly, mechanical maintenance and maintenance should be done to ensure its normal operation; thirdly, drilling and cofferdam sinking operations should be carefully organized to control operation time.

(iii) *Water pollution control*

The most potential pollutant affecting the water body is the engineering waste such as drilled mud and so on in the construction of bridge foundation. The waste must be transported out of the river area for storage in strict accordance with the relevant norms and regulations, and certain protective measures must be taken. In order to minimize the impact of waste on water quality and prevent the adverse impact of waste stacking on flood control, supervisors must supervise the transportation and storage process and not allow it to be discarded at will.

Domestic waste generated during construction period shall be cleaned up in time and collected every day. Food waste can be reused as farmyard manure. The rest of the waste should be transported to the garbage dump for disposal. The stacking position of construction materials should be far away from the water body. All kinds of materials should have rain-shielding facilities. Open trenches, sand wells and protective walls shall be excavated around the material yard to avoid materials being washed into the river by heavy rain. It is forbidden to discharge directly wastewater from production and domestic sewage into rivers. Wastewater containing general suspended solids should be discharged after sediment deposition. Other wastewater and domestic sewage shall be treated by simple sewage treatment facilities. At the end of the construction, the coastal ecological environment should be restored in time to avoid the impact of soil erosion on the water environment.

(4) Loss of corridors and habitat fragmentation

Due to the nature of the project vegetation will be cleared and replaced with rail lines and supporting infrastructure and this will result in additional habitat fragmentation both within the terrestrial and aquatic environments, i.e. the elevated embankments on which the rail lines would

disrupt movement corridors. The construction phase would have the greatest impact in terms of habitat destruction, but the actual impact of fragmentation would occur in the operational phase.

Significance of impact with mitigation

With the mitigation measures in place as listed below, the definite impact on the fragmentation would remain within the Local area, resulting in a long-term impact of Moderate intensity for the operational phase, resulting in a Moderate (with mitigation) significance (Table below). This is assuming that the proposed infrastructure will allow for culverts in suitable areas to maintain links within the aquatic and terrestrial environment.

Mitigation:

- Wetland and flood line areas must be excluded from development as far as possible, i.e. designs should include means to span these areas thus maintain open ecological networks.
- Where culverts are installed across drainage lines and watercourses, the proposed designs should ensure that natural ground levels are maintained, i.e. the culvert base does pose as an obstacle for the movement of aquatic organisms.
- Construction activities should not exceed the proposed construction boundaries by more than 15 m to avoid the secondary impact of construction and increasing the areas that would require clearing and rehabilitation.
- Re-vegetation as part of a rehabilitation plan is always advocated, however due the nature of the vegetation, this may not be practical. It is suggested that the shallow topsoil layer be stockpiled separately from the subsoil layers, should the excavation exceed 0.5 m. When the construction has been completed, then the topsoil layers, which contain seed and vegetative material, should be reinstated last thus allowing plants to rapidly re-colonize the bare soil areas.
- Alien plant regrowth should also be monitored, and any such species should be removed during the construction phase.

Land Resource Protection Measures (Managements Control)

(1) For occupied agricultural land, surface soil should be preserved and stacked in layers for soil improvement of newly reclaimed cultivated land, inferior quality or other cultivated land.

For temporary occupied agricultural land, after the completion of construction, soil restoration measures shall be taken, such as planting green manure crops to enhance soil fertility.

(2) During the construction around the farmland, the influence of the activities of the constructors and the mechanical rolling on the crops and the soil quality of the farmland shall be minimized; in the construction of the developed sections of the water network, the construction materials should be stacked to avoid the blockage and pollution of the irrigation water network caused by the construction activities, so as to protect the farmland as much as possible. In rainy season construction, temporary windproof and rainproof facilities should be adopted for material yard, and shielding measures should be taken for construction transport vehicles.

(5) Loss of species of special concern

Any loss of systems could possibly result in the loss of species of special concern within the habitats as a result of their destruction during the construction phase. The lack of any rainfall also seemed to precluded the early growth or appearance of species known to occur in the area so as precautionary step, it is important that all riparian areas are retained and allowed to function, as a number of protected species listed do occur within the region.

Twelve rare and endangered plants distributed along the line are included in the IUCN Red list and CITES appendices: Aquilaria malaccensis Lam., Tetrameles nudiflora, Mangifera sylvatica, Bhesa sinensis, Cephalotaxus griffithii Hook. F., Dipterocarpus turbinatus Gaertn.f.,Dipterocarpus retusus, Taiwania cryptomerioides Hayata , Craibiodendron stellatum, Caesalpinia sappan L, Holarrhena pubescens Wall.ex G.Don and Bretschneidera sinensis Hemsl. Most of the rare and endangered plants are located in the sensitive areas (such as forest parks and national parks). Through environmental protection route selection, the route scheme avoids all the environmental sensitive areas along the line, and reduces the impact of the work on rare and endangered plants as much as possible.

Significance of impact with mitigation

The impact would be rated as a regional impact due to the species under consideration and the lack of potential habitat still remaining. The impact would persist into the long-term however in view of the unlikely probability of finding such species the intensity of the impact would be Moderate

(Table below). The impact would be rated as Moderate without mitigation due to confidence in this assessment based in the reasons listed above.

Mitigation:

- All designs should include means to protect or maintain the current hydrological regime, thus maintaining and not impeding or diverting any surface water flows.
- Stormwater management systems should include energy dissipation structures to minimize the potential impact of erosion and sedimentation.
- Clearing of vegetation should be kept to a minimum, keeping the width and length of the earth works to a minimum and the floodplain / wetlands habitats identified should be retained within the development footprint in its current state.
- Construction activities should not exceed the proposed construction boundaries by more than 15 m to avoid the secondary impact of construction and increasing the areas that would require clearing and rehabilitation
- A search and rescue operation for both plants and fauna (particularly reptiles) must be initiated prior to the commencement of any construction once the required permits are in place. Applications must be submitted to the applicable department for the removal of any protected floral and faunal specie.
- Re-vegetation as part of a rehabilitation plan is always advocated, however due the nature of the vegetation, this may not be practical. It is suggested that the shallow topsoil layer be stockpiled separately from the subsoil layers, should the excavation exceed 0.5 m. When the construction has been completed, then the topsoil layers, which contain seed and vegetative material, should be reinstated last thus allowing plants to rapidly re-colonize the bare soil areas.
- Alien plant regrowth should also be monitored, and any such species should be removed during the construction phase.

(6) The potential spread of alien vegetation

Large areas contain alien plants, and these are mostly limited to disturbed areas or example.

Significance of impact with mitigation

With the above mitigation measures in place, the impact on the vegetation would remain within the site, with natural re-vegetation happening within a short time period, resulting in a Very Low impact significance with mitigation (Table below). This is also based on the fact that during the operational phase on-going clearing and maintenance practices will be employed by Myanma Railway.

Mitigation:

- Clearing of vegetation should be kept to a minimum, keeping the width and length of the earth works to a minimum.
- Re-vegetation as part of a rehabilitation plan is always advocated, however to the low annual rainfall (normal conditions), this may not be practical. It is suggested that the shallow topsoil layer be stockpiled separately from the subsoil layers, should the excavation exceed 0.5 m. When the construction has been completed, then the topsoil layers, which contain seed and vegetative material, should be reinstated last thus allowing plants to rapidly re-colonise the bare soil areas.
- Alien plant regrowth should also be monitored, and any such species should be removed during the construction phase.

Effect Analysis of Protective Measures (Managements Control)

(1) Tunnels and bridges are widely used in engineering design, which reduces the occupation of land and the destruction of vegetation; because railway is only a linear project, its ecological impact is limited, and the construction of the project will not lead to changes in biodiversity and floristic composition along the line.

(2) Animal resources are mainly distributed in mountainous forest areas. The bridge-tunnel ratio of this project is large, and a large number of culverts are set up, which can satisfy the animal activities and traffic on both sides. Rare and endangered animals are mainly distributed in mountainous areas. And railways pass through tunnels, so the railway construction has no obvious impact on them.

(3) Reasonable selection of spoil ground sites shall be made, establishment of complete drainage system shall be set up, greening and reclamation shall be done as soon as possible after the

abandoned soil has been removed, and adoption of restoration measures for soil can effectively control soil erosion and enhance soil fertility.

Significant of Impacts on Flora and Fauna Diversity

The main effect of the proposed project is likely to be permanent loss of habitat for a range of plants and animals and habitat types due to land take. There may also be temporary loss of land during construction. This is likely to affect all the plants, animals and habitat types. Long-term or permanent effects and short-term effects on natural ecological systems and wildlife would be anticipated as a result of construction period. Long-term or permanent effects on vegetation, including sensitive plant communities, would occur from permanent structures (e.g., track, stations), clearing for construction, staging of equipment, and stockpiling of soil, ballast, or other construction materials. Short-term effects on adjacent habitats and their corresponding wildlife would be caused by noise, vibration, and air pollution from construction equipment and activities. Higher-speed and high-speed rail service types would have more effects during construction because some or all of the alignment would be constructed in a new corridor. Impacts from the development during the construction period could include disturbance to, loss of and damage to (i.e. pollution) habitats of biodiversity value. In addition, there is potential for any protected species utilizing these habitats to be killed, injured or disturbed and their resting and / or breeding places destroyed, damaged or disturbed. Furthermore, there is the potential for designated sites / their associated features to be impacted through pollution events.

The impact on fauna diversity will be minimal due to the site had already cleared by human activities and very little fauna species are found within the project site (direct impact zone). However, there will be a little impact on surrounding fauna diversity (indirect impact zone), due to the construction noise.

Mitigation Measures for Impacts on Fauna Diversity

To minimize construction effects and minimize disturbance of terrestrial and aquatic habitats and wildlife, BMPs would be used during construction. BMPs (Best Management Practices) would include but are not limited to the following

- Construct multiple and varying crossing structures at a wildlife crossing point to provide connectivity for species likely to use a given area.
- Determine and construct the appropriate number, spacing, and location of crossing structures based on species-specific information.
- Monitor structures for obstructions, such as detritus or silt blockages, that impede movement
- Manage human activity near crossing structures, with use of measures such as fencing and signage.
- Routes outside existing transportation corridors could be designed with alternative pathways or under crossings to maintain wildlife migratory paths or corridors.

Local ordinances would be followed for erosion, sediment, and storm-water controls during construction to minimize potential effects on aquatic resources. For terrestrial habitats that might be temporarily disturbed by construction, pre-construction conditions or better would be restored once construction is complete.

Residual Impact on Biodiversity during Construction Phase

The intensity of the impact on the biodiversity environment during construction phase is initially very low, so there would be no residual impact after conducting the mitigation measures.

(c) Impacts on Human Environment

Total of 500 people are employed during the construction period (5years) and this is shown in the following table.

Duration	Job Opportunity	Machinery and Equipment	Units
5years	500	Truck	6
		Bulldozer	2
		Excavator	2
		Concrete mixer	2
		Compactor	1
		Motor grades	1
		Generator	1
		Paver	1

6.2.2.5. Anticipated Impacts and Mitigation Measures on Socio-economic Environment during Construction Phase

(a) Positive Socio-economic Impact

The potential positive social impacts during construction phase is as follow:

(i) Job Creation

The proposed project will provide about the employment opportunities for local people during construction phase.

Impact Significance of Job Creation without Enhancement Measures

According to the primary data collection by household survey, almost all of the local people are not practiced to construction activities. Nevertheless, there has jobless persons in nearest villages and job creation during construction phase can be considered as low without enhancement measures as follow:

Anticipated Impact	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Potential to Increase in household income	Positive (+)	Limited (+2)	Medium term (+3)	Medium (+3)	Intermittent (+2)	Probable (+3)	Low (+40)

Consideration of Enhancement Requirement for Job Creation

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Potential to Increase in household income	Low (+40)	Yes	Yes	Moderate	Construction Service Provider(s)

Enhancement Measures for Job Creation during Construction Phase

The project developer will do the following mitigation measures for ensuring job opportunities for local people.

(a) Training program for welding will be opened before the construction phase.

(b) Unskilled and semi-skilled job opportunities will be offered to the local communities as much as possible.

(c) As the population of females is slightly higher than that of males in the township, employment opportunities for construction works will be created to ensure that the local female population also has equal chance for these opportunities (Gender Equality).

(d) The developer will encourage construction sub-contractor to use local labor force as part of tender requirement.

Impact Significance of Job Creation after Enhancement Measures

If job creating is provided to local people, the impact will become low after enhancement actions as follow:

Anticipated Impact	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Potential to Increase in household income	Positive (+)	Limited (+2)	Medium term (+3)	Medium (+3)	Very often (+4)	Highly probable (+4)	Low to Moderate (+64)

Job opportunities for local people is one of the most public needs according to the primary data collection and through public meeting. So, the project developer will intensely consider to create job opportunity for local people during construction phase.

(ii) Skill Development for Local People

Local people hired by the proposed project would remain in communities with skills acquired during project construction including concrete work for offices and other facilities, steel work for oil tanks and stone work for retaining wall. Communication skills for local people will also improve in office works during construction period.

Impact Significance of Skill Development without Enhancement Measures

According to the primary data collection, most of the sub-contractors for minor construction works in nearest villages are not too familiar with modern construction technique. So, the impact significance of local skill development during construction phase without enhancement measures can be considered very low as follow:

Components	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Local skill development	Positive (+)	Local (+3)	Long term (+4)	Low to Moderate (+3)	Intermittent (+2)	Very Seldom (+1)	Low (+30)

Consideration of Enhancement Requirement for Skill Development

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Local skill development	Low (+30)	No	Yes	Minor to Moderate	Construction Service Provider(s)

Enhancement Measures for Skill Development for Local People

The project developer will do the following enhancement measures for local skill development.

(a) Training programs (e.g. maintaining of vehicles, welding, wiring, masonry building etc.) will be implemented prior to and during the construction phase because majority of the local people may not be adequately skilled to qualify for positions requiring skilled labor, if required.

(b) Local construction sub-contractors will be chosen as first priority during tender process.

(c) The project developer will encourage construction contractors and sub-contractors to stimulate local skill development as part of tender requirement.

Impact Significance of Skill Development after Enhancement Measure

Skill development for local people will be great benefit for local engineers near the construction sites. However, local skill development is not the public needs according to the public consultation. So, the impact significance of local skill development during construction phase can be considered as low to moderate after enhancement measures as follow:

Components	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Local skill development	Positive (+)	Local (+3)	Long term (+4)	Low to Moderate (+3)	Intermittent (+2)	Highly Probable (+4)	Low to Moderate (+60)

(iii) Potential to Growth of Local Economy and Businesses

There will be benefit for local economy if the required food and consumer goods for construction workers are bought from nearest villages. There will be potential to growth local business and enterprise if the developer will buy construction materials from local market and helping hand construction related services from local.

Impact Significance of Growth of Local Economy and Businesses without Enhancement Measures

Since the construction period is 5 years, the required food and consumer goods are bought from the nearest villages. According to the primary data collection, there are no construction contractors and business for construction materials in nearest villages. So, this kind of impact during construction period will be considered as very low for local people in nearest villages and low for local business without enhancement measures as follow:

Components	Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Growth of local economy	Growth of economy in nearest villages	Food and consumer goods for construction workers	Positive (+)	Local (+3)	Short term (+2)	Low to medium (+3)	Regular (+3)	Seldom (+2)	Low (+40)
	Growth of business in nearest villages	Supply of construction services and materials	Positive (+)	Local (+3)	Short term (+2)	Low (+2)	Intermittent (+2)	Very Seldom (+1)	Very Low (+21)

Consideration of Enhancement Requirement for Growth of Local Economy and Business

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Growth of economy in nearest villages	Low (+40)	No	Yes	Minor to Moderate	Construction Service Provider(s)
2.	Growth of business in nearest villages	Very Low (+21)	No	Yes	Minor to Moderate	Construction Service Provider(s)

Enhancement Measures for Growth of Local Economy and Businesses

Any food and consumer goods that can be bought in nearest villages should be preferred as first priority. Local business for food and consumer goods in nearest villages should boost by buying required things regularly. The project developer should encourage construction contractors and sub-contractors to stimulate the emergence of local small business as part of tender requirement. The project developer should establish a policy to encourage services and materials from local in relation to construction works. Any construction services and construction materials that can be available in nearest villages should be preferred as first priority if feasible and should encourage construction contractors and sub-contractors to stimulate the emergence of local small business as part of tender requirements. But after the construction period is over, the construction site should be restored as the normal condition and make sure there would be no permanent business left in the construction site.

Impact Significance of Local Economy and Businesses after Enhancement Measures

Impact significance can be raised by enhancement measures as follow:

Components	Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Growth of local economy	Growth of economy in nearest villages	Food and consumer goods for construction workers	Positive (+)	Limited (+2)	Short term (+2)	Low Medium (+3)	Very often (+4)	Highly probable (+4)	Low to Moderate (+56)
	Growth of business in nearest villages	Supply of construction services and materials	Positive (+)	Limited (+2)	Short term (+2)	Low to medium (+3)	Intermittent (+2)	Probable (+3)	Low (+35)

Comments for Growth of Local Economy and Businesses

As some parts of the places along the proposed project are just developing, the boost in local economy will have advantage for local people during construction period. The project developer should have policy to support local businesses, especially in nearest villages.

(b) Negative Socio-economic Impacts during Construction Phase

The negative socio-economic impacts during the construction phase are as follows:

(i) Traffic Congestion

Disruption of access to infrastructure or social resource due to construction activity will cause nuisance and to a certain extent additional cost to the public in terms of longer travel period due to diversion or traffic. It will also pose risk of accident to motorist at night if these blockages and disruption are not clearly demarcated.

Significant of Impacts on Traffic Congestion before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Traffic congestion	Construction activities	Negative (-)	Limited (-2)	Medium term (-3)	Low (-2)	Intermittent (-2)	Probable (-3)	Low (-35)

Consideration of Mitigation Requirement for Traffic Congestion

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Traffic congestion	Low (-35)	Yes	Yes	Minor to moderate	Construction Service Provider(s)

Mitigation Measures

To avoid disruption of the existing traffic due to construction activities, comprehensive traffic management plan shall be drawn up by the contractor. Retro-reflectorized traffic caution signs shall be used during construction. Regular safety audit or periodic review shall be made to assess the effectiveness of safety measures adopted during construction. According to the traffic count results, in weekend day, the peak period hours is 4:00-7:00pm, and in the work days, the peak period hour is 7:00-10:00 am. So, the transportation of the construction materials should avoid the peak period hours.

Significant of Impacts on Traffic Congestion after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Traffic congestion	Construction activities	Negative (-)	Limited (-2)	Medium term (-3)	Very low (-1)	Intermittent (-2)	Seldom (-2)	Very low (-24)

(ii) Livelihood and Economic Activity

During construction stage, disruption of the livelihood and economic activities of businesses which are located along the route is expected. These businesses will get hampered because of traffic congestion, inability to park vehicles, and temporary loss and/or impedance of access to such business premises. The partially affected structures may have space to rebuild in the same land but, the fully affected structures must be relocated elsewhere. There are employees working in these commercial places. When the structures are partially affected, there will be temporary impact on the businesses and the employees may lose income temporarily. However, if the commercial places are fully affected and if they need to be relocated elsewhere, there can be permanent impact. The income of employees working in these commercial places will also be affected. They may have to find other jobs or will have to face difficulties until the businesses are re-established. There will also be an impact on paddy lands where Depot is proposed and paddy land owners and tenant farmers may permanently lose their livelihood. The Project may also impact people whose livelihood is linked with existing modes of transportation due to inaccessible roads and/or worsened traffic conditions.

Significant of Impacts on Livelihood and Economic Activity before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Livelihood and economic	temporary loss and/or impedance of access to such business premises	Negative (-)	Limited (-2)	Medium term (-3)	Low (-2)	Intermittent (-2)	Probable (-3)	Low (-35)

Consideration of Mitigation Requirement for Livelihood and Economic Activity

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Livelihood and activity	Low (-35)	No	Yes	Minor	Construction Service Provider(s)

Mitigation Measure

The proposed project has significant impact on livelihood and economic activities of commercial property owners, residential property owners and paddy land owners. Special attention will be paid to these affected people to mitigate the impacts on them. Compensation will be paid to the affected parties according to the stipulations of the Land Acquisition Act (LAA) and Land Acquisition and Resettlement Committee (LARC). Payments for loss of business (temporary or permanent), loss of livelihood, loss of wages employment will be provided to affected parties, as compensation. Further, there are stipulations in the LARC on an ex-gratia payment for paddy lands to be acquired. The livelihood of the persons occupying in business premises and residences will be temporarily disturbed by the construction of the proposed project and following mitigation measures in summary will be implemented.

- Provision of compensation to the Project Affected Parties (PAPs) using the compensation
- Package decided for proposed project based on LARC (Land Acquisition and Resettlement Committee) stipulations on assessing the financial and other losses of PAPs.
- Provision of alternative access to their premises as far as possible outside the construction sites to carry out their usual business activities and other domestic or related employment activities.
- Continual liaising with the Project Affected Parties (PAPs) will be undertaken to decide on the site-specific mitigation measures.
- Consultation with people whose livelihood depend on modes of transportation that may be affected by the project. They will be included in the development of the traffic management plan.

Significant of Impacts on Livelihood and Economic Activity after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Livelihood and economic	Traffic congestion	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Intermittent (-2)	Seldom (-2)	Very low (-24)

(iii) Blockage of Drainage System

There will potential to blockage of drainage system during earth filling for railway during pre-construction phase. This kind of impact can be considered as medium to high due to the possibility of flash flood in nearest farm lands as shown in the following.

Significant of Impacts on Livelihood and Economic Activity before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Potential to Blockage of drainage system	Earth filling	Negative (-)	Limited (-2)	Medium term (-3)	High (-5)	Regular (-3)	Highly Probable (-4)	Low to moderate (-70)

Consideration of Mitigation Requirement for Livelihood and Economic Activity

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Potential to Blockage of drainage system	Low to moderate (-70)	Yes	Yes	Moderate	Construction Service Provider(s)

Mitigation Measures for Blockage of Drainage System

MR will use alternative waterway (manmade drainage system that can drain the large water volume) to avoid potential to flood due to the blockage of natural drainage system during pre-construction phase. According to the site survey, there will potential to blockage of natural drainage system, blockage of village road and natural spring due to the construction of railway alignment. The alternative water way will prepare to flow the water volume more than natural

drainage system to reduce potential to flood. Potential changes in hydrological regimes of creeks due to waterways blockages by proposed project activities will have negative impact not only on flowing characteristic along the longitudinal profile of creeks but also on surface water volume area of creeks. Review on outcomes of public stake holder meetings and focus group discussion reveal that nearest villages is likely to have flooding effect resulting from existing creek is essential to be utilized as drainage facilities to discharge the harvested rain water from neighboring paddy fields in the rainy season and tidal wave period.

Significant of Impacts on Livelihood and Economic Activity after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Potential to Blockage of drainage system	Earth filling	Negative (-)	Limited (-2)	Medium term (-3)	Low to moderate (-3)	Regular (-3)	Seldom (-2)	Low (-40)

(iv) Conflict between Communities

The types of violent and aggressive conflict between non-Shan communities and Shan Ethnic Minority were overwhelmingly perceived to be one-off incidents between individuals from different communities and exposures that were often fueled by alcohol and anti-social behavior, and not always related to the migrant's ethnic origin. The sporadic and "one off" nature of these incidents were reported by all the communities – both migrant and local, across urban and rural communities alike. A higher frequency of violence and abuse could probably be among ethnic minority groups especially Shan and non-Shan migrants in the project construction area, perpetrated by individuals from both immigrants and other ethnic minority groups. A significant conflict between individual communities could be a higher frequency of incidents of name-calling, spitting, hostile attitudes, damage to property and racially motivated violence against them. This would suggest that the dynamics of race and religion negatively influence the sort of reception that the communities receive. The other significant social problems between communities may be the hostile attitudes of non-Shan migrants to local community such as sexual harassment of migrant workers to ethnic local women and hostility of that workers to low skilled local labors.

Significant of Impacts on conflict between communities before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Conflict between communities	Increase in workers	Negative (-)	Limited (-2)	Medium term (-3)	Low (-2)	Intermittent (-2)	Seldom (-2)	Low (-28)

Consideration of Mitigation Requirement for Conflict between Communities

The intensity of mitigation requirement for conflict between communities according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Conflict between communities	Low (-28)	Yes	Yes	Minor	Construction Service Provider(s)

Mitigation Measures for Conflict between Communities

- Use local people as much as possible.
- Limit night out for foreign workers.
- Limit the use of foreign workers.
- When making an agreement contract with contractors and subcontractors, it must include the fact that they have to use local workers as much as possible.
- Raise awareness to respect custom of local people for foreign and migrant workers.

Significant of Impacts on conflict between communities after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Conflict between communities	Increasse in workers	Negative (-)	Limited (-2)	Medium term (-3)	Very Low (-1)	Rare (-1)	Very Seldom (-1)	Very Low (-12)

(v) Impacts Associated with Social Services

The increase of population during construction phase will increase temporary pressure on existing infrastructure and services including health care, food, shelter, water, transport and recreational facilities.

Significant of Impacts Associated with Social Services without Mitigation Measures

As some parts of the proposed project is very close to urban area, there will have little impact on local health care facilities and local food consumption. Moreover, the requirements for housing and water for construction workers will be provided by the project developer inside the project site and no more facilities are required. Impact significances related to population influx during construction period will be considered as follow:

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Increase pressure on housing, recreational facilities, and water	Increase in population	Negative (-)	Limited (-2)	Short term (-2)	Very low (-1)	Continuous (-5)	Probable (-3)	Low (-40)
Increase pressure on health care facility	Increase in population	Negative (-)	local (-3)	Short term (-2)	Low to Moderate (-3)	Regular (-3)	Highly Probable (-4)	Low to moderate (-56)
Increase pressure on adequate amount of local food	Increase in population	Negative (-)	Limited (-2)	Short term (-2)	Very Low (-1)	Continuous (-5)	Very seldom (-1)	Low (-30)

Consideration of Mitigation Requirement for Impacts Associated with Social Services

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Increase pressure on housing, recreational facilities, and water	Low (-30)	Yes	Yes	Moderate	Construction Service Provider(s)
2.	Increase pressure on health care facility	Low to moderate (-56)	Yes	Yes	Moderate	Construction Service Provider(s)
3.	Increase pressure on adequate amount of local food	Low (-30)	Yes	Yes	Moderate	Construction Service Provider(s)

Mitigation Measures for Impacts Associated with Social Services

All of the impacts due to increase in population can be mitigated by appointing local construction workers and it will also reduce pressure on health care facilities for construction workers. No mitigation measures are required for pressure on housing, recreational facilities and water for additional workers because the impact rating is very low. Similarly, impact significant of pressure on local food consumption is very low and no mitigation measure is required. All of the impacts associated with population influx can be minimized by the use of local labor force. Own health care facilities will be supported to workers during construction period.

Significant of Impacts Associated with Social Services after Mitigation Measures

All of the impacts due to increase in population can be mitigated by appointing local construction workers and it will also reduce pressure on health care facilities for construction workers. Own health care facilities should be provided for workers during construction phase. So, impact on health care facility due to population influx will be very low after mitigation measures as follow:

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Increase pressure on housing, recreational facilities, and water	Increase in population	Negative (-)	Site (-1)	Short term (-2)	Low to Moderate (-3)	Intermittent (-2)	Seldom (-2)	Very Low (-24)
Increase pressure on health care facility	Increase in population	Negative (-)	Limited (-2)	Short term (-2)	Low to Moderate (-3)	Intermittent (-2)	Seldom (-2)	Low (-28)
Increase pressure on adequate amount of local food	Increase in population	Negative (-)	Limited (-2)	Short term (-2)	Very Low (-1)	Regular (-3)	Very seldom (-1)	Very Low (-20)

(vi) Increase in Crime and Security

An inflow of skilled migrant construction workers and their dependents from other areas may increase in social pathologies and crime including drug and alcohol abuse, assault, theft and violence in nearest villages.

Impact Significance of Increase in Crime and Security before Mitigation Measures

The impact can be considered as moderate without mitigation measures and the impact rating is as follows:

Components	Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Increase crime and security	Public security	Migrant construction workers	Negative (-)	Limited (-2)	Short term (-2)	Low to moderate (-3)	Intermittent (-2)	Probable (-3)	Low (-35)

Consideration of Mitigation Requirement for Increase in Crime and Security

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Increase crime and security	Low (-35)	Yes	Yes	Moderate	Construction Service Provider(s)

Mitigation Measures for Increase in Crime and Security

This kind of impact can be mitigated by the use of local labour force as much as possible. The developer should encourage the construction contractors or sub-contractors to ensure that the local community communicates their expectations of construction workers' behavior, and formalize between the community and them. The developer also needs to continue to work with the local and regional police personnel and local administrative members in the resolution of potential increase in crime and violence. Management of construction camp should be adequately formalized and have communication channels with local police force in order to take measures for any inappropriate behavior that may occur. Construction workers should be clearly identifiable. Construction site should be fenced and all of the construction workers should not allow going out at night. Security force should be organized and trained to put a stop to crime and violence.

Impact Significance of Crime and Security after Mitigation Measures

After systematically control of foreign and migrant workers and continuous cooperation with local administrative office and police force, the impact will be low as follow:

Components	Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Increase crime and security	Public security	Migrant construction workers	Negative (-)	Limited (-2)	Short term (-2)	Low (-2)	Rare (-1)	Very Seldom (-1)	Very Low (-12)

(vii) Impact to Tradition of Shan

According to the primary and secondary data collection, most of the people are Shan/Buddhist and the influx of people due to the operation of railway will have impact on traditional of Shan. Sudden improvement of infrastructures and influx of different people with different life style from another place can have impact on traditional and custom of local people in general.

Impact Significance of Impact on Traditional of Shan before Mitigation Measures

The impact will be considered as low to moderate because it is the most public concerns during social survey and public meetings.

Components	Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Impacts to Customs of Shan	Traditional and religious	Increased in population	Negative (-)	Local (-3)	Medium term (-3)	Moderate (-4)	Regular (-3)	Probable (-3)	Low to Moderate (-60)

Consideration of Mitigation Requirement for Impact on Tradition of Shan

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Impacts to Customs of Shan	Low to Moderate (-60)	Yes	Yes	Moderate	Construction Service Provider(s)

Mitigation Measures for Impacts to Custom of Shan

The developer should encourage the visitors to know about the custom and behaviors of local people (Customs of Shan). Gallery of custom of Shan should be constructed during the construction of Railway (especially in Station and tunnel portal). Local dancers for Shan Culture should be taken every celebrations patty related to railway.

Impact Significance of Impact on Custom of Shan after Mitigation Measures

The impact will be considered as low after mitigation measures as follow:

Components	Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Impacts to Customs of Shan	Traditional and religious	Increased in population	Negative (-)	Local (-3)	Medium term (-3)	Low to moderate (-3)	Regular (-3)	Seldom (-2)	Low (-45)

Comments for Impact on Custom of Shan

Although the developer can have difficulties about to change the minimum requirements of railway station and tunnel portal, it is necessary to put culture and custom of Shan Gallery inside the Railway Station or near the Railway recreation places. It is one of the most public concerns during social survey.

(viii) Impacts due to Population Influx

The social impacts described in the pre-construction phase will continue into the construction phase with more workers, increased number of work locations, more frequent transportation of construction materials as additional workers are brought in to complete the work, the risk of social conflicts, risks of spread of communicable diseases, health and safety risks, waste generation and sewage and increased pressure on resources, are all expected to increase. As news regarding the proposed project spreads, expectations regarding possible employment opportunities may also take root. Consequently, the area surrounding the site or construction areas may experience an influx of job seekers. The magnitude of this impact depends on the severity of unemployment in surrounding areas. It could be expected that migrant labors will flock to the area. It is likely that a large enough number of job seekers will flock into the area to have fairly significant population impact on the immediate social environment. This population increase may impact on the area in terms of additional demand for services and infrastructure.

An influx of newcomers seeking opportunities associated with the project could also create various social problems. Tension or conflict can be created as a result of religious or ethnic rivalries. Single men predominately occupy the construction camps which could create social conflicts, usually as

a result of cultural differences, alcohol abuse or being away from their wives or girlfriends for extended periods of time. A possible reason for conflict will be the perception among locals that the outsiders are taking up jobs that could have gone to unemployed members of the local community. An influx of unemployed job seekers could also add to the potential for conflict.

Significant of Impacts due to Population Influx before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Population Influx	Increase in people	Negative (-)	Local (-3)	Medium term (-3)	Low to moderate (-3)	Very often (-4)	Probable (-3)	Low to moderate (-63)

Consideration of Mitigation Requirement for Impacts due to Population Influx during construction phase

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Population influx	Low to moderate e (-63)	Yes	Yes	Moderate	Construction Service Provider(s)

Mitigation Measures for Impacts due to Population Influx

Ensure that employment procedures and policy is communicated to local stakeholders, especially local Labor Department, and Local Administrative Offices.

- Have clear rules and regulations for access to the construction village to control loitering.
- Consult with local Labor Department to establish standard operating procedures for the control and removal of loiterers at the construction site.
- Construction workers will be clearly identifiable by wearing proper construction uniforms displaying the logo of the construction company. Construction workers must also be provided with identification tags.
- Unskilled job opportunities will be afforded to the local communities as far as possible. Even if Transnet uses a recruiting agency, the local Labour Department, and Local Administrative Offices will be utilised for recruitment process.

• Equal opportunities for employment will be created to ensure that the local female population also has access to these opportunities.

• Individuals with the potential to develop their skills will be afforded training opportunities.

• Mechanisms will be developed to provide alternative solutions for creating job security upon completion of the project.

• Payment will comply with applicable Labor Law legislation in terms of minimum wages.

• Indirect formal and / or informal employment opportunities to local individuals

• Through consultation with relevant key stakeholders, identify the segment that might benefit from informal indirect opportunities, and promote skills development and subsidisation initiatives that are sustainable.

• Encourage, in consultation with key stakeholders, construction workers to use local services.

• Raise awareness amongst construction workers about local traditions and practices.

• Inform local businesses about the expected influx of construction workers so that they could plan for extra demand.

• Ensure that the local community communicates their expectations of construction workers' behavior with the construction sub-contractor, and formalize a written agreement between the community and sub-contractor.

Significant of Impacts due to Population Influx after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Population Influx	Increase in people	Negative (-)	Local (-3)	Medium term (-3)	Low (-2)	Regular (-3)	Seldom (-2)	Low (-40)

(ix) Public Road Damage

The transportation of workers and construction materials can damage the damage to the public road but this impact would not be significant.

Significant of Impacts due to public road damage before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Public road damage	Construction activities	Negative (-)	Limited (-2)	Medium term (-3)	Low (-2)	Intermittent (-2)	Seldom (-2)	Low (-28)

Consideration of Mitigation Requirement for Impacts due to public road damage

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Public road damage	Low (-28)	Yes	Yes	Minor to moderate	Construction Service Provider(s)

Mitigation Measures

- Use bypass roads instead of public roads and bridges;
- Repair the roads as soon as possible if the public roads are damaged by the construction activities; and
- Use public roads as per resistance of roads if unavoidable.

Significant of Impacts due to public road damage after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Public road damage	Construction activities	Negative (-)	Limited (-2)	Medium term (-3)	Very Low (-1)	Rare (-1)	Very Seldom (-1)	Very Low (-12)

(x) Controversy with EAOs

The proposed project can be in the vicinity of territory of Ethnic Armed Organizations. Thus, it can lead to controversy between EAOs and the parties taking part directly or indirectly in the project.

Significant of Impacts of Controversy with EAOs before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Controversy with EAOs	Construction activities	Negative (-)	Limited (-2)	Medium term (-3)	Low (-2)	Intermittent (-2)	Seldom (-2)	Low (-28)

Consideration of Mitigation Requirement for Impacts of Controversy with EAOs

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Controversy with EAOs	Low (-28)	No	Yes	Minor	Construction Service Provider(s)

Mitigation Measures of Controversy with EAOs

- Have transparency in every development of the project.
- Inform the EAOs before any development of the project.
- Discuss and negotiate with EAOs if any conflicts occur.

Significant of Impacts of Controversy with EAOs after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Controversy with EAOs	Construction activities	Negative (-)	Limited (-1)	Medium term (-3)	Low (-2)	Rare (-1)	Very Seldom (-1)	Very Low (-12)

Residual Impact on Socio-economic during Construction Phase

The impact on livelihood and economic of the community is still be residual because the commercial places are fully affected and need to be relocated somewhere else and so the income will be affected. This also impact people whose livelihood is linked with existing modes of transportation. The permanent land loss will cause effects on the agricultural activity. The impact on the community due to loss of property such as paddy fields because of the risk of fire and electrocution of the train operation would be residual.

Mitigation:

Land loss is not sufficiently large to result in a material effect through diminishing the quality of life as replacement could be made in locality or be compensated for. Payments for loss of business (temporary or permanent), loss of livelihood, loss of wages employment will be provided to affected parties, as compensation.

6.2.2.6. Anticipated Impacts and Mitigation Measures on Archaeology and Cultural Heritage during Construction Phase

Construction of the proposed railway and station complex has the potential to disturb, damage or destroy features or buried remains of cultural heritage interest. Other construction activities, such as vehicle movements, soil and overburden storage and landscaping also have the potential to cause direct permanent and irreversible effects on the cultural heritage.

Impacts on Anthropology Site

Due to the construction activities of the railway alignment, the fossils of the buried remains can be disturbed.

Mitigation Measures

If the buried remains of the fossils are found while construction activities, inform the Department of Archaeology, National Museum and Library, and Department of Historical Research.

***Significant of Impacts on Archaeology and Cultural Heritage* before mitigation measures**

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Impact on archaeology and cultural heritage	Vehicles movements, soil and overburden storage and landscaping	Negative (-)	Limited (-2)	Medium term (-3)	Low (-2)	Intermittent (-2)	Seldom (-2)	Low (-28)

Consideration of Mitigation Requirement for Archaeology and Cultural Heritage

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Impact on archaeology and cultural heritage	Low (-28)	No	Yes	Minor	Construction Service Provider(s)

Mitigation

Mitigation measures designed to prevent, reduce or offset any potential direct adverse effects will be identified. Where artifacts of historic interest in relation to the railway's previous use are

identified they may be incorporated into the proposed development, avoided through design and preserved in situ unaffected by the proposed development, or recorded prior to their removal. Environmental Team to determine the need for and scope of a potential mitigation strategy. Potential mitigation may include a programmed of archaeological works designed to identify, characterize and record buried archaeological remains. Avoid the archaeological site that will be pointed out by heritage advisors, and an archaeological evaluation. In the event of any discoveries, further mitigation through recording and publication of the results of any excavations may be required in line with the requirements of planning policy.

***Significant of Impacts on Archaeology and Cultural Heritage* after mitigation measures**

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Impact on archaeology and cultural heritage	Vehicles movements, soil and overburden storage and landscaping	Negative (-)	Limited (-2)	Medium term (-3)	Very Low (-1)	Rare (-1)	Seldom (-2)	Very Low (-18)

Residual Impact on Archaeology and Cultural Heritage during Construction phase

The residual impact on the archaeology and cultural heritage during the construction phase is negligible after conducting the described mitigation measures.

Community Health Impact and Mitigation Measures during Construction Phase

During construction phase, the anticipated health related impacts are as follows:

(a) Increase Infection of Air-borne Diseases

An influx of construction workers from other places can lead to overcrowded conditions where air-borne diseases such as tuberculosis, influenza and meningitis can spread easily.

Impact Significance for Increase Infection of Air-borne Diseases

According to the secondary data collection, infections of TB is one of the common diseases in Upper Myanmar. So, impact rating for air-borne diseases will be considered as follow:

Who will affected?	Magnitude/Consequence of impact			Likelihood/Probability of impact			Health Impact Significance Rating		
	Low	Medium	High	Unlikely to occur	Likely to occur sometimes	Likely to occur often	Low	Medium	High
People in nearest residents	√	-	-	-	√	-	√ (HIR 1)	-	-
Construction workers	-	√	-	-	√	-	-	√ (HIR 2)	-

Mitigation Measures for Infection of Air Borne Diseases

This potential impact will be minimized by providing medical check for workers who are susceptible infection of air-borne diseases.

(b) Fugitive Dust Emissions

During construction phase, the main source of air pollution will be dust generation due to site clearing, ground levelling activities, construction activities and transportation of construction materials. Dust will expose the construction workers and some local people in nearest villages to bronchial and other respiratory tract diseases.

Impact Significance for Fugitive Dust Emissions

The impact will be mainly on construction workers within the project and little on local people in nearest villages.

Who will affected?	Magnitude/Consequence of impact			Likelihood/Probability of impact			Health Impact Significance Rating		
	Low	Medium	High	Unlikely to occur	Likely to occur sometimes	Likely to occur often	Low	Medium	High
People in nearest residents	√	-	-	-	√	-	√ (HIR 1)	-	-
Construction workers	-	√	-	-	√	-	-	√ (HIR 2)	-

Mitigation Measures for Fugitive Dust Emission

Dust can be controlled by:

(a) Wetting of roads by water spraying;

(b) Seeding storage mound surfaces as soon as is practicable;

(c) Spraying exposed surfaces of mounds regularly;

(d) Restricting vehicle speeds;

(e) Watering roadways; and

(f) Wheel or body washing.

(c) Increase Infection of Water Borne Diseases

Project activities could become sources of pollution, as a result of infiltration into the surface stream. The incidence rate of water borne diseases such as cholera and diarrhea will increase if there will be no proper sanitation practices at the construction site. Improper waste disposal of construction debris will also have potential to increase water borne diseases because the project site is very close to surface water resources. The possible negative impacts considered significant are:

- Loose soil from earthworks may be washed into river.
- Irresponsible dumping of domestic solid waste can lead to underground water contamination, due to contaminants emanating from various products into the groundwater and filtering through to the aquifers. This will be a particular problem during the rainy season.
- Potential surface water pollution can emanate from waste products generated by construction activities entering the surface drainage.

Impact Significance for Increase Infection of Water Borne Diseases

According to the secondary data collection, infections of water borne diseases such as diarrhea are still the public healthcare problems in Upper Myanmar Region and so the impact will be considered as follow:

Who will affected?	Magnitude/Consequence of impact			Likelihood/Probability of impact			Health Impact Significance Rating		
	Low	Medium	High	Unlikely to occur	Likely to occur sometimes	Likely to occur often	Low	Medium	High
People in nearest residents	√	-	-	√	-	-	√ (HIR 1)	-	-
Construction workers	-	√	-	-	√	-	-	√ (HIR 2)	

Mitigation Measures for Increase Infection of Water Borne Diseases

Avoid construction time during rainy seasons. If it is not possible to avoid rainy seasons, proper sanitation system will be provided for construction workers during construction period. Construction debris will be disposed at suitable location that does not impact on local nearest rivers. Construction activities will ensure that no loose soil is permitted into watercourses and stockpiles are located away from surface water. All mixing of cement will be carried out in a designated area away from surface water and areas of potential runoff. All areas of fuel storage will be banned to prevent hydrocarbon pollution of surface water.

(d) Potential to Increase Infections from Mosquito

Stagnant pools of water during the construction phase will cause bleeding zone for mosquitoes and can cause potential to cause infections from mosquitoes especially in rainy season.

Impact Significance of Infections from Mosquito

The impact can be rated as medium because malaria is still a health problem in Upper Myanmar Region.

Who will affected?	Magnitude/Consequence of impact			Likelihood/Probability of impact			Health Impact Significance Rating		
	Low	Medium	High	Unlikely to occur	Likely to occur sometimes	Likely to occur often	Low	Medium	High
People in nearest residents	√	-	-	√	-	-	√ (HIR 1)	-	-
Construction workers	-	√	-	-	√	-	-	√ (HIR 2)	

Mitigation Measures for Infections from Mosquito

Avoid construction time in rainy seasons as much as possible. Ensure that there are no stagnant pools of water during the construction phase. Proper temporary or permanent drainage system will be compensated if there will be the blocked of natural drainage system during construction phase.

(e) Increase Risk of Sexually Transmitted Infections

During construction phase, the improved economic status of the area and the influx of new migrant workers, living away from their families, can also lead to an increased risk of sexually transmitted infections such as HIV/AIDS, gonorrhoea and chlamydia. Major outbreaks of infectious diseases can have a devastating effect not only on or near the project site but also on local communities.

Impact Significance of Increase Risk of Sexually Transmitted Infections

Impact rating for sexually transmitted infection (448 people in Upper Myanmar Region in 2017) can be considered as moderate in Upper Myanmar Region.

Who will affected?	Magnitude/Consequence of impact			Likelihood/Probability of impact			Health Impact Significance Rating		
	Low	Medium	High	Unlikely to occur	Likely to occur sometimes	Likely to occur often	Low	Medium	High
Local people in nearest villages	-	√	-	-	√	-	-	√ (HIR 2)	-

Mitigation Measures for Increased Risk of Sexually Transmitted Infections

MR will provide information and education about safe sex and implement HIV control program for migrant construction workers.

(f) Health Impact Related to Increase in Noise Level

Construction activities normally generate a lot of noise. Noises will also arise from various construction machineries at site. Pilling operation will also produce high noise level. Both acute loud noise and chronic lower level noise have been associated with a variety of negative health

effects. Hearing loss and impairment are known to occur as a result of exposure to acute, high decibel noise (greater than 85 dB). Noise annoyance can lead to stress related impacts on health such as feelings of displeasure, interference with thoughts, feelings, and activities and disturbed sleep and can have impacts on mood, performance, fatigue, and cognition.

Impact Significance of Increase in Noise Level

The impact will be considered as low for local people due to the distance of nearest villages and medium to construction workers inside the construction site as follow:

Who will affected?	Magnitude/Consequence of impact			Likelihood/Probability of impact			Health Impact Significance Rating		
	Low	Medium	High	Unlikely to occur	Likely to occur sometimes	Likely to occur often	Low	Medium	High
People in nearest residents	√	-	-	-	√	-	√ (HIR 1)		-
Workers at site	-	√	-	-	-	√	-	-	√ (HIR 2)

Mitigation Measures Health Impact Related to Increase in Noise Level

1. Reduce speed limits for trucks in the project area to reduce noise level.
2. Alert residents of anticipated noise, including time, duration, decibel levels, and machinery to be used to protect public health.
3. Avoid working at night.

(g) *Community Health and Safety*

There are anticipated temporary health impacts such as increase of stress levels of commuters and residents living nearby construction sites. Other impacts that may affect community health include noise, vibration, dust generation that may cause respiratory diseases and accidents.

Significant of Impacts on Community Health and Safety before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Community health and safety	Construction activities	Negative (-)	Limited (-2)	Medium term (-3)	Low to moderate (-3)	Very often (-4)	Probable (-3)	Low to moderate (-56)

Consideration of Mitigation Requirement for Community Health and Safety

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Community health and safety	Low to moderate (-56)	No	Yes	Minor	Construction Service Provider(s)

Mitigation Measure

Mitigation measures are required to protect people and work force from accidents in the work sites. The construction activities will be performed on existing roads and on elevated structures. The project will take optimum measures to assure the protection of people living, working and moving in the project areas. In order to mitigate the impact on health and safety risk of surrounding communities, following mitigation measures will be considered.

- The project site should be fully fenced and access points should not be available for the public.
- Temporary sanitary facilities should be provided at all construction sites, especially for the Depot site.
- Environmental pollution control measures, including watering standard maintenance of machinery will be implemented.
- Arrange construction activities and schedule to minimize the impact on surrounding communities (e.g. prohibit high noise generating activity on night time)

(h) Increased in Traffic

As the construction operations will last about 5 years, traffic flows can be increased by the activities such as increase in public unease will lead to increasing in traffic volumes to and from

the site. This will lead to an increase the risk of accidents to the employees and in the local community as well as present the potential for nuisance from the increase or if the traffic presents delays to the public. Additionally, equipment, material and construction debris in and out of the site not be secured correctly, there is a risk that this transported material could become a hazard and further increase the rates of accident and injury.

Significant of Impacts on Increased in Traffic before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Increased in traffic	Construction activities	Negative (-)	Limited (-2)	Medium term (-3)	Low to moderate (-3)	Very often (-4)	Probable (-3)	Low to moderate (-56)

Mitigation Measures for Increased in Traffic during Construction Phase

Traffic control plan which is to be prepared by the contractor, and ensuring that traffic into and out of the site will occur mainly during the daytime, especially for heavy machinery, and will do so in an ordered manner. In addition, the movement of heavy machinery during the construction phase will be limited to off-peak hours and prior notification will be provided to minimize the potential negative impacts of traffic on local communities. Affected communities will be notified regarding the construction schedule during the construction and rehabilitation phase. In addition, a traffic re-routing plan will be provided for the construction phase, with alternative routes delineated where feasible. Any road damage sustained by transportation of heavy equipment will be repaired.

Residual Community Health Impact during Construction Phase

The potential health impact on the residents nearest to the proposed project is very low in construction phase so there would be no residual impact.

6.2.2.7. Anticipated Visual Impacts and Mitigation Measures during Construction Phase

Since the proposed project site is very close to the popular tourist attraction place: Pyin Oo Lwin, Thi Paw and other tourist attraction places along the railway line, some local community depends

on the tourism business, the visual pollutants like construction materials and equipment impact on their visualization. The tracks of tyres on the public road during the rainy season can decrease the visual amenity. Visual intrusions arise from the inevitable presence of construction equipment, materials, transport vehicles, and piles of soil and debris during construction activities. If the storage, transportation and disposal of these waste materials are not managed properly, the waste will decrease visual amenity. There will have potential to visual impact as cumulative impact due to the potential to increase in industrial sector (gas pipeline, transmission line and railway).

Significant of Visual Impacts during construction phase before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Visual impact	Construction materials and piles of soil and debris	Negative (-)	Limited (-2)	Medium term (-3)	Low (-2)	Very often (-4)	Probable (-3)	Low (-49)

Consideration of Mitigation Requirement for Visual Impacts

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Visual impact	Low (-49)	No	Yes	Minor	Construction Service Provider(s)

Mitigation Measures for Visual Impacts

Visual impacts will be prevented through the installation of natural visual barriers and vegetation. Landscape management and site restoration plans will be in place with recommended mitigation measures. To decrease the project impacts on landscape and visual amenity, MR will be undertaken several steps as follows:

- Enclose the construction camp sites with non-transparent fencing to minimize the visual impacts on nearby areas;
- Prohibiting the parking of construction equipment, construction materials, and transport vehicles along public road;

- Wash the wheels of the vehicles before leaving the construction site;
- Site housekeeping to keep project area clean and limit visual intrusion; and
- Efficient and timely removal of all demolition and construction wastes as per requirements.

Significant of Visual Impacts during construction phase after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Visual impact	Construction materials and piles of soil and debris	Negative (-)	Limited (-2)	Medium term (-3)	Very Low (-1)	Intermittent (-2)	Seldom (-2)	Low (-24)

Residual Visual Impact during Construction Phase

The main source of visual impact during the construction phase is visual pollutants like construction materials and equipment. So, there would be no residual impact on visual after the construction period.

6.2.2.8. Anticipated Impacts and Mitigation Measures of Utility Consumption during Construction Phase

(a) Water Consumption

Huge water intake will be necessary during construction. The proposed project uses water for the mixing of cement, and for curing works. There would be an impact on the water usage of local community if the water source is from the local community. The water volume used for the construction processes depends on the site condition and construction method. The amount of water used by the domestic workers can be calculated as:

Maximum water consumption rate for a person per day = 200 gallons
Total workforce for construction = 500 employees
Water consumption rate per day (work force) = 100,000 gallons

Significance of Impact of Water Consumption before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Water scarcity	Construction activities	Negative (-)	Limited (-2)	Medium term (-3)	Medium (-4)	Regular (-3)	Probable (-3)	Low to moderate (-54)

Consideration of Mitigation Requirement for Water Consumption

The intensity of mitigation requirement for water consumption according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Water scarcity	Low to moderate (-54)	Yes	Yes	Minor to moderate	Construction Service Provider(s)

Mitigation Measures for Water Consumption

If the construction materials are prepared beforehand and not on the site, amount of water needed for construction processes will be reduced significantly. The construction activities like mixing concrete should not do in the dry season. Water from the rivers which are not used for the agricultural and domestic purposes should be taken for the construction activities. If the surface water is the source of the local community, the use of alternative ways like rainwater harvesting and from the groundwater source where the source is available, should be made. In areas where such sources cannot be used, springs or underground water from nearby villages can be an option. As spring water or underground water can be the only sources of water for villages unlike cities which have many water utilities companies, it is important to consider residents' opinion and make agreements or contracts with the head of the village. This way, there will be no further problem with the residents as the construction will take place for a long period of time. To reduce the water usage of the construction workers, dry type urinals will be used selectively. The following are the specific measures:

(a) Awareness campaign to disseminate knowledge on strategies and technologies that can be used for water conservation;

(b) New employees will be issued standard water information packed. The information should include water conservation plans, water conservation methods being adopted in the complex and a list of essential and nonessential water uses;

(c) Proper methods of water use will be placed in the toilets and other areas of water consumption; and

(d) Recycle the process water for the domestic purposes.

Significance of Impact of Water Consumption after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Water consumption	Construction activities	Negative (-)	Limited (-2)	Medium term (-3)	Low to Moderate (-3)	Intermittent (-2)	Seldom (-2)	Low (-32)

(b) Use of Topsoil

The total length of the railway alignment is 409.96km. So, there would need a huge amount of topsoil for the alignment construction. If the topsoil is taken from the nearby land like agricultural and farm land, there would be an impact on the environment and the local people.

Significance of Impact of Use of Topsoil before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Use of topsoil	Construction activities	Negative (-)	Limited (-2)	Medium term (-3)	Medium (-4)	Intermittent (-2)	Highly probable (-4)	Low to moderate (-54)

Consideration of Mitigation Requirement for Use of Topsoil

The intensity of mitigation requirement for use of top soil according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Use of topsoil	Low to moderate (-54)	Yes	Yes	Minor to moderate	Construction service provider(s)

Mitigation Measures for Use of Top Soil

If the topsoil is taken from the nearby land, the compensation should be made with the land owner. The important fact to consider is not to take, the soil from the land which can have impact on the environment and this should be avoided.

Significance of Impact of Use of Topsoil after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Use of topsoil	Construction activities	Negative (-)	Limited (-2)	Medium term (-3)	Low to moderate (-3)	Intermittent (-2)	Seldom (-2)	Low (-32)

(c) Use of Gravel

There would need a huge amount of subgrade materials like gravel. If gravels are made from the own stone crusher, there would be an impact on the environment, and the local community near the proposed project site.

Significance of Impact of Use of Gravel before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Subgrade material usage	Construction activities	Negative (-)	Limited (-2)	Medium term (-3)	Low to moderate (-3)	Regular (-3)	Probable (-3)	Low (-48)

Consideration of Mitigation Requirement for Use of Gravel

The intensity of mitigation requirement for the use of gravel according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Subgrade material usage	Low (-48)	No	Yes	Minor	Construction service provider(s)

Mitigation Measures for Use of Gravel

The first-grade gravel for the subgrade should be bought from the local agent. Making the subgrade gravels by the use of the stone crushers should be avoided.

Significance of Impact of Use of Gravel after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Subgrade material usage	Construction activities	Negative (-)	Limited (-2)	Medium term (-3)	Low (-2)	Regular (-3)	Seldom (-2)	Low (-35)

(d) Fuel Consumption

Construction operations consume huge amounts of energy in various forms but have never been sufficiently accounted for. A significant portion of energy utilization on construction site is usually used for transportation, levelling, earthworks, lifting, compacting and mixing, including the embodied energy in materials extraction. However, electricity cannot be directly used from existing power lines since the construction process takes place where there is no electricity and generators will be mainly used as the source of energy. The different forms of energy are used for different purposes in the construction process. For instance, diesel fuel is an important petroleum product and offers a wide range of performance, efficiency and safety features. It also offers a greater power density than other fuels. Petrol is also in used construction processes and is used for powering small petrol engines especially power tools, such as hammers and small compressors. Electricity is used for the operation of almost all the power tools or equipment on site. Fused distribution boards are used to enable easy plugging of power tools to the electrical source. The machines used in this process are divided into two; excavators (such as backhoes and pile driving machines) and tractors (bulldozer). Concreting processes require a significant amount of energy. The machines used in this process are; mixers, concrete pumps, placers, vibrators and conveyors and are either mechanically or pneumatically operated. Concreting and the type of equipment used have a large embodied energy in the ingredients used and the transportation process.

Significance of Impacts of Fuel Consumption before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Fuel consumption	Use of generators for construction activities	Negative (-)	Limited (-2)	Medium term (-3)	Medium (-4)	Intermittent (-2)	Probable (-3)	Low (-45)

Consideration of Mitigation Requirement for Fuel Consumption

The intensity of mitigation requirement for the fuel consumption according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Fuel consumption	Low (-45)	No	Yes	Minor	Construction service provider

Mitigation Measures for Fuel Consumption

Make minimal usage of fuel such as diesel and petrol that are used in operating machines for construction processes and transportation processes.

- Use construction machines efficiently.
- Train workers to gain the knowledge of energy conservation.
- Learn the efficient construction site management.
- Record and reduce electricity usage across the construction period.
- Turning off the equipment when it is not in use.

Significance of Impacts of Fuel Consumption after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Fuel consumption	Use of generators for construction activities	Negative (-)	Limited (-2)	Medium term (-3)	Low to medium (-3)	Intermittent (-2)	Seldom (-2)	Low (-32)

6.2.3. Anticipated Impacts and Mitigation Measures in Operation Phase

The anticipated environmental impacts during operation phase will be as follows:

(a) Impacts on air environment;

(b) Impacts on surface water environment;

(c) Impacts on soil and ground water environment;

(d) Impacts on biodiversity environment; and

(e) Impacts on human environment.

(a) Impacts on Air Environment during Operation Phase

(i) Impacts on Air Environment due to Gaseous Emissions

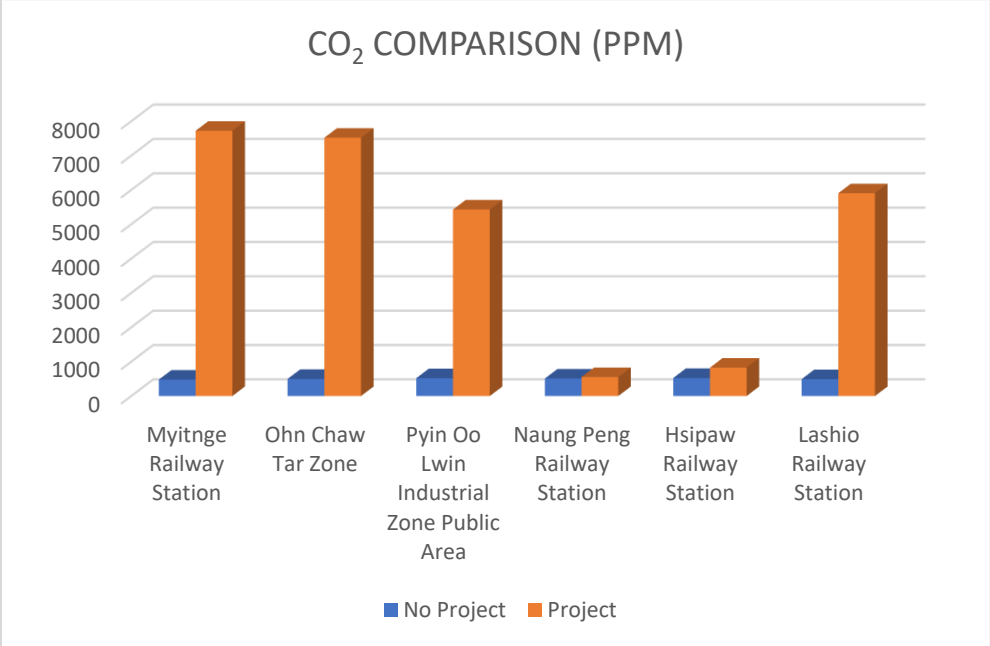
The impacts on air environment during the operation phase is from the emissions of gases from the vehicles and from the food stalls at the stations. So, there will have a little environmental impact on the environment but the impact would not be significant. The emissions during the operation phase is as shown below.

Comparison of Air Dispersion at Average 8 hours on No Project and Project Conditions (Operation Phase)

For the operation phase, as CO_2 is the most emission gas from a railway station and its dispersion is predicted at the railway stations. The concentration of CO_2 in a railway station is based on restaurants, motorcycles and cars. It is assumed to have 2 restaurants and, at least 20 motorcycles and 6 cars for traffic. The concentration of CO_2 is measured at average 8 hours in no project conditions, so the model is predicted at average 8 hours as in no project condition at each sample point. The concentration of CO_2 is shown in below.

Table – Average Concentration of CO_2 at each sample point for 8 hours in No Project and Project Condition

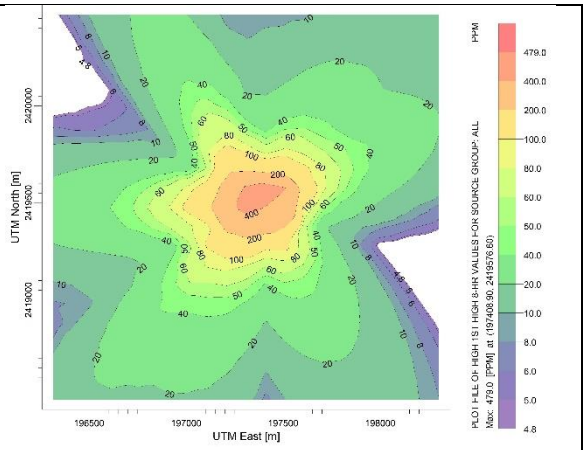
Sample Time	Sensitive Areas	CO_2 (ppm)	
		No Project	Project
Time 8 hours for each point	Myitnge Railway Station	479	7722
	Ohn Chaw Tar Zone	498	7521
	Pyin Oo Lwin Industrial Zone Public Area	519	5430
	Naung Peng Railway Station	509	552
	Hsipaw Railway Station	526	826
	Lashio Railway Station	491	5905



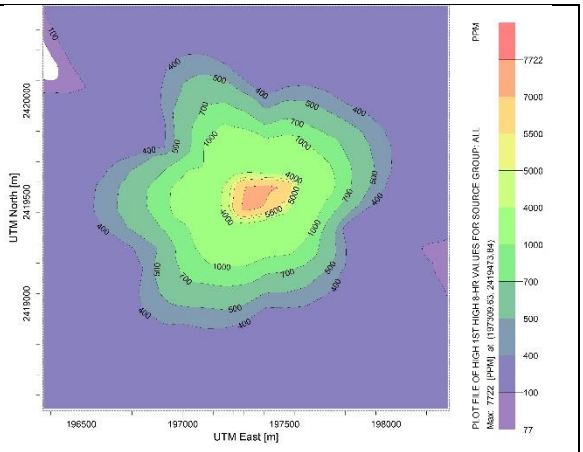
CO_2 Comparison for No Project and Project Conditions

Myitnge Railway Station

CO_2



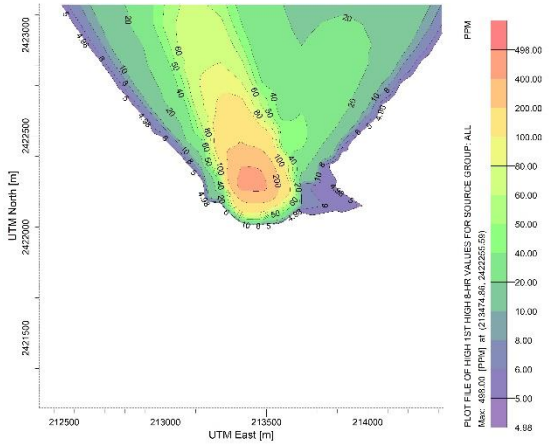
No Project Condition



Project Condition

Ohn Chaw Tar Zone

CO_2



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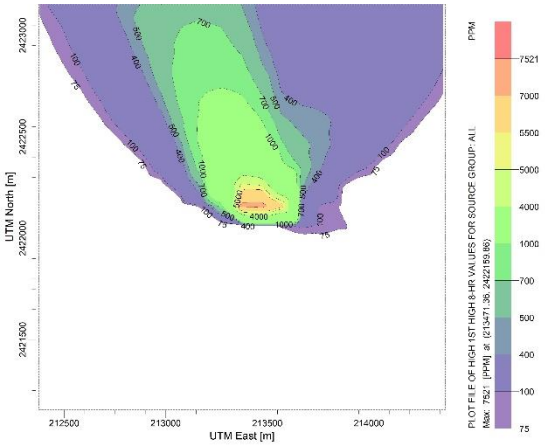
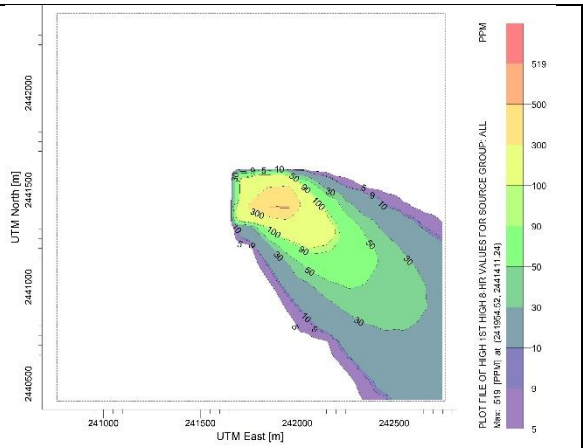


Project Condition

Pyin Oo Lwin Industrial Zone Public Area

CO_2



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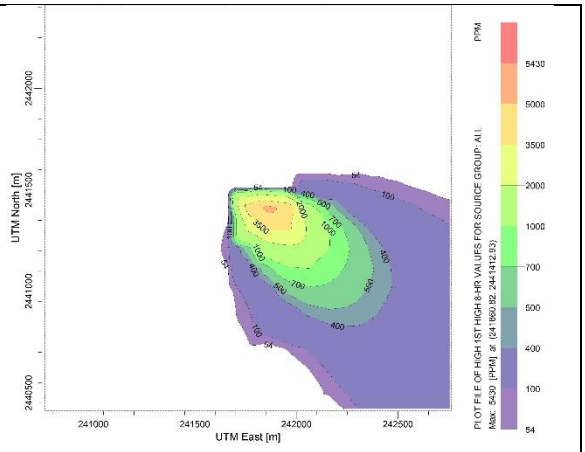
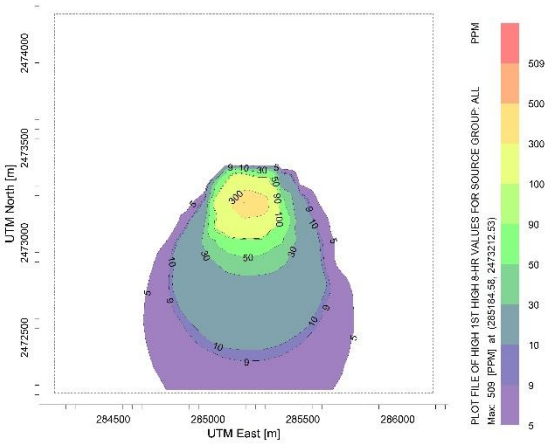


Project Condition

Naung Peng Railway Station

CO_2



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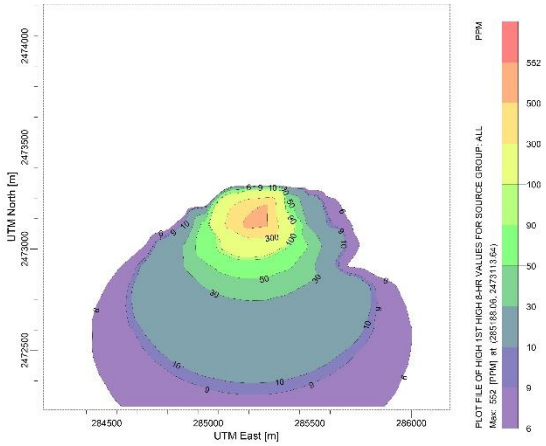
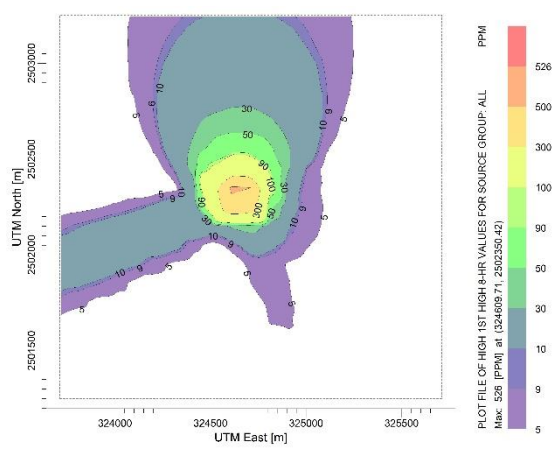


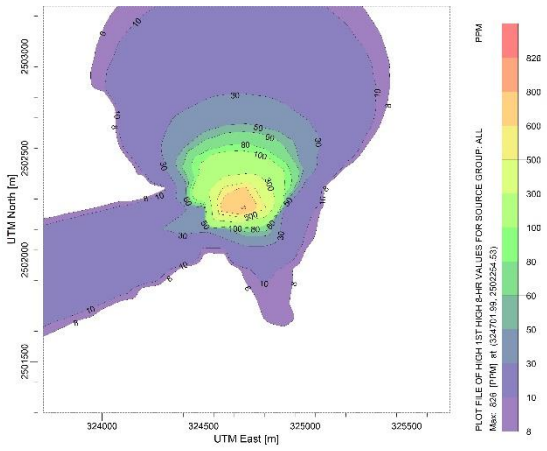
Project Condition

Hsipaw Railway Station

CO_2



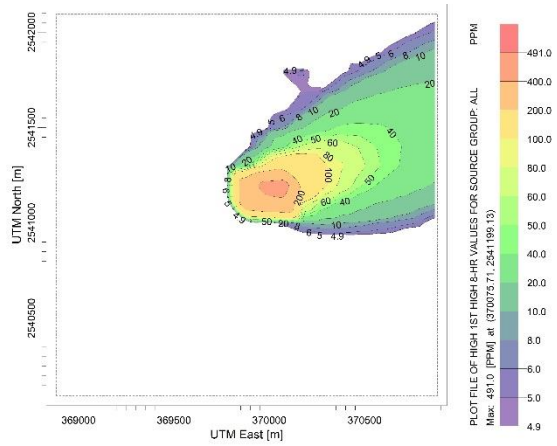
No Project Condition



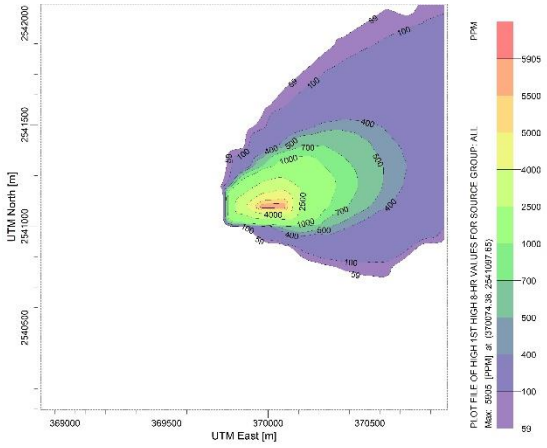
Project Condition

Lashio Railway Station

CO_2



No Project Condition



Project Condition

Significance of Impacts on Air Environment due to Gaseous Emissions before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Vehicular emissions	Emissions from vehicles and food stalls at stations	Negative (-)	Limited (-2)	Long term (-4)	Low (-2)	Very Often (-4)	Very Probable (-4)	Low to Moderate (-56)

Consideration of Mitigation Requirement for Gaseous Emissions

The intensity of mitigation requirement for gaseous emissions according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Vehicular emissions	Low to Moderate (-56)	No	Yes	Moderate	Operators

Mitigation Measures for Gaseous Emissions

The vehicles with good engine and low sulphur content fuel should be used. The regular maintenance of machineries, and if the generators are used for electricity, make regular maintenance of the generators. The gas exhaust should be installed at the food stalls.

Significance of Impacts on Air Environment due to Gaseous Emissions after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Vehicular emissions	Emissions from vehicles and food stalls at stations	Negative (-)	Limited (-2)	Long term (-4)	Low (-2)	Regular (-3)	Seldom (-2)	Low (-40)

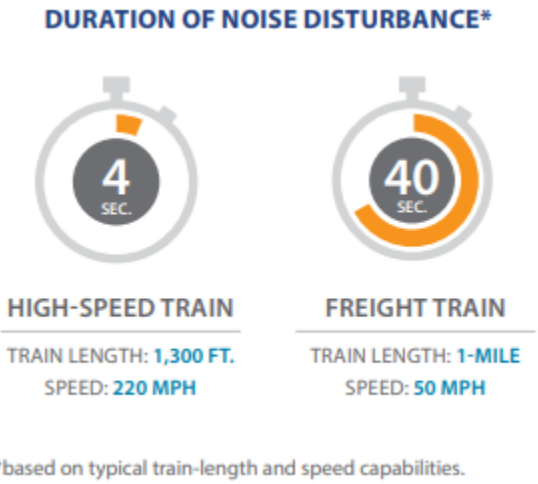
(ii) Impacts of Noise

During operation, noise generated from the train depends on volume, speed, and the type of vehicle. Generally, an increase in volume, speed or vehicle size will increase traffic noise levels. Vehicular noise is a combination of noises from the engine and tyres. The distances within which potential effects may occur are defined based on the operations of a typical high-speed rail system. These distances were developed from detailed noise models that (1) used empirical measurements of noise levels generated by existing steel-wheel-on steel- rail high-speed trains, (2) used expected maximum operation levels and speeds, and (3) are considered sensitive land uses. Operational noise within the screening distances, the conventional and higher-speed service types would also generate potential noise effects caused by warning horns and bells near at-grade crossings. The

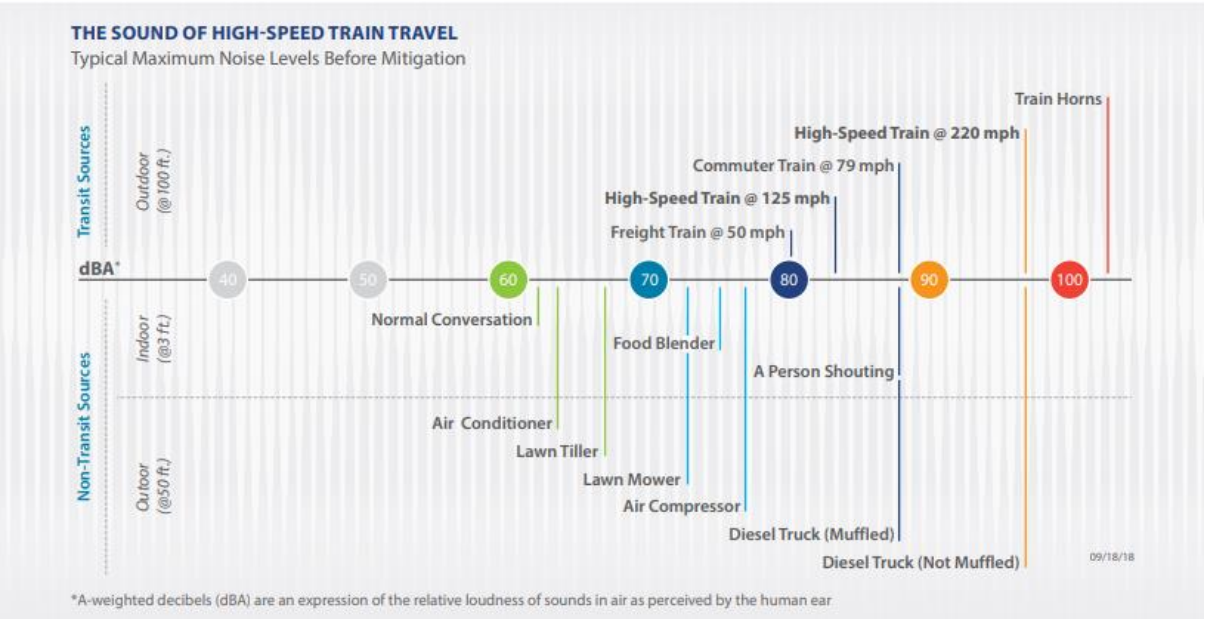
noise generation is the short term and the noise generated from the horns of the train ranges from 80-92 dB(A) and the guideline value of noise level for the residential area at daytime is 55dB(A), and for the night time, 45dB(A).

Methodologies for Operation Noise Level Prediction

Railway noise is generated from a variety of sources, each contributing to the total noise output. Sources include rolling noise generated by the contact between wheel and rail during normal movement and braking; aerodynamic noise generated by the train pushing air (particularly for high speed trains).



Source: California High-Speed Rail Authority



Source: California High-Speed Rail Authority

For noise generated by rail cars and electric locomotives (that is, without including horn noise) will be used by the following equation.

$$SELcars = Leqref + 10log (Tpassby) + 30log(S/Sref)$$

For locomotives, which can be modeled as moving monopole point sources, the corresponding equation is as follows:

$$SELlocos = SELref + 10log (Nlocos) – 10log(S/Sref)$$

The total train sound exposure level is computed by logarithmically adding SELlocos and SELcars
The parameters that apply to the equations above are:
SELcars = Sound exposure level of railcars
Leqref = Level equivalent of railcar
Tpassby = Train passby time, in seconds
S = Train speed, in miles per hour
Sref = Reference train speed
SELlocos = Sound exposure level of locomotive
SELref = Reference sound exposure level of locomotive
Nlocos = Number of locomotives
The reference speed of the train is 160 km/hr but in the FS study, it is stated that 120 km/hr is the maximum average speed available in current condition. Thus, the noise level of a train passing is assumed 85 dB(A) and the maximum sound level of an electric locomotive is assumed to be 85 dB(A) and the no. of locomotives is 18. The noise level of the train will be calculated by using the above equations.

$$SELcars = Leqref + 10log (Tpassby) + 30log(S/Sref)$$

$$SELcars = 85 + 10log (4) + 30log(74.56/99.42)$$

SELcars = **87.27 dB(A)**

$$SELlocos = SELref + 10log (Nlocos) – 10log(S/Sref)$$

$$SELlocos = 85+ 10log (18) – 10log(74.56/99.42)$$

SELlocos = **98.80 dB(A)**

SELtrain = SELcars + SELlocos

= **99.10 dB(A)**

Significance of Impacts of Noise before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Nosie	Railway operation	Negative (-)	Limited (-2)	Long term (-4)	Very Low (-1)	Rare (-1)	Seldom (-2)	Very Low (-21)

Consideration of Mitigation Requirement for Impacts of Noise

The intensity of mitigation requirement for impacts of noise according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Noise	Very Low (-21)	No	Yes	Minor	Operators

Mitigation Measures

Along the railway lines, there will be needed to build sound barriers in near residential area and biodiversity sensitive area. For example, replanting native trees and building sound barrier walls in sensitive areas. It will require regular maintaining of train wheel and vehicles. Care must be taken to ensure that the sound produced by the proposed development is at a reasonable level in relation to the existing ambient sound levels. Some steering mechanism like wheel suspension units should be installed. The developer could implement a noise measurements programme and reporting conducted on an annual basis. This may enable the developer to identify and potential problems relating to noise from the development at that stage of the project operations. The developer could consider a line of communication (e.g. a help line where complaints could be lodged). All potential sensitive receptors should be made aware of these contact numbers. Sporadic and legitimate noise complaints could develop. For example, sudden and sharp increases in sound levels could result from poorly maintained tracks. Noise complaints can be logged and supplied to railway maintenance staff to further investigate (rail roughness).

Significance of Impacts of Noise after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Nosie	Railway operation	Negative (-)	Limited (-2)	Long term (-4)	Very Low (-1)	Rare (-1)	Very Seldom (-1)	Very Low (-14)

(iii) Impacts of Vibration during Operation Phase

In the operation period, the railway vibration is mainly from the mechanical vibration produced by wheel-rail interaction and excitation in the process of train operation. Vibration will adversely affect the residential areas, schools and hospitals. According to the German Standards DIN 4150 and DIN 45669-1 the vibration level will allow 0.3mm/s in residential area and vibration produced by electric railway is 0.6mm/s (max). The vibration level will reduce to 0.3mm/s at the boundary of 500m.

Significance of Impacts of Vibration before mitigation measures

The significance of vibration impact rating is as follows:

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Vibration	Railway operation	Negative (-)	Site (-1)	Long term (-4)	Very Low (-1)	Regular (-3)	Seldom (-2)	Low (-30)

Consideration of Mitigation Requirement for Impacts of Vibration

The intensity of mitigation requirement for vibration according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Vibration	Low (-30)	No	Yes	Minor	Operators

Mitigation Measures for Impacts of Vibration

Railway vibration monitoring shall be strengthened during operation period. If buildings on both side of the railway are obviously affected by railway vibration and residents complain about

railway vibration, the reasons should be found out in time and wheel-grinding and low-vibration rolling stock should be adopted to reduce the impact of railway vibration. Moreover, the use of disc brakes and vibration reduction measures on the bogie are preferred.

Significance of Impacts of Vibration after mitigation measures

The significance of vibration impact rating is as follows:

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Vibration	Railway operation	Negative (-)	Site (-1)	Long term (-4)	Very Low (-1)	Intermittent (-2)	Very Seldom (-1)	Very Low (-18)

Residual Impact

Whilst mitigating with the screening, the noise from the horns and bells is still generated when the train runs on the track. But this would be a short duration and it would not be an impact anymore beyond one mile from the noise source. If there is any vibration-sensitive land uses within the screening distances, there is potential for vibration impact but that would not be significant.

Mitigation:

The re-plantation should be done in places near residential area and biodiversity sensitive area.

(b) Impact on Surface Water Environment during Operation Phase

As drainage from stations and depots will be perpetual, and so this waste water can have impact on the surface water environment.

(i) Oil and Grease from Depots

Wastewater generates from the train washing process, and oil and grease are also generated from the maintenance activities of the train. If the waste water are discharged to the drain and reaches to the nearest water body, it can have impact on the surface water environment.

Significance of Impacts of Oil and Grease from Depots before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Surface water pollution	Oil and grease from depots	Negative (-)	Site (-1)	Short term (-2)	Very Low (-1)	Rare (-1)	Seldom (-2)	Very Low (-18)

Consideration of Mitigation Requirement for Impacts of Oil and Grease from Depots

The intensity of mitigation requirement for impacts of oil and grease from depots according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Oil and grease from depots	Very Low (-18)	No	Yes	Minor	Operators

Mitigation Measures

Appropriate treatment equipment shall be installed so that no drainage may be released directly into adjacent rivers without being treated.

- Purification system for the type of waste water produced from Depot shall be provided.
- Oil absorption mats shall be provided to remove oils from waste water.

Significance of Impacts of Oil and Grease from Depots after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Surface water pollution	Oil and grease from depots	Negative (-)	Site (-1)	Short term (-2)	Very Low (-1)	Rare (-1)	Very Seldom (-1)	Very Low (-12)

(ii) Domestic Wastes from Stations

Domestic wastes from stations include domestic wastes from both operating staff and the passengers coming to the stations. This domestic waste can also impact the surface water environment through improper disposal.

Significant of Impacts on Surface Water Environment due to Domestic Wastes before mitigation measures

Anticipated Impacts	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Surface water pollution	Domestic Wastes	Negative (-)	Limited (-2)	Very Short term (-1)	Very Low (-1)	Very Often (-4)	Very Seldom (-1)	Very Low (-20)

Consideration of Mitigation Requirement for Surface Water Environment due to Domestic Wastes

The intensity of mitigation measures for surface water environment according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by Impact Evaluation	Required Mitigation Scale	Responsibility
1.	Domestic Wastes	Very Low (-20)	No	Yes	Minor	Operators

Mitigation Measures for Domestic Wastes

The domestic wastes can be mitigated by the following measures:

(a) Proper disposal of wastes according to the CDC's instruction;

(b) Domestic effluent will be collected and contained in septic tanks; and

(c) The contents will be removed for disposal as and when necessary by an MCDC licensed contractor.

Significant of Impacts on Surface Water Environment due to Domestic Wastes after mitigation measures

Anticipated Impacts	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Surface water pollution	Domestic Wastes	Negative (-)	Limited (-2)	Very Short term (-1)	Very Low (-1)	Regular (-3)	Very Seldom (-1)	Very Low (-16)

Residual Impact on Surface Water Environment

After conducting the mitigation measures, there is no residual impact on the surface water environment because initially the impact rating is low.

(c) Impacts on Soil and Ground Water Environment during Operation Phase

During the operation phase of the proposed project, the leakage of oil and grease, hazardous chemicals from the train maintenance and in depots can lead to soil contamination and have impacts on the soil and ground environment.

Significant of Impacts on Soil and groundwater Environment before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Soil and ground water pollution	Effluents from depots	Negative (-)	Site (-1)	Long term (-4)	Very Low (-1)	Intermittent (-2)	Seldom (-2)	Very Low (-24)

Consideration of Mitigation Requirement for Impacts of Soil and Ground Water Environment

The intensity of mitigation requirement for impacts of soil and ground water environment according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Effluents from depots	Very Low (-24)	No	Yes	Minor	Operators

Mitigation Measures

The proper management and control leakage of oil and grease in the depots, hazardous chemicals will be handled and stored according to their MSDS instructions. To reduce impact on ground water environment, the effluent from the depots should pass through oil and grease separator at the point before disposal.

Significant of Impacts on Soil and groundwater Environment after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Soil and ground water pollution	Effluents from depots	Negative (-)	Site (-1)	Long term (-4)	Very Low (-1)	Intermittent (-2)	Very Seldom (-1)	Very Low (-18)

(d) Impact on Biodiversity during Operation Phase

Flora and Fauna

Operations effects on wildlife for conventional and higher-speed rail would include making wildlife movement vulnerable to an increased risk of strikes. During the operational phase, the potential for disturbance to retained habitats and species, their resting and breeding places remains. In addition, designated sites and their associated features could be impacted through disturbance from increased recreation. Potential effects during operation might include the following:

- ✓ direct mortality of protected species from site activity, especially vehicle movements;
- ✓ disturbance to plants and animals in areas surrounding the site activity, personnel and vehicle movements; and
- ✓ disturbance to plants and animals - especially bats - in areas surrounding the site from artificial lighting.

Significant of Impacts on Biodiversity Environment before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Impact on flora and fauna	Conventional and high-speed rails	Negative (-)	Limited (-2)	Long term (-4)	Very Low (-1)	Intermittent (-2)	Seldom (-2)	Low (-28)

Consideration of Mitigation Requirement for Biodiversity Environment

The intensity of mitigation requirement for biodiversity environment according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Impact on flora and fauna	Low (-28)	No	Yes	Minor	Operators

Mitigation Measures

High-speed rail would be completely fenced; therefore, the risk of strikes would be lower for this service type. Additionally, construction of new tracks on rail bed elevated above the floodplain could create barriers to wildlife movement. High-speed rail would be fully grade-separated; therefore, more passages for wildlife would likely be included. There will be significant sign board where the wildlife will be crossing the railroad, sounds barrier at the sensitive flora diversity area and also landside cover in the fauna diversity areas. The animal crossing bridge should be installed in biodiversity sensitive areas which could conserve biological resource and a good management plan.

Significant of Impacts on Biodiversity Environment after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Impact on flora and fauna	Conventional and high-speed rails	Negative (-)	Limited (-2)	Long term (-4)	Very Low (-1)	Rare (-1)	Very Seldom (-1)	Low (-14)

Residual Impact on Biodiversity

During operation phase, the loss of habitats and the fragmentation of the habitats can occur. But this would be very low after conducting the mitigation measures.

Mitigation:

This residual impact can be mitigated by re-plantation in the areas near to the residential area and biodiversity sensitive area.

(e)Impact on Human Environment during Operation Phase

The impacts on human environment during operation phase of the proposed project is described as follows.

Impacts on Socio-Economic Environment during Operation Phase

The positive and negative socio-economic impacts associated with the proposed project are shown in the following.

(a) Positive Socio-economic Impacts

(i) Improvement in Livelihood and Economic

The proposed project boosts regional economic activities along the route by providing an efficient mass transit system, which enhances workforce mobility from Mandalay to Muse. In addition, presence of the stations will also attract future commercial development around the area. While the proposed project can increase connectivity of existing bus routes through multi-modal transport centers/hubs, it may pose as a competitor for existing transport operators in terms of servicing passengers/commuters. The proposed project will bring various employment opportunities during the operational period. The direct employment opportunities would be increased for the local people.

Significance of Improvement in Livelihood and Economic before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Positive socio-economic impacts	Travel time saving	Positive (+)	Limited (+2)	Long term (+4)	Low (+2)	Intermittent (+2)	Probable (+3)	Low (+40)
	Employment generation	Positive (+)	Limited (+2)	Long term (+4)	Low (+2)	Regular (+3)	Probable (+3)	Low (+48)

Consideration of Enhancement Measures for Improvement in Livelihood and Economic

The intensity of enhancement requirement for improvement in livelihood and economic according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Travel time saving	Low (+40)	Yes	Yes	Moderate	Operators
2.	Employment generation	Low (+48)	Yes	Yes	Moderate	Operators

Mitigation Measures

Positive impact is expected since the proposed project would boost regional economic activities along the route and presence of stations will attract future commercial development. For PAPs whose livelihood had been affected during construction stage, monitoring of the implementation of the RAP will be conducted. Monitoring of the implementation of the resettlement action plan will be conducted.

Significance of Improvement in Livelihood and Economic after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Positive socio-economic impacts	Travel time saving	Positive (+)	Limited (+2)	Long term (+4)	Low (+2)	Regular (+3)	Very Probable (+4)	Low to Moderate (+56)
	Employment generation	Positive (+)	Limited (+2)	Long term (+4)	Low (+2)	Very Often (+4)	Very Probable (+4)	Low to Moderate (+64)

(ii) Improvement in Tourism Sector

Arrivals of Chinese travelers to Myanmar increased significantly in 2019 compared to 2018, and topped the list of the tourists to the Southeast Asian country, according to the ministry. China is the largest tourist source of Myanmar so if the transportation becomes easy, the tourism industry can gain more income and the number of people working in the tourism-related industry would increase.

Impact Significance of Improvement in Tourism Sector without Enhancement Measures

According to the primary data collection, there has jobless persons in nearest villages and job creation during construction phase can be considered as low without enhancement measures as follow:

Anticipated Impact	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Potential to increase in income	Positive (+)	Limited (+2)	Long term (+4)	Medium (+3)	Intermittent (+2)	Seldom (+2)	Low (+36)

Consideration of Enhancement Measures for Improvement in Tourism sector

The intensity of enhancement requirement for improvement in Tourism sector according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Potential to increase in income	Low (+36)	Yes	Yes	Moderate	Operators

Enhancement Measures for Improvement in Tourism Sector

The project developer will do the following mitigation measures for the improvement of improvement in tourism sector.

(a) Conduct capacity building activities with the civil society, workers and communities;
(b) Support the development of responsible tourism in Myanmar;
(c) Raise tourist awareness about how to avoid negative impacts of tourism;
(d) Make policy to make sure "zero-dollar tourism" would not occur;
(e) Advice on human rights aspects of tourism laws, regulations and guidelines; and
(f) Publicly report on the handling of complaints, investigations and follow up steps undertaken by the MNHRC and other institutions with regards to tourism development related grievances.

Impact Significance of Improvement in Tourism Sector after Enhancement Measures

Anticipated Impact	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Potential to increase in income	Positive (+)	Limited (+2)	Long term (+4)	Medium (+3)	Regular (+3)	Probable (+3)	Low to Moderate (+54)

(iii) Benefits to National Economy

The project operation will contribute to government revenues in terms of taxes paid to the government. The transportation with the train is more transparent to tax collection than the

transportation with the Muse-Mandalay Express road. It will also increase the foreign currency and stable of trade balance between Myanmar and China.

Impact Significance of Benefits to National Economy before Enhancement Measures

Impact significance of benefits to national economy before enhancement measures will be as low to moderate as follow:

Components	Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Income in government revenue	Benefit to national economy	Taxes	Positive (+)	Regional (+5)	Long term (+4)	Moderate (+4)	Intermittent (+2)	Highly Probable (+4)	Moderate (+78)

Consideration of Enhancement Measures for Benefits to National Economy

The intensity of enhancement requirement for improvement in Benefits to National Economy according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Income in government revenue	Moderate (+78)	Yes	Yes	Moderate	Operators

Enhancement Measures for Benefits to National Economy

Efficient and transparent tax collection mechanisms will be introduced and strengthened. By creating responsible taxes paying system to local or national government, it will be great benefit to national economy.

Impact Significance of Benefits to National Economy after Enhancement Measures

This positive impact will be moderate after enhancement measures as follow:

Components	Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Income in government revenue	Benefit to national economy	Taxes	Positive (+)	Regional (+5)	Long term (+4)	Moderate (+4)	Regular (+3)	Certain (+5)	Moderate to High (+104)

(iv) Benefits to Local Economy

There would be some businesses like food stalls, and so there would be an increase in economy of the community near the stations and some parts of the railway alignment near residential areas. The transportation services to and from the nearest villages and towns are improved.

Impact Significance of Benefits to Local Economy before Enhancement Measures

The impact rating will be considered as follow:

Components	Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Income in community revenue	Benefit to community economy	Operation of Railway	Positive (+)	Local (+3)	Long term (+4)	Moderate (+4)	Intermittent (+2)	Probable (+3)	Low to Moderate (+55)

Consideration of Enhancement Measures for Benefits to Local Economy

The intensity of enhancement requirement for improvement in Benefits to Local Economy according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Income in community revenue	Low to Moderate (+55)	Yes	Yes	Moderate	Operators

Enhancement Measures for Benefits to Local Economy

The developer should consider formulation of specific strategies to link project development with local community.

Impact Significance of Benefit to Local Economy after Enhancement Measures

Trading and services in the Muse Township play a part of local GDP, impact rating will be moderate after enhancement measures.

Components	Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Income in local revenue	Benefit to local economy	Operation of cement factory	Positive (+)	Local (+4)	Long term (+4)	Moderate (+4)	Intermittent (+2)	Highly Probable (+4)	Moderate (+72)

(v) Increase in Transportation Sector

Myanmar's transport sector is suffered because the needs have exceeded resources and the infrastructure has declined. There is only Muse-Mandalay main road in transportation from Muse to Mandalay. So, the traffic congestion is occurred frequently and the transportation of goods takes long. The gaseous emissions form the train is much less than that from the cars. The emissions of Green House Gas (GHC) would be reduced since the transportation at the Muse-Mandalay would be reduced. The implementation of Muse-Mandalay would be a great increase in transportation sector. Once the proposed project becomes operational there will be a significant travel time saving on the passengers. Many local and foreigners will travel more during operation phase since the transportation becomes easy. Local will be developed by mean of services for tourists, transportation and providing other necessary supplies. High capital investment in Shan Region and CSR activities will have potential to community development potential. The project may provide opportunities for continued improvements in basic infrastructure and community development, and in providing skill development. All of these can also potential for local community development and increased living standard for local people for long run.

Impact Significance of Increase in Transportation Sector

The impact rating will be considered as follows:

Components	Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Increase in transportation sector	Benefit to community economy	Operation of Railway	Positive (+)	Local (+3)	Long term (+4)	Moderate (+4)	Intermittent (+2)	Probable (+3)	Low to Moderate (+55)
Local community development potential	Development in nearest villages	Operation of Railway	Positive (+)	Local (+3)	Long term (+4)	Low (+2)	Intermittent (+2)	Seldom (+2)	Low (+36)

Consideration of Enhancement Measures for Increase in Transportation Sector

The intensity of enhancement requirement for improvement in Increase in Transportation Sector according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Benefit to community economy	Low to Moderate (+55)	Yes	Yes	Moderate	Operators
2.	Development in nearest villages	Low (+36)	Yes	Yes	Moderate	Operators

Enhancement Measures for Increase in Transportation Sector

The developer should consider the road networks of villages and towns with the railway stations. The implementation of the plan for the transportation of goods and the National Rural Road Access Program should be launched. This positive impact of the project can be enhanced by creating jobs for providing necessary services (transportation, tour trips to religious places, local tourist guide) to foreigners by local people. This positive impact of the project can be enhanced by adjusting allocation of CSR budget and giving priority for CSR activities relevant to community immediate needs each year after discussion with representatives from local authorities, CBOs, and NGOs. According to the social survey, it would be better to support the internal road within the villages and for local people are the most of the public needs, and it will also support community development. The reasonable railway fee that can be affordable to the local people should be designated.

Impact Significance of Increase in Transportation Sector after Enhancement Measures

The significant of impact will be considered as low to moderate after enhancement measures as follow:

Components	Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Local community development potential	Development in Muse and nearest villages	Operation of Railway	Positive (+)	Local (+3)	Long term (+4)	Moderate (+4)	Regular (+3)	Highly Probable (+4)	Moderate (+77)
Increase in transportation sector	Benefit to community economy	Operation of Railway	Positive (+)	Local (+3)	Long term (+4)	Low (+2)	Regular (+3)	Probable (+3)	Low to Moderate (+54)

Comments for Increase in Transportation Sector

The developer already had CSR policy and budget allocation for community development purposes. Corporate social responsibility (CSR) is the continuing commitment by business to behave ethically and contribute to economic development while improving the quality of life of the workforce and their families as well as of the local community and society. The developer is intending to use at least 2 % of annual net benefit after tax for every year in CSR activities. So, with enhancement measures, community development potential will be great benefits for local people.

(b) Negative Socio-economic Impacts

(i) Increase in Human Trafficking

Since the transportation becomes easy, the increase in human trafficking rate could also occur. Regionally, Shan state registered with 37 cases, followed by Mandalay region and with 10 cases. There were 22 domestic trafficking in persons in terms of forced labor, prostitution and forced marriage during the period. In 2019, 358 people including 297 females were victimized in connection with 239 human trafficking cases across the country. During the whole 2020, 167 people including 39 young girls were victimized while 339 traffickers were charged in connection with the cases.

Significance of Impacts of Human Trafficking before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Human trafficking	Transportation	Negative (-)	Local (-3)	Long term (-4)	Medium (-4)	Intermittent (-2)	Seldom (-2)	Low (-44)

Consideration of Mitigation Measures for Impacts of Increase in Human Trafficking

The intensity of mitigation requirement for increase in human trafficking according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Human Trafficking	Low (-44)	Yes	Yes	Moderate	Operators

Mitigation Measures for Impacts of Increase in Human Trafficking

The corporation with human trafficking team in every trip to Mandalay to Muse Permanent Immigration Inspection Team should be made. The people who smuggle women and children are sentenced to at least 10 years or up to lifetime sentence or fine while money or property received through trafficking will be confiscated by the government under the Anti-Trafficking in Persons Law.

Significance of Impacts of Human Trafficking after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Human trafficking	Transportation	Negative (-)	Local (-3)	Long term (-4)	Medium (-4)	Rare (-1)	Very Seldom (-1)	Very Low (-22)

(ii) Increase in Trade off Drugs

Since the transportation becomes easy and the profits of trade off drugs are high, the rate of trading off drugs would increase especially in Shan State.

Significance of Impacts of increase in Trade off Drugs before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Increase in trade off drugs	Transportation	Negative (-)	Local (-3)	Long term (-4)	Medium (-4)	Intermittent (-2)	Probable (-3)	Low to Moderate (-55)

Consideration of Mitigation Measures for Impacts of Increase in Trade off Drugs

The intensity of mitigation requirement for increase in trade off drugs according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Trade off drugs	Low to Moderate (-55)	Yes	Yes	Moderate	Operators

Mitigation Measures for Trade off Drugs

Trading off the chemicals and drugs used to manufacture drugs into Shan State should be restricted. The government should redouble its drug control and anti-corruption efforts, focusing on major players in the drug trade. Education and harm reduction should replace. At the community level, the government should focus more on education and harm reduction.

Significance of Impacts of increase in Trade off Drugs after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Increase in trade off drugs	Transportation	Negative (-)	Local (-3)	Long term (-4)	Medium (-4)	Rare (-1)	Seldom (-2)	Low (-33)

(iii) Impact to Tradition of Shan

Since the transportation becomes easy, the Chinese from Yunnan region can enter in large numbers. This influx of Chinese due to the operation of railway will have impact on traditional of Shan. The improvement of infrastructures and influx of different people with different life style from another place can have impact on traditional and custom of local people in general.

Impact Significance of Impact on Tradition of Shan before Mitigation Measures

The impact will be considered as low to moderate because it is the most public concerns during social survey and public meetings.

Components	Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Impacts to Customs of Shan	Traditional and religious	Increased in population	Negative (-)	Local (-3)	Long term (-4)	Moderate (-4)	Regular (-3)	Probable (-3)	Low to Moderate (-66)

Consideration of Mitigation Measures for Impacts to Traditions of Shan

The intensity of mitigation requirement for increase in trade off drugs according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Impacts to Customs of Shan	Low to Moderate (-66)	Yes	Yes	Moderate	Operators

Mitigation Measures for Impacts to Traditions of Shan

The developer should encourage the visitors to know about the custom and behaviors of local people (Customs of Shan). Gallery of custom of Shan should be constructed. The development of policies that include and support the role of culture and traditions of Shan should be promoted. The railway station design should be considered with the tradition of Shan. Shan foods should be promoted at the stations. The visitors and operating staffs should participate with the local people in traditional festivals of Shan.

Impact Significance of Impact on Tradition of Shan after Mitigation Measures

The impact will be considered as low after mitigation measures as follow:

Components	Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Impacts to Customs of Shan	Traditional and religious	Increased in population	Negative (-)	Local (-3)	Long term (-4)	Moderate (-4)	Intermittent (-2)	Seldom (-2)	Low (-44)

(iv) Economic Displacement along Muse-Mandalay Express Road

The businesses along the Muse-Mandalay express road like the food stalls are disturbed by the implementation of Muse-Mandalay railway.

Significance of Economic Displacement along Muse-Mandalay Express Road before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Economic displacement in Muse-Mandalay Express Road	Local business near Muse-Mandalay Road	Negative (-)	Limited (-2)	Long term (-4)	Low (-2)	Regular (-3)	Probable (-3)	Low (-48)

Consideration of Mitigation Measures for Economic Displacement along Muse-Mandalay Express Road

The intensity of mitigation requirement for economic displacement along Muse-Mandalay express road according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Economic displacement along Muse-Mandalay Express Road	Low (-48)	No	Yes	Minor	Operators

Mitigation Measures for Economic Displacement along Muse-Mandalay Express Road

The negotiation with the local community near Muse-Mandalay express road to make a plan to do business near stations like food stalls and restaurants, should be implemented. The affected businesses are planned to make a business at the nearest stations.

Significance of Economic Displacement along Muse-Mandalay Express Road after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Economic displacement in Muse-Mandalay Express Road	Local business near Muse-Mandalay Road	Negative (-)	Limited (-2)	Long term (-4)	Low (-2)	Rare (-1)	Very Seldom (-2)	Very Low (-24)

(v) Accidents on Railway Alignment

The accidents at railway alignment can occur when the human passes the railway alignment and hit by the train.

Significance of Impacts of Accidents at Railway Alignment (Human hit by the train) before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Accidents at railway alignment	Transportation	Negative (-1)	Local (-3)	Long term (-4)	Medium (-4)	Rare (-1)	Seldom (-2)	Low (-33)

Consideration of Mitigation Requirement for Accidents at Railway Alignment

The intensity of mitigation requirement for impacts of accidents at railway alignment according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Accidents at railway alignment	Low (-33)	No	Yes	Minor	Construction service provider

Mitigation Measures

- The warning signs and barriers should be made in the vicinity of residential areas;
- Culverts or crossover bridge should be built near residential area and when crossing with narrow village road in rural areas;
- Fence should be made along the railway alignment;
- Barrier gate should be positioned in the place where village roads cross the railway alignment; and
- Good lighting system should be provided especially where the railway alignment passes the village road.

Significance of Impacts of Accidents at Railway Alignment (Human hit by the train) after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Accidents at railway alignment	Transportation	Negative (-1)	Limited (-2)	Long term (-4)	Medium (-4)	Rare (-1)	Very seldom (-1)	Very Low (-20)

(vi) Social Tension

Social tension can be caused since the nearby villages do not get electricity all the time while the railway lighting is always on during the night.

Significance of impact for Social Tension before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Social tension	Railway lighting	Negative (-)	Local (-3)	Long term (-4)	Low (-1)	Regular (-3)	Very Probable (-4)	Low to Moderate (-56)

Consideration of Mitigation Requirement for Social Tension

The intensity of mitigation requirement for Impact due to Utility Consumption according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Social tension	Low to Moderate (-56)	Yes	Yes	Minor	Operators

Mitigation Measures for Social Tension

- Consider distributing electricity also for local people before starting the project if possible.
- Provide solar panel to local people.

Significance of impact for Social Tension after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Social tension	Railway lighting	Negative (-)	Local (-3)	Long term (-4)	Low (-1)	Intermittent (-2)	Seldom (-2)	Low (-32)

Residual Impact on Socio-economic Environment

There would be no significant residual impact because of occupational health and safety. The emergency response plan and the described mitigation measures would cover the impacts of occupational health and safety on the workers and the community.

Potential Impacts on Archaeology and Cultural Heritage during Operation phase

Operation of the proposed railway and station complex has the potential to affect cultural heritage assets within the wider landscape through changes occurring within their baseline setting. However, taking into account the nature of the proposed development it is unlikely that there will be any significant impacts on heritage assets in the wider historic landscape. Potential to have impact on cultural and religious in Mandalay and Shan regions due to the population influx and the impact on buried archaeological site can occur. Neither of the two scheduled monuments in proximity to the route of the railway would have their settings adversely affected by the proposed development (which lies at least 1km from both sites) and it is proposed therefore to Scope Out impacts on their settings. There are no inventory status gardens and designed landscapes or historic battlefields that would have their settings adversely affected by the proposed development and it is proposed therefore to Scope Out impacts on their settings. Based on the distribution of the heritage assets with statutory protection, and those with non - statutory designations, within 2 km of the proposed development, it is considered that effects on settings of heritage assets can be scoped out of the assessment.

Significance of impact for archaeology and cultural heritage before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Archaeology and cultural heritage	Increase in population	Negative (-)	Limited (-2)	Permanent (-5)	Low to Medium (-3)	Rare (-1)	Very Seldom (-1)	Very Low (-20)

Consideration of Mitigation Requirement for Archaeology and Cultural Heritage

The intensity of mitigation requirement for archaeology and cultural heritage according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Archaeology and cultural heritage	Very Low (-20)	No	Yes	Minor	Operators

Mitigation

It is expected that there will be no adverse impacts on the settings of heritage assets in the wider landscape from the Proposed Development. The participation of cultural and religious festival in Mandalay and Shan regions should be made and the awareness should be given to foreigners to respect the local custom. The archaeological site that will be pointed out by heritage advisors, and an archaeological evaluation, should be avoided. The pamphlet which explains about the cultural heritage should be distributed on the train, and the culture of the local people should be broadcasted on the train, if the broadcasting is possible.

Significance of impact for archaeology and cultural heritage after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Archaeology and cultural heritage	Increase in population	Negative (-)	Site (-1)	Permanent (-5)	Low (-2)	Rare (-1)	Very Seldom (-1)	Very Low (-16)

Residual Impact on Architectural and Archaeological Heritage

Since there is no adverse impact on the heritage assets, there would be no residual impacts.

Anticipated Health Impact and Mitigation Measures during Operation Phase

Although there are not many factories along the rivers, water can be polluted due to the spills and leakage of fuel oil and soil, ground water and surface water can be polluted within the miles of its radius. The following will be the anticipated positive and negative health impacts of the operation of proposed project.

(a) Increase Risk of Sexually Transmitted Infections

Increased risk of sexually transmitted infections such as HIV/AIDS, gonorrhea and chlamydia will be continued during operation phase because there will be KTV and massage related to the increased in population due. Major outbreaks of infectious diseases can have a devastating effect

not only on or near the proposed plant site but also on local communities. Moreover, the influx of large groups of, generally, male workers can sometimes lead to social unrest which may include violence and sexual assault in this region. Similarly, an increase in commercial sex workers (CSW) can have significant, long term, negative individual and community health and wellbeing impacts. It will also impact on custom of local people.

Impact Significance of Risk of Sexually Transmitted Infections before mitigation measures

Increased transmission of sexually transmitted infections and other social harms can cause serious health problem for local people. According to the secondary data collection, there are 488 persons who suffer HIV/AIDS in the Mandalay Region (in 2016-2017). So, impact rating for sexually transmitted infection can be considered as high.

Who will affected?	Magnitude/Consequence of impact			Likelihood/Probability of impact			Health Impact Significance Rating		
	Low	Medium	High	Unlikely to occur	Likely to occur sometimes	Likely to occur often	Low	Medium	High
Local people in nearest residents	-	-	√	-	√	-	-	-	√ (HIR 3)

Mitigation Measures for Risk of Sexually Transmitted Infections

To protect local communities in case of disease outbreaks among the workforce, a premedical examination for workers will be conducted, followed by routine medical examination during the works and a final post medical examination. MR will review sexually transmitted infection clinic access and education to reduce spread of sexually transmitted infections within the community. MR will also provide information and education to workers about safe sex and implement HIV control program for migrant workers per year or accordingly.

(b) Impact on Community Wellness

The commencement of proposed project may stimulate some forms of social pathologies and crime including increased substance abuse, drugs, thief, crime, human trafficking and decreased social cohesion. It will impact on mental health of people in nearest villages.

Impact Significance of Impact on Community Wellness before mitigation measures

Impact significance of impact on community wellness will be as follow:

Who will affected?	Magnitude/Consequence of impact			Likelihood/Probability of impact			Health Impact Significance Rating		
	Low	Medium	High	Unlikely to occur	Likely to occur sometimes	Likely to occur often	Low	Medium	High
People in nearest residents	√	-	-	-	√	-	√ (HIR 1)	-	-

Mitigation Measures for Impact on Community Wellness

MR will do the following ways to reduce the potential impact to community wellness.

1. Establish a mechanism to facilitate on-going community engagement between the local authorities and local residents for early identification of impacts on community wellness.
2. Implement smoking and drug free zone.

(c) Health Impact on Community due to Covid-19

Since the transportation becomes, the number of visitors would increase which can be the carrier of the Covid-19 viruses. This can be the spread of these virus to the local community.

Impact Significance of Health Impact on Community due to Covid-19 before mitigation measures

Impact significance of impact on community wellness will be as follow:

Who will affected?	Magnitude/Consequence of impact			Likelihood/Probability of impact			Health Impact Significance Rating		
	Low	Medium	High	Unlikely to occur	Likely to occur sometimes	Likely to occur often	Low	Medium	High
People in nearest residents	√	-	-	-	√	-	√ (HIR 1)	-	-

Mitigation Measures

The passengers and the staffs should follow the rules and regulations by the Ministry of Health and Sports. Moreover,

- Measure temperature before entering to the stations and also on the train;
- Wash hands with soap and water very often;
- Wear masks;
- Use a tissue or cover your mouth for each sneeze;
- Dispose of any tissues that have used; and
- Avoid the use of shared objects;

Residual Health Impact

There would be no residual health impact if MR provides information and education to workers about safe sex and establish the facility about the community engagement between local authorities and local residents.

Impacts of Utility Consumption

(a) Electricity Consumption

During operation phase, the electricity will be used up for lighting along the railway alignment and for the stations. If the electricity is used from the local community, there can be impact to the

electricity usage of local community. So, there would still need to mitigate not to impact the electricity usage of the local community.

Significance of Impact of Electricity Consumption before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Electricity consumption	Use of electricity for operational	Negative (-)	Local (-3)	Long term (-4)	Low (-2)	Regular (-3)	Very Probable (-4)	Low to Moderate (-63)

Consideration of Mitigation Requirement for Electricity Consumption

The intensity of mitigation requirement for electricity consumption according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Electricity consumption	Low to Moderate (-63)	No	Yes	Minor	Construction service provider

Mitigation Measures for Electricity Consumption

A reduction in energy consumption is also an important consideration in a pollution prevention program and in lowering the operational cost. There are several methods that can be employed to help conserve electricity, which include:

(a) Implementing good housekeeping measures such as turning off equipment such as fans, and lights when not in use;
(b) Use LED lights and/or lower wattage lamps;
(c) Using more efficient equipment when replacing old equipment (such as motors and transformer units);
(d) Preventative maintenance of operational processes and pipes so as to improve efficiency and minimize losses.

Significance of Impact of Electricity Consumption after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Electricity consumption	Use of electricity for operational	Negative (-)	Local (-3)	Long term (-4)	Low (-2)	Intermittent (-2)	Seldom (-2)	Low (-36)

(b) Water Consumption

The water usage in operation phase is from the use of operating staff and the passengers coming to the station. The operating staff is total of 264 people and so the volume of water used can be calculated as:

Maximum water rate for a person per day = 100 gallons

Total operating staff = 264 employees

Water consumption rate per day (operating staff) = 26,400 gallons

Significance of Impact of Water Consumption before mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Water consumption	Use of water for operational	Negative (-1)	Limited (-2)	Long term (-4)	Low to Medium (-3)	Regular (-3)	Probable (-3)	Low to Moderate (-54)

Consideration of Mitigation Requirement for Water Consumption

The intensity of mitigation requirement for water consumption according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern through Public Consultation Processes	Mitigation Requirement by impact evaluation	Required Mitigation Scale	Responsibility
1.	Water consumption	Low to Moderate (-54)	Yes	Yes	Moderate	Operators

Mitigation Measures for Water Consumption

Domestic water consumption will be minimized by implementing water efficient fixtures such as 3 liters WC flushing cistern, sensor operated urinals and taps to minimize the wastage of water together with other water conservation measures if feasible. Furthermore, to ensure ongoing water conservation, an employee education and awareness programmed will be introduced for the employee of the proposed project. To reduce the water usage of the operating staff, dry type urinals will be used selectively. The following are the specific measures:

(a) Awareness campaign to distribute knowledge on strategies and technologies that can be used for water conservation;

(b) Use water obtained from the water treatment plant which is sourced from the rivers and streams that are not used as a source of drinking water;

(c) New employees will be issued standard water information packed. The information should include water conservation plans, water conservation methods being adopted in the complex and a list of essential and nonessential water uses; and

(d) Proper methods of water use will be placed in the toilets and other areas of water consumption.

Significance of Impact of Water Consumption after mitigation measures

Anticipated Impact	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Water consumption	Use of water for operational	Negative (-1)	Limited (-2)	Long term (-4)	Low to Medium (-3)	Intermittent (-2)	Very Seldom (-2)	Low (-36)

6.2.2.4. Anticipated Impacts and Mitigation measures for Decommissioning Phase

Although, the proposed project is expected to have an operational life of at least 30 years, decommissioning of the project would occur at the end of its lifespan. The goal of project decommissioning will be to remove the concrete and steel structures and equipment for proposed project as a whole and return the site to a condition as close to a pre-construction state as feasible. The physical removal of the structures and equipment will be the reversal of the construction process. All areas disturbed by the proposed project would be restored to pre-project conditions and/or to conditions acceptable to the MCDC. During decommissioning phase, all concrete and

steel structures and equipment would be dismantled and removed. The major activities that will be required for the decommissioning of proposed project are:

(a) Concrete structures removal,
(b) Steel structures removal,
(c) Storage tanks removal,
(d) Concrete foundation removal, and
(e) Equipment and electrical system removal.

Impacts during decommissioning are expected to be limited to workers on site. No impacts are anticipated to nearest residences or businesses because all decommissioning activities will be expected to take place during daytime and will only use small number of machineries. Potential environmental impacts due to the decommissioning activities will include the following:

(a) Impacts on air environment;
(b) Impacts on surface water environment;
(c) Impacts on soil and ground water environment;
(d) Impacts on biodiversity environment; and
(e) Impacts on socio-economic environment.

(a) Impacts on Air Environment during Decommissioning Phase

The following will be the anticipated impacts on air quality during decommissioning phase.

(a) Fugitive Dust Generation

During decommissioning some localized increase in dust levels will be unavoidable. The impact of dust generation during decommissioning phase will be less than that of pre-construction and construction phase due to the lack of site clearing, ground leveling and earth filling. The sources of dust generation will be vehicle movement and demolishing of buildings.

(b) Gaseous Emissions

Gases (CO_2, CO, SO_2) will emit during the operation of dozer, trucks and generator used during decommissioning period.

(c) Increased in Noise Level

Existing local noise levels will increase temporarily by the operation of heavy machineries (dozer and trucks) used for demolition of concrete and steel structures.

Significant of Impacts on Air Quality before mitigation measures

As the project area is merely six acres and there will use about two trucks and one dozer for decommissioning purpose, the impact significance of dust generation, gaseous emissions, and noise level during decommissioning phase will be very low as follow:

Components	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Fugitive Dust Generation	Use of dozer and truck	Negative (-)	Limited (-2)	Very Short term (-1)	Low (-2)	Very Often (-4)	Probable (-3)	Low (-35)
Gaseous Emissions	Use of dozer and truck	Negative (-)	Local (-3)	Very Short term (-1)	Very Low (-1)	Intermittent (-2)	Highly Probable (-4)	Low (-30)
Increase in Noise Level	Demolishing activities	Negative (-)	Limited (-2)	Very Short term (-1)	Low (-2)	Very Often (-4)	Probable (-3)	Low (-35)

Consideration of Mitigation Requirements for Air Environment

The requirement of mitigation measures for air environment according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern	Mitigation Requirement	Mitigation Scale	Responsibility
1.	Fugitive Dust Generation	Low (-35)	No	Yes	Minor	MR
2.	Gaseous Emissions	Low (-30)	No	No	Minor	MR
3.	Increase in Noise Level	Low (-35)	No	Yes	Minor	MR

Mitigation Measure for Impacts on Air Environment

According to the above table, minor mitigation measures are required for air quality during decommissioning phase as follow:

(a) Spray water for dust control;

(b) Use machineries with good engine with low sulphur content fuel for gaseous emission; and

(c) Avoid working at night for noise control.

Significant of Impacts on Air Quality after mitigation measures

Components	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Fugitive Dust Generation	Use of dozer and truck	Negative (-)	Limited (-2)	Very Short term (-1)	Low (-2)	Regular (-3)	Seldom (-2)	Very Low (-25)
Gaseous Emissions	Use of dozer and truck	Negative (-)	Local (-3)	Very Short term (-1)	Very Low (-1)	Intermittent (-2)	Probable (-3)	Very Low (-25)
Increase in Noise Level	Demolishing activities	Negative (-)	Limited (-2)	Very Short term (-1)	Low (-2)	Regular (-3)	Seldom (-2)	Very Low (-25)

(b) Impacts on Surface Water Environment during Decommissioning Phase

Improper disposal of decommissioning debris such as concrete blocks, steel pieces and drainage from solid waste dump will cause surface water pollution in nearest rivers, if decommissioning debris is disposed to the river directly.

Impact Significance on Surface Water Environment before mitigation measures

The impact on surface water during decommissioning phase will be not be significant because the solid and liquid waste produced during decommissioning phase will be small amount.

Components	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Surface water pollution	Solid Wastes	Negative (-)	Limited (-2)	Very Short term (-1)	Low (-2)	Intermittent (-2)	Probable (-3)	Very Low (-25)

Intensity of Mitigation Measures for Surface Water Environment

The requirement of mitigation measures for surface water environment according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern	Mitigation Requirement	Mitigation Scale	Responsibility
1.	Solid Wastes	Very Low (-25)	No	Yes	Minor	MR

Mitigation Measure for Surface Water Environment

According to the above impact evaluation process, there will need minor mitigation measures for impact on surface water environment during decommission phase. So, MR will do the following mitigation measures for surface water quality during decommission phase.

(a) Pump all of the remaining fuel oil inside the tanks and pipe lines. Care have to be taken the remaining oil are not disposed to nearest water bodies directly.

(b) Waste water channels from the site should be connected to oil and grease separator during decommissioning to prevent wastewater from entering the nearest water bodies.

(c) Avoid any leakage of oil and lubricant from vehicles and machineries used in decommission phase.

(d) All the solid waste produced during decommissioning phase have to disposed according to the rule and regulations of CDC.

(e) Vegetation of bare areas after the decommission activities.

Impact Significance on Surface Water Environment after mitigation measures

Components	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Surface water pollution	Solid Wastes	Negative (-)	Limited (-2)	Very Short term (-1)	Low (-2)	Intermittent (-2)	Seldom (-2)	Very Low (-20)

(c) Impacts on Soil and Ground Water Environment

Decommissioning debris such as soils from earth working activities, concrete, steel structures, cabling, scrap metal, etc. will produce during decommissioning of the proposed project. Improper disposal of these solid wastes can have potential to soil and ground water pollutions.

Significant of Impact on Soil and Ground Water Environment before mitigation measures

The impact on soil and ground water quality during decommissioning phase will not be significant because the solid and liquid waste produced during decommissioning phase will be little amount. The impact on ground water quality will be minimal, short term and low probability. So, the impact will be considered as very low as follow:

Components	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Soil contamination	Solid Wastes and fuel oil	Negative (-)	Limited (-2)	Very Short term (-1)	Low (-2)	Intermittent (-2)	Seldom (-2)	Very Low (-20)
Ground water pollution	Solid Wastes and fuel oil	Negative (-)	Limited (-2)	Very Short term (-1)	Low (-2)	Intermittent (-2)	Seldom (-2)	Very Low (-20)

Consideration of Mitigation Requirements for Soil and Ground Water Environment

The requirement of mitigation measures for soil and ground water environment according to the consideration of impact rating and public concerns are as follow:

No.	Parameters	Impact Rating	Public Concern	Mitigation Requirement	Mitigation Scale	Responsibility
1.	Soil contamination	Very Low (-20)	No	Yes	Minor	MR
2.	Ground water pollution	Very Low (-20)	No	Yes	Minor	MR

Mitigation Measures for Soil and Ground Water Pollution

All the solid and liquid waste produced during decommissioning phase have to disposed according to the rule and regulations of MCDC. Vegetation of bare areas after the decommission activities.

Significant of Impact on Soil and Ground Water Environment after mitigation measures

Components	Sources	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Soil contamination	Solid Wastes and fuel oil	Negative (-)	Limited (-2)	Very Short term (-1)	Low (-2)	Rare (-1)	Very Seldom (-1)	Very Low (-10)

Ground water pollution	Solid Wastes and fuel oil	Negative (-)	Limited (-2)	Very Short term (-1)	Low (-2)	Rare (-1)	Very Seldom (-1)	Very Low (-10)

(d) Impacts on Human Environment

Impacts on Socio-economic Environment

Generally, it tends to reverse the benefits that are got from the operation of the proposed project on closing the project. As an example, it would have to face the cases like giving up job opportunity and losing taxes for National Government.

(i) Loss of Jobs for Local People and Revenues for the Government

In the event of the project closure, there will be potential negative impacts resulting in loss of jobs and indirect employment depending on the operation of proposed and of associated services for tourism as well as loss of revenues for the government. Since the revenues of this project comes as paid taxes, the decommissioning of this project can have impact on the national economy.

Significant of Impacts on Socio-economic Environment before mitigation measures

Being a developing country, loss of job opportunities and revenues for regional government will be greatly affected on GDP. So, impact significant will be considered as low to moderate for loss of jobs due to insignificant number of workers appointed during operation phase and moderate for loss of revenues due to important of income from industrial section.

Components	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Loss of jobs	Negative (-)	Local (-3)	Permanent (-5)	Low (-2)	Regular (-3)	Highly probable (-4)	Low to Moderate (-70)
Loss of revenues	Negative (-)	Regional (-5)	Permanent (-5)	Moderate (-4)	Rare (-1)	Certain (-5)	Moderate (-84)

Consideration of Mitigation Measures for Socio-economic Environment

The required mitigation measures for socio-economic environment are as follow:

No.	Parameters	Impact Rating	Public Concern	Mitigation Requirement	Mitigation Scale	Responsibility
1.	Loss of job	Low to Moderate (-70)	No	Yes	Sensible	Project developer
2.	Loss of revenue	Moderate (-84)	No	Yes	Sensible	Project developer

Mitigation Measures for Loss of Jobs and Revenues for the Government

Extensive and comprehensive warning to employees to allow them to source alternative livelihood will be taken early. Project developer will prepare their employees for forced retirement by providing applicable jobs at other oil stations under the same developer, if feasible. A plan to reuse the proposed project to other partner company to retain the revenue for the government should be prepared. Moreover, there will prepare a plan to reuse the proposed project to other partner company to retain the revenue for the government.

Significant of Impacts on Socio-economic Environment after mitigation measures

Components	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Loss of jobs	Negative (-)	Local (-3)	Permanent (-5)	Low (-2)	Regular (-3)	Seldom (-2)	Low (-50)
Loss of revenues	Negative (-)	Regional (-5)	Permanent (-5)	Moderate (-4)	Rare (-1)	Probable (-3)	Low to Moderate (-56)

(ii)Decline in Transportation Sector and Local Business

When the railway alignment is demolished, local people depending on it can be faced with difficulties in transportation. When the project comes to an end of its lifespan, the decommissioning of this project can have decline in the local businesses near stations and local community.

Significant of Decline in Transportation Sector and Local Business before mitigation measures

Being a developing country, loss of job opportunities and revenues for regional government will be greatly affected on GDP. So, impact significant will be considered as follows:

Components	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Decline in transportation	Negative (-)	Local (-3)	Permanent (-5)	Low (-2)	Regular (-3)	Highly probable (-4)	Low to Moderate (-70)
Decline in local business	Negative (-)	Local (-3)	Permanent (-5)	Moderate (-4)	Intermittent (-2)	Certain (-5)	Moderate (-84)

Consideration of Mitigation Measures for Socio-economic Environment

The required mitigation measures for socio-economic environment are as follow:

No.	Parameters	Impact Rating	Public Concern	Mitigation Requirement	Mitigation Scale	Responsibility
1.	Decline in transportation	Low to Moderate (-70)	No	Yes	Sensible	Project developer
2.	Decline in local business	Moderate (-84)	No	Yes	Sensible	Project developer

Mitigation Measures

Improvement of existing Muse-Mandalay Express Road before decommissioning phase. MR should operate the railway alignment with proper maintenance not to be decommissioning if possible. If the decommissioning is happened, MR should be responsible for the maintenance and upgrade of Muse-Mandalay Express Road.

Significant of Decline in Transportation Sector and Local Business after mitigation measures

Components	Impact Type	Scale	Duration	Severity	Frequency	Probability	Impact Rating
Decline in transportation	Negative (-)	Local (-3)	Permanent (-5)	Low (-2)	Intermittent (-2)	Seldom (-2)	Low (-40)
Decline in local business	Negative (-)	Local (-3)	Permanent (-5)	Moderate (-4)	Rare (-1)	Probable (-3)	Low (-48)

6.2.3. Characterization of Residual Impacts and Comparison with Applicable Regulations

Residual environmental effects (i.e., the environmental effects that remain after mitigation has been applied) are described during each Project phase (Construction, Operation and Decommissioning), taking into account how the proposed mitigation would alter or change the

environmental effect. The analysis includes both direct and indirect interactions. The analysis considers mitigation measures to reduce adverse environmental effects or to enhance positive environmental effects, as applicable and appropriate. Once mitigation measures are applied, any remaining environmental effect is residual. The characteristics of residual environmental effects include:

Direction – the ultimate long-term trend of the environmental effect (i.e., positive or adverse);

Magnitude – the amount of change in a measurable parameter or variable relative to existing (baseline) conditions; and

Reversibility – the likelihood that a measurable parameter will recover from an environmental effect, including through active management techniques (e.g., habitat restoration).

The comparison of residual impacts with relevant laws is described below.

- According to the land acquisition, resettlement and rehabilitation law, the land use for the proposed project should be prevented for the residents. Although land loss is not sufficiently large, the payments for the loss of business (temporary or permanent), loss of livelihood, and loss of wages should be provided to the affected people, as compensation.
- Since the proposed project passes through the forest areas, the need to protect wildlife, wild plants and conserve natural areas should be mitigated in order to prevent the residual impacts on biodiversity environment which favors the protection of biodiversity and protected area law. And also, the water resources and river systems alongside the project area should be conserved which is described in the conservation of water resources and rivers law.

6.2.4. Comprehensive Environmental Monitoring Plan

Category	Parameters to be monitored	Locations	Frequency of measurements	Responsibilities
During Pre-Construction / Preparation Phase				
Air quality	1) Site patrol 2) Checking received complaints from residents 3) Monitoring of air quality, if needed	Representative point(s) of construction site(s)	1) Monthly 2) Whenever received 3) When needed	Contractor (managed by MR or Project Developer)
Water quality	1) Site patrol 2) Monitoring of parameters stipulated by National Environmental Quality(Emission) Guideline	Creeks nearby construction site(s)	1) Monthly	Contractor (managed by MR or Project Developer)

Noise and vibration	1) Site patrol 2) Received complaints from residents 3) Monitoring the noise and vibration level, if required considering received complaints and sensitive receptors etc.	Construction site(s)	1) Monthly 2) Whenever received 3) When needed	Contractor (managed by MR or Project Developer)
Cutting of trees	1) Check of species and number of trees that need be cut 2) Prior consultation with administrative authorities in charge of (MONREC)	Construction site(s)	1) Weekly	Contractor (managed by MR or Project Developer)
Waste	1) Site patrol and housekeeping at construction site 2) Checking waste-disposal method	Construction site(s)	1) Monthly 2) Monthly	Contractor (managed by MR or Project Developer)
Hazardous materials and oil management	1) Site patrol to check a condition of handling or storing hazardous materials 2) Record of training on handling hazardous materials for workers	Construction site(s)	1) Monthly 2) Quarterly	Contractor (managed by MR or Project Developer)
Social environment related to resettlement	Progress of implementation of ARP	Project area and surrounding	Monthly and quarterly	Contractor (managed by MR or Project Developer)
Existing social infrastructure and services	1) Collection of complaints 2) Physical observation of road traffic condition 3) Interviewing/discussing with Traffic Police	Construction site(s) and surroundings	1) Whenever received 2) Every day of construction period 3) When necessary	Contractor (managed by MR or Project Developer)
Monitoring health and safety of the workers during the construction of the project components	Health records about occupational injuries	Clinic / hospital referred by the contractor	on received case	Contractor (managed by MR or Project Developer)
Traffic accident	1) Site patrol 2) Record of accidents 3) Record of safety-awareness campaign and other measures	Construction site(s)	1) Monthly at minimum 2) Monthly 3) Monthly	Contractor (managed by MR or Project Developer)

Air quality	Site patrol	Along the Railway Line	Monthly	MR, Project Developer
Water quality	Monitoring of parameters stipulated by National Environmental Quality (Emission) Guideline	Discharged point from depots	Every six months for the first 2 years after starting of the operation stage	MR or Project Developer
Noise and Vibration	Noise and vibration level	Monitoring stations at every place where the railway pass near the local residents	24 hours continuous monitoring for each frequency	MR or Project Developer
Soil contamination	1) Monitoring of soil quality near the stations and labour dormitory	Depots and labour dormitory	1) Quarterly 2) When needed	MR or Project Developer
Waste	1) Site patrol to check the waste management in stations, railcars and other related facilities 2) Check of waste-disposal method	Railway stations, depots and other related facilities	Every three months for the first 2 years after starting of the operation stage	MR or Project Developer
Management of the hazardous and non-hazardous materials	1) Record of training on handling hazardous materials for workers 2) Record and condition of handling or storing hazardous materials	Project area	Quarterly for the first 3 years after starting of the operation stage	MR or Project Developer
Traffic accidents	1) Records of accidents 2) Record of safety-awareness campaign and other measures	Around the MMR Line area	1) Monthly 2) Every for the first 3 years after starting of the operation stage	MR or Project Developer
Decommissioning Phase				
Air quality	1) Site patrol 2) Monitoring of parameters stipulated by NEQ(Emission) Guideline	Representative point of decommissioning work site(s)	1) Monthly 2) Whenever received 3) When needed	Contractor (managed by MR or Project Developer)
Water quality	1) Site patrol 2) Monitoring of parameters stipulated by NEQ(Emission) Guideline	Discharged point from decommissioning work site(s) and other project-related area	1) Monthly 2) Biannually	Contractor (managed by MR or Project Developer)

Noise	1) Site patrol 2) Whenever Received complaints from residents 3) Monitoring of noise and vibration level, if required considering received complaints	Decommissioning work site(s)	1) Monthly or whenever necessary	Contractor (managed by MR or Project Developer)
Soil contamination	1) Monitoring of soil parameters at waste disposal site stipulated by NEQ(Emission) Guideline 2) Monitoring of waste disposal site of decommissioning debris 2) Implementation of hazardous materials and oil management	Decommissioning work site(s)	1) Monthly or if needed	Contractor (managed by MR or Project Developer)
Working condition including occupational health and safety	1) Record of workplace accident 2) Record of implementation of OHS Plan 3) Record of safety-awareness campaign and other measures	Decommissioning work site(s)	1) Weekly or if needed	Contractor (managed by MR or Project Developer)
Traffic accidents	1) Site patrol 2) Record of railway accidents 3) Record of other accidents along the MMR	Decommissioning work site(s)	1) Weekly of if needed	Contractor (managed by MR or Project Developer)

6.3. Risk Assessment

Potential Risk Assessment

Elements of Risk (ISO/IEC GUIDE 51:2014(E))

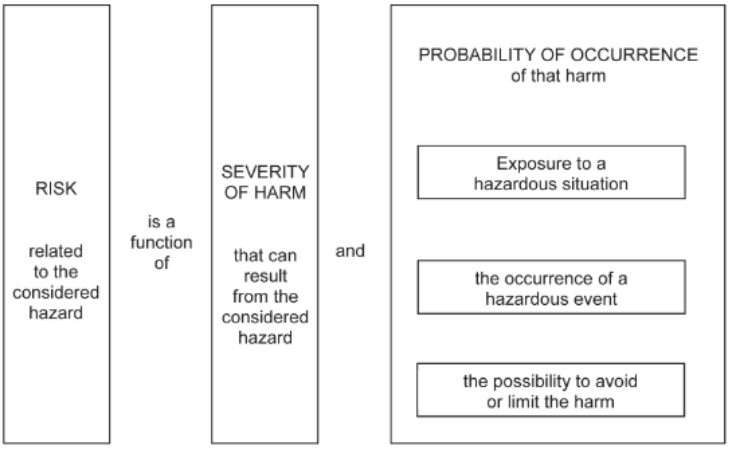


Figure - Elements of risk

The following procedure should be used to reduce risks to a tolerable level:

a. Identify the likely users for the product or system, including vulnerable consumers and others affected by the product;
b. Identify the intended use, and assess the reasonably foreseeable misuse, of the product or system;
c. Identify each hazard (including reasonably foreseeable hazardous situations and events) arising in the stages and conditions for the use of the product or system, including installation, operation, maintenance, repair and destruction/disposal;
d. Estimate and evaluate the risk to the affected user group arising from the hazard(s) identified: consideration should be given to product s or systems used by different user groups; evaluation can also be made by comparison with similar products or systems;
e. If the risk is not tolerable, reduce the risk until it becomes tolerable.

Hazards Identification

The hazard identification of railway accidents had been carried out by gathering various accident reports and information and having several workshops with railway safety experts. The railway accident scenarios are consisted of railway accident appearance scenarios and railway accident progress scenarios. Both scenario groups are divided by initiating hazardous events. Here, a hazardous event means one that has the potential to lead directly to death or injury. The railway accident appearance scenarios refer to the occurrence processes of accidents before hazardous events. These scenarios provide the base of FTA model structure for frequency evaluation on railway accidents. The railway accident progress scenarios mean the progress processes of accidents after hazardous events and they provide the base of ETA model for severity evaluation on railway accidents. The railway accident appearance scenarios provide the base of accident causal analysis models for the frequency evaluation. The railway accident progress scenarios provide the base of accident consequence analysis models for the severity evaluation and developed models will be applied to assessing the accident risk of the Slovakian railway.

Risk Analysis

Risk Analysis consists of the estimation of the frequency of the accidental events and their respective consequences. The frequency of the accidental events may be estimated based on historical data of previous incidents, fault tree analysis or expert judgment. The consequence analysis identifies both immediate consequences and those that are not apparent until sometime after the accidental event. All potential event chains following an accidental event must be identified and described.

Consequence analysis may be conducted using event tree analysis, simulations or can be derived from historical data. Cause-consequence analysis is another technique for consequence analysis which explores system responses to an initiating "challenge" and enables assessment of the probabilities of unfavorable outcomes at each of a number of mutually exclusive loss levels. This technique provides data similar to that available with an event tree; however, it offers two advantages over the event tree; time sequencing of events is better portrayed, and discrete, staged levels of outcome are analyzed. It is important to include all consequence categories, these include for the case of level crossing, rail company personnel, passengers, the environment (road side of LC), the economic impact, operational consequences and rail company reputation. Losses may be estimated in terms of human lives, or infrastructure damaged or in financial terms". Loss of Livelihood should also be included when estimating losses, livelihood being defined as "the command as individual, family or other group has over an income and/or bundle of resources that can be used or exchanged to satisfy its needs". In the absence of data, one can adopt an ordinal scale for hazard frequency classification and consequence or severity classification.

6.3.1. Occupational Health and Safety Risk

The project is a major infrastructure development project that will involve a number of skilled and unskilled laborer. These workers will be working at site, maneuvering heavy machinery and material. Risk of injuries and accident at the work site cannot be ignored. The workers may have to use power tools in making the elevated structure and there are risks of accidents and injuries. The risk of fire and electrocution will also be considered at work sites during a major project. Exposure of works in to hazardous fumes and flames is another occupational hazard during construction. Falling from heights may also happen if the workers do not use proper safety

measures when working at heights above 2 m from ground level. Stagnant water collected from rains and waste at construction sites may lead to spread of mosquitoes and flies and may increase the risk of spreading vector-borne diseases to workers and neighboring communities. Unhygienic site conditions will lead to spread of domestic pests. Communicable diseases also need significant consideration due to the involvement of migrant labour.

Mitigation Measure

Relevant labour laws should be strictly complied with pertaining to the health and safety of workers, employees and others.

- All workers and staff should be provided with Personal Protective Equipment (PPE) appropriate to their job on - site.
- All construction sites should be surrounded with secure tamper - proof fence, with security lighting, regular security patrols and other security measures.
- All materials and components should be stored and stacked safely in dedicated secure areas.
- Avoid use of any paints containing lead or its compounds as well as high VOCs
- Avoid roofing materials containing asbestos.
- Smoking should be prohibited near areas of fire or explosion risk.
- Sufficient supply of potable water should be ensured for all workers and employees on-site.
- Ensure that first aid kits are available in all work areas, supplied with adequate material to treat common workplace injuries.
- Dedicated transport should be provided at all work sites to take injured persons to hospitals if needed. Record of all nearest hospitals and health centers should be kept at each construction sites.
- A regular medical facility should be provided at each labour camp with suitable qualified staff and equipment to treat minor ailments and injuries.
- An effective alarm system should be established to warn track workers of approach of trains on existing IR lines in parallel route alignment.

- Protect all electric sub - stations, high - tension towers and other areas from electrocution risk by providing security fencing and lights, warning signs and security patrols.

Potential Impacts on Employees from Accidents and Fall

During the construction phase, an increased risk of accidents may occur due to operation of heavy construction equipment. In addition, employees risk electrocution during the operation of equipment if it is not correctly handled, or has not been regularly maintained. There is an increased risk of falls from elevated positions during construction activities, as well as falls from ground level into unsecured open trenches. In addition, should construction debris not be removed in a timely manner, it might lead to risk of trips, falls and injury.

Mitigation Measures

Appropriate working gear (such as nose, ear mask and clothing) and good construction site management shall be provided. Safety signal devices should be installed to ensure safety during construction. The contractor shall ensure that the construction site is fenced and hygienically kept with adequate provision of facilities including waste disposal receptacles, sewage, fire-fighting and clean and safe water supply. A well-stocked First Aid kit shall be maintained at each construction site. The medical personnel shall also be responsible for primary treatment of ailments and other minor medical cases as well as providing some health education to the workforce. The safety sign and notice board along the railway line should be installed in both Myanmar and Shan languages.

If the storage, transportation and disposal of these waste materials are not managed properly, the waste will contaminate the surrounding environment, contaminating soils and decreasing visual amenity.

Occupational Health and Safety Risk during Operation Phase

There is a risk of accidents due to improper working practice such as maintenance work at depot and inspection of the proposed project structure Associated risks from accidents and incidents could affect health and safety of workers and others on site. Since location of most of the operating

train will be away from the medical centers/hospitals/nursing home improper first aid facilities on site could affect health and safety of workers and others on site.

Mitigation Measure

There may be risk of accidents due to improper work practice, which would be a threat to health and safety of workers at the station, depot and the proposed structure. Health and Safety Management Plan for operational stage will be developed and implemented by the proposed organization which will be created for the operation of the proposed project. All workers undertaking maintenance work will be provided with appropriate personal protective equipment (PPE). Security guards will be deployed in Depot and all stations. Emergency Response Plan will be established by the Project Proponent.

Risks during transportation / on the track (Operation Phase)

Risks which have impact on passengers during transportation we can divide into:

(a) The risk caused by human factor

Intentional or unintentional action of man can be designated as a factor that raises risk that are employees from internal environment of railway and vandalism, terrorism, inadaptable citizens from external environment of railway.

(b) The risk of an economic nature

It represents risk which came out from business activity of individual business entities. These risks occur in such an extent as the State interferes in the transport policy of railway undertakings as are: low frequency of train connections, insufficient number of train connections.

(c) The risk arising from the nature of railway vehicles and the transport infrastructure

This area is primarily following mainly from the level of reliability, security, and the modernity and comfortability of driving (motive power unit) and powered vehicles. It is an important factor in the area of risk of railway tracks is technical and qualitative condition of railway tracks to a greater extent on regional level. Unsatisfactory technical condition of the railway tracks resulting

from wear material constitutes a risk for the customer, which is from his view difficult to assess due to the complexity and difficulty of the design elements of railway tracks.

(d) Train Collisions

Collisions can occur between two or more trains or between trains and infrastructure. Collisions between passenger trains travelling in opposite directions at speed are very rare but the consequences are usually serious. Railways operate signaling systems with varying degrees of complexity to ensure the separation of trains. More common occurrences include low speed accidents in stations, depots and yards. Train collisions can have a number of causes: drivers passing signals at danger, faulty routing, speeding, division of trains, poor wheel-rail adhesion and technical and human errors in the signaling system.

(e) Derailment

Derailments remain reasonably common although those leading to significant injury or loss of life are increasingly rare. They often involve just one train although further risks arise when a derailed train fouls an adjacent running line. Derailments are often related to technical failures such as poor track geometry, damaged or defective switches and crossings, wear and fatigue in the wheel-rail interface, vehicle suspension faults. Operator errors such as incorrect setting of points, excessive speed and poor driving behavior can also result in derailments as can track.

Mitigation Measures for Risks during Transportation

The introduction of train-borne moving block signaling such as ETCS may provide further safety benefits but also presents a number of technical challenges, particularly when transitioning between areas using different signaling systems. Train designers are also lowering the consequences of accidents by improving the crashworthiness and occupant protection of vehicles. Emergency responders should be determined the rail carriers of hazardous materials moving through the communities and ascertain if crude oil is one of the products being transported. The railway industry combats the risk of derailment by implementing rigorous maintenance systems and high levels of staff competence through comprehensive training.

Risks at railway station

The risks faced by passengers in railway stations have a similar distribution as risks during transportation. Possible risks of acting on the passenger railway station are divided into: the risk caused by human factor and risk of an economic nature. These risks can be divided into those that are caused by internal human factors (employees) and external human factors. The risks from the external environment associated with crime, vandalism, unadaptable citizens or terrorism and its result is an unsettling feeling of safety of passenger safety and in many cases also the public. The further risks which require management at stations are typically slips, trips and falls (particularly on stairs and escalators) and boarding and alighting incidents at the interface between the train and the platform.

Mitigation Measures for Risks at Railway Station

Security of both staff and passengers can present problems and control of large numbers of passengers to allow safe free-movement in heavily used stations is also a concern. The range of measures used to control these risks range from careful design of stations, clear signage and use of CCTV to staff training, cooperation with police and security services and technological solutions such as the use of platform doors. These risks arise in connection with railway stations and its environment. Include human factor or technical equipment of railway stations and others.

6.3.2. Disaster Risk

6.3.2.1. Fire Risk

The chances of a fire starting will be low if the premises have few ignition sources and combustible materials are kept away from them. In general, fires start in one of three ways:

- Accidentally, such as when smoking materials are not properly extinguished or when lighting displays are knocked over;
- By act or omission, such as when electrical equipment is not properly maintained or when waste packaging is allowed to accumulate near a heat source, or by storing LPG next to an electric fire or other source of heat; or

- Deliberately, such as an arson attack involving setting fire to external rubbish bins placed too close to the building.

Control Measures for Fire Risk

Common causes of fire in equipment and machinery are:

Causes of fire Risk	Prevention and Control Measures
allowing ventilation points to become clogged or blocked, causing overheating;	All machinery, equipment and plant should be suitable for its application, be installed (and protected) in accordance with both the manufacturer's instructions and the appropriate standard, and be properly maintained by a competent person. Appropriate signs and instructions on safe use of the equipment may be necessary.
allowing extraction equipment in catering environments to build up excessive grease deposits;	
loose drive belts or lack of lubrication leading to increased friction;	
disabling or interfering with automatic or manual safety features and cut-outs;	
leaking valves, glands or joints allowing oils and other flammable liquids to contaminate adjacent floors or goods; and	
Misuse or lack of maintenance of cooking equipment and appliances.	

Mitigation Measures for Fire Risk

The mitigation measures for fire risk include:

- Prepare escape routes from the site by analyzing the different ways available.
- Place fire extinguishers at various places in every station. Test and clean it at regular intervals.
- Controlling the type of combustible materials permitted onto the train into the tunnel
- Electrical systems should support life safety operations, fire emergency operations and normal operations.
- Use of materials that can withstand fire temperatures and not contribute to the toxic smoke and gases.
- Control the speed.

Electrical Fire Risk

Electrical equipment is a significant cause of accidental fires in premises. The main causes are:

- Overheating cables and equipment, e.g., due to overloading circuits;
- Incorrect installation or use of equipment;
- Lack of maintenance or testing of equipment;
- Incorrect fuse rating;
- Damaged or inadequate insulation on cables or wiring; combustible materials being placed too close to electrical equipment which may give off heat even when operating normally or may become hot due to a fault;
- Arcing or sparking by electrical equipment; and
- Embrittlement and cracking of cable sheathing in cold environments.

Mitigation Measures for Electrical Fire Risk

All electrical equipment should be installed and maintained in a safe manner by a competent person. If portable electrical equipment is used, including items brought into a workplace by employees, then the fire risk assessment should ensure that it is visually inspected and undergoes portable appliance testing ('PAT') at intervals suitable for the type of equipment and its frequency of use. If any doubt about the safety of electrical installation then it should consult a competent electrician.

6.3.2.2. Flood Risk

A flood is a high flow or overflow of water from a river or similar source of water occurring over a period of time. Heavy rain spell can result in an extra volume of water in the waterways, leading to a rise in the water level of streams and rivers. A flood happens when the carrying capacity of the waterways fails to hold the total volume of increased water at any given time. Nowadays, all the countries' climate is changing - temperatures are getting hotter and the monsoon season is getting shorter. That's why flooding cause of climate change, appear as a threat for us.

Many factors can go into the making of a flood;

The main causes of floods are:

- ❖ Continuous heavy rain
- ❖ Bad drainage facilities

- Blocking of river channels by landslides
- Narrowness of the river
- Change in the course of river
- Inefficient engineering design in the construction of embankments,
- dams and canals
- Failure of hydraulic and other control measures
- Destruction of mangroves and trees which do not grow back
- Deforestation and removal of root system
- Sediment deposit or silting of the river bed
- Rapid urbanization with no proper drainage facility
- Storm surge
- More and more, flooding factors are also linked to climate change.

Climate Change and Flooding

Connecting climate change to floods can be a tricky endeavor. Not only do myriad weather- and human-related factors play into whether or not a flood occurs, but limited data on the floods of the past make it difficult to measure them against the climate-driven trends of floods today. However, as the IPCC (Intergovernmental Panel on Climate Change) noted in its special report on extremes, it is increasingly clear that climate change "has detectably influenced" several of the water-related variables that contribute to floods, such as rainfall, extreme weather events, etc. Floods are made more likely by the more extreme weather patterns caused by long-term global climate change. Change in land cover—such as removal of vegetation—and climate change increase flood risk.

Extreme floods can be triggered by intense precipitation, longer duration, close repetition of precipitations or a combination of these. "While it is difficult to make a direct link between an individual extreme event and climate change, it is clear that we need to be prepared to face more intense and more frequent extreme hydro-meteorological events due to climate change," says Pascal Peduzzi, Director of the United Nations Environment Programme's (UNEP) Global Resource Information Database in Geneva.

Climate change endangers the railways system when subjected to flooding events. Flood events have caused property damage along with service disruptions, by the inundation of underground

infrastructures (e.g., tunnels and alignment). Therefore, it is important to evaluate flood risks in railways systems to plan for flood disasters and set mitigation strategies efficiently.

General Rainfall Conditions around Proposed Project

In Myanmar, annual rainfall in the delta region is approximately 2,500 mm (98.4 in), while average annual rainfall in the Dry Zone in central Myanmar is less than 1,000 mm (39.4 in). In specific, about 812 mm (32.0) inch of precipitation falls annually in Mandalay and around 1758 mm (69.2) inch per year in Shan State (climate-data 2020).

The floods in Myanmar mainly occur during the monsoon months (June to October). The type of floods occur in Myanmar may be generally classified into two; the wide spread flood and flash flood. The wide spread flood mostly occurs along Ayeyarwady, Chindwin, Sittoung and Thanlwin which are major rivers and the flash flood usually occur at the small rivers and stream. The main cause of wide spread flood is heavy rainfall striking at the head water regime for considerable period (1 to 3 days), the flood wave forming at the head water started to move downward and causing flood along the river up to the deltaic area. The flash flood is caused by heavy rainfall fell on the source and the flood wave move downward swiftly. Observation shows that the percentages of occurrence of floods (exceeding danger level) in medium and large rivers of Myanmar are 6% in June, 23% in July, 49% in August, 14% in September and 8% in October. The severe floods had occurred in 2004, 1974, 1997, 1976,1991,1973,1988 and 1997, and order of the years are arranged with respect to their intensities. Ref: (Department of Meteorology and Hydrology (Myanmar) 2020).

Preparedness Scale for Flood Risk Climate Change

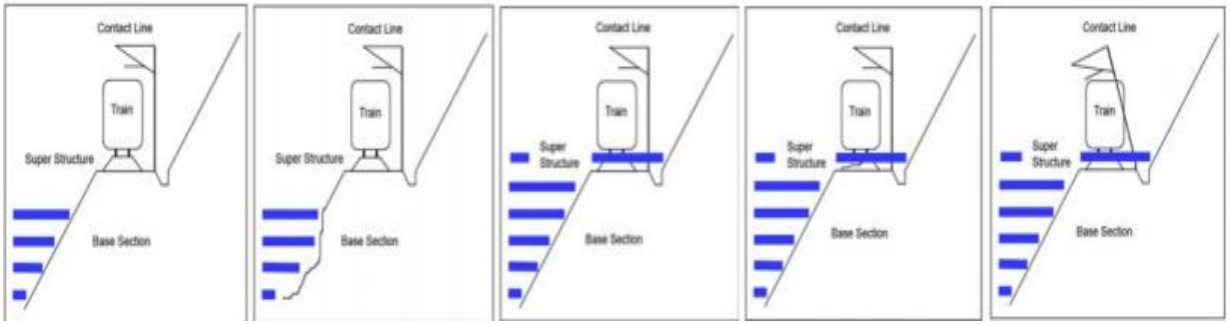
Since the beginning of the construction phase, the alignment construction process contains the construction of dub-grade drainage systems. So, to prevent the flood risk, the good sub-grade drainage facilities should be installed. Example preparedness scale for flooding and climate change;

We should prepare for unforeseen events and then identified the hazards with reactive action plans and set short-term forecast and plan. To implement long-term sustainable planning, a specific risk due to flooding and climate change, could impact on these parts on proposed project. Flooding can

have significant direct and indirect negative effects on a railway network affecting both rail operations and infrastructure. Such impacts include the delaying or cancelling of train services, causing damage to railway structures or the necessity to implement costly maintenance and monitoring programs to ensure the safety and performance of the system.

If some part of the railway networks were built near the rivers. At this area, flood-related erosion may cause and effect on alignment the risk of erosion on that kind of areas depends on: flood velocities—the bigger the flood, the higher the velocities and the orientation of vegetation rows and the amount of protective cover provided by crops or stubble when flooding occurs. Turfing of slopes with grass should propose on side slopes of the formation to prevent erosion of slopes during rain and floods.

The classification of structural damage is generally described as follows:



Description	Indirect effects
Flooding reaches the base section without notable damage	none
Flooding reaches the base section. Erosion occurs	Possible operational limitations (slower speeds, delays)
Track super structure is flooded.	Track is closed. Detours or replacement transport services are necessary.
Erosion of the track super structure. Reconstruction is necessary.	Detours or replacement transport services for several days are necessary.
Additional damage of the overhead contact line, signals etc.	Detours or replacement transport services for several weeks are necessary

Flash Flood

Flash floods are floods that rise and fall rapidly with little or no advance warning. A flash flood occurs when water overflows on or inundates land that is normally dry. Rivers can overflow

their banks to cause flooding, and sea waters can be pushed towards land by massive winds, which then cause flooding. Rainfalls over an extended period can cause major rivers to overflow their banks. Rivers can overflow their banks, causing flooding during heavy rains, severe storms and dam breaks. Huge amounts of water flowing in rivers are due to incessant heavy rains and melting of snow, resulting in severe flooding. Flash flood normally happens during the monsoon season. Around this time, potholes can overflow fast, breaking and damaging the river banks. Flash floods are common in mountainous regions. Lack of vegetation and denudation of the mountain areas are the major causes of flash floods.

Flash flood damages can be reduced by establishing a proper flood control management structure to manage floods and reduce their ill effects. Taking precautionary steps, measures, and actions with the help of the government will deliver communities, agricultural land, infrastructure, and livelihoods in flash flood-prone areas to safety.

River Flood

A river flood occurs when a river overspills its banks; that is, when its flow can no longer be contained within its channel. Flooding is a natural and regular reality for many rivers, helping sculpt soil and spread nutrients in alluvial valleys and supporting many ecosystems – such as swamps and bottomland forests – adapted to occasional inundation.

River floods have also been life-giving forces for human societies dependent on them for agriculture and soil fertility. Nonetheless, humans often perceive floods negatively because of the damage and loss of life they often wreak where natural floodways have become heavily developed and populated.

Mandalay Region

In Mandalay Region, both flash floods and river floods can occur because of its vicinity to Ayeyarwaddy River.

Calculation of Probability

Before Mitigation

Flash floods may occur at least once a year, so, the probability can be taken as "Likely". For river floods, it is estimated that it might occur at some time, and so, the probability can be taken as "Possible".

Calculation of Consequences

Before Mitigation

Flash floods can be low environmental damage, and so, the consequences can be taken as "Minor". River floods can be medium damage to environment, so, it can be classified as "Moderate".

After Mitigation

After proper mitigation measures and flood control measures, consequences of flash floods can be reduced to "Insignificant" and river floods "Minor".

Shan State

In Shan State, only flash floods mostly occur.

Calculation of Probability

Before Mitigation

Flash floods may occur at least once a year, so, the probability can be taken as "Likely".

Calculation of Consequences

Before Mitigation

Flash floods can be low environmental damage, and so, the consequences can be taken as "Minor".

After Mitigation

After proper mitigation measures and flood control measures, consequences of flash floods can be reduced to "Insignificant".

Flood Risk Assessment Table

Region & Flood Type	Consequences	Probability	Initial Risk	Mitigation Measures	Consequences after mitigation	Probability after mitigation	Reduced Risk
Mandalay (Flash Flood)	2	4	8 (Moderate Risk)	• Proper Drainage System • Re-vegetation after cutting trees in the vicinity	1	4	4 (Moderate Risk)
Mandalay (River Flood)	3	3	9 (High Risk)	• Avoid over cutting of trees in mountainous regions to reduce denudation	2	3	6 (Moderate Risk)
Shan State (Flash Flood)	2	4	8 (Moderate Risk)		1	4	4 (Moderate Risk)

Prevention Measures for Flood Risk

- Professional meteorologists should monitor the weather around the clock using all available weather models. If the predictive models show that something may occur on a section of the line that could adversely affect traffic, a storm warning will be generated. Then this warning will be received by the head of the Central Directorate of the Railways. When it is confirmed, the storm warning will become an order not only notifying about the danger, but also ordering the necessary security measures, for example, the preparation of equipment and deploying personnel to a certain part of the rail.
- Every year, just before the rain fall, specialists should inspect dams, bridges and tracks; measure river beds near bridges; and clean debris from channels, and drainage ditches, and the openings of small bridges and pipes. The main canals and other objects of the irrigation system should also be inspected, because if they are breached or destroyed, the safety and normal functioning of the railway infrastructure facilities could be compromised. Control measurements should be taken before and during the flood period.
- Prior to the floods, engineering structures and infrastructure are provided with anti-washout materials, tools, fuel and work clothes. If there are not enough workforces, additional workers should be hired for this period.
- If there are any sudden deformations of the roadbed that could lead to its full or partial failure and cause interruptions in the movement of trains, emergency and recovery operations involving material, technical and human resources should be carried out.
- It takes thousands of workers to ensure the safe passage of flood and storm water, and railway safety of trains depends on the cohesiveness of response.

Recommendation for Erosion control

In an erosion control processes during the construction is very important, especially at sites where cutting the slopes should be. At these some locations activation of erosion processes is expected. Therefore, implementation of erosion control measures: arrangement of berms, stone mounds and gabions will be required at the cut slopes and in the bottom of the slopes.

6.3.2.3. Earthquake Risk

The proposed Muse-Mandalay Railway line is actually located in the Shan-Thai Block and the rocks are mostly of limestone of Paleozoic age with some ragged mountain terrains. The carbonate rocks are mostly of the limestone from Maymyo Formation which has karst topography, cave and sinkhole natures. As the railway line is expected to be 431 kilometres long, it will be needed a significant number of bridges and tunnels. So, it is necessary to construct those infrastructures systematically and qualitatively. Another important thing is that as Myanmar itself falls in an earthquake prone and the strongest earthquake (Kyaukkyan Fault) happed in the railway line near Naungcho town, it should be conscious and thoroughly made any structures that must be resisted the magnitude (> R.M.8) of earthquake.

Earthquake related landslide and other natural disasters such as storms, cyclones, floods and landslide caused by heavy rains should be aware and taken into account in considering engineering designs. In addition to high cost involved, seismic, geological and natural hazardous issues are major burdens to the engineering project along Muse-Mandalay speed railway line.

The Muse-Mandalay railway line runs diagonally along the southwestern direction through Upper Myanmar. The geological structure is between two first-order geotectonic units of the mountain - nyenchen tanglha range fold system (II) and the India-Myanmar-Sumatra fold system (III).

There are six main faults near the line: Bangpaman fault (F9), branch fractures (Kyaukme fault F7-1and Kunlong fault F7-2) of Nantinghe fault (F7), Lashio fault (F8), Goteik fault (F6), and Sagaing fault (F4). In which, the faults that have been active since the Late Pleistocene to the Holocene are the Nantinghe fault (F7) and the Sagaing fault (F4), which are all regional active faults in Holocene, and where witnessed earthquakes of magnitude 7 or higher for many times in history. There is still the possibility of an earthquake of magnitude 7 or higher in the future.

A number of earthquakes have significantly affected railroads. The effects range from restriction or suspension of operations on a portion of the railroad, while earthquake effects are assessed by inspection, to extreme damage over large areas. Since earthquake intensity depends on both the distance from the fault rupture and local conditions as well as the magnitude and depth of the earthquake, the extent of railroad damage is only indirectly related to the characteristics of the earthquake.

Damage from earthquakes occurs through several mechanisms. Surface displacements across the fault rupture can directly damage facilities that cross the rupture or, if under the ocean can cause tsunamis. Shaking from seismic waves can derail cars and locomotives, can directly damage structures, can produce permanent ground movements related to liquefaction and landslides and can cause damaging floods from dam failures. Appropriate measures to minimize damage or facilitate recovery depend on the mechanism causing the damage.

Magnitude	Earthquake Effects	Estimated Number Each Year
2.5 or less	Usually not felt, but can be recorded by seismograph.	900,000
2.5 to 5.4	Often felt, but only causes minor damage.	30,000
5.5 to 6.0	Slight damage to buildings and other structures.	500
6.1 to 6.9	May cause a lot of damage in very populated areas.	100
7.0 to 7.9	Major earthquake, Serious damage.	20
8.0 or greater	Great earthquake Can totally destroy communities near the epicenter.	One every 5 to 10 years

Earthquake Magnitude Classes

Earthquakes are also classified in categories ranging from minor to great, depending on their magnitude.

Class	Magnitude
Great	8 or more
Major	7 to 7.9
Strong	6 to 6.9
Moderate	5 to 5.9
Light	4 to 4.9
Minor	3 to 3.9

Source: UPSeis

The most common effect of earthquake on railway alignment is that locomotives and/or cars can be derailed or overturned. They can also cause track damage and/or embankment failures. Track damage ranged from displaced ballast without other track disturbance to broken ties, pulled apart joints, broken rails, buckled track, and lateral displacement of up to several meters and loss of vertical support for track over appreciable distances.

Effects of earthquake on railway alignment also include:

- Collapse of train
- Effect on life of humans, fatalities and injuries
- Effect to economy such as cost to rebuild asset, cost to respond to and recover, cost resulting from disruption of product or service, long term costs due to environmental damage.

The recovery of a railroad from a significant earthquake depends on the severity and extent of damage, the resources available for repair and the urgency of restoring service. As a minimum, inspection to ensure the safety of the track and related systems is required after moderate and larger earthquakes in the vicinity of the railroad.

In order to ensure safety of trains and passengers at the time of earthquakes, continuous efforts must be made to control train operations quickly (intangible measures), strengthen the seismic performance of the structures (tangible measures), and maintain functions after disasters.

To limit the impact of natural disasters on railway operations, we need to be able to predict time, location, and type. But we are dealing with natural phenomena that are extremely difficult to predict accurately, even with today's advanced technology. So, we should concentrate on achieving safety and minimizing the impact as much as possible.

Following actions can be made to control and prevent the impact of earthquake on the railway alignment:

1. Selection of railway route which can have minimum impact by an earthquake.
2. Railway tracks should be made so that it can withstand earthquake impact as much as possible.

Earthquake Induced Liquefaction Risk

Liquefaction is a soil behavior phenomenon in which a saturated soil loss a substantial amount of strength due to high excess pore-water pressure generated by and accumulated during strong earthquake ground shaking or other rapid loading.

In Muse-Mandalay Railway alignment, it is observed that some sections of railway line are located in a high seismic intensity area, where Quaternary loose saturated sandy soil is prone to earthquake-induced liquefaction. Sand liquefaction problems exist in Lashio basin (Lashio Station) and Thazi

valley in Ayeyarwady basin. Saturated sand layers within 20 m depth below the surface on the riverbed, flood plain and terrace in tributaries of Ayeyarwaddy River are prone to sand liquefaction.

Evaluation of Earthquake Induced Liquefaction Potential

It is required to determine the liquefaction level to take suitable anti-liquefaction measures for relative project items. In proposed project, evaluation of liquefaction characteristics of soils will be tested by Standard Penetration Test (SPT). The liquefaction characteristic of a soil depends on several factors, such as ground acceleration, grain size distribution, soil density, thickness of the deposits and especially the position of the ground-water table.

During performing SPT in-situ test for liquefaction, it is observed that the assessments have been extended to a depth of 40 m below existing ground level. It is considered that below this depth, liquefaction is improbable and also unlikely to influence behavior of facilities founded near to the surface.

Calculation of Cyclic Stress Ratio (SR_{eq})

The cyclic shear stress ratios (SR_{eq}) induced by earthquake ground motions, at a depth z below the ground surface, using the following equation

$$SR_{eq} = 0.65 \left(\frac{\sigma_o \, a_{max}}{g \, \sigma'_o}\right) r_d$$

Where;

a_{max} = maximum horizontal acceleration at the ground surface

σ_o = total vertical stress

σ'_o = effective vertical stress at depth

r_d = stress reduction coefficient that accounts for the flexibility of the soil column

According to the above questions, the values of peak ground acceleration a_{max} of the areas that are prone to sand liquefaction along the railway line are shown in the following table:

S/N	O-D mileage	Project item	Ground motion peak acceleration (g)
1.	CK376+740～CK377+960	Bridge	0.3
2.	CK379+800～CK381+000	Subgrade	0.3
3.	CK381+400～CK383+040	Subgrade	0.3
4.	CK386+450～CK387+560	Subgrade	0.3
5.	CK387+560～CK387+880	Subgrade	0.4
6.	CK388+320～CK389+240	Subgrade	0.4
7.	CK390+320～CK394+300	Subgrade	0.4
8.	CK397+400～CK398+300	Subgrade	≥0.4
9.	LC1K0+000～LC1K4+169.87	Subgrade	≥0.4

Calculation of Cyclic Resistance Ratio (SR)

This is estimated based on either empirical correlation with the SPT N_m value allowing for the effects of the soil fines content (FC).

Empirical charts have been prepared to determine the cyclic strength based on corrected SPT blow count, (N_1) 60, calculated as follows:

$$(N_1)_{60} = C_n \frac{ER_m}{60} N_m$$

Where,

C_n = correction coefficient for overburden pressure

ER_m = actual energy efficiency delivered to the drill rod

Calculation of factor of Safety (FS)

The Factor of Safety against liquefaction is defined as

$$\boldsymbol{FS = \frac{(SR)}{(SR_{eq})}}$$

The following figure shows the flow chart of the Seed and Idriss simplified method for liquefaction analysis.

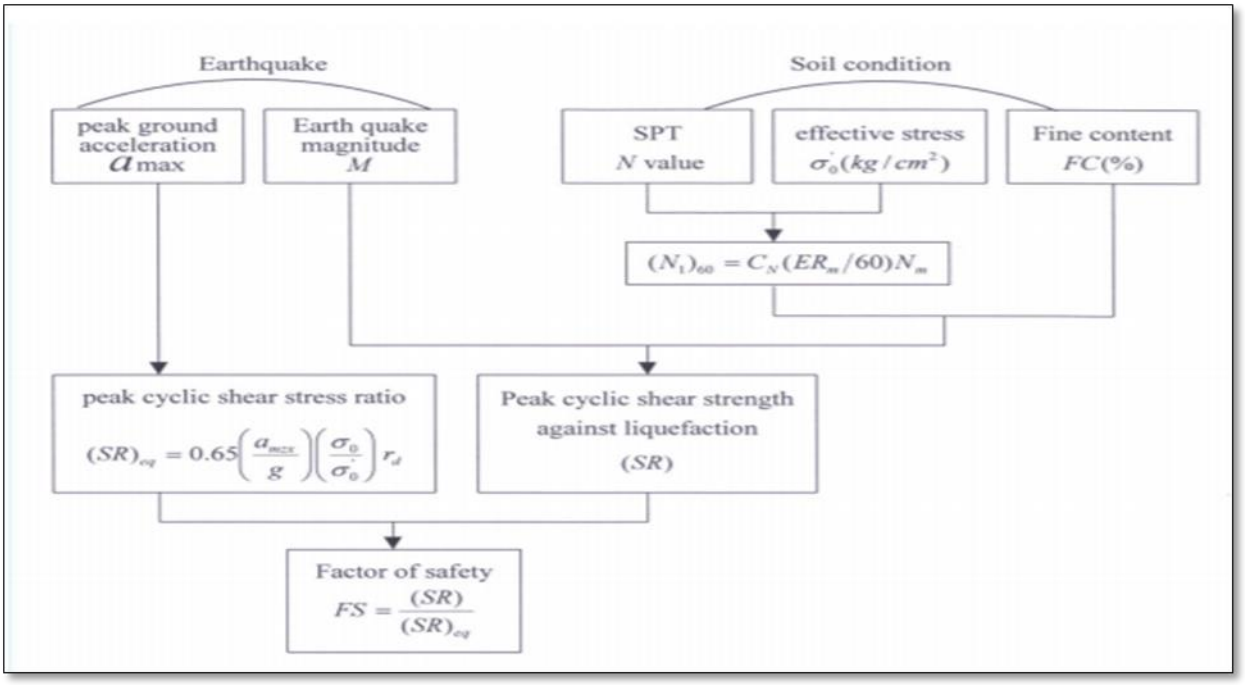


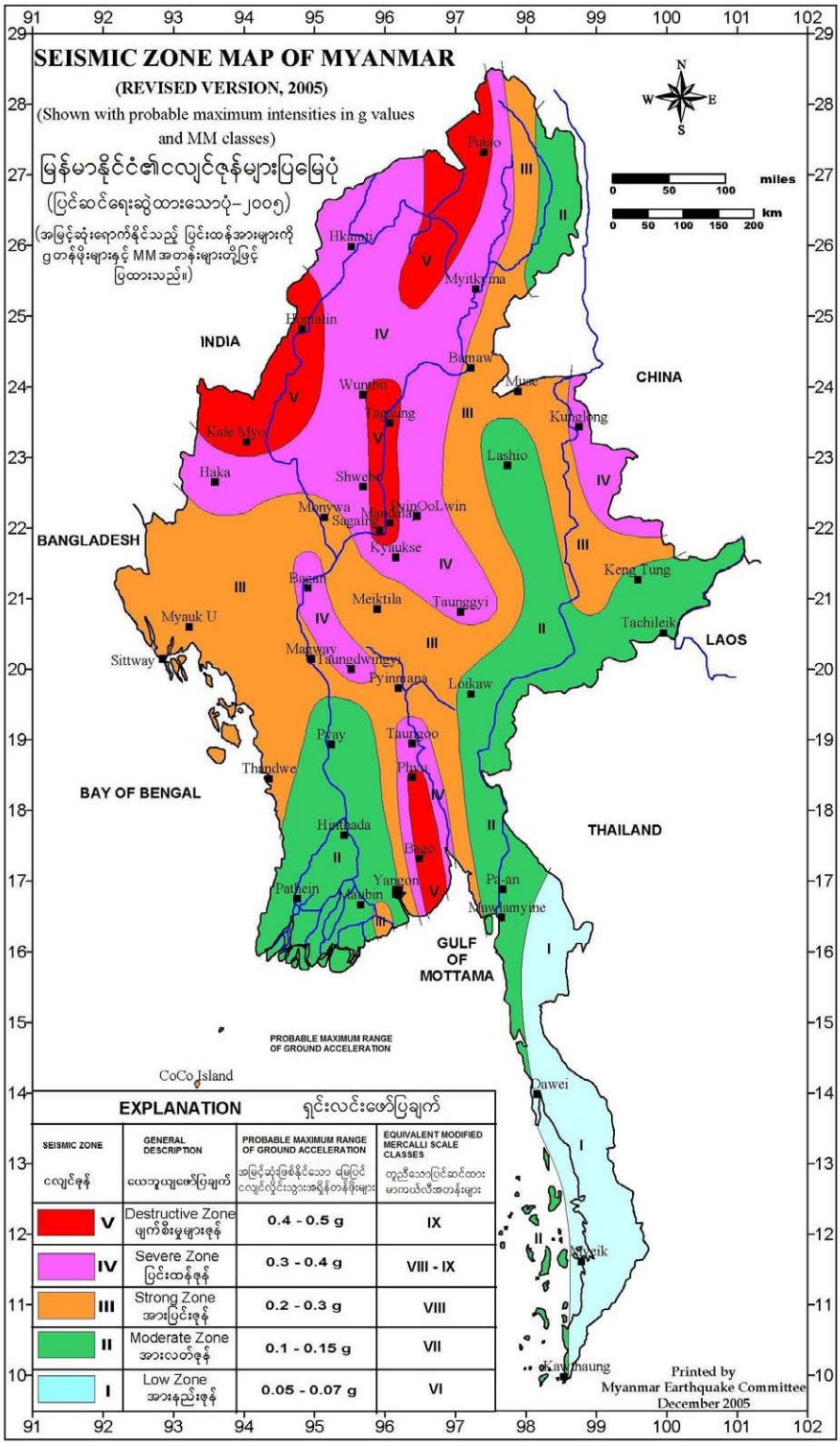
Figure: Flow Chart of Seed and Idriss Method for Liquefaction Potential Estimation

If the cyclic stress ratio caused by an earthquake is greater than the Cyclic Resistance Ratio of the in-situ soil, then liquefaction could occur during the earthquake and vice versa. Liquefaction is predicted to occur when FS $\leqslant$ 1.0, and liquefaction predicted not to occur when FS > 1. The higher the factor of safety, the more the resistance is against liquefaction. By observing the resulted values of FS, the relative project items can be taken corresponding anti-liquefaction measures. For example, bridges shall use pile foundations to pass through the liquefied soil layer or adopt other corresponding anti-liquefaction measures in face of the same.

Earthquake Risk Assessment

Earthquakes in last 50 Years (Source: volcanodiscovery.com)

Region	Date	Magnitude (Richter Scale)	Location
Mandalay-Sagaing	11.11.2012	5.0	Pyin Oo Lwin
	30.3.2013	5.0	Pyin Oo Lwin
	9.9.2013	5.0	Mandalay
	18.1.1986	5.1	Mandalay
	1.1.1988	5.2	Mandalay
	26.6.2014	5.2	Mandalay
	28.11.2019	5.2	Pyin Oo Lwin
Shan State	11.11.2012	5.6	Pyin Oo Lwin
	1.3.2015	5.2	Lashio
	1.3.1989	5.8	Lashio
	23.4.1984	5.9	Lashio
	9.7.1995	5.9	Lashio
	23.4.1992	6.1	Lashio
	23.4.1992	6.2	Lashio



Source: MIMU [Myanmar Information Management Unit]

Figure - Seismic Zone Map of Myanmar

Calculation of Probability

As stated in the above table, the probability of earthquakes, which can be slight to moderate damage (Richter scale 5-6.9), be occurred in 50 years can be taken as "Almost Certain".
An earthquake of magnitude 7.0 Richter scale occurred in Sagaing, 39km Northwest of Mandalay, on 16th July, 1956. A strong earthquake occurred on 24th July, 1485 near this location, which is also along the Sagaing fault. So, the return period of a strong earthquake to be occurred can be taken as 471 years where the probability for a strong earthquake to be occurred in 50 years can be calculated as 10.6%. It can be taken as "Likely".

Calculation of Consequences

Before Mitigation

Mandalay-Sagaing Region

Earthquakes occurred in Mandalay-Sagaing Region are generally 5.0-5.5 Richter Scale, which can be minor and slight damage to structures. However, since this region is classified as Severe to Destructive zone in Seismic Zone Map of Myanmar, the consequences can be taken as "Moderate". However, according to records, earthquake in 1485 in Sagaing destroyed 3 well known pagodas and the one which happened in 1956 severely damaged several pagodas and 40 to 50 people were killed by this one. So, strong earthquakes of magnitude 7.0 Richter scale and above can be taken as "Catastrophic" since the region is also classified in the Severe to Destructive Zone.

Shan State

Earthquakes in this region are generally 5.5-6.5 Richter Scale, which can be moderate damage to structures, but it is classified as Moderate zone in Seismic Zone Map of Myanmar. So, the consequences can be taken as "Moderate".

After Mitigation

After Mitigation measures, consequences taken as "Moderate" can be reduced to "Insignificant" and consequences taken as "Catastrophic" can be reduced to "Moderate".

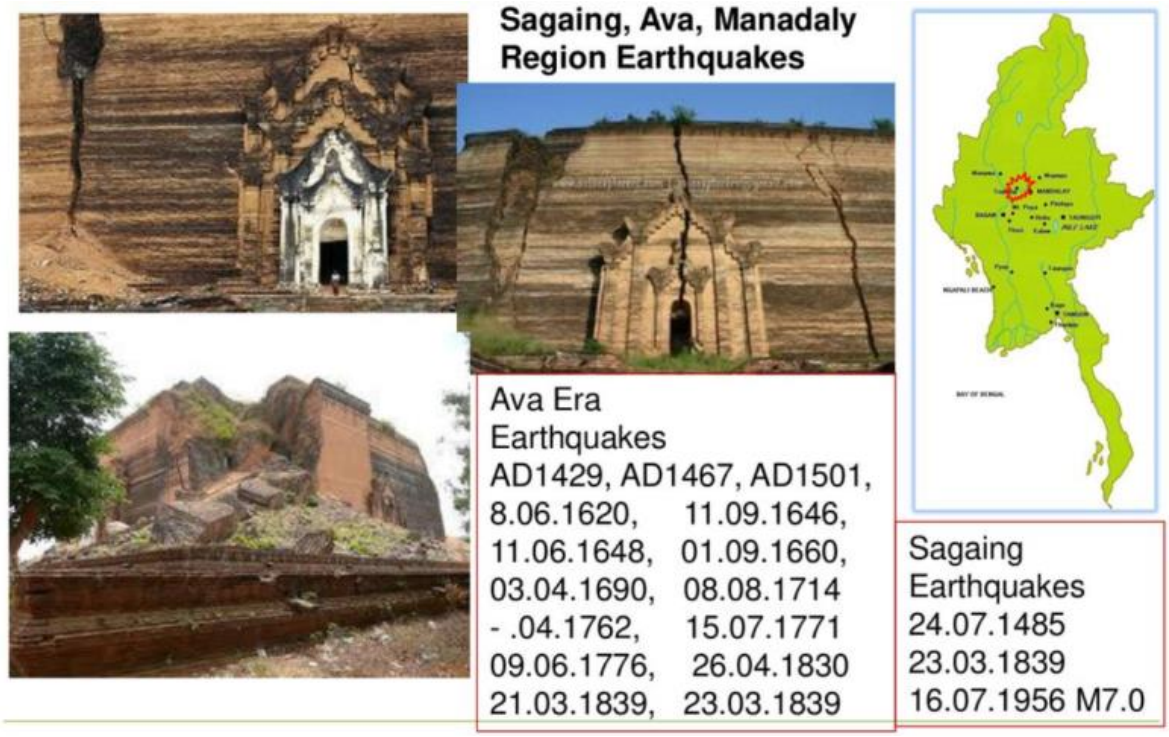


Figure - Past Earthquakes in Sagaing, Ava (Innwa) and Mandalay Region

Earthquake Risk Assessment Table

Region	Consequences	Probability	Initial Risk	Mitigation Measures	Consequences after mitigation	Probability after mitigation	Reduced Risk
Mandalay-Sagaing	3	5	15 (High Risk)	• Structures should be designed to withstand an earthquake of magnitude up to Richter Scale 8.0. • Selection of railway route which can have minimum impact by an earthquake. • If outdoors, find a clear spot away from buildings, trees, streetlights and power lines. Keep lying on the ground and stay there until the shaking stops. • If indoor, go below table until the shaking stops. Avoid lift and staircase.	1	5	5 (Moderate Risk)
Mandalay-Sagaing (Richter Scale 7.0 & above)	5	4	20 (Critical Risk)		3	4	12 (High Risk)
Shan State	3	5	15 (High Risk)		1	5	5 (Moderate Risk)

The calculation is based on the 5x5 risk matrix shown above. Residual risk even after mitigation measures cannot be mitigated more since earthquake is a natural disaster but it can be controlled by proper emergency planning after an earthquake.

- To organize search and rescue of people trapped under debris.
- Medical officer to ensure provision of proper Medical Aid to the injured.

Mitigation Measures for Liquefaction Hazards

Mitigation measures against liquefaction are

- The infrastructures should be supported on deep foundations, such as piles, that extend through the liquefiable soil to deeper strong and stable strata.
- The liquefaction of a soil can be prevented by compacting the soil and increasing its relative density by means of vibratory rollers, compaction piles, vibrio-flotation, blasting, etc.
- stabilizing soil is performed by injecting chemicals or cement grout into the soil
- By restoring to extensive ground water pumping in which the effective stress at a point increases as the water table is lowered, the liquefaction can be prevented to some extent.
- The liquefaction hazard can be reduced to some extent by providing coarse sand blankets and drains in the soil deposit.
- Applying a surcharge load to a soil deposit and construction of stone columns, the possibility of liquefaction is reduced by means of increasing the effective stress.

7.0. CUMULATIVE IMPACT ASSESSMENT

Cumulative Impact Assessment is the process of assessing potential effects on receptors from environmental and social impacts caused by the combined influence of more than one project. Evaluation of potential cumulative impacts is an integral element of an impact assessment.

7.1. Methodology and Approach

The cumulative environmental effects of the Project in combination with other projects or activities that have been or will be carried out are assessed. The assessment is carried out in the form to facilitate the evaluation, followed by a detailed discussion of how the Project may overlap with other projects or activities that have been or will be carried out and interact with the environment and mitigation measures.

The analysis of cumulative impacts in this section follows the processes recommended by EIA procedure (2015) and the regulations at Section 42 of the Environmental Conservation Law. Cumulative impacts in relation to an activity are defined in the EIA Regulations (Government Notice R543) as meaning "the impact of an activity that in it may not be significant, but may become significant when added to the existing and potential impacts eventuating from similar or diverse activities or undertakings in the area". Cumulative impacts were assessed by taking into consideration of potential environmental impacts of the proposed project and other related activities that had happened in the past, currently is happening at present and likely to happen in the future. In general, the proposed project cumulative impact railway facilities depending on the resource considered. The potential cumulative impact for the proposed project encompasses the area of physical disturbance along the proposed project construction ROW and adjacent areas that could have localized impacts associated with temporary access roads and aboveground facilities. The actions considered in the cumulative impact analysis may vary from the proposed project in nature, magnitude, and duration. These actions are included based on their likelihood of occurrence, and only projects with either ongoing or reasonably foreseeable impacts are identified.

7.2. Existing and Future Private and Public Projects and Developments

The followings are the existing private and public infrastructure, factory and industrial sector related to the proposed project.

7.2.1. Existing Private and Public Projects and Developments

7.2.1.1. NH3 Highway

NH3 highway, also known as "Stilwell Highway" in history, has the part in Chinese border, as No. 320 National Highway Western-Yunnan Section. The length in China is 850 kilometers long; it starts from Kunming to Shwe Li Wanding Port, the length from the Wanding port to the destination Lashio, Myanmar is 603 kilometers. It is an important transportation route connecting Southeast Asian countries. At present, it can reach Yangon, Bangkok, the capital of Thailand, to India in the west and Singapore in the southeast. There is only NH3 highway along the line, which is a two-way two-lane road with an existing width of 8m, 477 km (296 mi) length and asphalt concrete pavement.

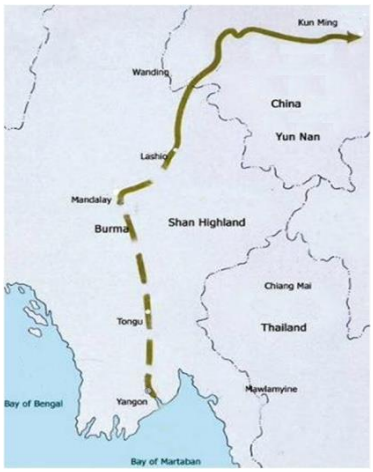
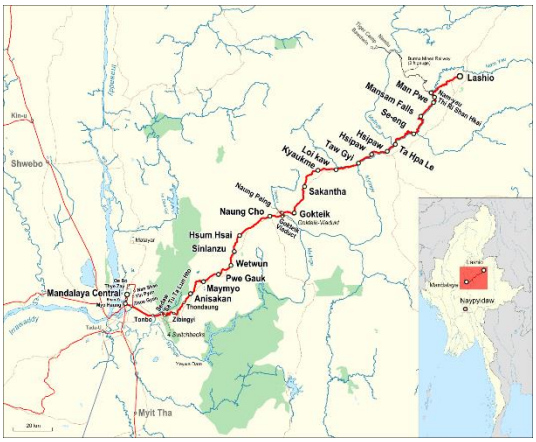


Figure 7.1 – NH3 Highway

7.2.1.2. Lashio-Mandalay Railway

Northern Shan State Railway is a 1,000 mm (3 ft 3 3/8 in) gauge railway line in Myanmar's Shan State, operated by Myanma Railways. The line runs from Mandalay Central railway Station to Lashio Station in 11 hours. The total length of this line is 441 kilometers (274 mi).



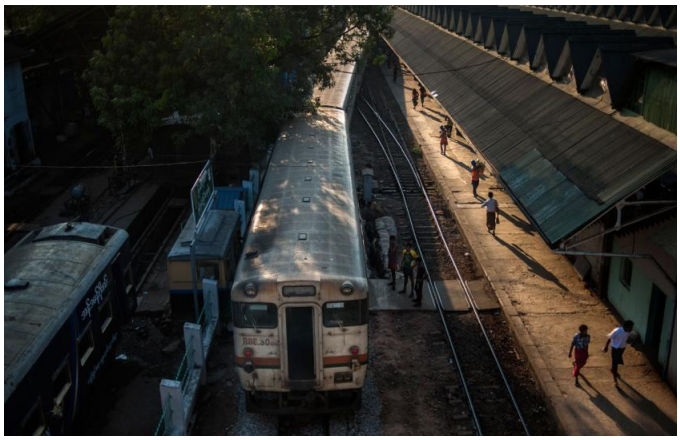


Figure 7.2 – Lashio-Mandalay Railway

(Source: Wikimedia Commons, and Belt & Road News)

7.2.1.3. Existing Gas Pipeline Project in Shan State

The Myanmar-China oil and gas underground pipeline has the diameter of 813mm-1,016mm. The starting point of Myanmar-China oil pipeline is located in Maday Island on the west coast of Myanmar. They enter China from Shwe Li, Yunnan Province, via Rakhine, Magwe, Mandalay and Shan State of Myanmar. The total length of crude oil and natural gas pipelines is 793km. Among them, the design capacity of Myanmar-China crude oil pipeline is 22 million tons/year, and the gas transmission capacity of Myanmar-China natural gas pipeline is 12 billion cubic meters/year. On July 28, 2013, gas transmission to China started.

Figure 7.3 – Myanmar-China Oil & Gas Pipeline

7.2.2. Future Private and Public Projects and Developments

The future project will be railway line, quarry mine sites during construction phase, illegal villages along the railway road after construction phase and shops at railway stations and transportation related infrastructure during operation phase as follow:

Figure 7.4 - Some Quarry Mine Site in Shan Region
Source: Frontier Myanmar

Figure 7.5 - Illegal Villages

Figure 7.6 – Shops at Stations

7.3. Assessment and Mitigation Measures of Potential Cumulative Impacts

Cumulative impacts for the proposed railway bridges and culverts will be as follow:

7.3.1. Anticipated Cumulative Impacts during Pre-Construction Phase

The cumulative impacts during pre-construction phase will be as follow:

7.3.1.1. Loss of Habitat

Site clearing activities during Pre-construction phase can lead to habitat destruction. Removing trees thins the forest canopy which is meant to block sun rays as good shelter during the day and holds in the heat at night. This damaging disruption leads to extreme temperature swings that are harmful to plants and animals. Many animals, insects, and plants lose their habitats. The loss of the habitats is expected to have indirect impacts on surrounding habitat areas and associated biota. Habitat destruction is currently ranked as the primary cause of species extinction worldwide. Clearing of existing vegetation which may leads to loss of habitat. Some places in the construction area are likely to be lost due to direct and indirect construction activities for resident animals.

Mitigation measures for loss of habitat

Clearing of vegetation should be kept to a minimum, keeping the width and length of the earth works to a minimum and the floodplain. Wetland habitats identified should be retained within the development footprint in its current state.

7.3.2. Anticipated Cumulative Impacts during Construction Phase

Cumulative impacts during construction phase will be as follows:

7.3.2.1. Cumulative Impacts on Climate Change due to Deforestation

Climate change is among one of the most important environmental challenges we face today. Mostly, the cause of climate change by human activities like project construction is that this adds enormous amounts of greenhouse gases to those naturally occurring in the atmosphere, increasing the greenhouse effect and the earth's temperature. Irrespective of the engine

technology employed, CO_2 is the largest component of the transport sector's contribution to the greenhouse effect. Impact activities of the proposed project on climate change include deforestation and vehicular emissions during construction phase.

There will have cutting down and clearing away of trees and natural vegetation along the railway project according to the needs of ROW width for section subgrade, power supply, tunnels and bridge construction. Large amount of greenhouse gases is generated from fuel powered machinery and vehicles by the operation of generator, concrete mixer, excavator, loaders, trucks and other construction machineries into the atmosphere both on-site and the public roads. Because of the development of the area, other commercial buildings such as factories can also exist in the future. These can also release a large amount of greenhouse gases. Healthy forests absorb carbon dioxide from the atmosphere, acting as valuable carbon sinks. Deforested areas lose that ability and release more carbon. The lack of trees allows a greater amount of greenhouse gases to be released into the atmosphere. This can lead to global warming which can be considered as a cumulative impact since it is happening currently. The lack of trees also allows a greater amount of greenhouse gases to be released into the atmosphere. This can lead to global warming which can be considered as a cumulative impact since it is happening currently.

Figure 7.7 – Loss of Habitat due to Deforestation and Population Increased

Mitigation Measures for Deforestation

- Protect natural carbon sinks that could be endangered by the project, such as peat soils, woodlands, wetland areas and etc.

- Clearing of vegetation should be kept to a minimum, keeping the width and length of the earth works to a minimum and the floodplain / wetlands habitats identified should be retained within the development footprint in its current state.
- Ensure there is selective clearing of the vegetation this allows future re-growth and regeneration.
- There should be initiated prior to the commencement of any construction once the required permits are in place and submitted to the authority for the removal of trees.
- Training of construction workers to raise awareness of environmental protection requirements.
- Avoid unnecessary idling of construction vehicles
- Construction machineries and vehicles will be maintained properly
- Vehicles for projects should be used energy-efficient machinery and the providers apply proper fuel oil and its suitable fuel management system.

7.3.2.2. Cumulative Impacts on Alteration of Land Use Pattern

According to the primary data collection by household survey, most of the farmers want to sell their farm lands and are willing to handover their lands with reasonable price and want to employ with the higher salary in the proposed project. So, to reduce alternation in land use pattern due to the land use of the proposed project and other related infrastructures for railway and related services.

Mitigation Measures for Alternation in Land Used Pattern

- Allow transportation of crops and other agricultural products of local farmer at railway station
- Fair price for local farmers

7.3.2.3. Increased in Water Scarcity as Cumulative Impact

Most of the villages in Northern Shan State are currently facing with water scarcity problems. The proposed project will use a large amount of water since it is involving construction

processes which need to use water and a large group of workers will also use water which can lead to more problems of water scarcity.

Mitigation Measures for Water Scarcity

1. Sustainable water management: Improving water infrastructure must be a priority, as water conservation and efficiency are key components of sustainable water management.
2. Reclaimed water: Rainwater harvesting and recycled wastewater also allows reducing scarcity and easing pressures on groundwater and other natural water bodies. Groundwater recharge, that allows water moving from surface water to groundwater, is a well-known process to prevent water scarcity.
3. Awareness & Education: Education is critical to solve the water crisis. Employees must be educated about water scarcity and must be trained to get knowledge on how to save water as much as possible.
4. Moreover, construction period should be started in the late rainy season in order to be able to store rainwater in storage tanks throughout the whole rainy season. Water usage of local people must not be disturbed. Besides, water from construction activities should be recycled by use of sedimentation ponds.

7.3.3. Anticipated Cumulative Impacts and Mitigation Measures during Operation Phase

Cumulative impacts during operation phase will be as follows:

7.3.3.1. Increased in Illegal Trading as Cumulative Impact

During the transportation of construction materials and for maintenance of construction machineries, jade, endangered species, wood, orchid, and other natural resources can be the main objects in illegal trading.

Mitigation Measures for Illegal Trading

- Proper inspection at every gate before going out of the country;
- Stop enough time for inspection; and
- Cooperate with respective organizations.

7.3.3.2. Visual Impact as Cumulative Impact

Shan State has beautiful landscape and it is also famous for its scenery. It can be a nuisance to local people since the railway may also pass through their houses and fields. It can also be unpleasant to see since the train may pass through beautiful mountains and fields of the Shan State. There will have potential to visual impact as cumulative impact due to the potential to increase in industrial sector (gas pipeline, transmission line and railway).

Before the Project

After the Project

Mitigation Measures for Visual Impacts

Visual impacts will be prevented through the installation of natural visual barriers such as vegetation. Landscape management and site restoration plans will be in place with recommended mitigation measures such as replacement planting, and vegetation barriers. The location and color of storage tanks will be selected with consideration of architecture view.

7.3.3.3. Increased in Electricity Consumption as Cumulative Impact

Electricity is mainly used in station, along alignment and yard where lighting is required. Load will be for communication, signaling, information and infrared axle temperature detection devices, locomotive maintenance and water supply and drainage equipment, indoor and outdoor lighting, etc in the stations along the line. The usage of local power system can be disturbed if the required power load is supplied by using local power supply system.

Mitigation Measures for Increased in Electricity Consumption

- Use the source of electricity that does not pressure on local use in the current and future.
- Use alternative source of energy such as solar power station or generators.

7.3.3.4. Increased in Water Scarcity

The areas in the vicinity of the project may be developed after the construction project. Due to the development of the area, population can also increase and this can lead to water scarcity problems currently faced by the local people.

Mitigation Measures for Water Scarcity

1. Sustainable water management: Improving water infrastructure must be a priority, as water conservation and efficiency are key components of sustainable water management.
2. Reclaimed water: Rainwater harvesting and recycled wastewater also allows reducing scarcity and easing pressures on groundwater and other natural water bodies. Groundwater recharge, that allows water moving from surface water to groundwater, is a well-known process to prevent water scarcity.
3. Awareness & Education: Education is critical to solve the water crisis. Employees must be educated about water scarcity and must be trained to get knowledge on how to save water as much as possible.
4. Moreover, construction period should be started in the late rainy season in order to be able to store rainwater in storage tanks throughout the whole rainy season. Water usage of local people must not be disturbed. Besides, water from construction activities should be recycled by use of sedimentation ponds.

8.0. ENVIRONMENTAL MANAGEMENT PLAN (EMP)

In order to manage the physical, biological and sociological impacts identified in the impact assessment, MR has committed to implement an environmental management plan of the project (EMP). This management plan will form the basis for the development of an integrated management system for environmental and community issues. EMP is a site-specific plan developed to ensure that the project is implemented in an environmentally sustainable manner where all contractors and subcontractors, including consultants, understand the potential environmental impacts arising from the proposed project and take appropriate actions to properly manage that risk. EMP also ensures the project implementation is carried out in accordance with the design by taking appropriate mitigation actions to reduce adverse environmental impacts during its life cycle.

In construction & operation environmental management plan for proposed project, the following plans should be considered:

- Environmental Monitoring Plan
- Traffic Management Plan
- Occupational and Community Health & Safety Management Plan
- Disaster Management Plan
- Waste Management Plan
- Cultural Heritage Management Plan
- Community Developmen Plan

8.1. Project Description by Project Phase

The following phases will be considered in conducting of EIA for the proposed project.

(i) Pre-construction Phase

Pre-construction activities will involve removal of selected vegetation, minor earth working activities such as ground levelling for the provision of temporary camps for workers and other activities and removal of top soil from the surface.

(ii) Construction Phase

Project development and construction activities typically include temporary camp for construction workers, access road construction, and installation of tracks alignment, site preparation and development (e.g. construction of stations, workshop and railway maintenance

yards / depots, signaling systems) and if any, the excavation and filling of soils for subgrade earthwork.

(iii) Operation Phase

The operational activities of railway (rolling stock) include all aspects of the movement of locomotives and railcars over a section of track, including passenger and freight transport, loading and unloading of freight at stations. Moreover, railways use automatic systems to monitor the location of trains and to operate signal / rail switching infrastructure. Operational and maintenance activities associated with rail infrastructure include the maintenance and clearance of tracks, signaling and switching systems, as well as associated roads, and buildings.

(iv) Decommissioning Phase

Although the proposed project is long-term project, decommissioning of the project would occur at the end of its lifespan. The goal of project decommissioning will be to remove the railway and related structures as a whole and return the site to a condition as close to a pre-construction state as feasible. The physical removal of the structures and equipment will be the reversal of the construction process. All areas disturbed by the proposed project would be restored to pre-project conditions and/or to conditions acceptable to the local rule and regulations.

8.2. Project's Environmental and Socio-economic Legal Requirements and Guidelines Related to Impacts

Laws and Regulations related to impacts	Year	Related Impacts
Air Environment		
National Environmental Quality (Emission) Guidelines (Section 1.3, 2.1.9)	2015	- Air emissions (Gaseous emissions, dust generation), noise
Australian Standard (AS 2187.2)	2016	- Vibration impact on humans and vicinity buildings
Surface Water Environment		
Conservation of Water Resources and Rivers Law (Law No. 8, 11(a), 13, 19, 24(b), 30)	2006	- Surface water environment near water resources
Conservation of Water Resources and Rivers Rules	2013	- Surface water environment near water resources
Law Amending Water Blockade Act (Law No 26)	2013	- Surface water environment near residential areas
Soil and Ground Water Environment		
Environmental Conservation Rules (Rule 55, 69 (a), (b))	2014	- Soil and ground water environment near project site
EIA Procedures (Article 102 to 110, 113, 115, 117)	2015	- Soil and ground water environment near project site
The Law Amending the Embankment Act (Law No.2)	1998	- Vicinity around alignment passed areas
Biodiversity Environment		
Protection of Biodiversity and Protected Area Law	2018	- Wildlife and wild plants in the areas of project passed
Forest Law	1992	- Forest areas of project passed
Environmental Conservation Law (Law No.7(o), 14,15,24,25,29)	2012	- Vicinity around the project area
Socio-economic Environment		

Law Amending the Workmen's Compensation Act	2005	- Occupation health safety impacts on construction workers
Prevention and Control of Communicable Diseases Law (Law No. 3, 4, 9, 11)	1995	- Health impacts on construction workers and local community
Occupational safety and health Law (Pyidaungsu Hluttaw Law No 8)	2019	- Occupation health safety impacts on construction workers
Prevention from Danger of Chemical and associated Materials Law (Law No.28)	2013	- Environmental resources and creatures around the project site and worksite safety
Protection and Preservation of Cultural Heritage Regions Laws (Law No. 15, 16)	2019	- Archaeological and cultural heritage impact around project site
Law on the preservation and protection of ancient buildings	2015	- Cultural heritage along the railway alignment
Land Acquisition, Resettlement and rehabilitation Law (Section 39,41,42,46,54(b and c),58)	2019	- Land use
Farm Land Law	2012	- Land use
Law of protection of farmer rights and enhancement of their benefits (Law No 32)	2013	- Compensation for land use
Public Health Law (Law No. 3, 5)	1972	- Community health and safety

8.3. Summary of Impacts and Mitigation Measures

The summary of potential environmental impacts and mitigation measures on the project during pre-construction, construction phase, operation phase and decommissioning phase are shown in table below.

Table - Summary of Potential Environmental Impacts and Mitigation Measures

Category	Item	Expected Environmental and Social Impacts and Sources of Impacts	Receptors	Mitigation Measures
PRE-CONSTRUCTION				
Site Clearing and Earth Working .0	**Impacts on air environment**	(a) Fugitive dust generation - Fugitive dust generation due to dozers and trucks for site clearing and ground levelling	Local residents in nearest villages, Local residents near along the hauling road, Flora diversity along the hauling road	- Water will be sprayed at construction site and along the construction road - Water will be sprayed by using handheld spray
		(b) Vehicular emissions - Vehicular emissions from the operation of vehicles and machineries	Ambient Air Quality	- Plan to reduce in loading and unloading time and idle time during working hours - Avoid local traffic time - Use machineries, vehicles and generator with good engine conditions and use low sulphur content fuel, - Regular maintenance of machineries, vehicles and generator
		(c) Increase in noise - Noise from heavy machineries and vehicles	Local residents in nearest villages	- Limit working at night and avoid the operation of noisy equipment and machineries at night if it is necessary to make operation at night - Arrange construction activities reasonably, especially at night - Regular maintenance of machineries
	Impacts on surface water environment	(a) Liquid wastes - Temporary water pollution due to earth working activities - Sedimentation of surface drainage networks	Surface water quality	- Training workers on appropriate handling of chemicals and fuels - Store and handling as per MSDS - Use temporary septic tanks and other waste water facilities

		- Improper handling of fuel oil and lubricants		- Sedimentation pond with suitable drainage system around the dumping sites
		(b) Solid wastes - Unsuitable soil materials from site clearing activities - Domestic solid wastes	Surface water quality	- Reduce, reuse and recycle of domestic wastes - Limit unnecessary earthworks - Prevent over-excavation - Working in a small area at a point of time
	Impacts on soil environment	- Domestic wastes from pre-construction workers - Biomass site clearing and tree cutting - Earth soil from earth cutting activities	Soil contamination and ground water quality	- Dispose according to the rules and regulations of CDC - Solid waste management plan
	Impacts on biodiversity environment	(a) Impacts on flora diversity Tree cutting alongside the railway and for the construction of stations	Flora diversity	- Avoid cutting of road side plants and fence plants
		(b) Impacts on fauna diversity Affect the feeding, breeding and movement of wildlife due to Increase in noise	Fauna diversity	- Sound proof measurement shall be constructed surrounding the construction sites as needed - Borrow pit will be away from fauna diversity abundance area
	Impact on human environment	***Impacts on socio-economic environment*** (a) Positive socio-economic impact - At least 3000 workers for local employment	Local people	- Policy to use local people as much as possible
		(b) Negative socio-economic impact (i) Visual Impacts Visual pollutants like waste from site clearance and from the tree cutting alongside of railway	Local community	- Efficient and timely removal of all demolition and construction waste as per requirement
		(ii) Land acquisition and involuntary resettlement - Land use and involuntary resettlement will affect socio-economic situation of local people - Resettlement or/and relocation of buildings and other assets, involving some changes - Loss of income opportunity of some PAPs due to resettlement and shop owners, vendors or farmers to be affected by construction works	Local residents near the railway line	- Compensation for affected structures and standing crops and assistance of livelihood restoration as per RAP. - Appropriate measures for relocated vendors - Avoid agricultural land, historiological places, archeological places, forest area and ecologically sensitive area as much as possible, reasonable compensation for land use as per compensation program in RAP

CONSTRUCTION PHASE				
Construction activities	**Impact on air environment**	(a) Fugitive dust generation - Dust emission from on-site vehicles and construction activities - Particulate matter from transportation of construction materials and demolition waste, and traffic movement on unpaved road	Local residents in nearest villages, Local residents near along the hauling road	- Use covers or control equipment on material handling sources - Properly enclosing the site through use of appropriate hoarding and screening - Covering excavated soils and demolition wastes with impervious sheeting - Applying water as a dust suppressant as needed
		(b) Gaseous emissions Gaseous emissions from the operation of generator, concrete mixer and vehicles	Ambient Air Quality	- Schedule for the transportation of personnel and materials to avoid periods of peak flow - Improve maintenance - Reduce duration of traffic interference and reduce from traffic delay - Avoid periods of peak flow - Regular equipment maintenance
		(c) Increased in Noise Level - Noise generation from earth moving and excavation equipment, generators, concrete mixer	Local residents in nearest villages	- Limit operation of heavy machinery at night - Choosing inherently quiet equipment with mufflers - Installing warning signs in areas of high noise levels - Keeping equipment speed as low as possible - Scheduling noisy activities during the morning hours
	Impacts on surface water environment	(a) Construction debris - Waste materials such as pallets, packing crates, steel structures off-cuts and waste concretes - Drainage and seepage from construction waste dumping site - Unsuitable soil material from foundation preparation	Surface water quality	- Minimize the time of exposure of any waste and erodible land exposed to stormwater runoff - Minimize land clearing activities to those of required work areas - Using sediment controls, with special care taken during the rainy season - Paving roads wherever possible.
		(b) Oil and grease - Leakage of fuel oil from transportation of construction materials - Lubricants and grease from construction machineries	Surface water quality	- Restore work areas as soon as possible once any construction is complete. - Avoid construction works during the rainy season. - Avoid any leakage of oil and lubricant from vehicles and machineries used in construction phase.
		(c) Domestic wastes from construction workers	Surface water quality	- Waste water channels from the site should be connected to septic tank - Vegetation of bare areas after the construction state, and

		- Domestic waste generation from construction workforce - Improper waste disposal from establishment of labor camps		- Compact soil as soon as building foundations are formed to prevent erosion, especially during the wet season.
	Impacts on soil and ground water environment	- Accidental spills of fuel oil and lubricants due to improper handling or storage of equipment - Wastewater from repair shops and washing places - Construction debris and domestic wastes from construction workers - Soil contamination and ground water pollution from improper disposal of solid wastes - Seepage from construction waste dump site	Soil contamination	- Use generated materials for reclamation purposes whenever applicable on site - Minimize construction wastes through careful planning - Label all chemical wastes and store in corrosion and resistant containers - Identify collection sites and schedule for the removal of construction wastes to minimize odor and pest infestation - Sedimentation pond with suitable drainage system around the dumping sites
		Impacts on Soil Quality due to Hazardous Wastes - Oil-based paints are consisted of VOC, so these paint cans can be hazardous to the environment if they are not properly disposed. - The lead-based paints for the steel structure for the construction of the stations	Soil contamination	- Where possible, substitute water-based paint for oil-based paints; - Never discharge any oil-based paint or residuals down the drain - Disposal of hazardous wastes should be made according to the rules and regulations of CDC
	Impacts on biodiversity environment	(a) Impact on flora diversity - Clearing away trees and natural vegetation	Flora diversity	- Determine and construct the appropriate number, spacing, and location of crossing structures based on species-specific information. - Monitor structures for obstructions, such as detritus or silt blockages, that impede movement - Manage human activity near crossing structures, with use of measures such as fencing and signage.
		(b) Impact on fauna diversity - Hazards to the habitats of birds and butterflies due to clearing away trees - Disturbance to the aril and wild animals due to noise from construction activities	Fauna diversity	- Construct multiple and varying crossing structures at a wildlife crossing point to provide connectivity for species likely to use a given area. - Routes outside existing transportation corridors could be designed with alternative pathways or under crossings to maintain wildlife migratory paths or corridors.

	Impacts on human environment	Positive socio-economic impact (i) Job Creation Nearly 500 employment opportunities for local people	Local residents near the railway line	- Unskilled and semi-skilled job opportunities will be offered to the local communities as much as possible - The developer will encourage construction sub-contractor to use local labor force as part of tender requirement
		(ii) Skill development for local people Local people hired by the proposed project would remain in communities with skills acquired during project construction	Local residents near the railway line	- Training programs will be implemented prior to and during the construction phase
		(iii) Potential to growth of local economy and business - There will be benefit for local economy if the required food and consumer goods for construction workers are bought from nearest villages	Local residents near the railway line	- Any food and consumer goods that can be bought in nearest villages should be preferred as first priority - The project developer should encourage construction contractors and sub-contractors to stimulate the emergence of local small business as part of tender requirement
		Negative socio-economic impacts (i) Traffic congestion - Road traffic congestion in surrounding area during construction period	Local residents near the railway line	- Arrange construction hauling reasonably, especially during local traffic time. - Use alternative road that will not pressure on public road.
		(ii) Livelihood and economic activity - Disruption of livelihood and economic activities of business located along the route - Impact on people whose livelihood is linked with existing modes of transportation	Local people alongside the railway line	- Payment for loss of business (temporary or permanent), loss of livelihood, loss of wages - Provision of compensation to the Project Affected Parties (PAPs) using the compensation - Continual liaising with the PAPs will be undertaken to decide on the site-specific mitigation measures. - Consultation with people whose livelihood depend on modes of transportation that may be affected by the project. They will be included in the development of the traffic management plan.
		(iii) Blockage of drainage - Blockage of drainage system, natural spring and village road due to land filling - Increase potential to flood in nearest agricultural lands	Local people	- Alternative water way will prepare - Utilize drainage facilities to discharge the harvested water
		(iv) Conflicts between communities	Local community near the railway line	- Use local people as much as possible - Limit night out for foreign workers

		- Conflict between non-Shan communities and Shan ethnic - A higher frequency of incidents of name-calling, spitting, hostile attitudes, damage to property and racially motivated violence against them		- Limit the use of foreign workers - When making an agreement contract with contractors and subcontractors, it must include the fact that they have to use local workers as much as possible.
		(v) Impacts associated with social services - Increase in temporary pressure on existing infrastructure - Increase in pressure on local food consumption	Local community near the railway road	- Own health care facilities will be supported to workers - Appoint local construction workers
		(vi) Increase in crime and security An inflow of skilled migrant construction workers and their dependents from other areas may increase in social pathologies and crime	Local community near the railway road	- The impact can be mitigated by the use of local labour force as much as possible - Construction site should be fenced and all of the construction workers should not be allowed going out at night
		(vii) Impact to tradition of Shan - The influx of people due to the operation of railway will have impact on traditional of Shan	Local community in Shan region	- Gallery of custom of Shan should be constructed during the construction of Railway - The developer should encourage the visitors to know about the custom and behaviors of local people (Customs of Shan)
		(viii) Impacts due to population influx - The risk of social conflicts, risks of spread of communicable diseases, health and safety risks, waste generation and sewage and increased pressure on resources, are all expected to increase	Local community near the railway alignment	- Equal opportunities for employment will be created to ensure that the local female population also has access to these opportunities. - Raise awareness amongst construction workers about local traditions and practices
		(ix) Public road damage The transportation of workers and construction materials can damage the damage to the public road	Local community	- Repair the roads as soon as possible if the public roads are damaged by the construction activities - Use public roads as per resistance of roads if unavoidable
		(x) Controversy with EAOs The proposed project can be in the vicinity of territory of Ethnic Armed Organizations	Construction workers and local people	- Have transparency in every development of the project. - Inform the EAOs before any development of the project. - Discuss and negotiate with EAOs if any conflicts occur.

		Impacts on archaeology and cultural heritage - Disturb, damage or destroy features or buried remains of cultural heritage interest - Potential to cause direct permanent and irreversible effects on the cultural heritage due to construction activities	Cultural and Religious custom near the construction site	- Programme for archaeological works designed to identify, characterize and record buried archaeological remains - Avoid the archaeological site that will be pointed out by heritage advisors, and an archaeological evaluation
		Potential health impacts (a) Increase infection of air-borne diseases An influx of construction workers can lead to the spread of air-borne diseases	Community health	- Providing medical check for workers who are susceptible infection of air-borne diseases
		(b) Fugitive dust emission - Dust will expose the construction workers and some local people in nearest villages to bronchial and other respiratory tract diseases	Local people	- Wetting of roads by water spraying - Seeding storage mound surfaces as soon as is practicable - Spraying exposed surfaces of mounds regularly - Restricting vehicle speeds - Watering roadways
		(c) Increase infection of water borne diseases - Loose soil from earthworks may be washed into river - Potential surface water pollution can emanate from waste products generated by construction activities entering the surface drainage	Construction workers and community health	- Avoid construction time during rainy seasons - Construction debris will be disposed at suitable location that does not impact on local nearest rivers - All areas of fuel storage will be banned to prevent hydrocarbon pollution of surface water
		(d) Potential to increase infections from mosquito - Stagnant pools of water during the construction phase will cause bleeding zone for mosquitoes - Potential to cause infections from mosquitoes especially in rainy season	Construction workers and community health	- Avoid construction time in rainy seasons as much as possible - Ensure that there are no stagnant pools of water during the construction phase - Proper temporary or permanent drainage system will be compensated
		(e) Increase risk of sexually transmitted infections - The improved economic status of the area and the influx of new migrant	Construction workers and community health	- MR will provide information and education about safe sex and implement HIV control program for migrant construction workers

		workers, living away from their families can lead to an increased risk of sexually transmitted infections		
		(f) Health impact related to increase in noise level - Hearing loss and impairment are known to occur as a result of exposure to acute, high decibel noise - Noise annoyance can lead to stress related impacts on health	Construction workers and local people near the railway line	- Reduce speed limits for trucks in the project area to reduce noise level - Avoid working at night
		(g) Increased in traffic Increase in public unease will lead to increasing in traffic volumes to and from the site	Local community	- Arrange construction hauling reasonably, especially during local traffic time and at night - Use alternative transportation ways where feasible
		Visual impacts - Visual pollutants like construction materials and equipment impact on their visualization - Visual intrusions arise from the inevitable presence of construction equipment, materials, transport vehicles, and piles of soil and debris	Local community	- Enclose the construction camp sites with non-transparent fencing to minimize the visual impacts on nearby areas - Site housekeeping to keep project area clean and limit visual intrusion - Efficient and timely removal of all demolition and construction wastes as per requirements
	Impacts of utility consumption	(a) Water consumption - Impact on local water usage due to the water used for construction process and for domestic workers	Local community	- Water can be taken from surface water sources or underground sources where the sources are available - Consider residents' opinion and make agreements or contracts with the head of the village if spring water or underground water are the water sources of villages - Awareness campaign to disseminate knowledge on strategies and technologies that can be used for water conservation
		(b) Use of topsoil If the topsoil is taken from the nearby land like agricultural and farm land, there would be an impact on the environment and the local people	Nearby land	- Compensation should be made with the land owner
		(c) Use of gravel	Local community	- The first-grade gravel for the subgrade should be bought from the local agent.

		If gravels are made from the own stone crusher, there would be an impact on the environment		- Making the subgrade gravels by the use of the stone crushers should be avoided.
		(d) Fuel consumption - The different forms of energy are used for different purposes in the construction process. - Electricity cannot be directly used from existing power lines since the construction process takes place where there is no electricity and generators will be mainly used as the source of energy	Local community	- Use construction machines efficiently. - Train workers to gain the knowledge of energy conservation. - Learn the efficient construction site management.
OPERATION PHASE				
Travelling of Trains along the railway	**Impact on air environment**	(h) Impacts on air environment due to gaseous emissions - Gaseous emissions from vehicles and food stalls from the stations	Ambient air	- Use vehicles with good engine and low Sulphur content fuel - Regular maintenance of machineries if generators are used for electricity - Install gas exhaust
		(ii) Impact of Noise - Noise and vibration due to the travelling of high-speed trains	Local residents near the railway line	- Sound proof measurements will be taking near the public area - Sound and vibration will be controlled by wheel maintenance, vehicle maintenance and elastic solution
		(iii) Impacts of vibration - Vibration will adversely affect the residential areas, schools and hospitals	Local residents near the railway line	- If buildings on both side of the railway are obviously affected by railway vibration and residents complain about railway vibration, the reasons should be found out in time and wheel-grinding and low-vibration rolling stock should be adopted to reduce the impact of railway vibration
	Impact on surface water environment	(i) Oil and grease from depots - Oil and grease from the depots and maintenance of activities	Surface water environment	- Purification system for the type of waste water produced from Depot shall be provided - Oil absorption mats shall be provided to remove oils from waste water
		(ii) Domestic wastes from stations - Domestic wastes from stations include domestic wastes from both operating	Local community	- Proper disposal of wastes according to the CDC's instruction - Domestic effluent will be collected and contained in septic tanks

		staff and the passengers coming to the stations.		
	Impact on soil and ground water environment	- Leakage of oil and grease, hazardous chemicals from the train maintenance and in depots	Local residents near the railway line	- Proper handling and storage according to their MSDS to control leakage of oil and grease
	Impact on biodiversity environment	- Direct mortality of protected species from site activity, especially vehicle movements - Disturbance to plants and animals - especially bats - in areas surrounding the site from artificial lighting - The potential for disturbance to retained habitats and species, their resting and breeding places remains	Flora and fauna diversity	- Rail would be completely covered - Sound barrier at the sensitive flora diversity area and landside cover in the fauna diversity areas
	Impact on human environment	Positive socio-economic impact (i) Improvement in livelihood and economic - Presence of the stations will also attract future commercial development around the area - The direct employment opportunities would be increased for the local people.	Local community	- Monitoring of the implementation of the resettlement action plan will be conducted - For PAPs whose livelihood had been affected during construction stage, monitoring of the implementation of the RAP will be conducted
		(ii) Improvement in tourism sector - Increase in the number of travelers especially Chinese from Yunnan	Local community and government	- Support the development of responsible tourism in Myanmar - Raise tourist awareness about how to avoid negative impacts of tourism
		(iii) Benefits to national economy - The project operation will contribute to government revenues in terms of taxes paid to the government	National government	- Efficient and transparent tax collection mechanisms will be introduced and strengthened
		(iv) Benefits to local economy - Increase in economy of the community near the stations - Transportation services to and from the nearest villages and towns are improved	Local community	- Consider formulation of specific strategies to link project development with local community

		(v) Increase in transportation sector - Increase in transportation for goods transportation - GHC emission reduces since gaseous emissions from the train is much less than that of train	Local community	- Consider the road networks of villages and towns with the railway stations - Enhance by adjusting allocation of CSR budget and giving priority for CSR activities relevant to community immediate needs each year after discussion with representatives from local authorities, CBOs, and NGOs
		Negative socio-economic impacts (i) Increase in Human Trafficking - Since transportation becomes easy, the rate of human trafficking would increase	Local community	- Corporation with human trafficking team in every trip to Mandalay to Muse Permanent Immigration Inspection Team
		(ii) Increase in trade off drugs The rate of trading off drugs would increase especially in Shan state	Local community	- Government should redouble its drug control and anti-corruption efforts - At the community level, the government should focus more on education and harm reduction
		(iii) Impact to tradition of Shan -Chinese from Yunnan can enter in large number and this influx can have impact on Shan tradition	Local community in Shan State	- Gallery of custom of Shan should be constructed - The railway station design should be considered with the tradition of Shan - Shan foods should be promoted at the stations
		(iv) Economic displacement along Muse-Mandalay express road The businesses along the Muse-Mandalay express road like the food stalls are disturbed by the implementation of Muse-Mandalay railway	Local business along Muse-Mandalay express road	- Negotiation with the local community near Muse-Mandalay express road to make a plan to do business near stations like food stalls
		(v) Accidents on railway alignment The accidents at railway alignment can occur when the human passes the railway alignment and hit by the train.	Local residents along the railway alignment	- Fence should be made along the railway alignment - Barrier gate should be positioned in the place where village roads cross the railway alignment - Good lighting system should be provided especially where the railway alignment passes the village road
		(vi) Social tension The nearby villages do not get electricity all the time while the railway lighting is always on during the night	Local community	- Consider distributing electricity also for local people before starting the project if possible. - Provide solar panel to local people
		Impact on archaeology and cultural heritage	Local community	- Participation of cultural and religious festival in Mandalay and Shan Regions - Awareness to foreigners to respect local custom

		- Impact on cultural and religious in Mandalay and Shan regions due to population influx - Impact on buried archeological site		- Avoid the archaeological site that will be pointed out by heritage advisors, and an archaeological evaluation
		Health impacts (a) Increase risk of sexually transmitted infections - Risk of sexually transmitted infections such as HIV/AIDS because of the population influx	Local community	- Premedical examination for workers will be conducted, followed by routine medical examination during the works and a final post medical examination - MR will review sexually transmitted infection clinic access and education to reduce spread of sexually transmitted infections within the community.
		(b) Community wellness - Social pathologies and crimes including increased substance abuse, drugs, thief, crime, and human trafficking can impact on the mental health of people in nearest villages	Local people in nearest villages	- Establish a mechanism to facilitate on-going community engagement between the local authorities and local residents for early identification of impacts on community wellness. - Implement smoking and drug free zone.
		(c) Health impact on community due to Covid-19 Since the transportation becomes, the number of visitors would increase which can be the carrier of the Covid-19 viruses	Local community	- Measure temperature before entering to the stations and also on the train; - Wash hands with soap and water very often; - Wear masks
	Impacts of Utility Consumption	(a) Electricity consumption The electricity will be used up for lighting along the railway alignment and for the stations	Local community	- Implementing good housekeeping measures such as turning off equipment such as fans, and lights when not in use - Use LED lights and/or lower wattage lamps - Using more efficient equipment
		(b) Water Consumption The water usage in operation phase is from the use of operating staff and the passengers coming to the station	Local community	- Dry type urinals will be used selectively - Awareness campaign to distribute knowledge on strategies and technologies that can be used for water conservation
DECOMMISSIONING PHASE				
Removing the concrete and steel structure, and equipment	**Impacts on air environment**	(a) Fugitive dust generation - Fugitive dust emission from site clearing, ground leveling and earth filling	Local residents along the railway line	- Spray water for dust control,
		(b) Gaseous emissions - Gaseous emission from the operation of dozer, trucks and generator used	Local residents along the railway line	- Use machineries with good engine with low sulphur content fuel for gaseous emission

		(c) Noise - Increasing in noise levels from the operation of heavy machineries used for demolition of concrete and steel structures	Local residents along the railway line	- Avoid working at night for noise control
	Impact on surface water environment	- Improper disposal of decommissioning debris such as concrete blocks, steel pieces and drainage from solid waste dump	Nearest rivers and water body	- Pump all of the remaining fuel oil inside the tanks and pipe lines. Care have to be taken the remaining oil are not disposed to nearest water bodies directly. - Waste water channels from the site should be connected to oil and grease separator during decommissioning to prevent wastewater from entering the nearest water bodies. - Vegetation of bare areas after the decommission activities.
	Impacts on soil and ground water environment	- Improper disposal of solid wastes such as concrete, steel structures, cabling, scrap metal, etc.	Soil contamination	- Dispose wastes according to the rules and regulations of MCDC. - Vegetation of bare areas after the decommission activities.
	Impacts on socio-economic environment	(i) Loss of jobs for local people and revenues for the government Loss of jobs for local people indirect employment depending on the operation of proposed and of associated services for tourism	Local people	- Allow local people to source alternative livelihood. - Project developer will prepare their employees for forced retirement by providing applicable jobs at other oil stations under the same developer, if feasible.
		(ii) Decline in transportation sector and local business Local people depending on it can be faced with difficulties in transportation	Local people	- If the decommissioning is happened, MR should be responsible for the maintenance and upgrade of Muse-Mandalay Express Road - MR should operate the railway alignment with proper maintenance

8.4. Overall Budget for Implementation of the EMP

Project activities	Parameters to be monitored	Locations	Measurements (Methods and Equipment)	Frequency of measurement	Cost estimates (Kyats)**	Responsibilities
During Pre-Construction and Construction phase						
Gaseous emission, and PM generation	Ambient air quality (CO, CO2, SO2, NOx)	Within the site and surrounding establishments	Visual investigation and monitoring by handheld PM meter and CO, CO2, SO2, NOx meter	During the construction activities at different locations at least per month or every complaints or if necessary	100000 Kyats per once	Construction contractor(s) (as a part of contractor's financial offer)
Construction machineries	Noise complaints from the neighboring	Within the site and surrounding establishments	Monitoring by noise level meter	During the construction activities at different locations at least per month or every complaints or if necessary	50000 Kyats per once	Construction contractor(s) (as a part of contractor's financial offer)
Area of spillage	Soil contamination and water resource pollution	Project sites and agricultural lands	Visual observation; Recording and documentation of spillage	Daily	12000 Kyats per day	Construction contractor(s) (as a part of

		nearby, nearest surface water resources				contractor's financial offer)
Management of construction waste and handling of hazardous waste	Amount of hazardous and nonhazardous waste generated	Project sites and agricultural lands nearby, nearest surface water resources	Estimation of the hazardous waste and non-hazardous waste in relation to the handling and transporting to the landfill	Weekly or monthly depending on the volume of waste	12000 Kyats per day	Contractor(s) during construction and operators during operation
Storage of the machines and construction materials of the project components	Complaints from neighboring communities and records and documentation of the temporary area for storage of materials or machineries	Project sites	Recording and documentation	Monthly	-	Construction contractor(s)
Storage of surplus soil particle from	Complaints from neighboring communities and records and documentation of the temporary area for storage of materials or machineries	Project sites	Recording and documentation	Monthly	-	Construction Contractor(s)
Monitoring the traffic disturbance	Traffic complaint	Within 500 m from the	Visual observation and	During the duration of the	-	Construction Contractor(s)

due to the vehicles and machineries movement and other related construction activities		construction site	recording complaint received	construction activities		
Impacts of culture and privacy of local communities	% of local labor to total labor	Construction site	Construction site Reporting labor origin governorates and calculating the native's ratio	Quarterly	-	Construction Contractor(s)
Monitoring health and safety of the workers during the construction of the project components	Health records about occupational injuries	Clinic / hospital referred by the contractor	Medical reporting on received cases	on received case	The cost is undefined, depending on the cases	Construction Contractor(s)
Base camp preparation for the workers	Neighbors /project' complaints	Project construction sites	Recording of complaint and type of complaint	Once during the preparation and prior to start the construction phase	-	Construction Contractor(s)
Site clearance	Worker's injuries	Construction site location	Preparation of recording form of workers injures during the construction	Monthly	-	Construction Contractor(s)

During Operation and Maintenance						
Management of the hazardous and nonhazardous waste	Amount of hazardous and nonhazardous waste generated	At the designated landfill for solid waste	Record keeping of the admitted waste and their quantity	Quarterly	Undefined	Operators during operation
Management of risks during the emergency situations (fire, soil contamination, water resource contamination and smoke)	Records of emergency situations	At surrounding the alignment area	visual monitoring for possible leak and for possible damage on the foundation and isolated area	Weekly or if required	Undefined	Monitoring team of Railway Project
Workers' health and safety	Workplace health and accidents record	Workplace	Medical reporting on workplace injuries	Monthly	undefined	Monitoring team of Railway Project

8.5. Management and Monitoring Sub-Plans

8.5.1. Environmental Monitoring Program

8.5.1.1. Objective

The purpose of environmental monitoring is to evaluate the effectiveness of implementation of Environmental Management Plan (EMP) by periodically monitoring the important environmental parameters within the impact area, so that any adverse effects are detected and timely action can be taken. Main objectives of environment monitoring plan include:

(a) Identify all environment changes which may cause adverse effects on environment by the project implementation;
(b) Monitor discharge sources (gas emission, waste water and solid waste) and operation of environmental protection equipment in order to ensure that these activities will comply with legislative requirements;
(c) Check monitoring process and inspect installation system and equipment in respect of pollution prevention and control;
(d) Prevent potential incidents;
(e) Propose appropriate environment protection measures based on results of environmental monitoring;
(f) Overcome and repair all weak-points based on results of environment monitoring program.

8.5.1.2. Legal Requirements

The laws and regulations related to this sub-plan include:

Laws and Regulations	Year	Purposes
Forest Law	1992	To implement forest policy and environmental conservation policy, to promote public cooperation in implementing these policies, to develop the economy of the State, to prevent destruction of forest and biodiversity, to carry out conservation of natural forests and establishment of forest plantations and to contribute towards the fuel requirement of the country.
Protection of Biodiversity and Protected Area Law	2018	▪ To protect wildlife, wild plants and conserve natural areas, to contribute towards works of natural scientific research, and to establish zoological gardens and botanical gardens.

Conservation of Water Resources and Rivers Law (Law No. 8, 11(a), 13, 19, 24(b), 30)	2006	▪ To conserve and protect the water resources and rivers system for beneficial utilization by the public; to prevent environmental impact.
Conservation of Water Resources and Rivers Rules	2013	▪ To conserve and protect the water resources and rivers system for beneficial utilization by the public; to prevent environmental impact.
Animal Health and Development Law (Law No.17)	2010	▪ To carry out animal health and development work and promote livestock development; ▪ To prevent outbreak of contagious disease in animals and to control the outbreak systematically when occurs; ▪ To inspect imported animal, animal product and animal feed; ▪ To issue recommendation certificate concerning animal, animal product and animal feed for export; ▪ To protect animals by law from being ill-treated.

8.5.1.3. Overview Map

The monitoring location would be within the project site, surrounding establishment, and vicinity around the project area. The overview map of Muse-Mandalay railway alignment is divided into six sections and these sections are shown in the figures below.

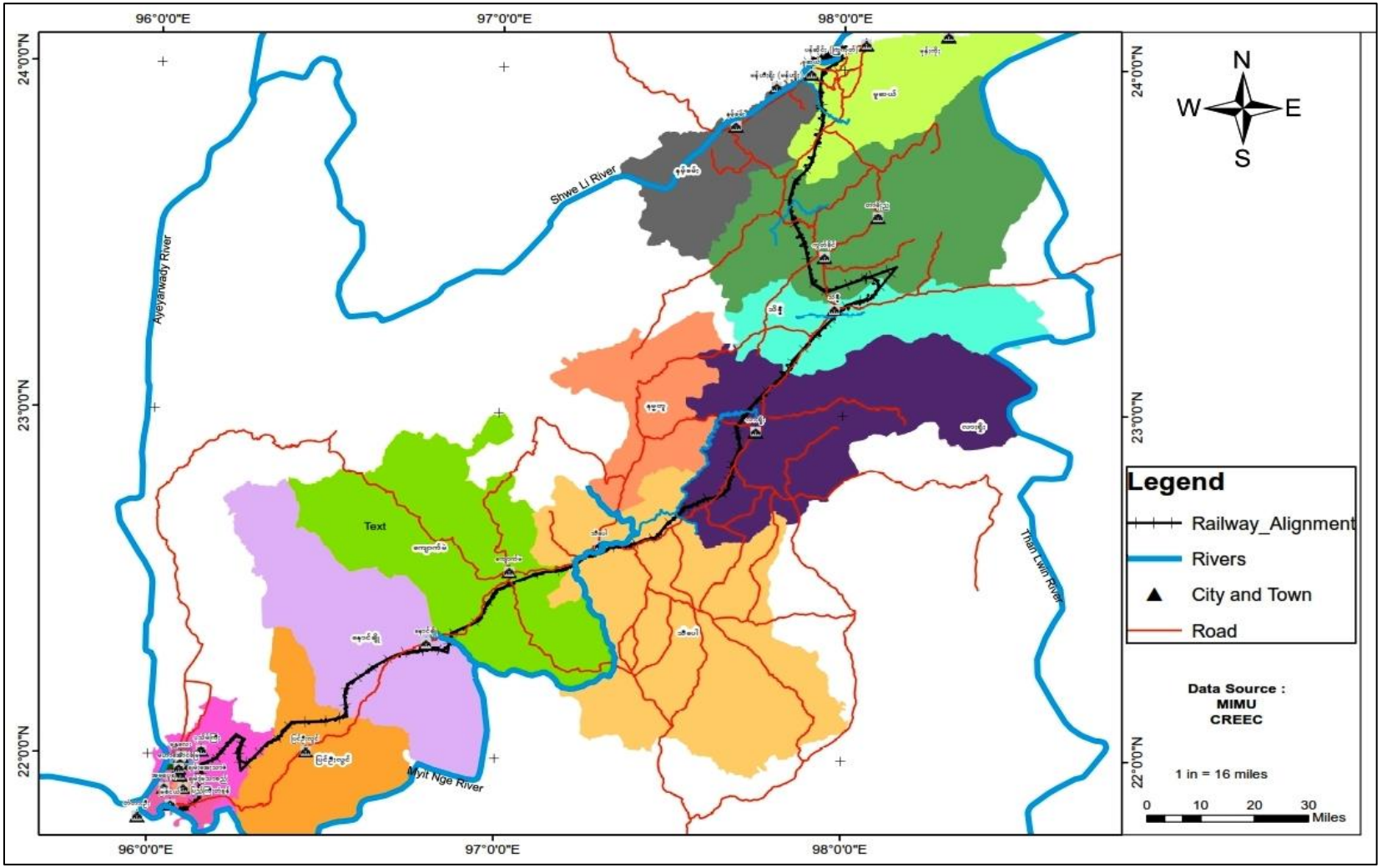


Figure – Map of Alignment Plan of Muse-Mandalay Railway Line

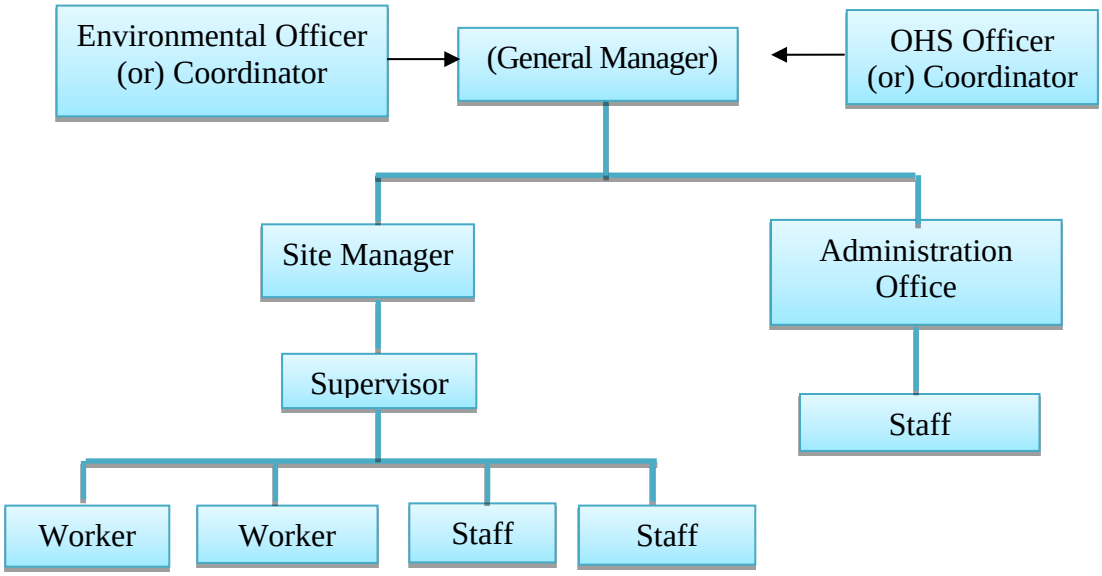
8.5.1.4. Management Plan for Environmental Monitoring

An executive agency of the Muse-Mandalay Railway Project is MR. They will be organizing a project Environmental Management and Monitoring Team (EMMT) for assist the implementation of the proposed project.

The environmental monitoring team will accomplish regular environmental monitoring. The environmental officer or environmental coordinator will be fully responsibility for environmental affair and environmental monitoring. The following table will be the organization plan for the environmental monitoring team of the proposed project.

No.	Group Member	Quantity
1.	Environmental Officer (or) Coordinator	1
2.	Occupational Health and Safety Officer (or) Coordinator	1
3.	Site Manager	1
4.	Supervisor	1
5.	Worker &Staff	8

The following will be the organization structure of environmental monitoring team.



Organization Structure for Environmental Monitoring Team

Apart from having an Environmental Management Plan, it is necessary to have a permanent staff charged with the task of ensuring its effective implementation of mitigation measures and to

conduct environmental monitoring. Environmental monitoring can also be done by registered third party monitoring agency. Detailed function of the environmental officer but not limited are as follow:

Environmental Officer

The major duties and responsibilities of the environmental officer or person-in-charge for environmental monitoring of proposed project will be as given below:

(a) To implement the environmental management plan,

(b) To assure regulatory compliance with all relevant rules and regulations,

(c) To ensure regular operation and maintenance of pollution control devices,

(d) To minimize environmental impacts of operations by strict adherence to the EMP.

(e) To initiate environmental monitoring as per approved schedule.

(f) Review and interpretation of monitored results and corrective measures in case monitored results are above the specified limit,

(g) Maintain documentation of good environmental practices and applicable environmental laws as ready reference,

(h) Maintain environmental related records,

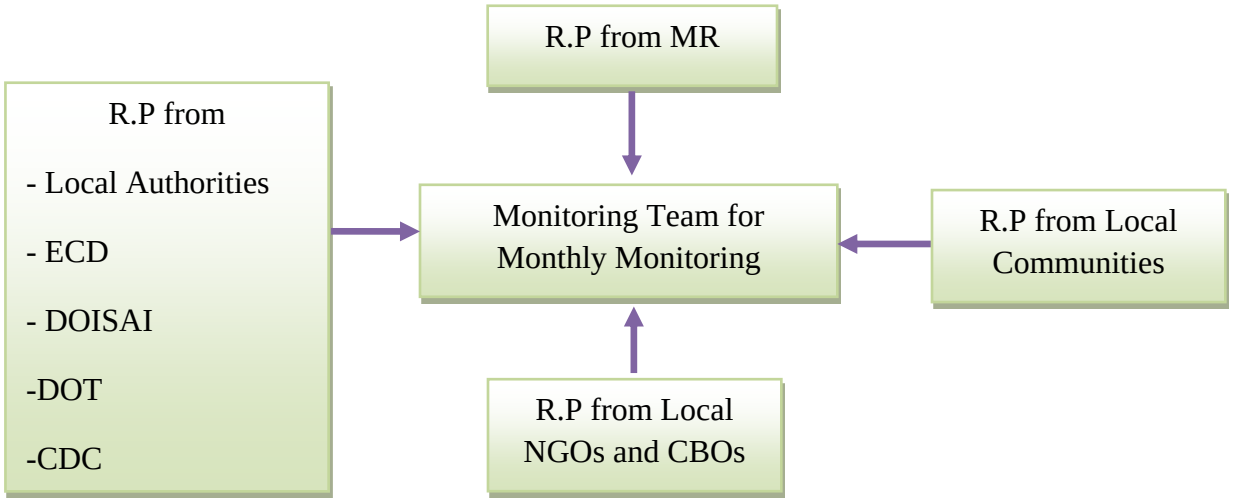
(i) Coordination with regulatory agencies, external consultants, monitoring laboratories,

(j) Maintain of log of public inconvenience and the action taken,

Be ready to solve any complaints from local people about environmental and social issues especially in waste water and traffic.

8.5.1.5. Environmental Monitoring Team for Monthly Monitoring

Environmental monitoring team for monthly monitoring has to organize representatives from environmental monitoring team for regular monitoring, representative persons from General Administrative Office (GAO), Department of Industrial Supervision and Inspection (DOISAI), Department of Transportation (DOT), Environmental Conservation Department (ECD, Mandalay), MCDC, City Development Committee (CDC), local communities and local NGOs & CBOs as follow:



Note: should participate, R.P = Representative Persons

Proposed Environmental Monitoring Team for Monthly Monitoring

8.5.1.6. Important Factors for Environmental Monitoring

The following factors will be considered during the environmental monitoring.

(a) Monitoring will be done by registered third party monitoring agency or proposed environmental monitoring team of the proposed team. and at least three representatives from proposed monitoring team will be participated in every monitoring process.

(b) If monitoring results show constantly (3 consecutive years) and significantly (e.g. less than 75 percent) better than the required levels, frequency of monitoring can be reduced (IFC, World Bank, 2007).

(c) By studying the wind rose, the most dominant wind direction and wind speed for every season can be predicted and monitoring station for dust, noise and gas emissions will be carried out at that wind direction.

8.5.1.7. Environmental Management Training Program

Environmental management training program is an important part in EMP. Training and human resource development is an important link to achieve sustainable operation of the facility and environmental management.

Training Program for Construction Phase

During construction phase, construction contractor must ensure that project staffs are trained on labor safety and environment protection during construction phase.

Training Program for Operation Phase

In operation phase, all staff of proposed plant will be trained on environment safety throughout training courses to be familiar with operation processes and guidelines, firefighting exercises and practices, etc. Project Management Board will be established and maintain training programs that are regularly updated to help staff at all levels and related functional departments are aware of their responsibility on environment protection. For successful functioning of the project, relevant EMP's will be communicated to the following groups of people:

Employees

Employees must be made aware of the importance of safety, waste segregation and storage, and energy conservation. This awareness will be provided through leaflets and periodic in-house meetings. They will be informed about their responsibilities for successful operation of various environmental management schemes inside the premises.

Site Staff

Relevant personnel at site will be trained for:

(a) Collection, segregation and storage of the solid and waste generated during operation,
(b) Operation and maintenance of sewage treatment plant and reclamation system,
(c) Requirements of the emergency response plan in case of an emergency,
(d) Techniques for waste minimization, water conservation and energy conservation,
(e) Applicable environmental, health and safety regulations and compliance requirements,

(f) Functioning of the environmental management system including environmental monitoring, reporting and documentation needs.

8.5.1.8. Record Keeping

Record keeping and reporting of performance is an important management tool for ensuring sustainable operation. Records will be maintained for regulatory, monitoring and operational issues. Typical record keeping requirements for the site is summarized in following table.

Record Keeping Requirements

Parameter	Particulars
Resources Use	- Daily quantity of electrical power consumption through power meter - Daily quantity of water use for cooling system and domestic use through water meter
Solid Waste Handling and Disposal	- Daily quantity and management of domestic solid waste from workers' dormitory
Monitoring and Survey	- Records of all monitoring carried out as per the finalized monitoring protocol.
Complaints from Nearest Residents	- Records of all complaints about the traffic from the nearest villages
Employee Health and Safety Record	- Daily record for accidents at the workplace
Others	- Equipment inspection and calibration records, where applicable - Vehicle maintenance and inspection records

8.5.1.9. Environmental Audits and Corrective Action Plans

To assess whether the implemented EMP is adequate, MR will conduct periodic environmental audits. Environmental audit is an independent and objective oriented examination of whether the

practice complies with expected standards. Broadly, environmental audit means a check on some aspects of environmental management, and implies some kind of testing and verification.

There are two levels of Environmental Audits, i.e. Environmental Impact Audit and Environmental Management Audit. Environmental Impact Audit involves comparing the impacts predicted in an EIA with those that actually occur after implementation of the project while Environmental Management Audit involves checks against adherence to plans, mitigation measures and general compliance of terms and conditions. These audits will be followed by Corrective Action Plans (CAP) to correct various issues identified during the audits.

8.5.1.10. Reporting Monitoring Results

Results of recorded in files to monitor and audit monitoring will be carried out strictly as required by the related national regulations and the monitoring results of required parameters should be reported to local authorities monthly and copies to MOl (Mandalay), ECC (Mandalay), MCDC and Quarter Administrative Offices.

8.5.2. Traffic Management Plan

8.5.2.1. Objective

The primary objectives of this Traffic Management Plan are:

- To ensure efficiency and safety of the movement of people, goods, or vehicles.
- To manage potential adverse impacts on traffic flows and pedestrian movements to ensure road and pedestrian network performance is maintained at an acceptable level.

'Traffic' in this sense refers to the interaction of vehicles, mobile plant (machinery) and pedestrians. Areas where pedestrians are exposed to the risk of a collision between mobile plant and vehicles should be identified, for example, in a warehouse where forklifts and workers both operate.

8.5.2.2. Legal Requirements

The laws and regulations related to this sub-plan include:

Laws and Regulations	Year	Purposes
Railway Transportation Service Law (Section 28 to 39, 42 and 43)	2016	▪ To be safe environment for construction site ▪ To attain required land use permissions validly
The Highways Law (Law No.24)	2015	▪ To cause easier communication and transportation among states and divisions by constructing the highways and to strengthen national solidarity and friendship and to cause all-round development in all regions and areas in economic and social sectors, ▪ To give support in implementing the duty for security and convenience in road and communication and quickness in flow of commodities; and to supervise systematically in respect of traffic and use of highways. ▪ To give support in the modernization and development of the State by constructing highways within the State or by constructing highways which connect with neighboring countries; ▪ To carry out systematically the works of extension, repair and maintenance for durability of highways;
Road Carriers Law (No 3)	2016	▪ Systematic supervision for the development of road transport drugs in the country ▪ The economic medicine of the country; Social medicine coordinate and coordinate the needs of private transport agents to improve the management and transportation of medicines and transportation. ▪ Road transport drugs are required by law for systematic medicine and developmental medicine; Rules and regulations can be enacted, ▪ Coordinate with relevant departments and organizations for the environmental impact of road transport in the transport sector ▪ To prevent car vehicle accident and road accidents, coordinate with relevant agencies and organizations.
The Law Amending the Embankment Act (Law No.2)	1998	▪ Prohibitions on damaging or trespassing on embankments; or constructing and maintaining embankments without prior permission

8.5.2.3. Overview Map

The traffic management plan consideration combined with the geographical location of the project, the railway will be divided into 6 sections including Mandalay beyond, Mandalay, Pyinoolwin, Lashio (including Kyaukme), Muse and China, shown in the figure below.

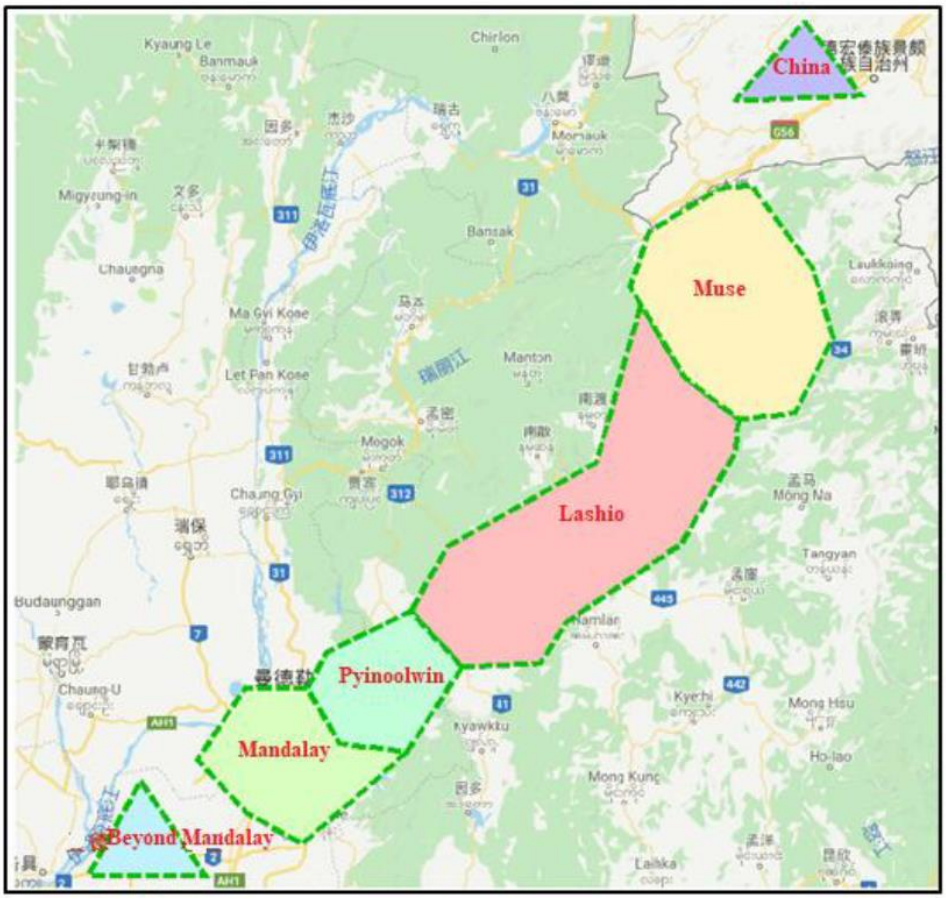


Figure – Schematic Diagram of Selected Division

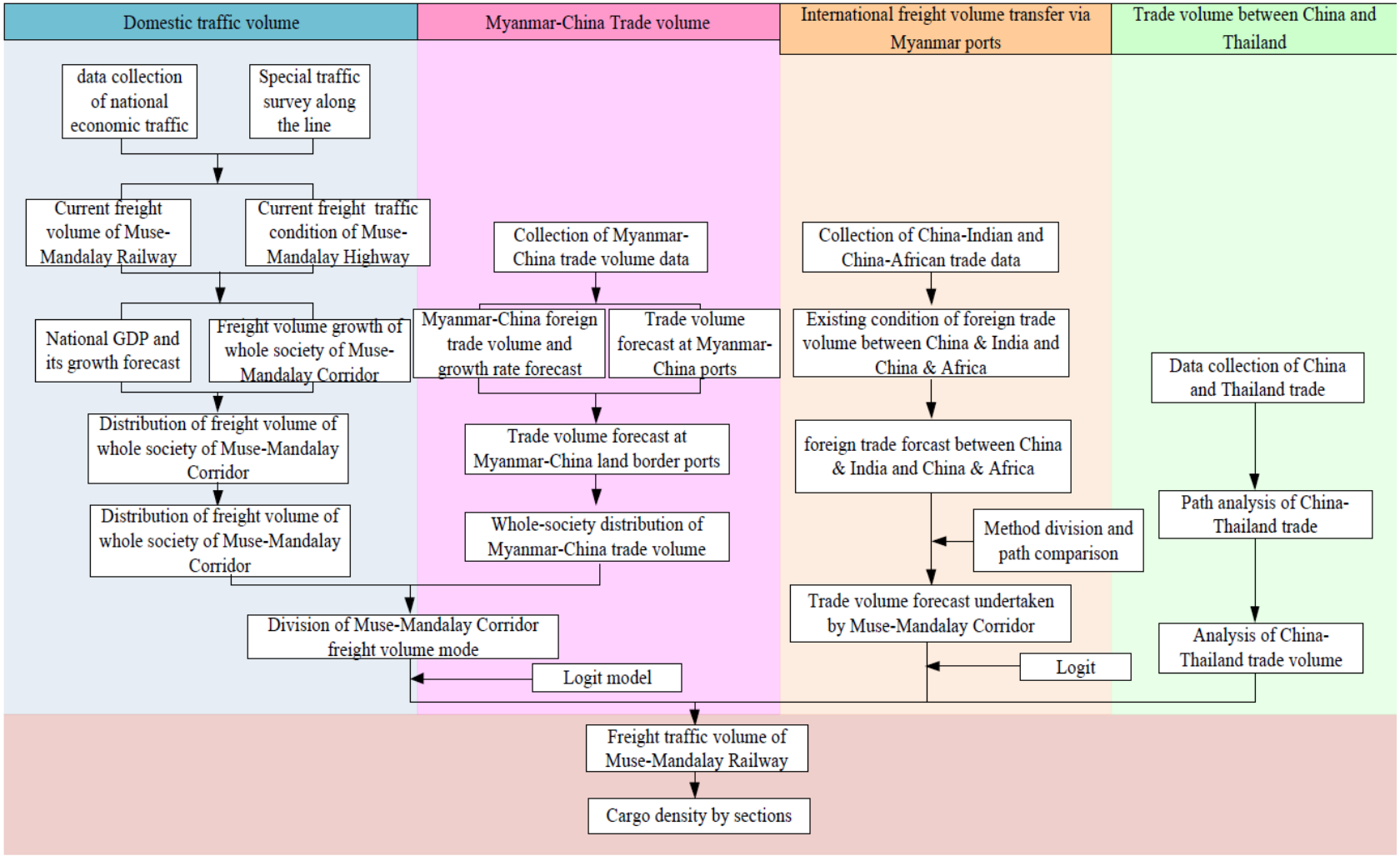


Figure – Techical Roadmap of Freight Traffic Volume Forecasting for Muse-Mandalay Railway

8.5.2.4. Management Plan

Construction Phase

Construction site vehicle incidents should be prevented by the effective management of transport operations throughout the construction process. Key issues in dealing with traffic management on site are:

- Keeping pedestrians and vehicles apart
- Minimizing vehicle movements
- People on site
- Turning vehicles
- Visibility
- Signs and instructions

Keeping pedestrians and vehicles apart

The majority of construction transport accidents result from the inadequate separation of pedestrians and vehicles. This can usually be avoided by careful planning, particularly at the design stage, and by controlling vehicle operations during construction work.

The following actions will help keep pedestrians and vehicles apart:

Entrances and exits – separate entry and exit gateways for pedestrians and vehicles should be provided;

Walkways – firm, level, well-drained pedestrian walkways that take a direct route should be provided where possible;

Crossings – where walkways cross roadways, a clearly signed and lit crossing point should be provided where drivers and pedestrians can see each other clearly;

Visibility – drivers driving out onto public roads should be made sure that they can see both ways along the footway before they move on to it;

Obstructions – walkways should not be blocked so that pedestrians have to step onto the vehicle route; and

Barriers – a barrier should be installed between the roadway and walkway.

Minimizing vehicle movements

Good planning can help to minimize vehicle movement around a site. For example, landscaping to reduce the quantities of fill or spoil movement.

To limit the number of vehicles on site:

Car and van parking for the workforce and visitors should be provided away from the work area;

Entry to the work area should be controlled; and

Storage area should be planned so that delivery vehicles do not have to cross the site.

People on site

Employers should take step to make sure that all workers are fit and competent to operate the vehicles, machines and attachments they use on site by, for example:

Checking when recruiting drivers/ operators or hiring contractors;

Training drivers and operators;

Managing the activities of visiting drivers.

People who direct vehicle movements (signalers) must be trained and authorized to do so. Accidents can also occur when untrained or inexperienced workers drive construction vehicles without authority. Access to vehicles should be managed and people alerted to the risk.

Turning vehicles

The need for vehicles to reverse should be avoided where possible as reversing is a major cause of fatal accidents. One-way systems can reduce the risk, especially in storage areas. A turning circle could be installed so that vehicles can turn without reversing.

Visibility

If vehicles reverse in areas where pedestrians cannot be excluded, the risk is evaluated and visibility becomes a vital consideration. The following list should be considered:

Aids for drivers – mirrors, CCTV cameras or reversing alarms that can help drivers to see movement all around the vehicle;

Lighting – so that drivers and pedestrians on shared routes can see each other easily. Lighting may be needed after sunset or in bad weather;

Clothing – pedestrians on site should wear high-visibility clothing.

Sign and instructions

All drivers and pedestrians must know and understand the routes and traffic rules on site. Standard road signs should be used where appropriate. Induction training for drivers, workers and visitors should be provided and instructions should be sent out to visitors before their visit.

Pedestrian routes should be:

Kept clear and free of tripping hazards

Segregated from vehicle routes

Adequately signed

Provided with crossing points that have a clear view

Vehicle routes should be;

Segregated from pedestrian routes

Designed to minimize reversing

Suitable for the vehicles that need to use them with appropriate speed limits

Designed to avoid steep gradients and sharp bends

Designed with ramps, signage, and berms as required

Designed to take into account loading and unloading areas

Hoarding, barriers, lighting and signs will be required at startup. As construction progresses, pedestrian and traffic routes will change and barriers, traffic cones, and signs will need to be moved to ensure that there is adequate pedestrian and vehicle separation. Fixed barriers should be used to separate vehicles from pedestrian walkways and to protect loading and unloading areas on site.

Injuries from construction site vehicles can be quite serious; an injured worker may be out of commission for weeks, months, or even longer.

Trucks, earth-moving equipment, and other heavy vehicles are essential on construction sites. These vehicles not only help workers with large scale projects but also make their jobs a little less strenuous. Unfortunately, these vehicles, when placed in the hands of other workers, can also be dangerous. Furthermore, dangerous vehicles that pass-through construction zones can also threaten the lives of those working nearby.

Distracted and inattentive drivers can easily run over or back over road construction workers or collide with other vehicles. Similarly, unsafe drivers on public roads pose their own threats while passing through construction zones.

The following are meant to control and limit the following common vehicle accident types:

- **Collisions and rollovers.** The most common type of accidents with any kind of vehicle is a collision or rollover. These occur as a result of erratic driving, failure to pay attention, and reckless driving. These types of accidents are extremely dangerous to construction workers who aren't protected inside vehicles. Also, because construction

vehicles are significantly larger and heavier than normal vehicles, they can inflict even greater damage when they collide with workers or other vehicles.

- **Back-up accidents.** A back-over incident occurs when a vehicle strikes a worker who is standing, walking, or kneeling behind the vehicle. Nearly 70 workers a year die from back-over incidents that could have been avoided. These kinds of incidents can happen for a variety of reasons. Drivers may not be able to see workers in their blind spots, injured workers may fail to hear backup alarms, drivers may fail to check their surrounding properly, etc.
- **Cargo spills.** Unsecured cargo can pose an extreme threat when it spills or falls out of a vehicle. In addition to causing debris that can affect the safety of other drivers, the weight of the cargo could potentially crush nearby workers.
- **Pinning.** When drivers fail to pay attention or inadvertently leave vehicles in motion, workers on the ground can become stuck or pinned between the vehicle and other objects. This pinning can result in severe crush injuries.

According to the traffic study data done on NH_3 Road along the railway, morning peak hour occurs at 7am to 10am, midday peak at 11am to 2pm, evening peak at 4pm to 7pm and night peak at 7:30pm to 9:30pm.

According to the study, the vehicle movements in weekend day is 14.5% greater generation rate that of in working day vehicle volumes as many visitors coming to Pyin Oo Lwin, Hsi Paw and Muse.

To avoid traffic accidents as much as possible, transportation vehicles to and from the construction site should not be operated during peak hours if possible.

Operation Phase

A traffic management plan is needed to minimize inconvenience and help ensure road users and workers remain as safe as possible.

- To avoid crowding in parking area, parking fees should be charged based on how long one uses the parking.
- The speed of vehicles will be limited inside the station compound to avoid accidents.
- Pedestrian roadways will be provided to avoid accidents.
- Drop off/ pickup areas should also be provided and passenger cars should be allowed to stop in these areas for only limited amount of time.

- Road markings and signs will be installed. The road markings are a tool to provide guidance and information for drivers to drive safely and smoothly and for pedestrians to walk safely.
- On-street parking will be restricted outside the station to avoid traffic congestion and unwanted accidents.
- Traffic officers will be assigned to solve any problems regarding traffic. They are greatly important roles to ensure safety and smooth traffic flow and the assigned officers should be trained properly before assigning to the post.
- CCTV cameras should be installed outside the station for safety purposes.

8.5.3. Occupational and Community Health and Safety Management Plan

8.5.3.1. Objectives

The primary objectives of this plan are:

- To secure the health, safety and welfare of employees and other people at work.
- To eliminate workplace risks at the source, and
- To involve employers, employees and the organizations that represents them in the formulation and implementation of health, safety and welfare standards.

Occupational health and safety risk specific to Rail industry sources of risk include:

a) Collisions between trains
b) Collisions of trains with objects
c) Derailment
d) Collision of trains with road vehicles
e) Persons hit by train
f) Slips, trips, falls
g) Entrapment
h) Fire/explosion
i) Flood
j) Electricity
k) Structural failures
l) Construction and maintenance
m) Human Factors

8.5.3.2. Legal Requirements

The laws and regulations relevant to this sub-plan include:

Laws and Regulations	Year	Purposes
Law of protection of farmer rights and enhancement of their benefits (Law No 32)	2013	▪ To support farmers by providing suitable loans and assistance for investment ▪ To manage for providing technology, input and production facility to farmers smoothly to improve production; ▪ To assist farmers for getting reasonable price and market in selling agricultural ▪ produces; ▪ To protect the rights of farmers possessing small plot and to enhance their benefits ▪ effectively; ▪ To provide aids as much as possible for loss and damage caused by any natural disaster
The Law Relating to Private Health Care Services ***(Law No.5)***	2007	▪ Develop private health care services in accordance with the national health policy; ▪ To participate and carry out systematically by private health care services in the national health care system as an integral part; ▪ To enable utilizing effectively the resources of private sector in providing health care to the public; ▪ To enable the public to choose as desired in fulfilling their needs for health by establishing private health care services; To enable provision of quality service at fair cost and to take responsibility.
Public Health Law (Law No. 3, 5)	1972	To promote and safeguard public health and to take necessary measures in respect of environmental health.

8.5.3.3. Overview and Layout Map

The contemplation for the occupational safety and health for this sub-plan is considered as shown in the figure below.

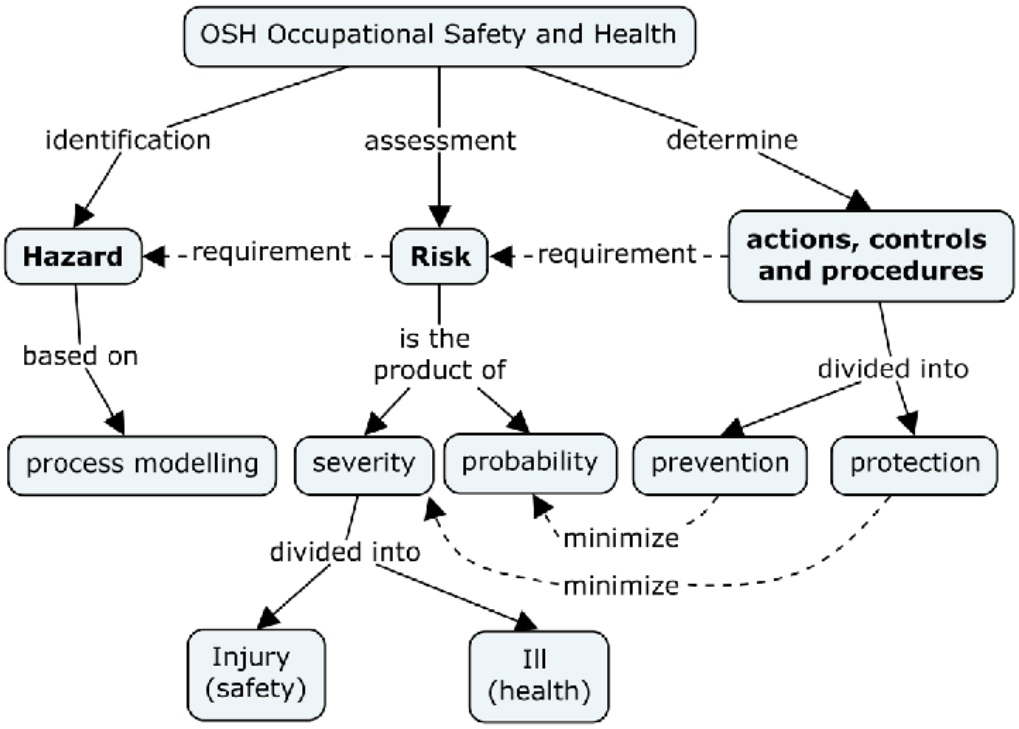


Figure – Mind Map of Occupational Health and Safety Risk

8.5.3.4. Occupational Health and Safety Management Plans

Occupational health and safety management plan for the proposed railway project will include the following:

a) Emergency and First-aid Procedures

b) Medical Precautionary Measures

c) Maintenance and Troubleshooting Precautions

d) Housekeeping

e) Safety awareness

f) Safety training

Construction sites are high risk working environments. Employees are expected to work at great heights with heavy machinery and potentially dangerous building materials. It is crucial that health and safety regulations are closely followed to reduce the chance of injury and protect the lives of workers. Most common health and safety risk in a construction site include:

- Slips and trips
- Electricity
- Airborne fibres and toxins
- Asbestos

- Unintended collapse
- Material handling
- Hand and vibration syndrome
- Noise
- Moving objects
- Working from height

(a) Emergency and First-aid Procedures

When an accident occurs at the construction site, it is essential that the proper steps are taken to secure the safety of the injured person. These steps include:

Getting medical care: The first and most important steps to follow after a work site injury are assessing and treating the damage. Even if the injury seems minor, a medical professional should diagnose and treat the injury before the injured person attempts to return to work. A minor bump on the head could mask a concussion, or a bruised abdomen could be a sign of internal injuries.

Taking note of where, when, and how the accident occurred: If the victim is physically capable, he should make sure to record the significant aspects of the accident, including time, place, and potential cause.

Reporting the injury: The injured person absolutely must inform his supervisor, or superior of the accident as soon as possible. Make sure to record the name and position of the person who accepted the report and the date the report was submitted.

First-aid program should include the following elements:

- **Emergency medical services (EMS) response time**: Contact local EMS or nearest hospital to assess the response time to the facility in an emergency. This will help to determine whether or not employees should be trained in first-aid on site. If an EMS or ambulance from nearest hospital can reach workers at the site within 3 to 4 minutes in a life-threatening emergency, then the EMS is considered "in near proximity" to the workplace. If this is the case, then employees trained in first-aid are not required (but are still recommended) on site.
- **Trained personnel**: Employees who have taken first-aid training course should be assigned responsibility for providing first aid. Employers should ensure that at least one of their employees takes a first-aid course or arrange for such a program to be taught at

the workplace. It is recommended that 15 to 20 percent of the workforce should be trained in first aid.

- **Written procedure**: Have a qualified medical professional provide written "standing orders" for basic first-aid treatment procedures. Have the doctor designate what is to be done in the case of a serious injury and what hospitals are to be used for emergency treatment. Local police and fire telephone numbers should be prominently displayed in enough places so that all employees can access them.
- **First-aid kit**: First-aid supplies must be easily accessible when they are required. The contents of the first-aid kit must be stored in a sealed weatherproof container with individual sealed packages for each type of item and must be checked by the employer before being sent out on each job and at least weekly to ensure that expended supplies are replaced.
- **Communications**: Let everyone in the organization know who the trained first-aid personnel are; state that these persons are the only ones who should render first-aid assistance. Be sure to keep the list up-to-date. Also, publicize the names and phone numbers of local police and fire departments, as well as others outside the organization who should be called.
- **Medical log**: Maintain a medical or first-aid log convenient to your first-aid kits; ensure that every use of the first-aid kit, even for giving out a bandage, is noted, including: date, time, person receiving treatment, person giving treatment, what injury or symptom was treated, what treatment was given, and first-aid materials used.
- **Appropriate means of transporting injured workers to medical aid**: If a worker is injured, after the first-aid procedure, choose the transportation mode to transport the injured worker to be able to arrive at a medical aid as fast as possible.

First aid is immediate, temporary treatment given in the event of accident or illness.

Eye: Contact lenses, if worn, will be removed. Irrigate the eyes immediately with large amounts of water for 15 minutes. Occasionally hold the eyelids apart to insure complete irrigation. Apply a dry protective dressing. Call for emergency medical assistance.
For "flash burns" cover the eye with cold (preferably iced) compresses for 5 to 10 minutes; then repeat. Apply a dry protective dressing. Call a physician. Don't rub the eye. Don't use ointments or drops unless prescribed by a physician.

Skin: For skin contact with irritants, flush the areas with large amounts of water, and then wash with soap and water. Remove contaminated clothing. If mucous membranes are irritated, flush

with water. Wash cuts and scrapes with mild soap and water. Avoid contamination. Apply a dry sterile dressing.

For thermal bums, cold water is an effective first aid measure. If skin is not broken, immerse bum part in clean cold water or apply clean ice to relieve pain. Do not disturb or open blisters. Prevent contamination. Bandage loosely with a clean dry dressing. Call for emergency medical assistance.

Electrical Shock and Electrical Burns: Disconnect and turn off power. Remove victim from contact. Use no conducting materials if the rescuer must resort to pulling the victim from the live contact. The rescuer must first protect himself by use of insulated materials such as gloves. If not breathing, administer CPR as soon as electrical contact is broken. Call for emergency medical assistance. Continue CPR until spontaneous breathing has been restored or until a physician arrives. Administer oxygen. Keep comfortably warm. Keep horizontal until there is no further evidence of shock. Treat electrical bums as thermal bums. For electrical bums apply clean, cold (iced) compresses. Prevent contamination. Cover with a clean, dry dressing. Call for emergency medical assistance.

Developing First Aid Procedures

It is important to keep up-to-date written first aid procedures at the workplace. All workers must know where first aid kits are located and how to call for first aid personnel. To develop and keep workplace first aid procedures current, consider:

- **Drills** – Conduct a drill at least once a year. It will test the workers' awareness of how to call for first aid, how well the communication system works, and the ability of first aid attendants to respond. It will also help to determine if the first aid services are adequate to deal with injuries and illnesses most likely to happen in the workplace.
- **Maintaining the system** – A worker should be assigned to manage the first aid services at the workplace. The duties should include ensuring that required first aid attendant(s), supplies, facilities, and equipment are always available.

(b) Medical Precautionary Measures

The following medical precautionary measures will be conducted by MR.

(a) Periodic health examinations will do with the cooperation with Public Health Office (Upper Myanmar). The potential health effects of non-work-related factors, such as smoking, must be considered.

(b) An effective educational, training, and industrial hygiene program will be instituted. The program will cover the following: (a) the nature and potential hazards of welding, cutting and gouging; (b) proper and safe use of equipment; and (c) emergency and first aid procedures.

(c) Medical personnel will be available on-site or by phone for advice and consultation. Emergency phone numbers will be posted near the telephones. At least one person on each shift will be trained in first aid, as well as qualified to administer oxygen and cardiopulmonary resuscitation (CPR).

(d) The following will be readily available: (a) first aid supplies approved by a physician; (b) stretchers and blankets for transportation; (c) oxygen inhalation equipment; and (d) approved instant acting eye washes and showers.

(e) Good personal hygiene practices are very important. Employees will wash their face and hands before eating, and it is recommended they not be permitted to eat, drink, or smoke in the work area. Food and beverages will not be stored in the work area. Contaminated clothing will be changed.

(f) Protection against skin conditions, such as chemical burns, rashes, and dermatitis can be provided by appropriate protective clothing and equipment, as well as the use of protective creams or lotions.

(c) Maintenance and Troubleshooting Precautions

Faulty or improperly maintained equipment can cause property damage, physical injury, or possibly death by fire or electrical shock. Here is a list of some important items to check when troubleshooting or maintaining equipment.

(a) Stop operating immediately if equipment is malfunctioning.

(b) Do not perform any maintenance unless you are qualified to perform such work.

(c) Make test readings carefully.

(d) Protect the equipment from heat, excessive wet conditions, oil or grease, corrosive atmospheres, and inclement weather.

(e) Replace parts only with manufacturer's recommended replacement parts.

(f) Keep all protective devices and covers in position.

(d) House Keeping

The following measures will be practiced at the proposed plant.

(a) Regular cleaning of the floors with service water.

(b) Avoid dumping of wastes, damaged equipment and items anywhere inside the plant affecting aesthetics and increasing risk of fire and other hazards.

(c) Maintaining hygienic conditions in areas like canteens, near drinking water sources and toilets.

(d) Maintaining green belt along the project boundaries to suppress noise, fugitive dust and to improve the aesthetics.

(e) Developing a positive outlook in the employees for improving the working place, both in railway area and office clean and well maintained.

(e) Safety Awareness

Safety awareness must be promoted among project managers and employees by:

(a) Imparting regular training.

(b) Installing/displaying safety caution boards and safety posters mentioning Do's & Don'ts at different vulnerable locations.

(c) Arranging safety & housekeeping competition etc.

(d) To procure and maintain personal protective equipment in good working condition.

(f) Safety Training

Training programmes in safety and accident prevention will be organized at all levels of employees with a view to familiarize them with the general safety rules, safety procedures in various operational activities and to update their knowledge in safety and accident prevention, industrial hygiene and emergency equipment. These training programmes will be conducted periodically in a planned manner to refresh their knowledge. Training shall be imparted for:

(a) Safe working and maintenance practices.

(b) Use of proper tools and tackles.

(c) Use of personal protective equipment.

(d) Handling emergency situation.

Development of an Environmental Health and Safety Plan

An Environmental Health and Safety Plan will be prepared for the demolition, construction, operation and decommissioning phases of the Project to ensure compliance with the Ministry of Health's Guideline for Occupational Health and Safety and the IFC guidelines.

To ensure its employees' health and safety, the Health and Safety plan will address the following topics:

- Safety devices to protect employees from injuries or hazardous conditions;
- Safe drinking water;
- Immunizations, as applicable;
- Clean eating area;
- First aid facilities;
- Sanitary conditions;
- Waste management, including bathrooms, and proper disposal procedures;
- Appropriate signage;
- Fire prevention facilities, training, and awareness; and
- Personal Protective Equipment (PPE).

A safety committee will be formed by LEC and regular safety meetings will be organized. General mitigation measures aimed at employees and contractors include the following:

- Provision of training about the fundamentals of occupational health and safety procedures.
- Provision of appropriate PPE (for example: latex gloves, working overalls, safety boots, safety helmets, safety glasses, hearing protection).
- Ensuring that especially sensitive or dangerous areas (like areas exposed to high noise levels, areas for especially hazardous work, etc.) are clearly marked, and barricaded if appropriate.
- Ensuring that all maintenance work necessary for keeping machines and other equipment in a good state is regularly carried out.
- Ensuring that the workers (and especially those doing hazardous work or otherwise exposed to risks) are qualified, well-trained and instructed in handling their equipment, including health protection equipment.
- Provision of adequate loading and off-loading space.
- Development of an emergency response plan.
- Provision of appropriate lighting during night-time works (if any)
- Enforcement of speed limits for vehicles entering and exiting the site.

A basic first aid program will be extended to all employees and will ensure that in the event of an accident or injury, someone with first aid knowledge will be present to render initial assistance until further medical attention can be made available. Qualified personnel will

provide instruction on the necessary theoretical as well as practical skills required. The advanced first aid program will be an extension of the basic first aid program attended by selected employees, including supervisors and the Health and Safety Officer, and will train participants in the recognition and initial management of serious injuries and illnesses. Employee health and safety orientation will train all employees on the basic rules of work, safety procedures, site-specific hazards, and emergency procedures. A visitor orientation and control program will be implemented if visitors will be entering areas of the site where hazardous conditions or substances are present. Supervisory personnel and safety representatives will attend training on accident investigation and reporting procedures.

Employees and contractor personnel will be provided health and safety training prior to commencing work or a new assignment on this project. The training will consist of basic hazard awareness, identification of site-specific hazards and how they are controlled, safe work practices, potential risks to health and precautions to prevent exposure, hygiene requirements, PPE requirements and proper use, equipment labeling, accident prevention and reporting, and emergency procedures for fire, evacuation, or natural disaster.

All employees, contractors and visitors will be informed of their responsibility to participate in the creation of a healthy and safe environment by reporting unsafe and hazardous conditions when detected and performing work in a safe manner by following the correct work procedure.

Hazardous areas will be marked with appropriate signs, which identify the hazard and associated safety measures. All signs will conform to international standards and will be designed to be understood by all employees and visitors. Signs may contain both text and pictures, as necessary, to ensure that any illiterate employees or visitors would be made aware of the hazard.

Containers of hazardous materials will be labeled with the contents and associated hazards. A color-coding system will be implemented to allow immediate visual identification of containers or equipment which contains hazardous substances.

Emergency personnel will be made aware of the types of fuel and of other hazardous materials and typical amounts stored onsite, and storage locations to expedite emergency response. Local emergency response personnel will be invited to inspect the site periodically to ensure familiarity with potential hazards present.

8.5.4. Disaster Management Plan

8.5.4.1. Objectives

The primary objectives of this plan are to:

- Reduce, or avoid, losses from hazards; and
- Achieve rapid and effective recovery

Disaster means a catastrophe, mishap, calamity or grave occurrence in any area, arising from natural or man-made cause, or by accident or negligence which result in substantial loss of life or human suffering or damage to, or degradation of, environment, and is of such nature or magnitude as to be beyond the coping capacity of the community of the affected area. Disaster Management implies continuous and integrated process of planning, organising, coordinating and implementing measures which are necessary as expedient for

- Prevention of danger or threat to any disaster.
- Mitigation or reduction of risk of any disaster or its severity or consequences.
- Capacity building.
- Preparedness to deal with any disaster.
- Prompt response to any threatening disaster situation or disaster.
- Assessing the severity of magnitude of effect of every disaster.
- Evacuation rescue & relief.
- Rehabilitation and reconstruction.

8.5.4.2. Legal Requirements

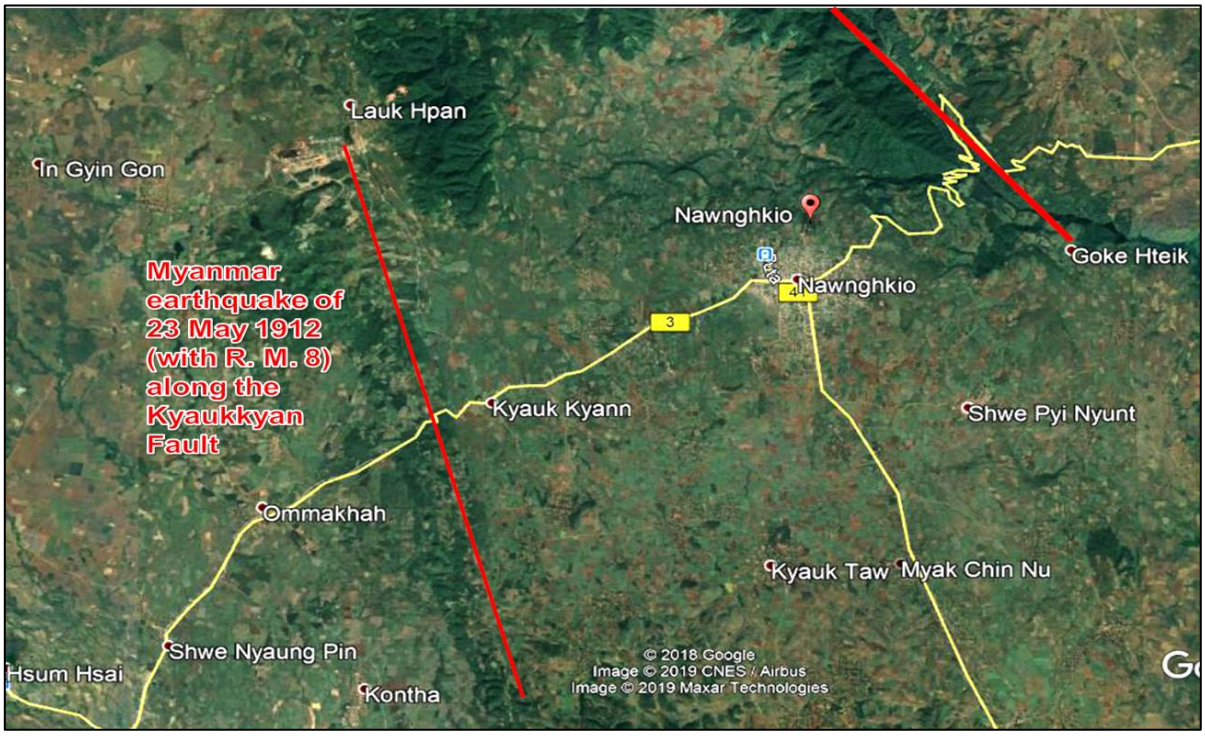
The laws and regulations relevant to the disaster risk and management plan include:

Laws and Regulations	Year	Purposes
Natural Disaster Mangement Law (No 21)	2013	▪ To implement natural disaster management programmes systematically and expeditiously in order to reduce disaster risks; ▪ To form the National Committee and Local Bodies in order to implement natural disaster management programmes systematically and expeditiously ▪ To coordinate with national and international government departments and organizations, social organizations, other nongovernment organizations or international organizations and regional organizations in carrying out natural disaster management activities ▪ To conserve and restore the environment affected by natural disasters ▪ To provide health, education, social and livelihood programmes in order to bring about better living conditions for victims.

Myanmar Fire Force Law, (Law No. 25)	2015	▪ To take precautionary and preventive measure and loss of state own property, private property, cultural heritage and the lives and property of public due to fire and other natural disasters ▪ To organize fire brigade systemically and to train the fire brigade ▪ To prevent from fire and to conduct release work when fire disaster, natural disaster, epidemic disease or any kind of certain danger occurs ▪ To educate, organize an inside extensively so as to achieve public corporation ▪ To participate if in need for national security, peace for the citizens and law and order
National Environmental Quality (Emission) Guidelines (Section 2.1.9)	2015	These national Environmental Quality (Emission) Guidelines (hereafter referred to as Guidelines) provide the basis for regulation and control of noise and vibration, air emissions, and liquid discharges from various sources in order to prevent pollution for purposes of protection of human and ecosystem health.

8.5.4.3. Overview Map

The strongest earthquake (Kyaukkyan Fault) is happened in the railway line near Naungcho town, it should be conscious and thoroughly made any structures that must be resisted the magnitude (>R.M.8) of earthquake. The satellite image of Kyaukkyan Fault near Naungcho town is shown in the figure below.



Source: Google, 2008

Figure – Satellite Image of Kyaukkyan Fault near Naungcho Town

8.5.4.4. Management Plan

Types of Disasters

1. Fire
2. Accidents – Collision, transport or work place accidents.
3. Natural calamities - Flood and Earth quake

Internal Department

The primary focus of the disaster management system is to mitigate the effects of disaster on port community wherever possible or practical, while preparing to respond when disaster occur. The role and responsibilities specifically for each phase being.

Specific responsibilities – Response Phase

- Activate the disaster management response team and also crisis response team.
- Activate the relevant / workplace emergency team for the first strike response including traffic and pollution
- Thereafter assist emergency services to respond to the event.
- Assist with providing relief for persons affected by disaster.

Specific responsibilities – Recovery Phase

- Satisfy immediate, essential personal and port community needs to extent of port capability.
- Maintain liaison and timely communication with district disaster coordinator.
- Contribute to the recovery function coordinated by District Disaster coordinating authority.
- Coordinate the recovery of physical infrastructure.
- Coordinate activities with relevant Disaster district initiatives and plans.
- Participate in long term recovery, reconstruction and rehabilitation.
- Communicating regarding restoration of Plant activities.

Flood (Similar to Cyclone)

DEPT	ACTION
EMT	• Signal Station passes weather message to On-scene Commander and Planning Leader • HM places on-site action group alert • Conservator apprises Chairman of weather developments who places CMG on alert if necessary.
Civil Dept.	• Sand bags to be used around sensitive areas including water supply • Pump stations electric sub stations
E & M Dept.	• All the outside installations and equipment shall be properly secured. • Cyclone field units to be made alert
Administration	• To make standby arrangements for transportation to evacuate population to cyclone centers and relief centers.

Re-life Work after an Earthquake

ACTION
To contact the District Collector, Relief Commissioner, fire force and seek assistance for project site.
To assist the Chairman to assess relief requirements. Arrange Food, shelter & transportation
To provide and hire if necessary, earthmoving equipment, cranes, forklifts, bull dozers etc.
Deploy engineers to direct or guide earth moving equipment and cranes to remove the debris
To organise Search and Rescue of persons trapped under debris.
Medical officer to ensure provide of proper Medical Aid to the injured

- If outdoors, find a clear spot away from buildings, trees, streetlights, and power lines. Keep lying on the ground and stay there until the shaking stops. Injuries can occur from falling trees, street-lights and power lines, or building debris.
- If on vehicle, pull over to a clear location, stop and stay with your seatbelt fastened until the shaking has stopped. Trees, power lines, poles, street signs, and other overhead items may fall during earthquakes. Stopping will help reduce the risk. Once the shaking has stopped, proceed with caution. Avoid bridges or ramps that might have been damaged by the quake.
- If indoor – Go below bed / table until the shaking stops. Avoid lift and Staircase.

8.5.4.5. Emergency Planning and Response Procedures

A plan to deal with major emergencies is an important element of Occupational Health & Safety programs.

An emergency is an unplanned event when a project operation loses control, or could lose control, of a situation that may result in risks to human health, property, or the environment, either within the facility or in the local community. Emergency incident response plan for proposed railway project is proposed to mitigate harms on humans and environment in the project area and its vicinity in case of incident. This plan provides the management structure, key responsibilities, emergency assignments and general procedures to follow during and immediately after an emergency. Moreover, it is necessary to establish ERP to address the immediate requirements for a major disaster or emergency in which normal operations are interrupted and special measures must be taken to:

(a) Save and protect the lives of employees;
(b) Manage immediate communications and information regarding emergency operations and work site safety;
(c) Provide essential services and operations;
(d) Provide and analyze information to support decision-making and action plans; and
(e) Manage resources effectively in an emergency operation.

An emergency plan specifies procedures for handling sudden or unexpected situations. The objective is to be prepared to:

- Prevent fatalities and injuries
- Reduce damage to buildings, stock, and equipment
- Protect the environment and the community
- Accelerate the resumption of normal operations

When the organization's plan involves using outside resources, such as fire, police or ambulance, other appropriate organizations should also be consulted.

Having identified the hazards, the possible major impacts of each should be itemized, such as:

- Sequential events (e.g. a fire after an explosion)
- Evacuation
- Casualties
- Damage to plant infrastructure
- Loss of vital records/ documents
- Damage to equipment

- Disruption of work

Based on these events, the required actions such as the following are determined.

- Declare emergency.
- Sound the alert.
- Evacuate danger zone.
- Close main shutoffs.
- Call for external aid.
- Initiate rescue operations.
- Attend to casualties.
- Fight fire.

Also consider what resources are required and their location, such as:

- Medical supplies.
- Auxiliary communication equipment.
- Power generators.
- Respirators.
- Chemical and radiation detection equipment.
- Mobile equipment.
- Emergency protective clothing.
- Firefighting equipment.
- Ambulance.
- Rescue equipment.
- Trained personnel.

The emergency plan includes:

- All possible emergencies, consequences, required actions, written procedures, and the resources available.
- Detailed lists of emergency response personnel including their cell phone numbers, alternate contact details, and their duties and responsibilities.
- Floor plans.
- Large scale maps showing evacuation routes and service conduits (such as gas and water lines).

8.5.4.6. Development of an Emergency and Response Plan

The EPRP must comply with the IFC Occupational Safety Guidelines and Performance Standards. The EPRP must include:

Roles and responsibilities of emergency personnel;

- Emergency contacts and communications systems/protocols, including procedures for interaction with local and regional emergency authorities;

Specific emergency response procedures;

- Design and implementation of an emergency alarm system audible across the entire site;
- An evacuation plan which must be read and practiced by all employees and contractors. The evacuation plan will include emergency escape routes, procedures for accounting for employees after an evacuation, and roles and responsibilities of personnel during an evacuation;
- Identification of supplies and resources to be utilized during an emergency event, including emergency equipment, facilities, and designated areas; and
- A training plan, which includes specific training and drill schedules for personnel who are responsible for rescue operations, medical duties, spill response, and fire response.

If an emergency develops, all persons on the project site must be notified immediately and efforts must be coordinated with others in the vicinity surrounding the project area in order to reduce impacts, if applicable. If an emergency is imminent, but has not yet begun, steps must be initiated to immediately advise persons in the vicinity of the emergency to evacuate and notifications will be made to the local ECD, the County Superintendent, local police, and all other authorities which have responsibility regarding the emergency.

If there is a slowly developing emergency or unusual situation where an emergency is not imminent, but could occur if no action is taken, project personnel will notify the ECD, the County Superintendent, local police, and all other authorities of the potential problem and keep them advised of the situation. These agencies will be requested to indicate if there are any immediate actions that will be taken to reduce the risk or severity of the emergency and if necessary, what preventative actions have to be implemented. In an emergency situation, equipment and supplies have to be needed on short notice. Therefore, the LEC must maintain an accurate inventory of emergency response equipment and supplies.

The EPRP will include an evacuation plan which will be read and practiced by all employees and contractors. The evacuation plan will include emergency escape routes, procedures for

accounting for employees after an evacuation, and roles and responsibilities of personnel during an evacuation. In general, the following evacuation procedures will be followed:

- Alert the Emergency Response Team to assist in the evacuation.
- Use communications tools that are appropriate for the type of incident and the time of occurrence, such as alarms or loud speakers.
- When communicating an evacuation, speak clearly and succinctly: "We have a [state the type of emergency]. Evacuate to [state the assembly point]".
- Turn equipment off, if possible.
- Take emergency supplies and staff rosters, if possible.
- Account for personnel.
- Wait at the assembly point for further instructions.

The EPRP will have specific information on fire safety and explosion response, which will provide additional details specific to these emergencies.

Elements of ERP

Emergency Preparedness and Response Plan that is commensurate with the risks of the facility and that includes the following basic elements:

(a) Communication systems
(b) Emergency resources
(c) Training and updating
(d) Business Continuity and Contingency

Additional information is provided for key components of the emergency plan, as follows:

(1) Worker Notification and Communication

Alarm bells, visual alarms, or other forms of communication will be used to reliably alert workers to an emergency. Related measures according to IFC Guidelines include:

(a) Testing warning systems at least annually (fire alarms monthly), and more frequently if required by local regulations, equipment, or other considerations; and

(b) Installing a back-up system for communications on-site with off-site resources, such as fire departments, in the event that normal communication methods may be inoperable during an emergency.

Community Notification

If a local community may be at risk from a potential emergency arising at the facility, the company will implement communication measures to alert the community, such as:

(a) Audible alarms, such as fire bells or sirens;
(b) Fan out telephone call lists;
(c) Vehicle mounted speakers;
(d) Communicating details of the nature of the emergency;
(e) Communicating protection options (evacuation, quarantine); and
(f) Providing advice on selecting an appropriate protection option.

Media and Agency Relations

Emergency information will be communicated to the media through:

(a) A trained, local spokesperson able to interact with relevant stakeholders, and offer guidance to the company for speaking to the media, government, and other agencies.
(b) Written press releases with accurate information, appropriate level of detail for the emergency, and for which accuracy can be guaranteed.

(2) Emergency Resources

(a) Fire Services

MR will consider the level of local firefighting capacity in the event of a major emergency or natural disaster. If insufficient capacity is available, firefighting capacity will be acquired that may include personal fire engine, pumps, water supplies, trucks, and training for personnel.

(b) Medical Services

MR will provide first aid attendants for the facility as well as medical equipment suitable for the personnel, type of operation, and the degree of treatment likely to be required prior to transportation to hospital during emergency case.

(c) Availability of Resources

Appropriate measures for managing the availability of resources in case of an emergency in Upper Myanmar region include:

(i) Maintaining a list of external equipment, personnel, facilities, funding, expert knowledge, and materials that may be required to respond to emergencies. The list will include personnel with specialized expertise for spill clean-up, flood control, engineering, water treatment, safety, environmental science, etc., or any of the functions required to adequately respond to the identified emergency.
(ii) Providing personnel who can readily call up resources, as required.
(iii) Tracking and managing the costs associated with emergency resources.
(iv) Considering the quantity, response time, capability, limitations, and cost of these resources, for both site-specific emergencies, and community or regional emergencies.
(v) Considering if external resources are unable to provide sufficient capacity during a regional emergency and whether additional resources may need to be maintained on-site.

Note: All of these resources will have alternate facilities.

(d) Mutual Aid

Mutual aid agreements decrease administrative confusion and provide a clear basis for response by mutual aid providers. Where appropriate, mutual aid agreements will be maintained with other organizations to allow for sharing of personnel and specialized equipment.

(e) Contact List

The company will develop a list of contact information for all internal and external resources and personnel in Upper Myanmar region. The list will include the name, description, location, and contact details (telephone, email) for each of the resources, and be maintained quarterly. The contact list will include General Administrative Office (Upper Myanmar), Myanmar Police Force (Upper Myanmar), Public Health and Medical Services (Upper Myanmar), Fire Services Department (Upper Myanmar), Fire Services Department (Upper Myanmar), Department of Relief & Resettlement (Mandalay) and Department of Relief & Resettlement (Mandalay) etc.

(3) Training and Updating

The emergency preparedness facilities and emergency response plans require maintenance, review, and updating to account for changes in equipment, personnel, and facilities. Training programs and practice exercises provide for testing systems to ensure an adequate level of emergency preparedness. Programs will:

(i) Identify training needs based on the roles and responsibilities, capabilities and requirements of personnel in an emergency

(ii) Develop a training plan to address needs, particularly for flood control, firefighting, spill response, and evacuation. Conduct annual training, at least, and perhaps more frequent training when the response includes specialized equipment, procedures, or hazards, or when otherwise mandated

(iii) Provide training exercises to allow personnel the opportunity to test emergency preparedness, including:

- Desktop exercises with only a few personnel, where the contact lists are tested and the facilities and communication assessed.
- Response exercises, typically involving drills that allow for testing of equipment and logistics.
- And what aspects require improvement.
- Update the plan, as required, after each exercise. Elements of the plan subject to significant change (such as contact lists) will be replaced. `
- Record training activities and the outcomes of the training.

(4) Business Continuity and Contingency

Measures to address business continuity and contingency include:

(i) Identifying replacement supplies or facilities to allow business continuity following an emergency. For example, alternate sources of water, electricity, and fuel are commonly sought.

(ii) Using redundant or duplicate supply systems as part of facility operations to increase the likelihood of business continuity.

(iii) Maintaining back-ups of critical information in a secure location to expedite the return to normal operations following an emergency.

Proposed Organization for ERP Team

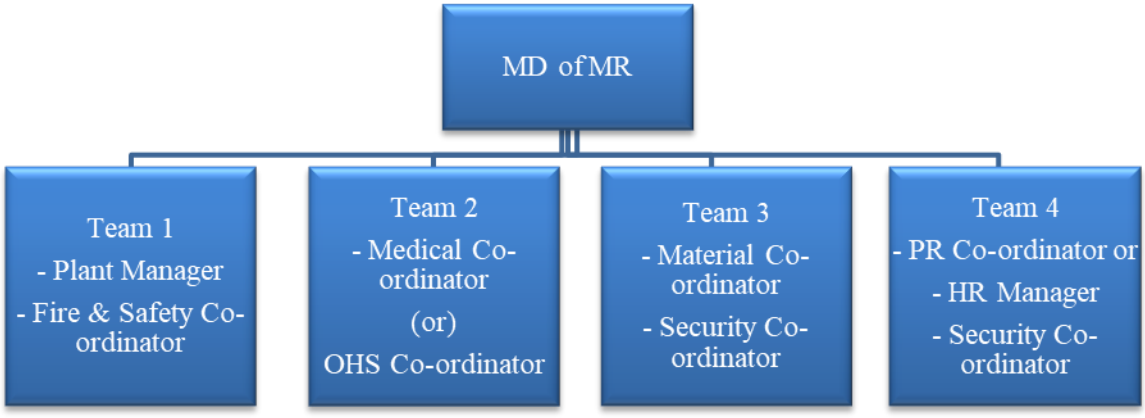


Figure - Proposed Organization for ERP Team

Proposed Duty Allocation for EPR Team

The followings are the proposed duty allocation for EPR team.

Chief Emergency Controller (General Manager)

- Take control and declare emergency.
- Focal person for all team.
- Contact Authorities.

Plant Manager

- Take steps. Make Emergency shut-down of activities. Put everything in Safe condition.
- Evacuate.
- Commence initial emergency case, till Fire Department or other agencies comes to take up.
- Identify materials requirements and call Material Manager.

Medical Coordinator

- Establish Emergency Center, Treat affected persons,
- Transfer/Remove Patients.
- Assign and Deploy staff.
- Contact Authorities.

Material Coordinator

- Dispatch necessary Supplies.
- Arrange Purchases.
- Providing equipment perform shutdown procedures, damage assessments, emergency repairs and equipment protection.

Fire & Safety Coordinator

- Be Overall in-charge for Fire and Safety.
- Coordinate with Area Coordinator and Direct the Operations.
- Coordinate with City and Other Fire-tenderers.

Public Relationship Coordinator & Security Coordinator

- Remove Crowd
- Arrange Gate security
- Contact Police
- Arrange evacuation
- Contact outside Agencies if asked.
- Handle news media
- Mobilize vehicles
- Arrange Food, clothing to Officers inside.

Emergency Control Center

- Adequate Internal phones
- Adequate external phones
- Workers Tally
- Map showing hazardous storages, Fire horns, Safety equipment, Gates and side gates, Assembly points, List of persons.

Evacuation Plan

Emergency Action Plan includes evacuation plans and procedures for implementation based on local needs. These could be:

- Demarcation/prioritization of areas to be evacuated;
- Notification procedures and evacuation instructions;
- Safe routes, transport and traffic control;
- Safe areas/shelters; and
- Functions and responsibilities of members of evacuation team.

Any precarious situation during floods will be communicated either by an alert situation or by an alert situation followed by a warning situation. An alert situation would indicate that although failure of flooding is not imminent, a more serious situation could occur unless conditions improve. A warning situation would indicate that flooding is imminent as a result of an impending failure of the dam. It would normally include an order for evacuation of delineated inundation areas. The most vulnerable/submergence area in the downstream will be demarcated with the help of flood wave travel time analysis and accordingly would be planed the evacuation plan in inundation areas.

Evacuation Team

The evacuation team will comprise of following officials/representatives:

- Chief District Officer (CDO) or designated officer to immediately relocate people to places at higher elevation;
- Engineer-in-charge of the project;
- Superintendent of Police (SP) or his designated officer to maintain law and order;
- Chief Medical Officer (CMO) of respective district hospital to tackle morbidity of affected people;
- Head of the affected village/s to execute resettlement operations with the aid of district machinery and project proponents; and
- Sub-committees at village level.

The Engineer-in-Charge will be responsible for the entire operation including prompt determination of the flood situation time to time. Once the red alert is declared, the entire local state machinery will come into full swing and start evacuating people in inundation areas delineated in the inundation map. For successful execution, mock drills and demonstration exercise will be annually conducted. CDO is expected to monitor the entire operation.

8.5.4.7. Emergency Response for Fire

Typically, railway facilities can be considered as one of the fire hazard industry and proposed plant must have fire control plan. In order to achieve this target, firefighting system have to be designed in compliance with requirements of local firefighting station or the American National Fire Fighting Association (NFPA) standards as shown in table below.

Table - American National Fire Fighting Association (NFPA) Standards

No.	Parameters	Proposed Capacity
1.	Maximum water pressure	14 bar
2.	Fire water flow	12.0 liters/m^2/min

Structural Response During Fire Event

The structural response during a fire is determined by the high temperature material properties and the temperature of the bridge members. The bridge system involves a complex interaction between components and substantial temperature gradients throughout the structure. The end boundary conditions of the fire-affected span, such as expansion joints and multi-span continuity, will also have an effect on structural response. The most accurate way to predict high temperature bridge response is to use refined analysis methods such as 3D non-linear finite element analysis (FEA). Behavior approximations are possible based on strain compatibility if the temperature distribution is known. Any type of structural analysis requires knowledge of two things; the temperatures developed in the structure and high temperature material properties. The methodology involved a coupled, three-step procedure that simulates the fire event and heat transfer to the bridge, performs a thermal analysis to determine the material temperatures at all locations, and performs a non-linear structural analysis that is programmed with the high temperature material properties. This procedure involves advanced software and computer resources that typically exceed those available to bridge engineers. While they can serve as a model methodology for engineers if the tools are available, the most valuable use is to serve as benchmarks for evaluating structural temperature and response using simpler engineering analysis methods. Knowing the high temperature structural response of bridges is useful for predicting behavior prior to fire events. The maximum deflection at high temperatures is determined by thermal expansion effects, reduced material strength, the reduced modulus of materials at high temperatures, and the effects of creep. When the structure

cools after the fire event, a substantial amount of this deflection recovers. It is even possible in some cases to have some positive residual camber if localized yielding occurs during the fire. If the deflection recovers, the geometry of the bridge is still suitable for its intended traffic use. Any affect on load rating needs to be determined based on a survey of localized damage and post-fire material properties. Predicting the maximum high temperature deflection of structures is interesting, but the most important aspect is to predict the presence of permanent deformation after the fire. Although not practical in most cases, a rigorous fire engineering analysis could be performed in the design process to predict the ability of a bridge to remain serviceable following fire events. The most important engineering problem is to evaluate the post-fire strength and serviceability of the bridge structure. Any permanent deflections will be obvious and their impact can be assessed without the need for high temperature modeling.

Fire Fighting Equipment

The proposed project will be equipped with the following firefighting systems:

(a) Firewater system and posts; and
(b) Firefighting foam and
(c) Portable Fire extinguishers.

All of the firefighting facilities will be equipped according to the rules and regulations of local firefighting station (Upper Myanmar).

(a) Firewater System and Posts

Firewater posts will be equipped with the interval of 80m or according to the local firefighting station's rules and regulations. Tools and accessories will be provided in box at each post.

(b) Firefighting Foam

Firefighting foam is foam used for fire suppression. Its role is to cool the fire and to coat the fuel, preventing its contact with oxygen, resulting in suppression of the combustion.

Types of foam are aqueous film forming foams (AFFF), film-forming fluoroprotein (FFFP), alcohol-resistant fluoroprotein foam (AR-FP), and alcohol-resistant film-forming fluoroprotein (AR-FFFP). Every type of foam has its application. High-expansion foams are used when an enclosed space, such as a basement or hangar, must be quickly filled. Low-expansion foams are used on burning spills. AFFF is best for spills of jet fuels, FFFP is better for cases where the burning fuel can form deeper pools, and AR-AFFF is suitable for burning alcohols. The most flexibility is achieved by AR-AFFF or AR-FFFP. AR-AFFF must be used in areas where

gasolines are blended with oxygenates, since the alcohols prevent the formation of the film between the FFFP foam and the gasoline, breaking down the foam, rendering the FFFP foam virtually useless.

General Guidelines for the Storage and Handling of Foam Concentrates

The effective life of foam concentrates can be maximized through optimal storage conditions and proper handling. Foam concentrates have demonstrated effective firefighting performance with contents stored in the original package under proper conditions for more than 10 years. To optimize the effective life and performance of firefighting foams they will be stored in the following ways:

Do not expose to direct sunlight or any heat source. The product will be maintained within the recommended temperature range - refer to specific foam concentrate product data sheet for recommended storage temperatures. The storage area will not be susceptible to flooding.

Fire Protection Products recommends tracking of inventory batch numbers and rotating inventory to ensure older batches are used first. Foam color may differ from batch to batch, and foam color can also change during aging. Mixing firefighting foam concentrates (different types, brands, products) for long-term storage is not recommended. However, it is appropriate to use in conjunction with comparable firefighting foam type for immediate incident response. Contact the manufacturer prior to topping off existing stock with any new foam other than the original product.

Inspection

The foam concentrate will be inspected periodically in accordance with any of the following standards: NFPA 11, EN 13565 -2, or other relevant standard. A representative concentrate sample will be sent to qualified laboratory for quality analysis per the applicable standard. An annual inspection and sample analysis are typically sufficient. In case of any doubts, please contact the manufacturer.

Specific guidelines on the storage of foam concentrate

Totes/Original Packing (Optimum Storage)

The following guidelines are recommended when storing foam concentrates in totes**:**

- Totes are best stored in an environmentally controlled, indoor warehouse
- The storage area around the tote will be clean

- The tote will be stored on the floor and on a rack system rated for the volume of foam concentrate being stored
- Tote will be kept closed and sealed during storage

(c) Portable Fire Extinguishers

Fire Extinguishers of suitable type e.g. CO_2 and DCP extinguishers shall be provided in the proposed project and shall be distributed in vulnerable areas. The extinguishers shall be checked/inspected at regular intervals for replenishment according to the rules and regulations of firefighting station (Amarapura).

Safety Equipment and Personal Protective Appliances for Fire Fighting

Safety and personal protective appliances shall be provided in adequate numbers and shall be distributed in different sections according to requirement. A list of such appliances that must be available in the plant is given in the Table below.

Table – List of Safety Equipment for Fire Fighting

No.	Safety Equipment
1.	Gas Mask
2.	Compressed air breathing apparatus
3.	PVC hand gloves
4.	Electrical hand gloves
5.	PVC apron
6.	Face shield of different colour
7.	Goggles of different types
8.	Safety belt
9.	Safety helmet
10.	Leather hand gloves
11.	Chargeable hand set
12.	Ear muffs and ear plugs
13.	Smoke exhauster cum blower

Proposed Organization for Fire Fighting Team

Firefighting organization is proposed for MR as follow:

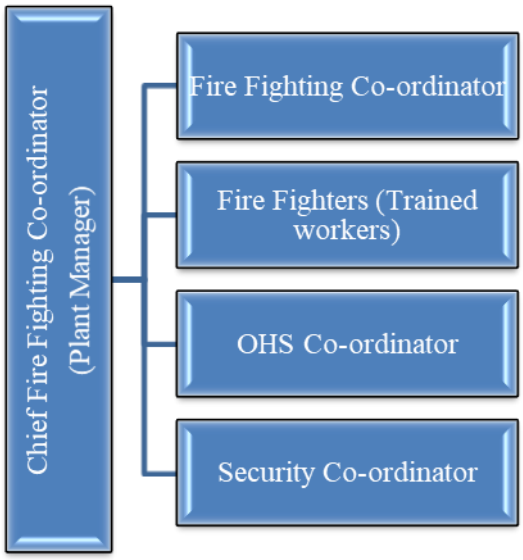


Figure - Proposed Organization for Fire Fighting Team

Role and Responsibilities of Fire Fighting Team

The following role and responsibilities for firefighting team but not limited are recommended to MR.

Team Members	Role	Responsibilities
Plant Manager	Chief co-coordinator	• Make Emergency shut-down of activities. Put everything in Safe condition. • Commence initial emergency case, till firefighting department (Upper Myanmar) comes to take up.
Firefighting leader	Firefighting co-coordinator	• Be Overall in-charge for Fire and Safety. • Coordinate with Local firefighting station.
Trained workers and securities	Fire fighters	• Put off fire by using available equipment.
Safety officer	OHS co-coordinator	• Establish Emergency Center, Treat affected persons, Transfer/Remove Patients. • Workers Tally • Map showing hazardous storages, Fire horns, Safety equipment, Gates and side gates, Assembly points, List of persons.
Security leader	Security co-coordinator	• Remove Crowd • Arrange Gate security • Contact Police if necessary • Handle news media • Mobilize vehicles

8.5.4.8. Emergency Response Plan for Derailment

The recent experiences have demonstrated the need for development of formal emergency plans. The absence of clear emergency procedures or information has resulted in confusion and delayed emergency response.

The emergency procedures should be developed for:

- Reporting the emergency
- Evaluating and establishing the parameters of the emergency
- Notifying emergency response personnel and equipment to the emergency site
- Coordinating the activities of all emergency response personnel
- Protecting passengers, personnel, and equipment at the emergency site
- Evacuation of passengers
- Keeping passengers, employees, emergency response personnel, and other agencies informed, and
- Restoring normal operations of the transit system.

Each transit system should address the following key response areas:

- Notification
- Communications
- Removal of traction power from vehicles
- Ventilation
- Coupling and uncoupling of vehicles
- Evacuation
- Firefighting

Passenger Emergency Care Training

Rail transit systems should provide emergency care training to appropriate employees. These emergency care training programs may involve the following:

- First aid treatment of hemorrhages, bruises, abrasions;
- Recognition and immobilization of passengers with head and back injuries; Cardio-pulmonary resuscitation (CPR); Treatment of respiratory blockages and convulsions.

Crowd Control and Panic Prevention

When possible, training programs in crowd control and panic prevention techniques should be developed for use by rail transit operating personnel.

Emergency Uncoupling of Rail Cars

Appropriate personnel should be provided with training in techniques for uncoupling rail cars in emergency situations.

Removal of Traction Power from Vehicle

Rail transit systems should provide training in the emergency removal of traction power from the system.

Passenger Awareness

Passenger education and training should be conducted to make passengers aware of emergency procedures and enable them to respond properly in the event of an emergency.

This should be accomplished primarily by the distribution of pamphlets, the posting of information in stations and transit vehicles, and broadcasts over the public address systems in the stations and transit vehicles. The information from these various sources must be consistent in content, sufficient for first-time users of the system (especially from posters), but not so overwhelming as to arouse undue concern.

Passenger emergency preparedness training should include information on:

- How to recognize and immediately report emergency situations to transit employees;
- How to recognize system hazards (e.g., third rail, other high voltage equipment, passage between cars, etc.);
- How to recognize and operate appropriate emergency-related facility features and equipment, such as:
- Vehicle intercom to train operator,
- Vehicle fire extinguishers,
- On-board emergency stop devices,
- Vehicle side doors,
- Vehicle end doors,

- Ladders, ramps, and planks for facilitating vehicle evacuation,
- Devices for assisting evacuation and rescue of elderly and handicapped passengers,
- Subway emergency exits, doors, grates, etc.,
- Station emergency phones;
- How to recognize and anticipate the potential special needs of fellow passengers (children, elderly, handicapped, etc.) during emergencies.

8.5.4.9. Emergency Response to Structural Collapses

The personnel involved in a structural collapse response will be highly dependent on the type of event. In general, following personnel will be involved in most responses to a large structural collapse:

- Firefighters
- Emergency managers
- Skilled support personnel, including construction, trade services, utility, transit, public works, and other private-sector workers
- Employees
- Volunteers, both organized and independent

Response Activities at a Structural Collapse

Several phases and operations occur in a structural collapse such as

- Phase 1: arrival on scene
- Phase 2: pre-rescue operations
- Phase 3: rescue operations
- Phase 4: selected debris removal
- Phase 5: debris removal and termination

Arrival on the scene is concerned with command and coordination functions. Carrying out these functions requires establishing a chain of command, positioning equipment, and setting up a staging area from which operations can be managed.

Pre-rescue operations involve assessing possible hazards at the site. At the same time, the incident command establishes a perimeter and, in coordination with the police, maintains access into and out of the site.

During rescue operations, command implements an action plan to search for remaining victims. If the location of victims is unknown or if victims are potentially buried, then debris must be removed.

Finally, general debris removal begins when it has been ascertained that no live victims remain at the site.

Work at a building collapse can be extremely demanding physically. The combination of hazards that particular responders face depends on their roles during the response and the zones in which those roles must be carried out.

8.5.5. Waste Management Plan

8.5.5.1. Objectives

The purpose of the waste management plan is the following:

- To develop action plans for achieving the objectives of the waste management plan;
- Monitor discharge sources (waste water and solid waste) and operation of environmental protection equipment in order to ensure that these activities will comply with legislative requirements; and
- To provide guidance on how to minimize, handle, contain, control, re-use, recycle and dispose of all waste generated.

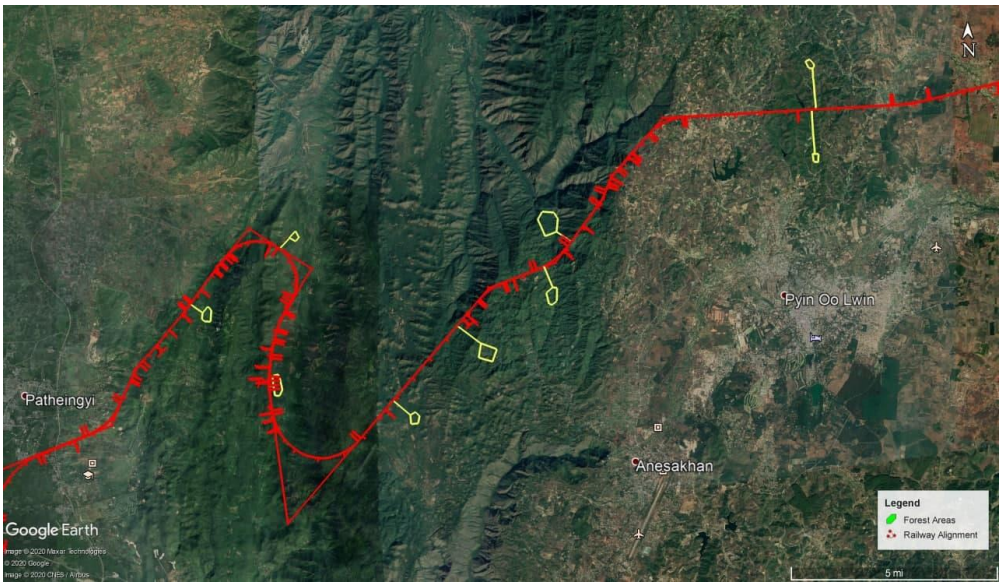
8.5.5.2. Legal Requirements

Laws and Regulations	Year	Purposes
The Prevention of Hazard from Chemicals and Related Substances Rules (Law No. 8, 15, 16, 17, 20, 22, 23, 27)	2013	▪ Performing the sticking pictogram for being least the health impacts and accident injuries in the occupational area according to the prescribed standards and norms of the Globally Harmonized System GHS); ▪ Making the necessary arrangements to be safety of the occupational area and issuing orders and directives for preventing and decreasing the accident; ▪ Laying down the proliferation plans on knowledge, and safety of chemical and related substances to administrators, license holders, public and workers; ▪ Cooperating with local and foreign governmental departments, organizations and non-governmental organizations in respect of safety management for chemicals hazard.

Prevention of Danger of Chemical and Associated Materials Law (Law No. 28)	2013	▪ To prevent from damaging the environmental resources and from endangering the lively creatures due to the chemical and associated materials; ▪ To control systematically for the safety in carrying out in accord with the approval for chemical and associated materials business; ▪ To carry out the data information acquiring system and to widely do the educating and research works in order to utilize the chemical and associated materials systematically; ▪ To carry out continuous development for worksite safety, health and environmental conservation.
Conservation of Water Resources and Rivers Law (Law No. 8, 11a, 13, 19, 24b, 30)	2006	To conserve and protect the water resources and rivers system for beneficial utilization by the public; to prevent environmental impact.
Land Acquisition, Resettlement and Rehabilitation Law (Section 39, 41, 42, 46, 54b and c, 58)	2019	▪ In this law, it is stipulated that the government holds rights to take over land provided that compensation is made to the original land owner. No private ownership of land is permitted ▪ To prevent potential impacts on environmental and social sectors due to land use for projects

8.5.5.3. Overview Maps

The proposed waste dumping sites along the railway alignment for the waste management plan are shown in the following figures.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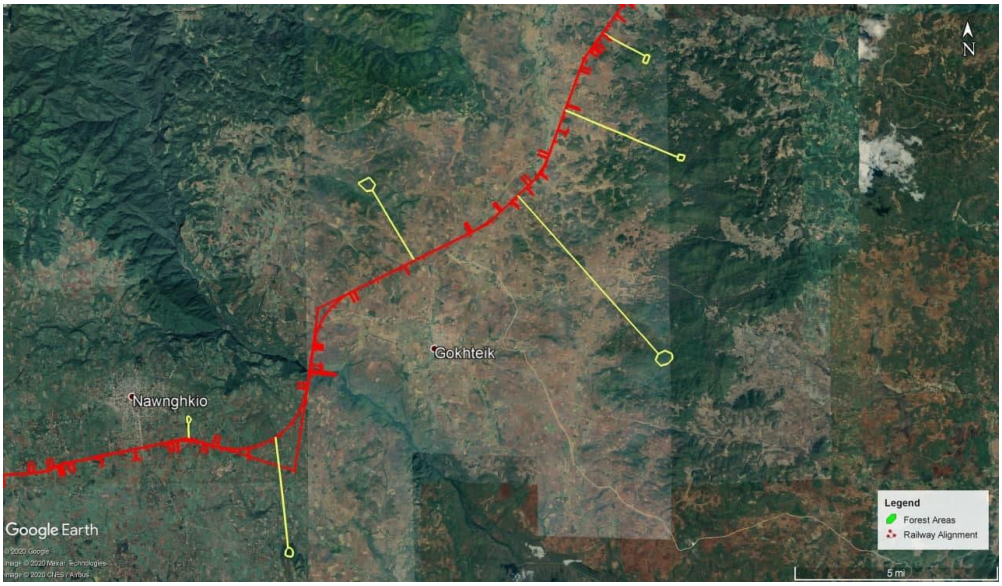
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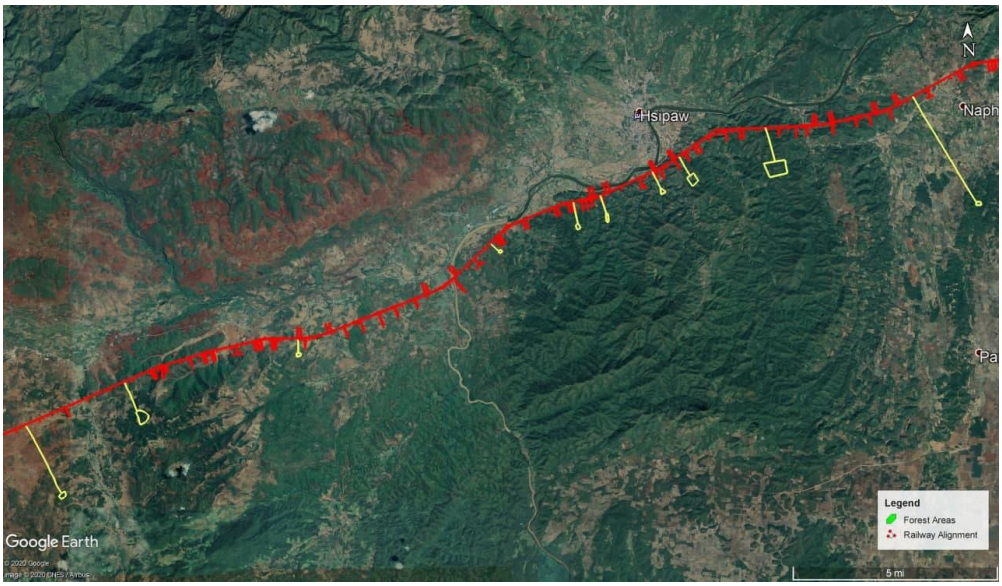
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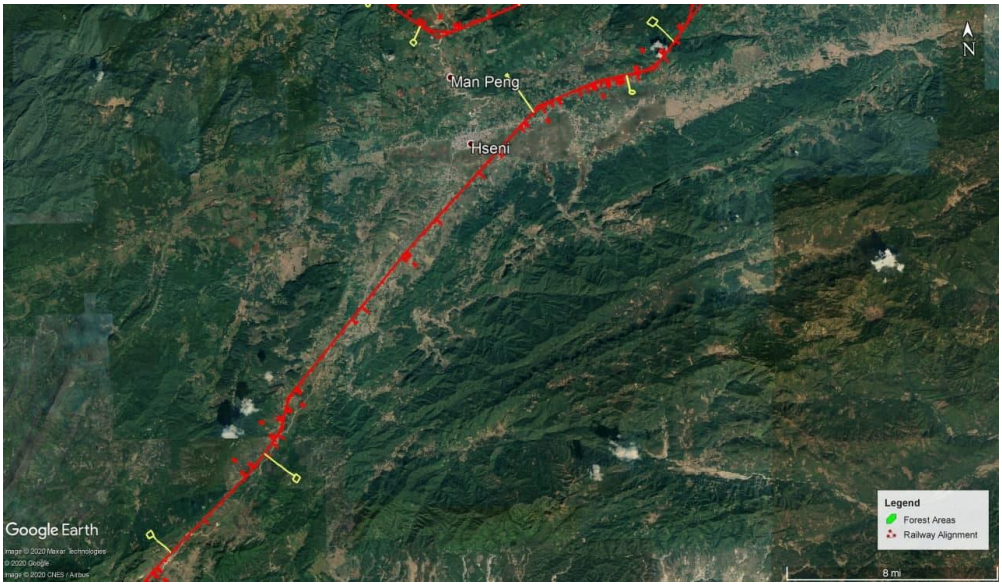
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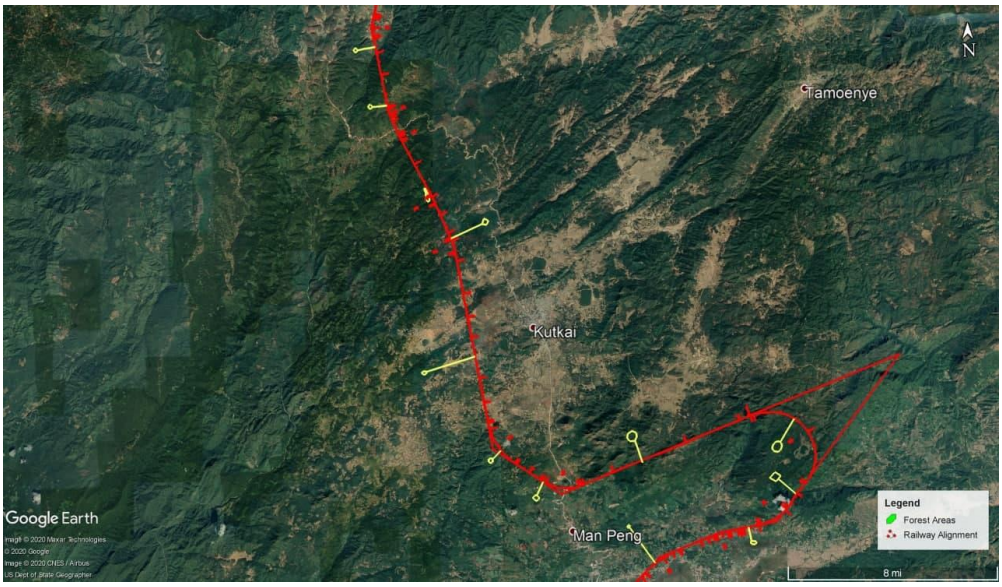
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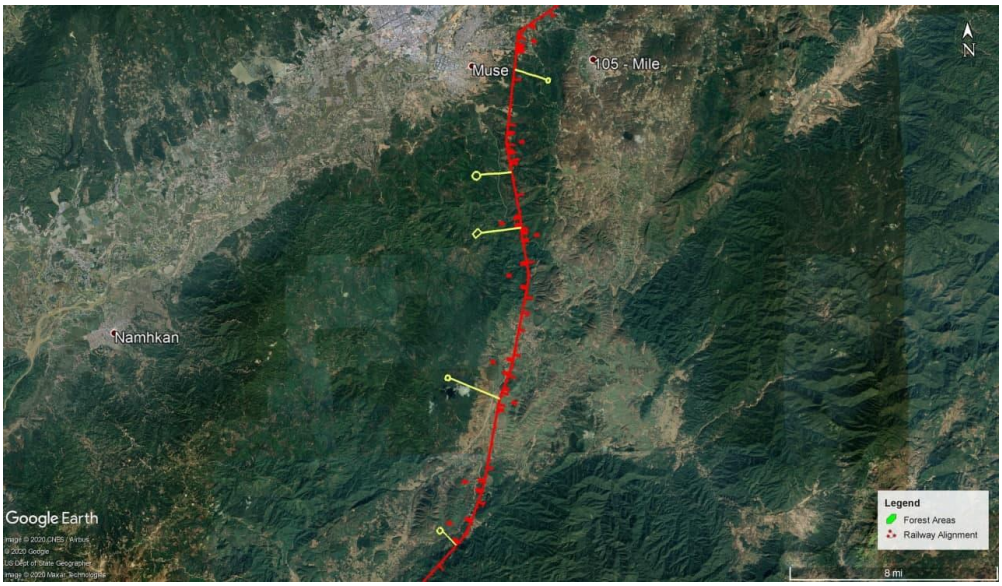


Figure - Waste dumping sites along the railway alignment

8.5.5.4. Management and Monitoring Plans

The waste management plan will thus have a positive contribution in reducing disposal costs, minimizing waste going to landfill sites, and an overall contribution to integrated waste management according to the rules and regulations of CDC. Adherence to the waste management plan should be exercised by all employees, contractors and service providers to ensure proper waste management is applied. This will be undertaken when appointed and through regular auditing. Service providers and contractors are required to furnish evidence of proper waste management (i.e. classification, quantities and disposal).

To help manage waste effectively, the Project has committed to implementing the "hierarchy of waste management" with a focus on waste prevention; and then a decreasing focus on waste reuse; recycling; recovery and elimination. Only when waste prevention cannot be achieved will the waste be reused, recycled or used as a source of energy.

(a) Waste avoidance

(b) Re-use

(c) Recycling

(d) Energy recovery

(e) Treatment

(f) Disposal

Solid waste (non- putrescible) (Construction Phase)

Solid waste consists of mainly of unwanted or unused material produced by the construction company responsible for the construction or upgrade of the railway line. This waste will be produced either directly or indirectly by the construction team and temporarily stored at an identified area. The waste generated like raw construction and demolition debris can be diverted and used as a resource. Some materials that can be diverted include:

- Landscape and land clearing debris
- Unsuitable soil material from foundation preparation
- Gravel and aggregate products
- Waste Concrete
- Plastics, Pallets
- Packing crates
- Steel structure off-cuts
- Insulation materials

Recommended prevention and control techniques to reduce the amount of solid waste include the following:

1) Dedicated waste storage areas will be established at all construction and operation sites. Waste storage areas will include areas for segregation of wastes and secure, contained storages for hazardous and putrescible wastes. Waste storage areas will be clearly signed and located so as to be at low risk of interaction with vehicles and equipment.

2) All waste suitable for recycling will be stored in a dedicated area for periodic collection by a MCDC licensed contractor.

3) Generation of spoil will be minimized where possible and reused as backfill or to widen embankments

4) Spoil that cannot be reused onsite will be moved to an approved landfill site. Spoil will be tested in accordance with the relevant legislation prior to disposal and stockpiled within the project area

5) Cleared vegetation that is weed free will be mulched, chipped and stockpiled for rehabilitation and re-vegetation works on-site

6) Vegetation that cannot be reused will be transported to a processing facility for chipping, mulching or composting.

7) The generated materials will also be used for reclamation purposes whenever applicable on site in the project. Sorting of construction wastes will be encouraged, as well as, adoption of a re-use/recycle program on site whenever deemed feasible. This may include:

- Timber will be reused on site where possible, or recycled on or offsite
- Concrete sleepers will be crushed and recycled
- Ballast will be removed and cleaned off site for reuse. Any ballast not reused will be sent for recycling.
- Waste concrete will be crushed and recycled where possible
- Suitable steel off cuts or scrap metal will be recycled
- Cabling will be recycled
- Recyclable packaging material

Wastes which cannot be reused or recycled, such as debris from excavation works which cannot be reused in foundation works, will be disposed of in a permitted disposal facility. Excavated soil, sediment, or tailings can be disposed of either on site, in an approved repository constructed for this purpose or another location where the exposure pathways allow the material to be beneficially reused, or off site in a permitted disposal facility. Solid wastes will be removed and transported to dumping site or landfill on a daily basis.

Selection of Landfill

An ideal sanitary landfill:

1. Will meet local zoning and land use criteria, including local road weight limits and other limitations;
2. Is easily accessible by solid waste vehicles in all weather conditions;
3. Safely protects surface and groundwater quality;
4. Controls landfill gas;
5. Has access to earth cover material that can be easily handled and compacted;
6. Is located where the landfill's operation will not affect external environmentally sensitive areas;
7. Should not be very close to significant water bodies (water courses or dams);
8. Will be that no major power transmission or other infrastructure like sewers, water supply lines should be crossing through landfill developmental area;

9. Comprises enough land and internal capacity to provide a buffer zone from neighboring properties and is able to be expanded; and
10. Will be the most economic site available given haul distances to user communities and other economic considerations.

Domestic waste

During Construction

A certain amount of domestic waste will be generated from construction workforce. The establishment of labor camps will also be affected on environment through improper waste (solid & garbage /sewage) disposal. Management of domestic waste can be done by as follows:

- Domestic waste generated during construction period shall be cleaned up in time and collected every day.
- Food waste can be reused as farmyard manure.
- The rest of the waste should be transported to the garbage dump for disposal.
- The stacking position of construction materials should be far away from the water body.

During operation

Rail operation may cause many kinds of wastes mainly disposed of by passenger rail service and by passenger stations. The types and amount of waste depend totally on the number of passengers handled and the services provided. The solid waste generated from trains and passenger train stations will include food waste, paper and newspaper, a variety of used plastic bags and plastic water bottles, beer cans, disposable food containers, in additional is a big volume of human waste from passengers on trains. The domestic waste generated from railway stations can be classified by:

- Waste generated from passengers waiting for the train;
- Waste generated from station's activities;

Management of domestic waste can be done by as follows:

- Household garbage produced by employees and passengers while waiting will be collected wholly.
- Garbage bins, garbage bins and other collection and storage facilities shall be provided at each station, section and point, and rain-proof facilities are set up to avoid the surface runoff

generated by rain-washed garbage from polluting the surrounding soil, water and ecological environment.

- Household garbage by staff, passengers' garage while waiting for train shall be disposed altogether cannot be dumped at freewill.
- It is needed to have respective bins at every station and also on train for separating for each type of waste like plastic bin, glass bin, food waste bin, paper bin to make easier to manage recycling and reused purposes.

Sewage and Domestic Wastewater

Wastewater comes from ordinary living processes: toilet flushing, dish washing, etc. from temporary facilities in construction camps during construction phase and railway stations during operation phase.

Wastewater is broken into two categories, depending upon the source.

1. Gray water: Gray water is from showers, laundry, dish washing and sinks other than the kitchen sinks.
2. Black water: Black water is from toilets and kitchen sinks.

Wastewater also includes rainwater that has accumulated pollutants as it runs into oceans, lakes, and rivers. Pollutants are unwanted chemicals or materials that contaminate air, soil, and water.

Sewage treatment involves three stages: primary treatment, secondary treatment, and tertiary treatment.

Primary treatment physically separates solids and liquids. The wastewater passes through a grating that strains out large particles. The remaining water is left to stand in a tank, where smaller sediments (particles of sand, clay, and other materials) settle to the bottom. These sediments are called sludge. At this point, this liquid part of the wastewater still contains many pollutants and is not safe for exposure to humans or the environment.

In secondary treatment, the liquid part of the wastewater passes through a trickling filter or an aeration tank. A trickling filter is a set of pipes with small holes in it that dribbles water over a bed of stones or corrugated plastic. Bacteria in the stones or plastic absorb pollutants from water and break them down into substances that are not harmful. An aeration tank is a tank that contains bacteria that break down pollutants. The liquid part of the wastewater from primary treatment is pumped into the tank and mixed with the bacteria. Air is bubbled through the tank

to help the bacteria grow. As bacteria accumulate, they settle to the bottom of the tank and form sludge. The sludge is removed from the bottom of the tank and buried in landfills.

After secondary treatment, the water is generally free from the majority of pathogens and heavy metals. It still contains high concentrations of nitrate and phosphate, minerals that can over-stimulate the growth of algae and plants in natural waters, which can ultimately cause them and the surrounding organisms to die. Tertiary treatment removes these nutrients from the wastewater. One method of tertiary treatment involves using biological, chemical, and physical processes to remove these nutrients. Another method is to pass the water through a wetland or lagoon.

Wastewater should be treated before discharging to the land, or to surface or groundwater. At least secondary treatment should be done before discharging.

Hazardous Waste during construction and operation

During construction and operation, clearly marked skip bins will be used to collect hazardous waste materials which are expected to include solvents, paints from painting works and waste oil. Trucks and vehicles can leak fuel oil during transportation of construction materials and workers and maintenance process during construction and operation phase. The surrounding water that includes fuel oil, diesel oil and lubricants can cause waste oil (increase in oil and grease content in nearest water bodies) for a while. Waste oils will be collected and tracked separately as they are suitable for reuse or reprocessing. These wastes will be removed, tracked and disposed of by a suitably licensed waste contractor.

Waste Oil

Mitigation Measures

MR will be used to enhance the removal of fuel oil, diesel oil and lubricants prior to entry into the wastewater stream:

1) Engine oil or fuel filters will be crushed and evacuated of oil. Filters will be stored in clearly labeled bunded filter ponds for collection and recycling by a licensed contractor There will be a prior agreement with the MCDC for the disposal of any hazardous waste generated.
2) Temporary sedimentation pond on the waterway to nearest water courses

3) Hydrocarbon wastes such as waste oils, fuels, lubricants and hydraulic fluids generated from the maintenance of light vehicles, plant and equipment will be stored in approved containers and conditions onsite prior to removal offsite for treatment and disposal by a licensed waste management contractor at a licensed waste management facility.
4) Pump all of the remaining fuel oil inside the tanks and pipe lines. Care have to be taken the remaining oil are not disposed to nearest water bodies directly.
5) Other miscellaneous oil/hydrocarbon wastes will be stored in designated bins for collection by a licensed contractor for energy recovery and/or disposal. Coolants will be stored in a separate tank for collection and reconditioning by suppliers.

Spillage of Hazardous Substances

1. Port Signal Station reports spillage of hazardous Substances on Port properties to Plant manager / EMT / SO.
2. Plant manager inform CEO.

Immediate Action

1. Determine the nature of the substance and approximate quantities involved. Verify from Master of the vessel, ship agent.
2. If details of substance are unknown and spill gives toxic or noxious fumes

- Inform local Hospital.
- Initiate evacuation measures.
- Notify Duty Pilot.
- Where applicable turn off Air Conditioning - ventilate to open air if possible
- Evacuation procedure to be upwind.
- Remove any ignition sources if the spill is suspected to be combustible.
- Cut Off Electric supply.
- Seal off water approaches with launches and crafts.
- Seal off entry points and clearing the area of all personnel / Public.
- Evacuated persons are not to return to the affected area until all clearance given.

Sabotage

• The proposed site will be fully secured all around the periphery and there will be only one entry and one exit to the entire facility.

• The entry and exit points will be manned for 24 hours with specially trained security staff fully equipped with latest security gadgets including closed circuit electronic surveillance

cameras/CCTVs monitoring all sensitive areas within the site complex. A log book will be maintained to record the identities of all "vehicles/staff/guests/visitors" entering and leaving the site.

All "persons/vehicles" entering the site will be fully checked for explosives and weapons.

Lubricants

Handling

- Prevent small spills and leakage to avoid slip hazard.
- Prevent small spills and leakage to avoid slip hazard. Material can accumulate static charges which may cause an electrical spark (ignition source).
- When the material is handled in bulk, an electrical spark could ignite any flammable vapors from liquids or residues that may be present (e.g., during switch-loading operations).
- Use proper bonding and/or earthing procedures. However, bonding and earthing may not eliminate the hazard from static accumulation.
- Consult local applicable standards for guidance.

Storage

- Do not store in open or unlabeled containers.
- Store in cool, dry, ventilated area, away from heat and ignition sources. Use good personal hygiene. Always keep the container close and the type of container used to store the material may affect static accumulation and dissipation.

Spill Management

Land Spill: Stop leak. Recover by pumping or with suitable absorbent.

Water Spill: Confine the spill immediately with booms. Warn other shipping. Remove from the surface by skimming or with suitable absorbents. Seek the advice of a specialist before using dispersants. Water spill and land spill recommendations are based on the most likely spill scenario for this material; however, geographic conditions, wind, temperature, (and in the case of a water spill) wave and current direction and speed may greatly influence the appropriate action to be taken. For this reason, local experts should be consulted.

Disposal Considerations

- Use material for its intended purpose or recycle if possible. Oil collection services are available for used oil recycling or disposal.
- Place contaminated materials in containers and dispose of in a manner consistent with applicable regulations. Contact your sales representative or local environmental or health authorities for approved disposal or recycling methods.

Diesel Oil

Handling

- Keep away from heat. Keep away from sources of ignition. Empty containers pose a fire risk. DO NOT reuse empty containers without commercial cleaning or reconditioning. Ground/bond line and equipment during pumping or transfer to avoid accumulation of static charge. Do not breathe gas/vapour/spray. In case of insufficient ventilation, wear suitable respiratory equipment.
- If ingested, seek medical advice immediately. Avoid contact with skin and eyes. Practice good personal hygiene. Wash hands after handling and before eating. Launder work clothes frequently. Discard saturated leather goods.
- Diesel is a flammable liquid and is dangerous unless handled and stored properly. Children and pets should have no access to the storage tanks to avoid accidents. Adult access to the tanks should be limited to only those who need access for refueling or maintenance of the tanks.
- The fuel should be stored in an isolated area away from residences. An above-ground container may be installed in a building or under a lean-to. This location helps prevent water from harming the tank and prevents radiant heat from evaporating the diesel.

Storage

- Store at cool, ventilated and specified place.
- Store in tightly closed containers in cool, dry, isolated, well-ventilated area, and away from incompatibles. Ground all equipment containing material.
- Keeping the fuel away from ignition sources is important. While diesel has a higher ignition point than gasoline, it is still flammable. Any electrical outlets nearby should

be rated for explosions. No smoking should be allowed within 50 to 100 feet of the storage area.

- If a small amount of diesel fuel needs to be restored, keep it in portable 5-gallon gas cans that can take to the gas station. For larger amounts, store in special storage containers, such as 55-gallon drums or a stand-alone tank.
- Larger diesel tanks, made of metal or specially formulated polyethylene, can be installed above ground or below ground, depending on the site and local regulations. These tanks can also be mounted on the back of trucks when necessary. The exact size of the tank is, of course, dependent on how much fuel needs to be stored.

Disposal Considerations

- Preferred waste management priorities are: (1) recycle or reprocess; (2) incineration with energy recovery; (3) disposal at licensed waste disposal facility. Ensure that disposal or reprocessing is in compliance with government requirements and local disposal regulations. Consult local or regional authorities.
- On large scale absorb and landfill, allow for atmospheric evaporation.

Fuel Oil

Handling

- Precautions for safe handling: Provide adequate ventilation. Use personal protective equipment as required.
- Do not breathe vapor/aerosol. Avoid contact with skin, eyes and clothing. Take any precaution to avoid mixing with combustibles. Ensure proper process control to avoid excess waste discharge (temperature, concentration, pH, time).
- Do not allow to enter into surface water or drains. Obtain special instructions before use. (Do not handle until all safety precautions have been read and understood.).
- Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking. Ensure equipment is adequately earthed. Use explosion-proof equipment. Use only non-sparking tools.
- Product may release Hydrogen Sulphide: A specific assessment of inhalation risks from the presence of hydrogen sulphide in tank head spaces, confined spaces, product

residue, tank waste and waste water, and unintentional releases should be made to help determine controls appropriate to local circumstances.

- Hygiene measures: Keep good industrial hygiene. Wash hands immediately after handling the product. When using, do not eat, drink or smoke. Keep away from food, drink and animal feeding stuffs. Separate working clothes from town clothes. Take off contaminated clothing. Wash contaminated clothing before reuse.

Storage

- Conditions for safe storage, including any incompatibilities
- Technical measures: Store in a dry, cool and well-ventilated place. Bund storage facilities to prevent soil and water pollution in the event of spillage.
- Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.
- Product may release Hydrogen Sulphide: A specific assessment of inhalation risks from the presence of hydrogen sulphide in tank head spaces, confined spaces, product residue, tank waste and waste water, and unintentional releases should be made to help determine controls appropriate to local circumstances.
- Packaging materials: Keep only in the original container. Suitable material: Carbon steel. Stainless steel.
- Unsuitable material: synthetic material.

Disposal Considerations

- Do not allow to enter into surface water or drains. Dispose of empty containers and wastes safely. Refer to manufacturer/supplier for information on recovery/recycling. Recycling is preferred to disposal or incineration.
- If recycling is not possible, eliminate in accordance with local valid waste disposal regulations.
- Additional information: Handle contaminated packages in the same way as the substance itself. Dispose of contaminated materials in accordance with current regulations. Do not pierce or burn, even after use. Never use pressure to empty container.

Treatment of Hydrocarbon-Containing Wastewater

Concentrations of petroleum hydrocarbons in wastewater may decrease due to natural processes of decomposition and chemical oxidation, evaporation and biological degradation by native microflora. In natural environments, however, these processes are relatively slow. To enhance the oil contaminant removal from wastewater, the mechanical, chemical, physicochemical and biological methods, as well as their combinations, are employed, providing the required purification rate at reasonable costs. Importantly, the choice of a treatment method in each case is determined by the source of wastewater, the diversity and levels of contaminants, and the subsequent intended use of treated effluents.

Treatment of petroleum wastewater usually involves two stages, firstly, physical (mechanical) pre-treatment to remove free oil & grease fractions and suspended particles. Secondly, an advanced treatment, usually involving a combination of different physicochemical and biological methods, to decrease the pollutant level to acceptable discharge values

a) The sedimentation treatment, which is used to separate bulk free oil from water, is mechanically achieved by gravity in API (American Petroleum Institute) or CPI (Corrugated Plate Interceptor) separators and dissolved air floatation (DAF) units. During wastewater sedimentation, insoluble solids are also removed, which prevents clogging and wearing of devices used in subsequent treatment stages.

b) Mechanical treatment techniques, while allowing the reuse of roughly purified water in the operation cycle, are inefficient in the recovery of finely dispersed oil, dissolved organics, metals and colloids. The mechanical step is followed by the physiochemical step, in which small-sized suspended solids and dispersed oil are further reduced by agglomeration into large-sized particles to ease the removal by filtration, sedimentation or floatation.

Paint

Temporary Onsite Storage

- Appropriate clean, dry, weatherproof, watertight containers.
- Labeling of paint waste containers onsite
- Container Storage area shall be secured
- Removal waste shall be deposited and sealed in containers or roll-offs concurrent with generation

- Containers shall be labeled prior to filling
- Close containers when they are not in use
- Maintain a daily waste transfer log, which will detail how much and what type of waste was placed in the container, and by whom.
- Do not over accumulate.
- Store in a cool, dry area, away from direct sunlight.

Figure - Lead Storage

(Ref. https://www.dot.ny.gov/main/business-center/contractors/construction-division/construction-repository/Lead_Paint_Final.pdf)

Transport and Disposal

Evidence presented that the transporter is a registered licensed professional driver. Hazardous paint waste (lead-based paint) is required to be transported using a hazardous waste manifest typically prepared by the transporter or contractor. Transport to an approved treatment, storage, or disposal facility (TSDF) is required. Transported by truck should be over public highway. Highway shipment is the most common because road vehicles can gain access to most industrial sites and approved TSDFs.

Environmental Precautions

Keep out of drains, sewers, ditches, and waterways. Minimize use of water to prevent environmental contamination. Methods for Containment: Contain and/or absorb spill with inert material (e.g. sand, vermiculite), then place in a suitable container. Do not flush to sewer or allow entering waterways. Use appropriate Personal Protective Equipment (PPE). Methods for Clean-Up: Scoop up material and place in a disposal container. Provide ventilation. All hazardous waste areas should be inspected weekly. Any concerns should be documented and fixed. If there are any spills, clean up and disposed of properly. Waste analysis and waste

determination records should be kept. Among several options available for hazardous waste management, the most desirable method is to reduce the quantity of waste at its source or to recycle the materials for some other productive use. However, some amount of hazardous waste needs to be treated, or disposed. Hazardous wastes must be deposited in secure landfills, which provide at least 3 meters (10 feet) of separation between the bottom of the landfill and the underlying bedrock or groundwater table.

Waste Inventory

Waste type	Waste characteristic	Source	Likely treatment/disposal
Green waste	Inert	Site clearing, Landscape maintenance	Trees used whole for erosion control or chipped and used onsite for erosion control and landscaping.
Concrete	Inert	Remnants from concrete pours	Broken up and used as fill material in bulk earthworks or removed to landfill and cast into molds for future use
General building materials	Inert	Construction	Landfill
Empty drums and containers suitable for return to supplier	Regulated if they Contain regulated waste products such as paint, oil etc. Otherwise, inert	Supply of chemicals, paint, oil, cleaning agents etc.	Return to supplier
Empty drums and containers suitable for recycling	Regulated if they Contain regulated waste products such as paint, oil etc. Otherwise, inert	Supply of chemicals, paint, oil, cleaning agents etc.	Recycling

Empty drums and containers not suitable for recycling	Regulated if they Contain regulated waste products such as paint, oil etc. Otherwise, inert	Supply of chemicals, paint, oil, cleaning agents etc.	Triple rinse on site, crush and puncture prior to disposal in landfill
Electrical cables	Inert	Cable off cuts	Recycling
Timber crates and pallets	Inert	Supply of machinery and parts	Returned to supplier where possible Remainder chipped and used onsite for landscaping
Scrap steel	Inert	Steel off cuts	Recycling
Plastics	Inert	Pipe and conduit of cuts	landfill
Oil and lubricants	Regulated waste	Machinery oil changes and lubrication	Recycling
Oil filters	Regulated waste	Vehicle servicing	Recycling
Cleaning rags	Regulated waste	Vehicle servicing	Regulated waste contractor
Tires	Regulated waste	Vehicle servicing	Regulated waste contractor
Lead acid batteries	Regulated waste	Vehicle servicing	Recycling
Paints and solvents	Regulated waste	Painting	Recycling
Sewage	Regulated waste	Construction Workforce, train passengers	Sewage Treatment
Domestic: food, wrapping	General waste	Construction Workforce, train passengers	Landfill

Domestic: recyclables e.g. cans, plastic bottles, glass	General waste	Construction Workforce, train passengers	Recycling

8.5.6. Cultural Heritage Management Plan

8.5.6.1. Objectives

A cultural heritage management plan aims to:

- Safeguard the cultural heritage values of a place;
- Develop and ensure attractive, competitive and multifunctional historic urban areas;
- Manage and balance conflicting uses/ functions and the different demands of "users" of an historic urban area: local economy, citizens, tourists, property owners, conservators, etc.

8.5.6.2. Legal Requirements

The laws and regulations related to the cultural heritage management plan include:

Laws and Regulations	Year	Purposes
The Protection of rights of National Race Law, (Law No. 5)	2015	▪ Consists of four bills, as submitted to the legislature; Buddhist Women ' s Special Marriage Bill, Religious Conversion Bill, Monogamy Bill and Population Control Bill.
Protection and Preservation of Cultural Heritage Regions Laws (Law No. 15, 16)	2019	▪ To implement the protection and preservation policy with respect to perpetuation of cultural heritage that has existed for many years; to protect and preserve the cultural heritage regions and the cultural heritage.
The Protection and Preservation of Antique Objects Law (Law No. 12,15 20)	2015	▪ To implement the policy of protection and preservation for the perpetuation of antique objects; ▪ To protect and preserve antique objects so as not to deteriorate due to natural disaster or man-made destruction;

		▪ To uplift hereditary pride and to cause dynamism of patriotic spirit by protection and preservation of antique objectives; ▪ To have public awareness of the high value of antique objectives; ▪ To carry out in respect of protection and preservation of antique monuments in conformity with the International Convention and Regional Agreement ratified by the State.
Law Concerning Religious Conversion (Law No.48)	2015	▪ To move freely from own religion to another religion, from one religion to atheism, from atheism to one religion

8.5.6.3. Overview Maps

Among cultural heritages along the railway, Baw Gyo Pagoda and Gohteik Bridge are the closet ones to the railway. The distances from the railway to them are shown in the figures below.

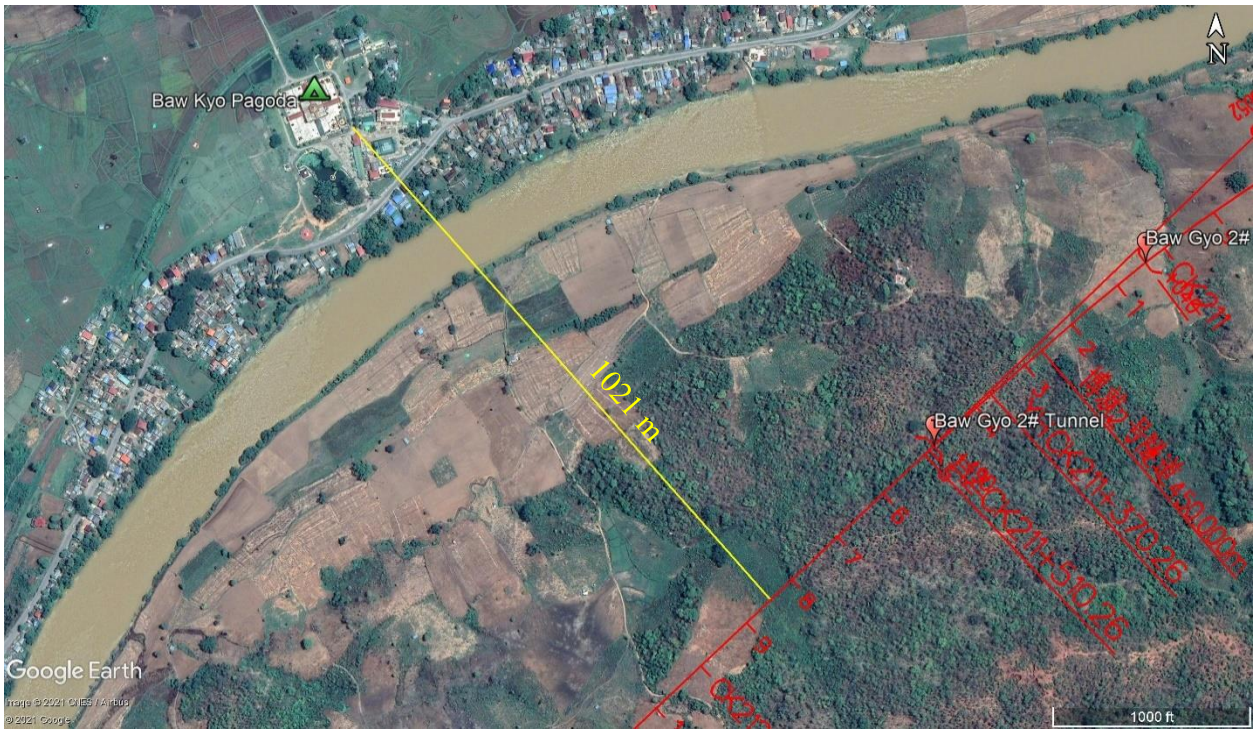


Figure – Distance from Muse-Mandalay Railway Alignment to Baw Gyo Pagoda

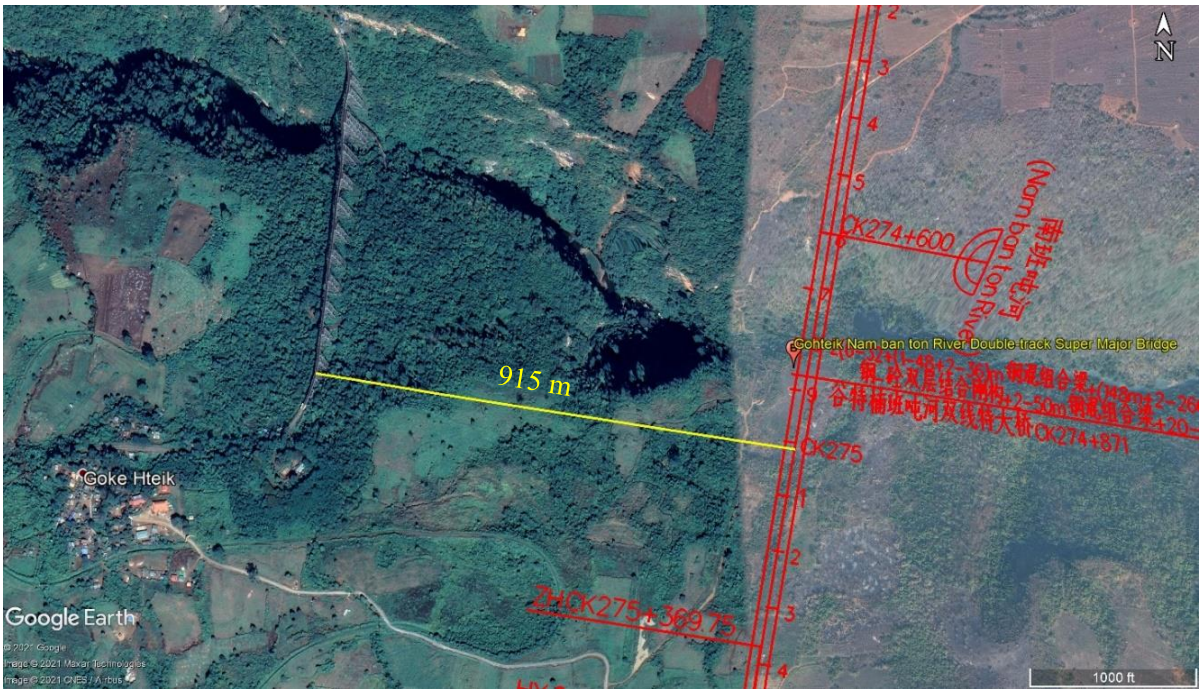


Figure – Distance from Muse-Mandalay Railway Alignment to Existing Goke Hteik bridge

8.5.6.4. Management Plans

During Construction Phase of proposed project**,** any heritage resources, located in close proximity to the project may be impacted through:

- Direct impact to historical (e.g. demolition) and sites of terrestrial archaeological potential (e.g. excavation); and
- Indirect vibration impact on historical buildings due to drilling and piling activities during construction phase that may lead to the structural damage or interference of normal activities;

General cultural heritage management measures should include:

- provision by the nominated undertaker to its contractors of locations and descriptions of all known cultural heritage assets within and adjacent to construction works, including restrictions to construction methods to protect cultural heritage assets;
- an historic environment investigation programme detailing the implementation of archaeological and heritage investigation and recording works prior to and during construction;
- the nominated undertaker will require its lead contractors to monitor compliance against the programme of historic environment investigation and recording works using appropriately qualified environmental management staff;

- during all stages, the nominated undertaker will require its lead contractors to facilitate archaeological and built heritage specialists undertaking the works as specified as an appropriate mitigation measure (including purposive investigation); and
- All archaeological, built heritage and historic landscape intervention, recording, analysis, dissemination and archiving will be undertaken by a suitably qualified and demonstrably experienced organization.

The cultural heritage management plan should include the following:

- The lead contractor will carry out works in such a way as to ensure that disturbance to all heritage assets is managed in accordance with accepted historic environment practice and, where disturbance cannot reasonably be avoided, is controlled and limited as far as reasonably practicable.
- implementation of controls on the movement of construction vehicles and machinery in areas of heritage interest (e.g. archaeological remains and historic buildings);
- The development and implementation of a procedure for soil stripping and excavation before commencement of such works. This procedure will identify the interface of those works with areas of identified archaeological investigations;
- procedures adopted to preserve archaeological remains in situ beneath earthworks; and
- Procedures for the recording, dismantling, storage and re-erection of buildings of heritage significance

Metal Detectors

During site preparation and construction, the use of metal detectors will be prohibited within areas of identified/defined archaeological interest unless deployed by archaeological specialists or other appointed persons in the execution of their activities.

Human remains

Should human remains be discovered during construction, either during archaeological works or as part of construction activity, the nominated undertaker and its lead contractors will comply with all relevant legislative and project-specific requirements.

Treasure Act

During the course of construction, if artifacts are located that are deemed by their material content or context to be treasure, then all necessary measures to comply with the requirements of the Act and any project-specific requirements will be implemented.

Measures in relation to unexpected discoveries of heritage assets

Should, during the course of construction works, artifacts and / or remains of archaeological interest or expected interest be located unexpectedly, these will immediately be reported to the lead contractor's project manager. The project manager will obtain specialist archaeological advice to undertake and prepare an appropriate response.

If that advice indicates that there is potential for the finds to be of national importance, then the Procedure for the unexpected discovery of archaeological remains of national importance procedure will be followed (see below).

Measures in relation to unexpected discovery of archaeological remains of national importance

Should heritage assets of potential national importance be unexpectedly revealed during construction, the unexpected discovery of archaeological remains of national importance will be implemented. Mitigation or investigation and recording may include the following, as appropriate:

- investigation and assessment of discoveries to determine their significance if this cannot be determined from the asset as found;
- assessment of potential project impacts to inform the design of appropriate mitigation or investigation and recording measures;
- preparation of a written scheme of investigation for any stage of archaeological work required;
- excavation, recording and reporting on any discoveries; and
- Recording and implementing measures to preserve any discoveries in situ, if required or if appropriate.

Monitoring

The nominated undertaker will require its lead contractors to implement appropriate monitoring of the consequences of construction work, as required, on all cultural heritage assets (designated and non-designated) to ensure the effectiveness of management measures and compliance with agreed approaches to construction activities and cultural heritage assets.
Risk assessments identifying appropriate surveys, for example, structural or condition surveys and vibration monitoring will be undertaken at locations of archaeological or built heritage interest adjacent to the construction site prior to, during and following construction works.

Noise and Vibration Management

Best practicable means will be applied during construction works to minimize noise (including vibration) at nearby cultural heritage properties and other sensitive receptors arising from construction activities.
Measures to reduce potential noise and vibration impacts

To reduce potential noise and vibration impacts, the following measures should be taken:

- Noise and vibration control at source – for example, the selection of quiet and low vibration equipment, review of construction programme and methodology to consider quieter methods, location of equipment on site, control of working hours, the provision of acoustic enclosures and the use of less intrusive alarms, such as broadband vehicle reversing warnings;
- Screening – for example, local screening of equipment, perimeter hoarding or the use of temporary stockpiles

8.5.7. Community Development Plan

8.5.7.1. Objectives

A community development and rehabilitation plan aim to:

- supporting people with disabilities to maximize their physical and mental abilities, to access regular services and opportunities, and to become active contributors to the community and society at large;

- activating communities to promote and protect the human rights of people with disabilities for example by removing barriers to participation;
- Facilitating capacity building, empowerment and community mobilization of people with disabilities and their families.

8.5.7.2. Legal Requirements

Laws and Regulations	Year	Purposes
Village Regional Development Law (Law No. 39)	2019	▪ To ensure that people in rural areas have access to personal hygiene and home pollution prevention activities by working together with the relevant government departments, government agencies, and non-governmental organizations ▪ To ensure the continuity of the development of rural areas and the social development of the rural population. ▪ To maximize the efficiency of human resources and finances that can be achieved in rural development activities, including the participation of the people
Law Regarding Population Control & Health (Law No. 28)	2015	▪ To improve living standards while alleviating poverty in the country; ▪ To ensure sufficient quality healthcare; and ▪ To develop maternal and child health

8.5.7.3. Overview Map

As the line pass through the Muse to Mandalay, there are many residential areas (e.g. villages, towns) along the railway. The nearby residential areas along the railway line are shown in the following figure.

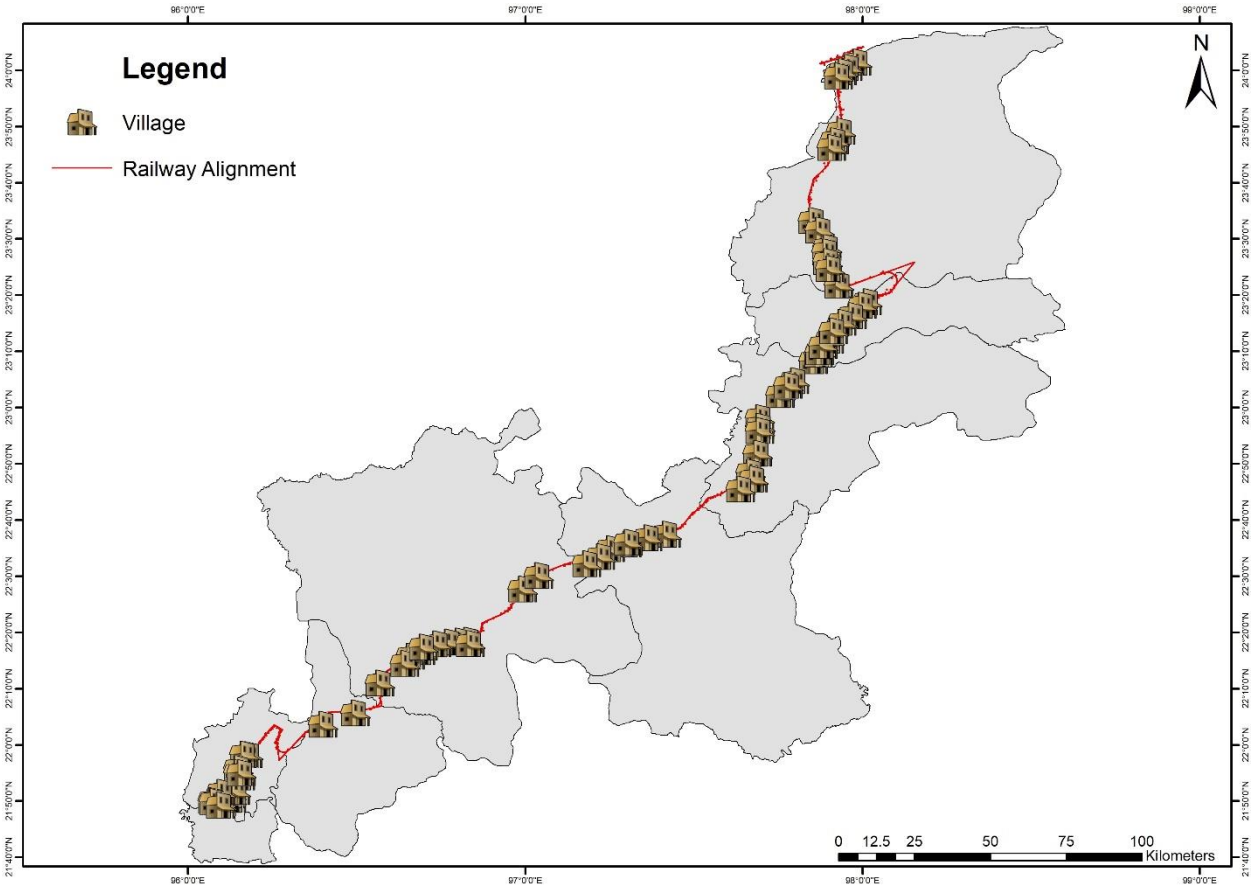


Figure – Residential Areas along the Railway

8.5.7.4. Management Actions

Building Trust – Mobilizing Community

Community mobilization is done by bringing together as many stakeholders as possible to raise people's awareness of and demand for a particular programme, to assist in the delivery of resources and services, and to strengthen community participation for sustainability and self-reliance. A lot can be achieved when people from different parts of the community share a common goal and actively participate in both identifying needs and being part of the solution. Community mobilization helps to empower communities and enable them to initiate and control their own development.

Community Implementation Agreement (Ownership and Sustainability)

Ownership and sustainability are dependent on community involvement through all phases of the project from project start up, through project implementation and until project handover. The ambitions for community involvement depend on the role of community expected to play in the project if they are expected to take an active part in project implementation and take over the project activities once the project is finalized. Therefore, the level of ambitions is ranging from community awareness raising and community consultations to community commitment, community investment through money, materials or human resources and community ownership of the project in the long run.

Providing Job Opportunity (Road Construction, Handicraft training, etc,.)

The community roads give a direct impact on improvement of livelihood and living environment; for instance, transportation of products and purchase of commodities. The implemented projects are High Labor-Intensive Work and Hybrid Method with both mechanical and manual. The road constructions improve the awareness of unemployment of the local people during the project life cycle.

Townships along the railway	**Kyaukme**	**Lashio**	**Hsipaw**	**Muse**	**Theinni**	**Naungkhio**	**Kutkai**	**Pyin Oo Lwin**
Unemployed Persons	1500	9700	1900	2350	1000	1800	6200	5600

In the awareness of unemployment for local people, the training associated with construction techniques and heavy machinery driving should be done before the actual construction phase because the lack of the experience can be substituted by the other experienced labor workers.

The villagers will be given more job opportunities mainly work on construction site. However, women in the villages will not be suitable for construction works. So, job opportunities will also be created for women.

Unskilled or semi-skilled men and women are hired from nearby villages and are trained to handle day-to-day work procedures. To become a certified heavy machine operator, there should be at least 12 weeks training program and 2-week practical work. If villagers are not trained beforehand, they will not be certified for such works and only get manual labor works. When they are certified, they can also work in large construction sites in the future as well.

The special training program such as making handicrafts, sewing clothes, broom making, etc. will be given to women. For these training programs, the trainers will be Shan and Burmese language speaking volunteers from the villages who will be trained beforehand for the program. Since some of the villagers are unable to speak Burmese, Shan Language will be needed at some time. After the training program, they will be capable of making handicrafts, clothes and broom which can be sold in the market. A souvenir shop will be opened at the subway stations so that villagers can sell their products. This way, women will be given job opportunities in the future as well.

Agriculture

Villages in Northern Shan State mainly cultivate betel, seasonal crops, flower, paddy and fruits. Proper cultivating techniques will be presented to the farmers.

To achieve higher yields, however, hybrid rice, heavily reliant on fertilizers and pesticides, needs more water and often requires mechanized farming equipment, all of which are either in short supply or beyond the financial reach of most Shan farmers, whose traditional rice-growing methods entailed few if any imported goods or equipment. According to researcher Hkun Seng, there have been no government programs to train the farmers how to grow the new rice or how to use the fertilizers and pesticides. The Lashio Township government put out a pamphlet on how to grow the rice - but only in English. To make matters worse, the instructions for the fertilizers and pesticides are all in Chinese, unreadable to most in Shan state. The lack of information has made it nearly impossible for farmers to know the proper concentrations to

use or what precautions to take when handling the pesticides and fertilizers. All most farmers are told is that they have to spray six kinds of pesticides at least six times within 120 days. Farmers have reportedly become ill, and a few reportedly have died, after improperly using the pesticides.

So, proper usage of pesticides and insecticides will be introduced and instructions to use them will be written to Burmese language and labeled on the bottles. The disadvantages of using them will also be informed to the farmers and usage of manure as much as possible will be suggested. Techniques for sustainable production of rice and application of resource conserving techniques (RCTs) will be introduced and recommended to the farmers.

During construction phase, for the source of food for employees on site, the agricultural products will be bought from the villagers.

Animal Husbandry

Villages in Northern Shan State mostly raise chicken for eggs and meat.

Modern animal husbandry will be introduced to the villagers. Modern animal husbandry can produce more and earn much more.

- Well-fed animals grow more quickly, they become bigger, yield more meat. They can be sold at a better price.
- Animals produce manure. Your soil will become richer and better. Your harvests will be better. You will make more money.
- Animals that are well fed and looked after are healthy. They have more young ones and your herd will be better and bigger. You can sell animals and earn more money. Animal husbandry is a capital that can produce a lot.

How to improve animal husbandry

If animal husbandry is to produce more, the animals must be raised in a different way.

- A farmer who wants to earn more money must look after his animals himself.
- He must both grow crops and look after his animals.
- The farmer must learn to look after animals.
- Chicken must be raised in a stress-free environment so that they can produce larger eggs and higher quality meat.

- There should be enough space for them to roam so that they can forage for bugs and other critter.

He must:

- Feed them better: especially the young animals; he must lay in reserves for the dry season; give the animals enough to drink.
- look after them better:
- Build a shelter for them, protect the animals against parasites and diseases, and look after them if they are hurt.

Improving Rural Transportation

Rural transport is the movement of people and goods in rural areas by any conceivable means, for any conceivable purpose along any conceivable route and plays as an important role in the local economy. The transportation fare of using the train will be subjected to a reasonable price which is convenient for the villagers so that they can use the train to transport conveniently. They can also reduce transportation fees when they go and sell their agricultural products at a large city like Mandalay.

Improving Water Resource

To promote community health an easily accessible water supply should be available that provides sufficient safe water to meet community needs. There are many types of water resources such as protected spring, dug well, borehole, piped water supply, rainwater harvesting, and ponds and lakes. The water supply such as wells and boreholes should be done for accomplishing the basic healthy life of individual indigenous people. Sometimes the best option for improving water quality is to treat water in the home by boiling. Bringing water to a rolling boil will destroy pathogens in the water and make it safe to drink. Therefore, the knowledge sharing should be done for improving the local people's hygiene and for avoiding the diarrhea especially in the children.

Providing Renewable Energy Supply for Rural Area

Providing access to electricity in rural areas is a major challenge. The fuel is generally of poor quality, and energy is used inefficiently; the power supply is unreliable and access to it limited. This not only has an adverse effect on economic productivity; more importantly, it

also affects people's quality of life and is having a strong impact on the environment. The unsustainable use of locally sourced biomass and an increasing dependence on fossil fuels are causing environmental degradation at local (land degradation), regional (air, water and soil pollution) and global levels (greenhouse gas – GHG emissions contributing to climate change). Providing solar energy make an improvement of rural economies with new sources of revenue, employment and business opportunities, product and policy innovation, capacity building, and, most notably, affordable energy. But the use of candles is surprisingly high. Given the high cost of candles, there is likely to be a strong economic case for switching to lower-cost and higher-quality alternatives in local community. Therefore, there is large potential for using solar PV to meet the demand for lighting in rural areas, particularly the sunny dry zone. If battery systems are used and energy management is already practiced, solar PV systems can offer a safe and increasingly inexpensive alternative to using candles for lighting.

Community Health Improvement Process

The main objective is to avoid or minimize risks to and impacts on the health and safety of the local community during the project life cycle from both routine and non-routine. This is done by providing the local clinics, supporting the facility requirements and improving the district hospitals.

Preceed-Proceed is a health promotion assessment and planning process. Communities precede by defining their desired outcome and conduction social, epidemiological, educational, ecological, adminstrative, and policy assessements to identify causes of health issues. Then, the proceed with intervention and evaluation.

Proceed – 1. Social Assessment (defining end result)

2. Epidemiological Assessment (identifies community health priorities)

3. Educational and ecological Assessment

4. Adminstrative and policy Assessement

Proceed – 5. Implementation

6. Process Evaluation

7. Impact Evaluation

8. Outcome Evaluation

8.5.7.5. Corporate Social Responsibility (CSR) Fund

It promises to set up at least 2% of annual profit as CSR fund. They also promise environmental mitigation and monitoring costs will not take account as CSR fund.

Developer's Policies for Socio-economic Development of Local People

The company's policies for local socio-economic development are shown in the following table.

No.	Description	Company's Policy
1.	Local Community Development Policy	Appoint local people with relevant skills as much as possible and at least 50% of local people will be appointed during operation phase.
2.	Corporate Social Responsibility (CSR) Policy	Contribute at least 3 percent of the annual net profit after tax as CSR fund

8.6. Environmental Management Action Plan

Environmental management action plan should be carried out throughout all project implementation phases and the responsibilities for construction and operation phases. Environmental impact; mitigation measures taken or to be taken; time frame and implementing responsible organization parameters are presented in the following Tables.

Table – Summary of Environmental Management Action Plan

Environmental Impact	**Mitigation Measures Taken or To Be Taken**	**Time Frame**	**Implementing / Responsible Organization**
DESIGN PHASE			
Muse-Mandalay railway alignment	The proposed railway alignment was selected to minimize the land disturbance to avoid displacement of people or households and environmentally sensitive areas in least.	During Design stage	MR / Project Developer
Cultural Heritage	Avoided by adjustment of railway alignment	During Design stage	MR / Service Provider
Loss of Water Bodies	Utmost care taken to avoid railway alignment crossing water bodies	During Design stage	MR / Project Developer
CONSTRUCTION PHASE			
Air Pollution & Dust	Vehicles and machinery are to be regularly maintained so that emissions conform to NEQG Standards. Water should be sprayed during construction phase, wherever it is required to avid dust.	Beginning with and continuing throughout construction	Contractor / Construction services provider

	Vehicles delivering materials should be covered to reduce spills and dust blowing off the load.		
Noise	Noise standard at processing sites, will be strictly enforced as per NEQG noise standards. Workers in vicinity of strong noise will wear earplugs and their working time should be limited as a safety measure. sound proof measurement will be taken for silence zones including schools and hospitals.	Beginning and through construction	Contractor / Construction services provider
Vibration	The vibration level limits at work sites adjacent to the alignment shall conform to the permitted values of peak velocity as given in article project EHS guidelines Manual	Beginning and through construction	Contractor / Construction services provider
Surface Water			
Contamination from Wastes	All justifiable measures will be taken to prevent the wastewater produced in construction from entering directly into river and irrigation system	Throughout construction period	Contractor / Construction services provider
Blockage of drainage due to earth filling	Earth filling will ensure not to block natural drainage system		
Oil and Grease & Domestic Wastes	Avoid any leakage of oil and lubricant Use proper waste management system		
Soil and Ground Water			
Potential to soil contamination	Proper waste management system	Throughout construction period	Contractor / Construction services provider
Leakage of fuel oil and lubricants	Store over concrete floor or impermeable pad		
Construction debris and domestic Wastes	Solid wastes according to the rules and regulations of local CDC.		
Flora And Fauna			
Loss of trees and Avenue Plantation	Areas of tree plantation cleared will be replaced according to Compensatory afforestation Policy under the Forest Law.	After Completion of construction activities	Contractor / Construction services provider MR / Project Developer
Social			
Resettlement or/and relocation of buildings and other assets, involving some changes in livelihood of project affected peoples	Compensation and assistance of livelihood restoration that will be elaborated in the entitlement matrix of updated Abbreviated Resettlement Plan	During construction	MR / Project Developer
Loss of Access	Temporary access should be built at the interchange and other roads.	During construction	
Traffic jams and congestion	Transportation vehicles should not be operated during peak hours if possible. If there are traffic jams during construction, measures should be taken to relieve the congestion with the co-ordination of transportation and traffic police department	During construction	Contractor / Construction services provider MR / Project Developer
Safety with vehicles, people and livestock and signage	Safety education and fines. Allow for adequate traffic flow around construction areas Provide adequate signage, barriers and flag persons for safety precautions.	During construction	Contractor / Construction services provider

	Communicate to the public through radio, TV & newspaper announcements regarding the scope and timeframe of projects, as well as certain construction activities causing disruptions or access restrictions		
Increase in disease Water-borne Insect-borne Communicable diseases	Make certain that there is good drainage at all construction areas, to avoid creation of stagnant water bodies. Provide adequate sanitation and waste disposal at construction camps. Provide adequate health care for workers and locate camps away from vulnerable groups	During construction At start-up Throughout construction	Contractor / Construction services provider MR / Project Developer
Location of camps depots and storage areas	Location of camps depots and storage areas shall be as per the contract specifications.	Throughout construction	Contractor / Construction services provider MR / Project Developer
Safety of employees	When an accident occurs at the workplace, the injured person should be given medical care, where, when, and how the accident occurred should be taken note, and the injury should be reported. Safety awareness must be promoted among employees and all employees should receive safety training.	Beginning with and continuing throughout construction	Contractor / Construction services provider MR / Project Developer
Earthquake Hazards	Selection of railway route which can have minimum impact by an earthquake. Railway tracks should be made so that it can withstand earthquake impact as much as possible.	Throughout construction	Contractor / Construction services provider MR / Project Developer
OPERATION PHASE			
Noise and Vibration	Suitable measures should be considered where warranted. The public shall be educated about the regulations of noise and vibration pollution and its implications.	During operation	MR / Project Developer
Waste			
Generation of municipal solid waste in stations and common passenger areas	Collection and separation of waste in the trains and stations Proper disposal of waste according to local CDC's instruction	During operation	MR / Project Developer
Surface Water			
Oil pollution	Suitable treatment shall be taken for treatment oil before discharging the wastewater especially in depot areas	During operation	MR / Project Developer
Maintenance of Storm Water Drainage system	The urban drainage systems will be periodically checked and cleared so as to ensure adequate storm water flow.	During operation	
Disposal of final treated effluent from treatment plan	Options for final disposal shall be studied and the suitable disposal route shall be decided carefully to minimize the impact of receiving bodies. As far as possible zero discharge rules may be adopted.	During operation	MR / Project Developer
Social			
Railway accidents of passengers and local people	Enlightening passengers and local residents about traffic safety specific to railways	During operation	MR / Project Developer

Traffic safety at stations	Enlightening passengers and local residents about traffic safety at the stations Traffic officers will be assigned to solve any problems regarding traffic.	During operation	MR / Project Developer
Traffic jams and congestion	On-street parking will be restricted outside the station. Drop off/ pickup areas should be provided and passenger cars should be allowed to stop in these areas for only limited amount of time.	During operation	MR / Project Developer
Explosion caused by terrorism	Proper Emergency Response System	During operation	MR / Project Developer
Accidents caused by structural and operational failure	Proper Emergency Response System	During operation	MR / Project Developer
Fire	All machinery, equipment and plant should be suitable for its application, be installed (and protected) in accordance with both the manufacturer's instructions and the appropriate standard, and be properly maintained by a competent person. Appropriate signs and instructions on safe use of the equipment may be necessary. Proper Emergency Response System	During operation	MR / Project Developer
Flood Hazards	Proper preparation should be done for unforeseen events. Specialists should inspect dams, bridges and tracks; measure river beds near bridges; and clean debris from channels, and drainage ditches, and the openings of small bridges and pipes.	During operation	MR / Project Developer

8.7. Parameters, Responsibilities, and Monitoring

Monitoring Team

Monitoring will be conducted daily by the environmental monitoring group in each railway stations and monthly by proposed monitoring team or by the registered monitoring agency throughout the railway line.

Monitoring Frequency

Monitoring frequency will be sufficient to provide representative data for the parameter being monitored. Monitoring data will be analyzed and reviewed at regular intervals and compared with the operating standards so that any necessary corrective actions can be taken. Monitoring will be carried out not only throughout all project implementation phases but also the decommissioning phase. The parameters to be monitored; location of the monitoring sites; frequency and duration of monitoring, responsibilities and monitoring parameters are presented in the following tables.

Table - Implementation Schedule and Projected Budgets of Sub-plans

Sub-plan	Implementation Schedule	Projected budgets	Responsibilities
Environmental monitoring program	During the duration of the construction activities at different locations	- Depending on the cases	Monitoring team of Railway Project and construction contractor(s)
Traffic management plan	During the duration of the construction activities	- Depending on the cases	Construction Contractor(s)
Risk management plan	During the duration of the construction activities and operation phase	- Depending on the cases	Monitoring team of Railway Project
Occupational health and safety plan	During the duration of construction activities and operation	The cost is undefined, depending on the cases	MR and Construction Contractor(s)
Disaster risk and management plan	During the operation	Depending on the cases	MR
Emergency planning and response procedures	During the construction activities and operation	Depending on cases	MR and Construction Contractor(s)
Waste management plan	During the construction activities	For area of spillage – 12000kyats per day For management of construction wastes and handling of hazardous waste – 12000kyats per day	Construction Contractor(s)
Water intake management plan	During the construction activities	- Depending on the cases	Construction Contractor(s)
Storm water management plan	During the construction activities	- Depending on the cases	Construction Contractor(s)
Cultural heritage management plan	During the construction activities	- Depending on the cases	Construction Contractor(s)
Community development and rehabilitation plan	Prior to operation phase	Undefined	MR and Construction Contractor(s)

9. PUBLIC CONSULTATION AND PARTICIPATION PROCESS

9.1. Objectives of Public Participation in an EIA

Public participation is an essential and regulatory requirement for EIA process according to the EIA Procedure, 2015. The public participation process will be designed to provide sufficient and accessible information to I&APs in an objective manner to assist them to:

During the Scoping Phase:

- Raise issues of concern and suggestions for enhanced benefits;
- Verify that their issues have been recorded;
- Assist in identifying reasonable alternatives

During the Impact Assessment Phase:

- Contribute relevant information and local and traditional knowledge to the Environmental assessment;
- Verify that their issues have been considered in the Environmental studies; and
- Comment on the findings of the Environmental assessments.

So, public participation is a process that is designed to enable all interested and affected parties (I&APs) to voice their opinion and/ or concerns which enables the practitioner to evaluate all aspects of the proposed development, with the objective of improving the project by maximizing its benefits while minimizing its adverse effects. I&APs include all interested stakeholders, technical specialists, and the various relevant organs of state who work together to produce better decisions. Public participation empowers local people so that they regard the development projects as their own. Public participation (community involvement) also reduces the impact of uncertainties and stress caused by the proposed project.

In this study, effective public consultation and participation approaches in the form of stakeholder identification, focus group discussions, public meetings and public disclosure process will be conducted.

9.2. Methodology Used in Public Consultation and Participation Process

Public participation has been conducting by the following procedures:

(a) Stakeholder engagement and identification;

(b) Focus group discussion;

(c) Household survey;

(d) Public consultation meetings; and

(e) Public disclosure process.

The EIA includes the activities undertaken during detailed design stage to engage the stakeholders, and planned information disclosure measures and processes for carrying out consultation with affected people and facilitating their participation during implementation stage. Five rounds of engagements have been undertaken as follow:

Table 9.1- Public Consultation and Stakeholder Engagement Process

Round	Method	Stakeholders
Round 1. Stakeholders Identification and Focus group discussions	Conduct discussion with local authorities, by studying GIS Map and social specialists' study	Head of GAMs along MMR and Villages Heads
Round 2: Information sharing and issues identification	Conduct house hold survey in local residents which the railway pass through or cross nearby	Village leaders and local people in project affected areas (nearest villages)
Round 3: Public Consultation meetings	(a) Invitation letters, handout, and report for current situation were distributed. (b) Posters and presentations were used during the meeting.	Regional Government, Key stakeholders in civil society, government officials and local authorities of Mandalay Region & Shan State, NGO's, INGO and CBO's, community leaders, and local communities
Round 5: Public disclosure	Distribution of executive summary, announcement of EIA Report in website	Regional Government, Key stakeholders in civil society, government officials and local authorities of Mandalay Region & Shan State, NGO's, INGO and CBO's, community leaders, and local communities

9.3. Summary of Consultations and Activities Undertaken

Round 1: Stakeholder Engagement and Identification

The involvement of the following groups or organisations in the stakeholder engagement process will be considered to be particularly important:

- Relevant Government Departments at the National, Provincial and Local level;
- Directly affected communities in the project area;
- Representatives of the local industries;
- Environmental groups and Non-Governmental Organisations (NGO)s;
- Community Based Organisations;
- Academic/research Organisations;
- International donors/funders active in the project area;
- Local communities; and
- The media.

So, the following stakeholders can be considered as key stakeholder for the proposed bridges and culverts project.

(a) Myanma Railways (MR)
(b) CREEC
(c) Local People (around the proposed railway project area)
(d) Village Administrative Offices (around the proposed railway project area)
(e) Environmental Conservation Departments in Lashio, Pyin Oo Lwin, Mandalay
(f) Head of Local Administration Offices (around the proposed railway project area);
(g) City Development Committee (Muse, Kuit Kai, Thein Ni, Lashio, Thi Paw, Kyuke Mae, Mandalay);
(h) Department of Public Health (Muse, Kuit Kai, Thein Ni, Lashio, Thi Paw, Kyuke Mae, Mandalay);
(i) Planning and Statistics Department (Muse, Kuit Kai, Thein Ni, Lashio, Thi Paw, Kyuke Mae, Mandalay);
(j) Department of Settlement and Land Record (Muse, Kuit Kai, Thein Ni, Lashio, Thi Paw, Kyuke Mae, Mandalay);
(k) Department of Archaeology and National Museum (Mandaly)
(l) Department of Water Resources Utilization Department (Mandalay, Lashio, Muse);

(m) Department of Labour (Muse, Kuit Kai, Thein Ni, Lashio, Thi Paw, Kyuke Mae, Mandalay);

(n) Myanmar Police Force (Muse, Kuit Kai, Thein Ni, Lashio, Thi Paw, Kyuke Mae, Mandalay);

(o) Local Media, and

(p) NGOs and CBOs.

Round 2: Information Sharing and Issues Identification

(a) Focus Group Discussions

Focus group discussions were carried out with heads of village administration office and elders from almost all of the nearest villages. Through these discussions, information will collect for consideration of PAPs (Project Affected Persons) and potential environmental and socio-economic impacts. Some recorded photos for example of focus group discussions are show in the following.

Sar Toe

Nyaung Pin Zout

Anauk Kyu Yinn Village

Taung Quarter

	
Myo Pyin Gyi	Sat Kway
	
Pan Kham Village	Ngon Sai Village
	
Min Ywar	Khie Tone Hone Village
	
Khar Shi Village	Mal Han Village

	
Nan Onn Village	Kaung Khan Village

(b) Household Surveys

Household sample survey was conducted to evaluate primary socio-economic conditions of the project area and to understand the mood, perceptions and extent of preparedness of the people towards the proposed project. The household survey was carried out to tap the baseline socio-economic conditions of project area and to assess project perceptions and attitudes of the local people over a period of twenty days. To get the accurate data, primary data collection will be conducted by social specialist, social consultants, local authorities and local people.

Sample Size Determination

i. Sample size

The sample size was determined using Yamane's formula. The sampling error was considered as 4 % as the confident level was set at 96%.

$$\mathbf{n} = \frac{N}{1+Ne^2}$$

Where,

n = sample size

N =total number of households in the study area

e = desired margin error

In order to have a clear understanding about the sampling error "e" value, the correlation between sample size and "e" value were presented in the following table.

Table: Correlation between Sample Size and Sampling Error

Size of Population	Sample Size (n) for Precision (e) of:			
	±3%	±5%	±7%	±10%
500	a	222	145	83
600	a	240	152	86
700	a	255	158	88
800	a	267	163	89
900	a	277	166	90
1,000	a	286	169	91
2,000	714	333	185	95
3,000	811	353	191	97
4,000	870	364	194	98
5,000	909	370	196	98
6,000	938	375	197	98
7,000	959	378	198	99
8,000	976	381	199	99
9,000	989	383	200	99
10,000	1,000	385	200	99

Source: Updated from Glenn D. Israel, 2003

This formula is not applicable for small population below 500 sizes of population, so the small size population was calculated 30% of each population's size. Then sample size was distributed according to the number of households in each village. However, the selection was done by the number of households located in the project affected part of the village. Thus, the sampled households were more or less differed from village to village. The following presented the sample households distributed in the survey.

ii. Sampling Method

The sampling unit was individual household in the study area. The sampling was carried out by stratified random sampling with the following steps.

- ***Step-1***, Households information were preliminary accessed during the pilot survey. The information includes baseline information of socio-economic activities and their concerns about the proposed projects.
- ***Step-2***, The households in each ward will be geographically classified sub-groups such as

  - households located nearby water sources by the proposed project
  - households located along the accessed roads to the proposed project site
  - households located beside the railway alignment of the proposed project
  - households located near the cultural and heritage site

- **Step**-3, The respondent households were randomly selected from each group according to the sample size.

The following table shows the list of household survey for proposed project. All of the villages are situated near the railway alignment.

Township	Village and Village Tract
Mandalay (Myit Nge)	Sar Toe Village Group (Sar Toe, Sat Kway, Myo Pyin Gyi) Danone Village, Nyaung Pin Ni Village, Nyaung Pin Zout Village, Myit Laung Village, Ashay Thar Yar Gone Village, Min Ywar Village, Pyauk Sake Kone Village, Sin Bo Village, Pauk Chine Village, Min Su Village, Saut Taw Wa Village
Mandalay (Pathein Gyi)	Than Ma Taw Village, Thansin Kone Village, Let Kaung Village, Tha le Kone Village, Yan Kin Taung Village, Lane Pin (Ashay and Anauk) Village
Pyin Oo Lwin	Thet Kan Kone (Hmyawt Taw) Village, Kone Kaw Village, Pin Lein (Middle) Village, Ashay Pin Lein Village, Pan U Taung Village
Naung Cho	Taung Quarter, Myat Chae Nu Village, Kone Gyi Ma Village, Ngoke Ka Lay Village, Ohmm Ma Khar Village, Kyin Ganai Village, Ban Bway Village, Samasal Village, Lone Yone Village, Anauk Kyu Yinn Village
Kyauk Me	Khie Tone Hone Village, Nar Kite Khan Village, Naung Ann Village, Ngon Sai Village, Know Kaw Village, Kyaung Kone Village, Mway Taw Village
Hsipaw	Kyin Thi Village, Twan Kar Village, Naung Eain Village, Swat Lann Village, Ho Naung Village, Pan Sauk Village, Nam Aun Village
Lashio	Khar Shi Village, Naung Mon Village, San Pyat Village, Lwin Lount Village, Khay Ninn Village, Mal Han Village, Kaung Ma Kyan Village, Naung Laing Village, Nam Tom

	Village, Ho Pate Village, Pan Hat Village
Theinni	Nan Onn Village, Man Sar Tone Village, Nar Chat Village, Nan Maw Hate Village, Pan Kham Village, Man Chat Village, Pan Sone Village, Pan Phat Village, Naung On Village, Wane Line Village
Kutkai	Nam Hpat Kar Village, Pang Sa Lorp Village, Ho Nar Village, Nan Khone Village, Nam Hpat Lun Village, Kawng Lein Village, Mhan Lone Village, Pa Gyo Village
Muse	Nan Pann Village, Nan Kon Village, Nan Sonn Village, Kaung Khan Village, Wane Mine Village, Nan Onn Village, Mhan Haunn Village, Phat Mhan Village, Mine Mine Village, Yaw Han Par Village

Sample Size Determination of sample size for each township

1.Mandalay (Myit Nge) Township	**Households**	**Sample Size**
Sar Toe Village Group (Sar Toe, Sat Kway, Myo Pyin Gyi)	1319	426
Da None Village	969	380
Nyaung Ni Pin Village	180	140
Nyaung Pin Zout Village	267	188
Myit Laung Village	404	246
Ashay Thar Yar Gone Village	217	162
Pyauk Sake Kone Village	215	160
Sin Boe Village	325	214
Pauk Chine Village	86	76
Min Su Village	95	83
Saut Taw Wa Village Group (Min Ywar Village, War Yone Pin Village)	917	372

2.Mandalay (Pathein Gyi)Township	**Households**	**Sample Size**
Than Ma Taw Village	1541	445
Thansin Kone Village	597	306
Let Kaung Village	250	179
Tha le Kone Village	601	307
Yan Kin Taung Village	1594	449
Lane Pin Village	406	247
3.Pyin Oo Lwin Township	**Households**	**Sample Size**
Thet Kan Kone (Hmyawt Taw) Village	126	105
Kone Kaw Village	150	121
Pin Lein (Middle) Village	159	127
Ashay Pin Lein Village	382	238
Pan U Taung Village	714	334
4.Naung Cho Township	**Households**	**Sample Size**
Taung Quarter Village	1121	402
Mak Hki Nu Village	1032	390
Kone Gyi Ma Village	904	370
Ngoke Ka Lay Village	580	301
Ong Ma Hkar Village	822	356
Kyein Ga Naing Village,	1515	443
Bant Bway Village	1643	453
Hsan Ma Hse Village	1478	440
Long Yon Village	1315	424
Ah Nauk Kyu Inn Village	537	289

5.Kyaukmae Township	**Households**	**Sample Size**
Nar Aik HkantVillage Group (Khie Tone Hone Village, Kone Kaw Village)	288	198
Naung Ann Village	109	93
Ngon Sai Village	80	71
Sai Khawng Village	36	35
Kyaung Kone Village	171	135
Mway Taw Village	108	93

6.Hsipaw Township	**Households**	**Sample Size**
Kyin Thi Village	423	253
Twan Kar Village	124	104
Naung Eain Village	90	79
Swat Lann Village	120	101
Ho Naung Village	156	125
Pan Sauk Village	55	51
Nam Aun Village	253	181
7.Lashio Township	**Households**	**Sample Size**
Hkar Shi Village	462	266
Nawng Mun Village	1982	476
San Pyat Village	137	113
Lwin Lount Village	410	248
Hkay Nin Village	514	283
Mae Han Village	1218	414
Kaung Ma Kyan Village	80	71
Naung Laing Village	290	199
Ho Peik Village & Pan Hat Village	839	359

8.Theinni Township	**Households**	**Sample Size**
Nar Chat Village	30	29
Nan Maw Hate Village	114	97
Pan Kham Village	95	83
Pan Sone Village	325	214
Pan Phat Village	354	226
Nam On Village	107	92
Pan Lawt Village Group (Man Chat Village, Wane Line Village, Man Sar Tone Village, Naung Onn Village)	505	280
9.Kutkai Township	**Households**	**Sample Size**
Nam Hpat Kar Village	1667	455
Pang Sa Lorp Village	245	177
Ho Nar Village	12	12
Nan Khone Village	40	38
Nam Hpat Lun Village	192	147
Kawng Lein Village	212	159
Mhan Lone Village	28	27
Pa Gyo Village	25	25
10.Muse Township	**Households**	**Sample Size**
Nam Pang Village	448	261
Nan Sonn Village	86	76
Kaung Khan Village	198	151
Wane Mine Village	181	141
Nam Aun Village Group (Phat Man Village, Man Haung Village)	717	334
Man Hai Village	576	300
Man Mai Village	63	58

Recorded photos for household survey in Mandalay (Myit Nge)

Sar Toe Village

Nyaung Pin Ni Village

Nyaung Pin Zout Village

Myit Laung Village


Danone Village


Myo Pyin Gyi


Sat Kway


Min Ywar Village

Pyauk Sake Kone Village

Ashay Thar Yar Gone Village


Saut Taw Wa Village


Pauk Chine Village


Min Su Village


Sin Bo Village

Recorded photos for household survey in Naung Cho Township

Taung Quarter

Myat Chae Nu


Anauk Kyu Yinn

Kone Gyi Ma


Lone Yone

Kyin Ganai


Ohmm Ma Khar


Ngoke Ka Lay

Ban Bway

Samasal

Recorded photos for household survey in Kyauk Me Township


Khie Tone Hone


Nar Kite Khan


Naung Ann


Ngon Sai


Know Kaw


Kyaung Kone


Mway Taw

Recorded photos for household survey in Lashio Township


Khar Shi


Naung Mon


San Pyat


Lwin Lount


Khay Ninn


Mal Han


Kaung Ma Kyan


Nam Tom


Pan Hat

Recorded photos for household survey in Theinni Township


Nan Onn


Man Sar Tone


Nar Chat


Nan Maw Hate


Pan Kham


Man Chat


Pan Sone


Pan Phat


Naung On


Wane Line

Some Recorded photos for household survey in Muse

Nan Pann

Nan Kon

Nan Sonn

Kaung Khan

	
Wane Mine	Nan Onn
	
Mhan Haunn	Yaw Han Par
	
Phat Mhan	Mine Mine

Most Public Needs and Concerns during Household Survey

As household survey was conducted in more than 70 villages, the results of household survey cannot be made very detailed to cover 70 villages. The following are the most important public concerns resulted by the household survey for the proposed project:

- Worry about the damage of agricultural land, forest area, historical places and archeological sites;
- Proper compensation to land use whether they don't have land permit or not;

- the blockage of rivers and water pollution;
- bridge collapse during operation;
- noise & vibration;
- discuss openly and transparency before starting any stage of project; and
- Ensure job opportunities for local people.

Round 3: Public Consultation Meetings (PCMs)

The aim of PCMs are to:

(a) To announce the process and procedure of EIA;
(b) To discuss about the possible environmental and social impacts;
(c) To discuss about the alternative ways to avoid the possible impacts; and
(d) To discuss effective mitigation measures most public concerns about the proposed project.

(a) Public Meeting for Scoping Proposal

Public meeting for scoping proposal were made six times from the date of (25.6.2019) to (2.7.2019) in six township, namely, Mandalay (Myit Nge), Naung Cho, Kyauk Mae, Lashio, Thein Ni and Muse as follow:

Table 9.2- Public Consultation Meetings for Scoping Proposal

No.	Meeting	Location	Date
1	Public Meeting for Scoping Proposal	Zaytawon Monastery, Myit Nga Mandalay	(25.6.2019)
2	Public Meeting for Scoping Proposal	Township Hall, Naung Cho	(26.6.2019)
3	Public Meeting for Scoping Proposal	Meeting Hall (GAO), Kyauk Me	(27.6.2019)
4	Public Meeting for Scoping Proposal	Meeting Hall (GAO), Lashio	(29.6.2019)
5	Public Meeting for Scoping Proposal	Township Hall, Thein Ni	(1.7.2019)
6	Public Meeting for Scoping Proposal	City Hall, Muse	(2.7.2019)

These townships will place railway stations and so public meetings are held at these townships initially. The following are the summary of discussions about the project and their exceptions from participants during the meeting.

Summary of Public Meeting Mandalay (Myit Nga Township)

Firstly, public consultation meeting for scoping proposal was held at the Zaytawon Monastery, Myit Nge Township, Mandalay in June 25, 2019. Over 200 people from local authorities, local people and other social communities groups from Myitnge region and other stakeholder are attended. The key discussion about this PCM is the compensation about land use and the not to use historical areas and places.

Recorded Photos from Public Meeting Mandalay (Myit Nga Township)

Summary of Public Meeting (Naung Cho Township)

Then, public consultation meeting for scoping proposal was held at the Naung Cho Township Hall in June 26, 2019. Over 100 people from local authorities, local people and other social communities groups from Naung Cho Township region and other stakeholders who are interest the project are attended. The key discussions are the land aquisation and compensation, announce the precise railway alignment and the impact on natural water spring.




Recorded Photos from Public Meeting Naung Cho

Summary of Public Meeting (Kyauk Mae Township)

Public consultation meeting for scoping proposal was held at the Kyauk Me General Administrative Office Meeting Hall in June 27, 2019. Over 120 people from local authorities, local people and other social communities groups from Kyauk Me Township region and other stakeholders who are interest the project are attended. The key discussion during public meeting are about the environmental baseline study, land aquisation and proper compensation, impact on national level security and impact on water resources.




Recorded Photos from Public Meeting Kyauk Mae

Summary of Public Meeting for Scoping Report (Lashio Township)

Public consultation meeting for scoping proposal was held at the Lashio General Administrative Office Meeting Hall in June 29, 2019. Over 120 people from local authorities, local people and social communities' groups from Lashio Township region and other stakeholders who are interest the project are attended. The key discussions during public meeting are about the registration of third party, proper land compensation, proper fair price, impacts on natural spring and national level security.

Recorded Photos from Public Meeting Lashio

Summary of Public Meeting for Scoping Report (Thein Ni Township)

Public consultation meeting for Thein Ni Township was held at Theinni Township Hall in 1st July, 2019. Over 120 people from local authorities, local people and other social communities' groups from Thein Ni Township are attended. The key discussions during public meeting are land aquisation and proper compensation to land use, impact on natural water resources, impact on agricultural lands, impact on public safety.

Summary of Public Meeting for Scoping Report (Muse Township)

We held the 6th Public Consultation Meeting at the Muse City Hall in 2nd July, 2019. Over 100 people from local authorities, local people and other participants from Muse Township are attended. The key discussion during public meeting are the compensation to tree cutting, impact to national security, impact to religious and national security.

Summary of Public Conservation Meeting for MMR

Ever Green Tech and MR hold 19 PCM in 9 townships along the MMR both for scoping and EIA reports.

<table>
<tr><td colspan="6">First PCM</td></tr>
<tr><td rowspan="2">Time</td><td rowspan="2">Location</td><td colspan="2">Participant</td><td rowspan="2">Key Discussion</td><td rowspan="2">Recorded Photo</td></tr>
<tr><td>Composition</td><td>Number</td></tr>
<tr><td rowspan="3">25.6.19
1:00 pm
to 4:00 pm</td><td rowspan="3">Mandalay Myit Nge)</td><td>Local authorities</td><td>20</td><td rowspan="3">• Proper compensation for land used;
• No or Less impact to monastery and pagoda;
• Not to pass railway through villages;
• Beware increase in human trafficking;
• Not to cause accidental cases to local people due to high speed train</td><td rowspan="3">  </td></tr>
<tr><td>NGOs</td><td>12</td></tr>
<tr><td>local people</td><td>180</td></tr>
<tr><td rowspan="3">26.6.19
1:00 pm
to 4:00 pm</td><td rowspan="3">Naung Cho</td><td>Local authorities</td><td>15</td><td rowspan="3">• Transparence for the project information in every stage;
• Not to use agricultural land or proper compensation for land use;
• Railway accidents when crossing with village road;
• Not to damage natural spring along the railway;
• Ensure job opportunities for local people.</td><td rowspan="3">  </td></tr>
<tr><td>NGOs</td><td>12</td></tr>
<tr><td>local people</td><td>120</td></tr>
</table>

<table>
<tr><td colspan="6">First PCM</td></tr>
<tr><td rowspan="3">27.6.19
1:00 pm
to 4:00 pm</td><td rowspan="3">Kyauk Mae</td><td>Local authorities</td><td>20</td><td rowspan="3">Proper compensation measures for land used;
Proper arrangement for sustainable livelihood for project affected persons;
Keep the alignment away from village and forest areas;
Blockage of natural drainage system and natural spring;
Prepare warning signs along the railway line in local language;
Need to care for natural springs along the project area</td><td rowspan="3">-
  </td></tr>
<tr><td>NGOs</td><td>12</td></tr>
<tr><td>local people</td><td>115</td></tr>
<tr><td colspan="6">First PCM</td></tr>
<tr><td rowspan="4">29.6.19
1:00 pm to
4:00 pm</td><td rowspan="4">Lashio</td><td colspan="2">Participant</td><td rowspan="4">Damage to agricultural lands along the railway;
Need sufficient compensation for every land used;
Damage to water resources by the project;
Worry for road accidents along the railway;
Need detailed assessment for socio-economic impacts;</td><td rowspan="4">  </td></tr>
<tr><td>Local authorities</td><td>22</td></tr>
<tr><td>NGOs</td><td>10</td></tr>
<tr><td>local people</td><td>110</td></tr>
</table>

1.7.2019 1:00 pm to 4:00 pm	Thein Ni	Local authorities NGOs local people	12 6 102	• Blockage of village roads along the railway line; • Need to construct over pass, when the railway and road cross point • Use warning signs in local languages along the railway line; • Avoid or less impact to agricultural lands. • Appropriate compensations are required for affected farmers. • Need to care for natural springs along the project area	
First PCM					
2.7.2019 1:00 pm to 4:00 pm	Muse	Local authorities NGOs local people	22 4 60	• Appropriate compensations are required for affected persons. • Tree plantation for cutting of trees • Need transparency for the project. • Want to care for road safety. • Need to care for natural springs along the project area • Keep away the alignment from the village • Need to protect illegal trades due to project development	

<table>
<tr><td colspan="6">First PCM</td></tr>
<tr><td rowspan="4">31.8.2019
1:00 pm to
4:00 pm</td><td rowspan="4">Pyin Oo Lwin</td><td>Local authorities</td><td>22</td><td rowspan="4">• Noise and vibration from the train;
• Replantation of trees for cutting of trees;
• Choose electrical power not to pressure on local electricity use;
• Compensate the farm and agricultural land of local people fairly and transparently-
• To protect the local people for their right with existing laws and regulation
• Not allow cross over the natural spring which are the main water source of local people
• Not to reduce the water catchment area due to railway line (in Pyin Oo Lwin) region
• To control natural resources that can be damage during construction and operation phases
• Not to take surplus soil and rock from tunnel construction</td><td rowspan="4">  </td></tr>
<tr><td>NGOs</td><td>10</td></tr>
<tr><td>local people</td><td>125</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="6">First PCM</td></tr>
<tr><td rowspan="4">17.8.2019
1:00 pm to
4:00 pm</td><td rowspan="4">Mandalay (Pathin Gyi)</td><td>Local authorities</td><td>16</td><td rowspan="4">• To reduce the damage of natural resources, trees and forest and the responsible agency have to undertake the compensation of damage
• To emphasize the public concerns
• To ensure job opportunities for local people, experts and engineers
• To make RAP for proper compensation for land use
• To prepare comprehensive assessment for implementation phase
• Damage to natural spring during tunneling
• Surface water pollution due to bridge construction</td><td rowspan="4">  </td></tr>
<tr><td>NGOs</td><td>13</td></tr>
<tr><td>local people</td><td>150</td></tr>
<tr><td>...</td><td></td></tr>
</table>

<table>
<tr><td colspan="6">First PCM</td></tr>
<tr><td rowspan="3">7.9.2019
1:00 pm
to 4:00 pm</td><td rowspan="3">Hsipaw</td><td>Local authorities</td><td>20</td><td rowspan="3">Not to damage natural spring
Compensate, rebuild and relocate the local residents which are removed for the railroad before the project are started
Proper and sufficient compensation to local people without delay
Worry to relocate the place of local people who are poor and to protect them by the laws
Build overpass and underpass where the joint with the road which the local people are using it</td><td rowspan="3">  </td></tr>
<tr><td>NGOs</td><td>12</td></tr>
<tr><td>local people
...</td><td>180</td></tr>
<tr><td colspan="6">First PCM</td></tr>
<tr><td rowspan="3">22.10.2019
1:00 pm
to 4:00 pm</td><td rowspan="3">Kuitkai</td><td>Local authorities</td><td>20</td><td rowspan="3">To reduce house demolishing and land acquisition as much as possible
Policy to control human trafficking
Control migrant workers who can be settlement near the project area after construction phase
If possible, the railway alignment is away far from the village
Worry to disturb the local electricity use
Do not allow soil and other material getting from project construction to carry the other place
Appropriate compensations are required for affected farmers and land owners
Not allow to destroy natural springs along the project area</td><td rowspan="3">  </td></tr>
<tr><td>NGOs</td><td>8</td></tr>
<tr><td>local people
...</td><td>180</td></tr>
</table>

<table>
<tr><td colspan="6">Second PCM</td></tr>
<tr><td rowspan="2">Time</td><td rowspan="2">Location</td><td colspan="2">Participant</td><td rowspan="2">Key Discussion</td><td rowspan="2">Recorded Photo</td></tr>
<tr><td>Composition</td><td>Number</td></tr>
<tr><td rowspan="5">10.10.2019
1:00 pm
to 4:00 pm</td><td rowspan="5">Mandalay Pathein Gyi</td><td>Local authorities</td><td>15</td><td rowspan="5">• To provide compensation for house demolishing and land acquisition according to laws and regulations
• To control noise during operation phase
• To provide sidewall along the railway
• To make comprehensive assessment for implementation phase
• To provide job opportunities
• To make open tender system for all implementation process
• To prevent human trafficking and drug handling</td><td rowspan="5">  </td></tr>
<tr><td>NGOs</td><td>10</td></tr>
<tr><td>local people</td><td>60</td></tr>
<tr><td>...</td><td></td></tr>
<tr><td></td></tr>
<tr><td colspan="6">Second PCM</td></tr>
<tr><td rowspan="4">11.10.2019
1:00 pm
to 4:00 pm</td><td rowspan="4">Pyin Oo Lwin</td><td>Local authorities</td><td>16</td><td rowspan="4">• To emphasize on the public voices and concern
• To publish the project related issues through media and make the meeting with media for the announcement.
• To avoid the blockage of natural springs
• To avoid the damage of religious and archeological places
• To provide resettlement action or compensation for house demolishing and land acquisition;
• To provide support for the basic infrastructure (such as, school, hospitals, road) of project related places and nearby areas;
• To make compensation for tree cutting;
• Not to damage the natural resources buried under the ground;
• Not to damage the buried archeological resources;
• To prevent the settlement of migrant workers near the project sites</td><td rowspan="4">  </td></tr>
<tr><td>NGOs</td><td>12</td></tr>
<tr><td>local people</td><td>90</td></tr>
<tr><td></td></tr>
</table>

<table>
<tr><td colspan="6">Second PCM</td></tr>
<tr><td rowspan="3">1.9.2019
1:00 pm
to 4:00 pm</td><td rowspan="3">Naung Cho</td><td>Local authorities</td><td>18</td><td rowspan="3">They want very less amount of damage size on their garden land and farm land.
If any damage, they would like to get appropriate compensation;
The use of electricity from local resources;
Need to care for natural springs along the project area
How the railway alignment pass through the natural springs and farm lands
Want to care about the railway pass for accidents and dangerous
When the alignment in detail design, local people want to care the roads and bridge that already exits
Secure job opportunities for local people
The illegal trade of unhealthy food from China
Prevent zero dollar tourism from other place</td><td rowspan="3">  </td></tr>
<tr><td>NGOs</td><td>9</td></tr>
<tr><td>local people</td><td>200</td></tr>
<tr><td colspan="6">Second PCM</td></tr>
<tr><td rowspan="4">21.10.2019
1:00 pm to
4:00 pm</td><td rowspan="4">Hispaw</td><td colspan="2">Participant</td><td rowspan="4">To avoid the blockage of natural springs
Having anxious to get damage on the religious buildings and historical places or buildings
Worry for water resources are damaged by the project.
To provide resettlement action or compensation for house demolishing and land acquisition
Want job opportunity favor for local peoples
Noise from blasting process
To emphasize the public concerns and their livelihood changes
Not to dispose soil material and other waste from construction near the agricultural lands
Control foreign and migrant workers</td><td rowspan="4">  </td></tr>
<tr><td>Local authorities</td><td>22</td></tr>
<tr><td>NGOs</td><td>10</td></tr>
<tr><td>local people</td><td>110</td></tr>
</table>

<table>
<tr><td colspan="5">Second PCM</td></tr>
<tr><td rowspan="3">25.10.2019
1:00 pm to
4:00 pm</td><td rowspan="3">Thein Ni</td><td>Local authorities</td><td>12</td><td rowspan="3">Need transparency for the project, when the project is being started to build.
Keep away the railway from the village area (limited area for relocation)
Want job opportunity favor for local peoples
Worry to disturb the local electrical power source
Don’t want to destroy the roads that are connecting village to village by the project
Want over pass, when the railway and road meet points.
Noise and vibration
Warning signs should be in local languages (Shan, Burmese, and other native languages)
Want to avoid grazing ground and agricultural land if possible
Appropriate and definite compensations are required for affected farmers.
Need to care for natural springs along the project area</td><td rowspan="3">  </td></tr>
<tr><td>NGOs</td><td>6</td></tr>
<tr><td>local people</td><td>102</td></tr>
<tr><td colspan="5">Second PCM</td></tr>
<tr><td rowspan="2">8.9.2019
1:00 pm to
4:00 pm</td><td rowspan="2">Lashio</td><td>Local authorities</td><td>22</td><td rowspan="2">To avoid the agricultural land and provide compensation for any damages
To avoid the damage of water resources
To improve the security to protect Myanmar national with laws as a lot of foreigners can ether into the country from this railway.
To consider the national security
To provide electricity and job opportunities
To reduce the adverse impacts on environment, cultural and socio-economic conditions
To prioritize the safety on road crossing
To provide compensation for house demolishing and land acquisition with current prices.</td><td rowspan="2">  </td></tr>
<tr><td>NGOs</td><td>10</td></tr>
</table>

		local people	200	• To implement the project after compensation process. • To replant the trees the railway • To make sure that the railway is readily accessible by local people. • To discuss with Ministry of Construction before choosing the railway alignment- • Ground water alternation due to blasting process	
Second PCM					
24.10.2019 1:00 pm to 4:00 pm	Muse	Local authorities	22	• To make sure that the project activities would not harm to the socioeconomic conditions • Need to care for natural springs along the project area • Want warning signs along the railway and both side. • To make sure that the implementation agency compensate to the affected person directly • Compensation should be done before the project beginning and paid transparently • Replanting trees as compensation for tree cutting • Limit tree cutting outside the project area	
		NGOs	10		
		local people	85		
		...			
Second PCM					
6.9.2019 1:00 pm to 4:00 pm	Kyuk Mae	Local authorities	16	• To provide sidewall along the railway • Impact to fauna diversity due to noise • To build underpass and overpass for the local people and animals • To compensate transparently for losing lands and household • Replant trees along the railroad • Worrying of human traffic and drugs • Suggest to build railroad after getting peace • Declare the width of the railway line and land use of other facilities openly	
		NGOs	13		
		local people	180		
		...			

<table>
<tr><td colspan="5">Second PCM</td></tr>
<tr><td rowspan="4">23.10.2019
1:00 pm
to 4:00 pm</td><td rowspan="4">Kuikhai (Nantphatkha)</td><td>Local Authorities</td><td>14</td><td rowspan="4">Minimize or avoid the farmland and agricultural land
Compensation will pay for affected farmers and land owners as soon as possible
To provide job opportunities
Want to avoid grazing ground
If possible, the railway alignment is away far from the village
Reasonable railway fee that can be affordable to local people</td><td rowspan="4">  </td></tr>
<tr><td>NGOs</td><td>6</td></tr>
<tr><td>local people</td><td>100</td></tr>
<tr><td>...</td><td></td></tr>
</table>

Review

During PCMs, the major difficulties are as follows:

No.	Challenges	Response
1.	The detailed railway alignment that pass the exact location	During FS stage, precise railway alignment cannot be got and proposed alignment can be changed during implementation stage
2.	Compensation for land use	Proper compensation will be made by organizing compensation team with local authorities during implementation phase
3.	Not believe all of the Chinese Project	International official tender will be made for selection of project developer(s)
4.	Commitments for compensation	Compensation will be made by organizing compensation
5.	The blockage of village roads, seasonal streams and natural springs	Will use adequate bridges and culverts along the railway line not to block any public worry
6.	Noise during operation phase	Will made sound barrier in some environmentally and socially sensitive areas
7.	Trees cutting outside of the project corridor	Limit tree cutting and replanting as per local forestry department if cutting No tree cutting outside of the project corridor
8.	The use of electricity in local	Power supply will be sourced that no pressure on local electricity use Source electricity from China if possible Will not construct power supply system in local for this purpose

9.	Quarry mine for extraction of road stone	Will not extract lime stone for railway subgrade without permission from Government
10.	Secure job opportunities for local people	Tender will be made transparency for every project development stage
11.	Take other natural resources (logs, metals and wild animals) during construction of railway and tunnels	Strictly control construction contractor(s) not to take other resources during construction phase
12	Blockage of spring water due to blasting process in tunneling	Beware the alternation of waterway during tunneling
13.	Avoid pagoda and monastery areas	Will avoid pagoda and monastery areas
14.	Avoid forest area to reduce tree cutting	Will avoid forest area as much as possible and will replant if cutting is made.

9.4. Results of Consultations

Key Findings from the Public Meetings Related to the Proposed Bridges and Culverts Project

The followings are the summary of key findings from public meetings for scoping proposal:

- Less damage to agricultural land, forest area and histological places;
- Not to damage to uncover natural resources; (keep away alignment from natural resources existing area);
- Proper compensation to land use with or without ground gram;
- Make sure compensation before the project without delay;
- Declare the width of the railway line and land use of other facilities openly;
- Limit tree cutting outside of the project area;
- Replanting trees as compensation for tree cutting;
- Not to dispose soil material from construction near the agricultural lands;
- Not to construct quarry mine site without permission from government;

- Not to take soil material for land filling at other place;
- Cover with side wall along the whole railway;
- Avoid blockage of natural drainage system;
- Avoid blockage of natural spring;
- Avoid blockage of village road;
- Less damage to wildlife along the railway line;
- Control foreign and migrant workers;
- Policy to prevent the settlement of migrant workers near the project sites;
- Policy to ensure job opportunities to local people;
- Tender system for every project implementation works;
- Not to haulage soil and earth materials that can contain some metals to another place from tunneling;
- Not to damage to buried archeological places due to excavation;
- Not to separate the agricultural lands by the railway;
- Policy to prevent human trafficking;
- Policy to prevent zero dollar tourism;
- Reasonable railway fee that can be affordable to local people;
- Construct flyover when meet the public road;
- Notice board along the railway road with local people languages;
- Not to increase in traffic during construction phase;
- Road damage during transportation of construction materials;
- Create job opportunities for local people at Muse-Mandalay Railway road where the economic conditions can be reduced due to the development of railway line;
- Construct railway stations not only for passengers but also for goods;
- Not to limit the village area by the railway line;
- Not to reduce the water catchment area due to railway line (in Pyin Oo Lwin) region;
- Not to produce the electricity for railway in Myanmar;
- Not to use the require electricity for rails in local source.

Public concerns and public needs for transmission lines will be considered in those of railway alignment. Public concerns and public needs for power stations for each township are as follows:

No.	Township Names	Village Names	Public Concerns						Public Needs				
			Traffic Congestion & Road Damage	Land Acquisition	Impact on Water Sources	Blockage of Natural Drainage and Village Road	Damage to Agricultural Lands	Proper Compensation for Land Use	Job Opportunities during Construction	Improvement in Drinking Water Supply	Health Care Facilities	Allow goods to be carried on the train	Reasonable Train Fares
1.	Mandalay (Myit Nge, Pathein Gyi, Pyin Oo Lwin)	Sar Toe, Sat Kway, Myo Pyin Gyi, Da None, Nyaung Ni Pin, Nyaung Pin Zout, Myit Laung, Ashay Thar Yar Gone, Pyauk Sake Gone, Sin Boe, Pauk Chine, Min Su, Min Ywar, War Yone Pin, Than Ma Taw, Thansin Kone, Let Kaung, Tha Le Kone, Yan Kin Taung, Lane Pin, Thet Kan Kone, Kone Kaw, Pin Lein (Middle), Ashay Pin Lein, Pan U Taung	√	√	√	-	-	√	√	√	-	√	-
2.	Naung Cho	Taung Quarter, Mak Hki Nu, Kone Gyi Ma, Ngoke Ka Lay, Ong Ma Hkar, Kyein Ga Naing, Bant Bway, Hsan Ma Hse, Long Yon, Ah Nauk Kyu Inn	√	√	√	√	√	√	√	√	√	√	-
3.	Kyaukmae	Khie Tone Hone, Kone Kaw, Naung Ann, Ngon Sai, Sai Khawng, Kyaung Kone, Mway Taw	√	√	√	√	√	√	√	√	√	√	√

4.	Hsipaw	Kyin Thi, Twan Kar, Naung Eain, Swat Lann, Ho Naung, Pan Sauk, Nam Aun	√	√	√	√	√	√	√	√	√	√	√
5.	Lashio	Hkar Shi, Nawng Mun, San Pyat, Lwin Lount, Hkay Nin, Mae Han, Kaung Ma Kyan, Naung Laing, Ho Peik, Pan Hat	√	√	√	√	√	√	√	√	√	√	-
6.	Theinni	Nar Chat, Nan Maw Hate, Pan Kham, Pan Sone, Pan Phat, Nam On, Man Chat, Wane Line, Man Sar Tone, Naung Onn	√	√	√	√	√	√	√	√	√	√	√
7.	Kutkai	Nam Hpat Kar, Pang Sa Lorp, Ho Nar, Nan Khone, Nam Hpat Lun, Kawng Lein, Mhan Lone, Pa Gyo	√	√	√	√	√	√	√	√	√	√	-
8.	Muse	Nam Pang, Nan Sonn, Kaung Khan, Wane Mine, Phat Man, Man Haung, Man Hai, Man Mai	√	√	√	√	√	√	√	√	-	√	-

0 to 10 % of respondents

10 to 30 % of respondents

31 to 60 % of respondents

61 to 90 % of respondents

9.5. Further Ongoing Consultations

Further Public Consultation Meetings

After submission of EIA Report, MR will hold following PCMs.

SN	PCM	Responsibilities	Remarks
1.	1 time for Land Compensation	MR	Places where every affected people can attend
2.	Once for any project development	MR	Places where every affected people can attend
3.	Once for any conflict between communities	MR	Places where every affected people can attend

9.6. Public Disclosure Process

EIA investigation

The EIA procedure of Myanmar (2015) requires that the Project Proponent shall undertake: timely disclosure of all relevant information about the proposed Project and its likely Adverse Impacts to the public and civil society through local and national media, the website(s) of the Project or Project Proponent, at public places such as libraries and community halls, and on sign boards at the Project site visible to the public, and provide appropriate and timely explanations in press conferences and media interviews.

In accordance with the guideline,

1. Sharing of relevant information about the proposed project was done by focus group discussions which was carried out with heads of village administration office and elders from almost all of the nearest villages.

2. Information regarding the proposed project was disseminated to the local community by sharing pamphlet and brochure which have images related to the project.

3. During Public Meeting, facts regarding the proposed project and potential impacts were presented in a transparent behaviour using Power Point presentation and posters.

Submission of EIA Report

The EIA procedure of Myanmar (2015) requires that not later than fifteen (15) days after submission of the EIA Report to the Department, the Project Proponent shall disclose the EIA Report to civil society, PAPs (project affected persons) , local communities and other concerned stakeholders: (i) by means of national media (i.e. newspapers); (ii) the website(s) of the Project or Project Proponent; (iii) at public meeting places (e.g. libraries, community halls); and (iv) at the offices of the Project Proponent.

In accordance with the guideline, draft EIA report will be made publicity on MR website and all comment and response will be accompanied in the final EIA report. The accessibility of final EIA report will be announced in local newspaper.

9.7. Grievance Redress Mechanism (GRM)

A grievance redress mechanism (GRM) must be made available to parties who have grievances or are not satisfied with any part of the development of proposed project and compensation process. A grievance redress mechanism (GRM), will be established to prevent and address community concerns, and reduce risks. The GRM is also an integral part of the monitoring and information system. It aims to ensure that feedback is received, that the voices from the poor and marginalized groups are heard, and that the issues raised are resolved effectively and expeditiously. It helps ensure that vulnerable households are treated equitably.

The GRM will be accessible to diverse members of the community and stakeholders. Multiple types of media, including face-to-face meetings, written forms, telephone conversations, or e-mail, will be available for raising issues, concerns and grievances.

The GRM aims to resolve concerns promptly, in an impartial and transparent process tailored to the specific community, and at no cost and without retribution to the complainant/s. The GRM will be communicated to different stakeholders. It is intended that information about the GRM be disseminated widely in meetings and through pamphlets and brochures in Myanmar language, and ethnic languages as needed/relevant. Specifically, information will be provided about how and where to lodge complaints/grievances. Villagers will be encouraged to seek clarification or remediation through the mechanism if they have any questions or complaints/ grievances.

Grievance Redress Monitoring Indicators

Grievance redress monitoring indicators will include:

- Number of complaints/ grievances registered.
- Percentage of grievances resolved.
- Percentage of grievances resolved within stipulated time period.
- Time required to resolve complaints.
- Percentage of complainants satisfied with response and grievance redress.
- Percentage of project beneficiaries that have access to the GRM.

9.7.1. Grievance Redress Committee (GRC)

In order to address grievances, a Grievance Redress Committee (GRM) will be formed for dealing with any grievances as they arise. This will include representatives from MMQ, representatives from Village Administrative Office of nearest project sites, representatives from Land Use Department (if necessary), representatives from Township Administrative Office, and representative from Village Administrative Office and PAPs.

Role and Responsibility of GRM Team

The GRM

The proposed GRM follows the existing approach taken for managing complaints about local issues by members of the public in Myanmar. Residents' complaints or concerns are generally taken to local government (village and township level) representatives for resolution; therefore this system is integrated into the GRM.

In their capacity as implementing agencies, the MMQ will establish a Public Complaints Unit (PCU) within the PMU early during project implementation prior to the start of planning and design of sub-projects and prior to negotiations for public complains. The PCU will deal with complaints from affected people and stakeholders throughout implementation of the project. This will include nearby residents, construction workers, and will involve village and township level government.

The PMU will be the key contact point for local government representatives who may require information about the project or who have an issue they would like to discuss. The PMU will issue public notices and leaflets in local languages early in the subproject design process to

inform people and organizations within the project area of the GRM. The PCU's phone number, fax, address, email address will be disseminated.

The PMU will maintain a complaints database which indicates the household making the grievance, the nature of the issue, the date the report was received and also dealt with and the result. Dispute receipt and resolution will be reported regularly in project quarterly reports.

9.7.2. Grievance Mechanism Procedures

The procedure for handling grievances should be as follows.

(i) The affected person will file his grievance in writing, to the Village Leader. The grievance note will be signed and dated by the aggrieved person. Where the affected person is unable to write, he will obtain assistance to write the note and emboss the letter with his/her thumbprint.

(ii) The Head of Village Administrative Office or Village Leader will notify the Grievance Committee and respond within 14 days during which any meetings and discussions to be held with the aggrieved person will be conducted. If the grievance relates to valuation of assets, an independent value will be requested to revalue the assets, and this may necessitate a longer period of time. In this case, the aggrieved person will be notified by the VOC's head or Village Leader that his/her complaint is being considered.

(iii)If the aggrieved person does not receive a response or is not satisfied with the outcome within the agreed time, he/she may lodge his/her grievance to the Local General Administration Department.

Table - Township, district and state level committees for the grievance redress mechanism.

No	Committee Member	Member Role
Township Level Redress Committee (TRC)		
	A person elected from citizen	Chairperson
	A person elected from experts	Member
	A person elected from CSOs	Member
	Deputy admin officer – township level (General	Member

	Administrative Department)	
	Township level officer	Member
District Level Redress Committee (DRC)		
	A person elected from citizen	Chairperson
	A person elected from experts	Member
	A person elected from CSOs	Member
	Deputy admin officer – district level (General Administrative Department)	Member
	District level officer	Member
State Level Redress Committee (SRC)		
	The president appointed mayor as a minister	Chairperson
	In Yangon, there are four districts and each district can elect one representative	4 Members
	Appointed from government	4 Members

GRM Steps and Timeframe

Procedures and timeframes for the grievance redress process are as follows:

Stage 1: Access to GRM. If a concern arises, the affected person will resolve the issue of concern directly with the contractor, or make his/her complaint known to either the PCU directly, or through the local village or township government, whichever level of authority he/she is most comfortable with;

Stage 2: Official Complaint to PCU. If a complaint is filed at local government level, the government representative will submit an oral or written complaint to the PCU. For an oral complaint the PCU must make a written record. For each complaint, the PCU must assess its eligibility. If the complaint is not eligible, for instance it is determined that the issue is outside the scope of the project, PCU will provide a clear reply within five working days to the affected person;

Stage 3: PCU Complaint Resolution. The PCU will register the complaints informing the respective local and district government, the PMU and contractors. The PCU, with support of the social specialist and other PICs depending on the issue will take steps to investigate and resolve the issue. This may involve instructing the contractor to take corrective actions. Within seven days of the redress solution being agreed upon, the contractor should implement the redress solution and convey the outcome to the PMU;

Stage 4: Stakeholder Meeting. If no solution can be identified by the PCU or if the affected person is not satisfied with the suggested solution under Stage 3, within two weeks of the end of Stage 3, the PCU will organize a multi-stakeholder meeting under the auspices of the head of local government, where all relevant stakeholders will be invited. The meeting will result in a solution acceptable to all, and identify responsibilities and an action plan. MMQ will implement the agreed redress solution and convey the outcome to the PMU within seven working days. The invitees to this meeting will depend on the nature of the complaint. For example, if the complaints relate to health, land disputes, or labor issues, the appropriate specialist in this field will be invited to the stakeholder meeting. This may include officers from the Department of Agricultural Land Management and Statistics (land rights issues), Myanmar Chamber of Commerce (business/commercial issues), various non-government organizations (NGOs) (gender or equity issues), Ministry for Ethnic Affairs (if ethnic group household involved), Ministry of Health (health issues), Ministry of Environmental Conservation and Forestry (environmental issues), and Ministry of Labor (labor issues); and

Stage 5: District Administration Officer Resolution. If the multi-stakeholder meeting cannot resolve the problem, and the affected person remains unsatisfied, the PMU will set up a meeting with the District Administration Officer to identify a solution.

10. CONCLUSION

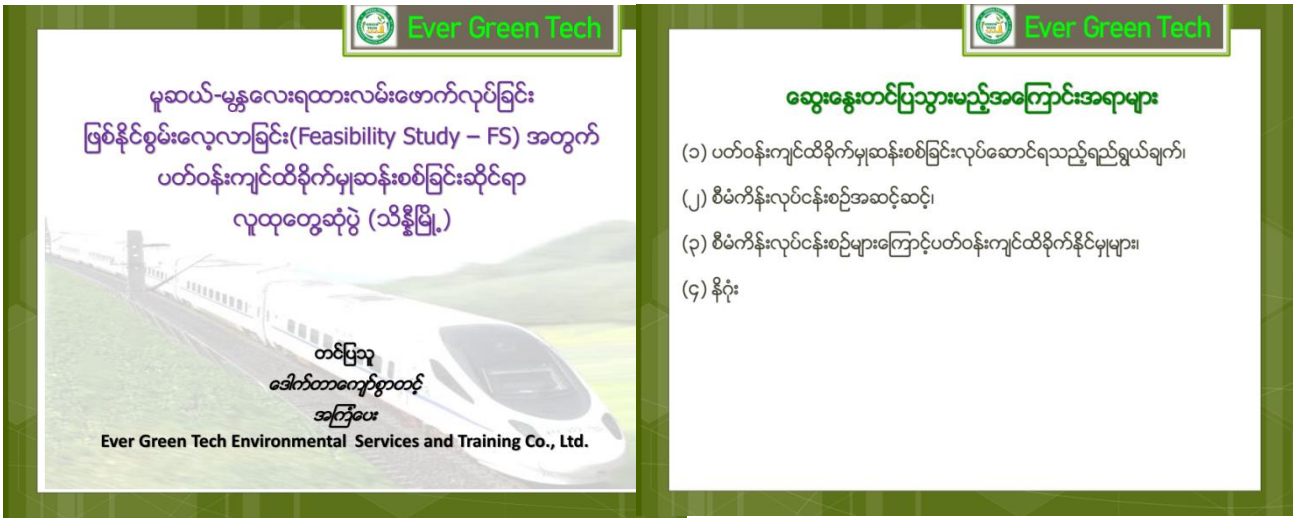
This EIA report will only consider the environmental, socio-economic and health impacts of the project related impacts and will not cover the political and economic issues correlated to the proposed project. According to the EIA study, the most public concerns is land acquisition of the railway. The most important environmental impact during construction phase will be impact on biodiversity, blockage of natural drainage system, village road, parting of agricultural land, flood and damage to natural spring. The most important environmental impacts during operation phase will be noise & vibration.

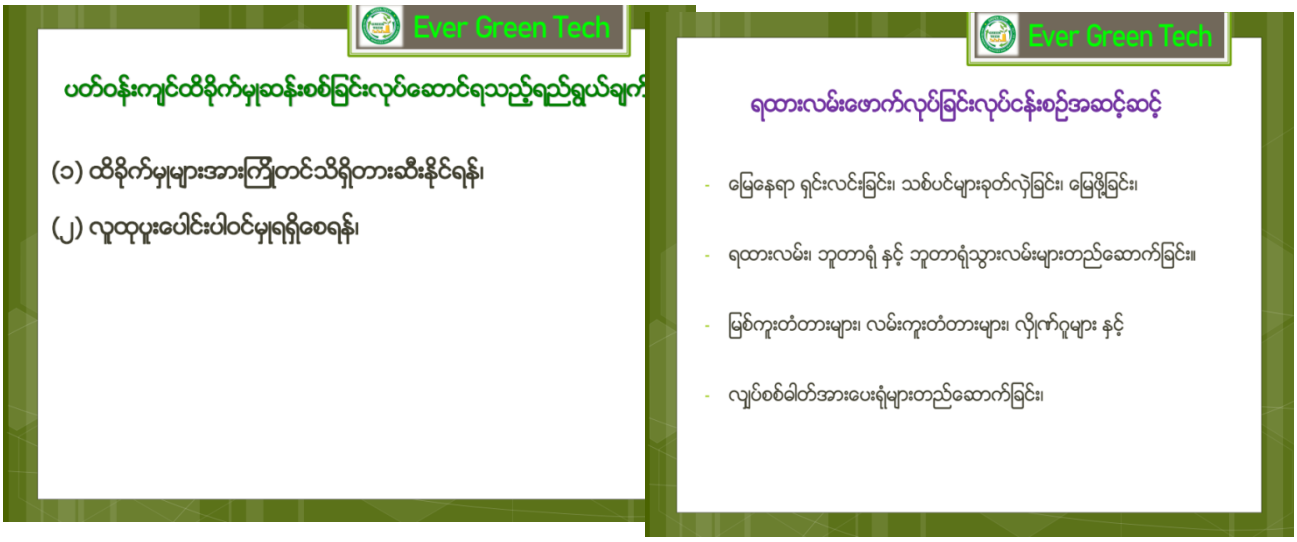
As for conclusion, all of the environmental and social impacts can be mitigated to proper mitigation measures to acceptable level described in this report. According to the nature of the environmental and social impacts for railway construction, the impact due to construction phase will have high impact than operation phase. So, the developer should have high attention for construction phase. For the land use, it is necessary to prepare comprehensive Resettlement Action Plan (RAP) and for proper compensation for land use and resettlement in the implementation stage.

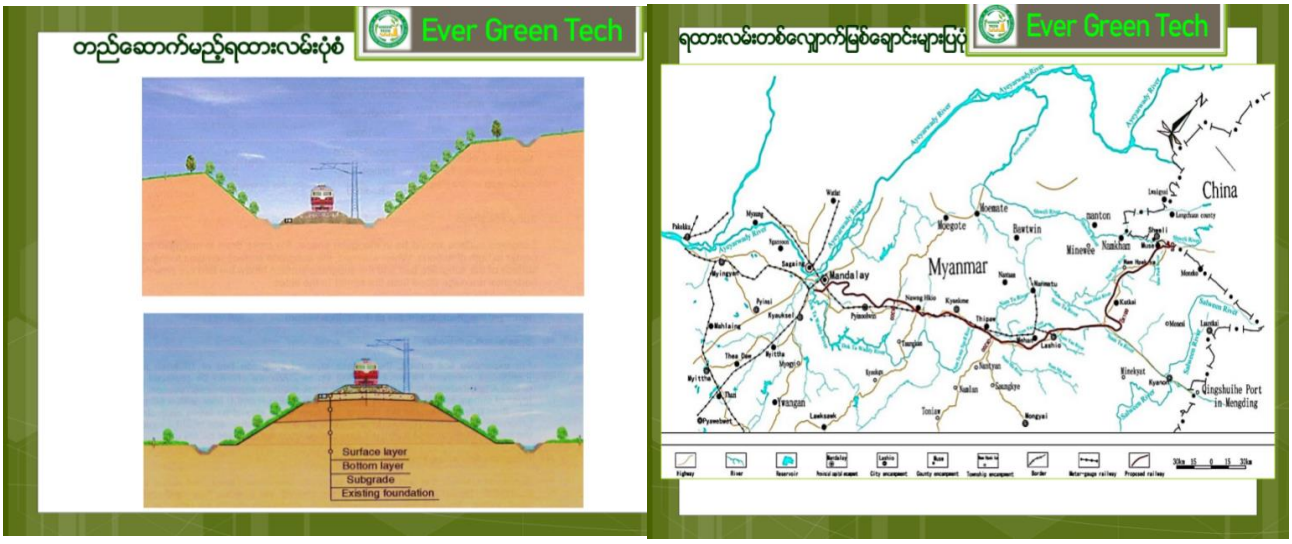
APPENDICES

APPENDIX A

EXAMPLE OF PPT PRESENTATION DURING PUBLIC MEETING

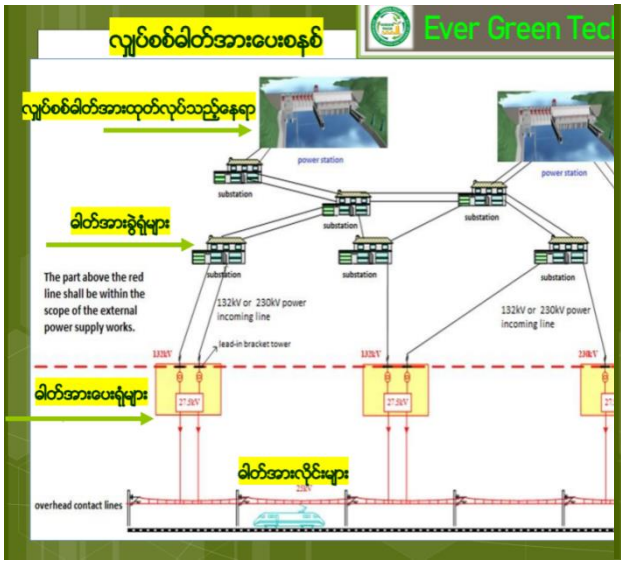


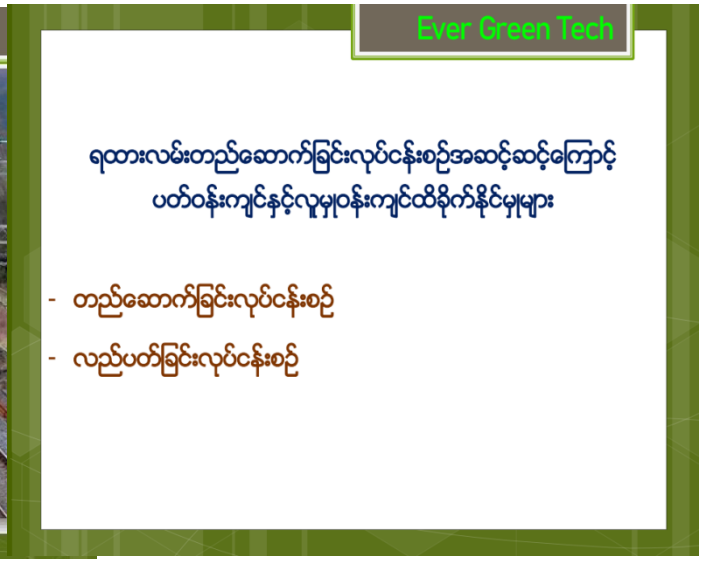




အသစ်တည်ဆောက်မည့်တံတားများ

Type	General super major , major and medium bridge		Special bridge		To
	Quantities (Nr.)	Total length (m)	Quantities (Nr.)	Total length (m)	Quantities (Nr.)
Double-track medium bridge	1	110.85			1
Single-track super major bridge	26	28531.57	1	647.31	27
Single-track major bridge	27	8173.66	1	306.8	28
Single-track medium bridge	9	747.10			9
Subtotal	65	37962.79	4	3072.39	69
Three-track major bridge	4	868.41	1	274.35	5
Double-track super major bridge	2	1101.06	2	3210.38	4
Double-track major bridge	1	142.8			1
Double-track medium bridge	3	275.66			1
Single-track super major bridge	41	44223.09	1	647.31	42
Single-track major bridge	56	17244.63	1	306.8	59
Single-track medium bridge	12	1014.13			12
Subtotal	119	64869.78	5	4438.84	124





ပတ်ဝန်းကျင်အပေါ် အဓိကထိခိုက်နိုင်မှုများ

အကြောင်းအရာ	ထိခိုက်နိုင်မှု	လျော့နည်းစေရန်နည်းလမ်း
တည်ဆောက်ခြင်းလုပ်ငန်းစဉ်		
သစ်ပင်ခုတ်လှဲခြင်း	ရာသီဥတုပြောင်းလဲ ခြင်း၊ မြေသားများပြို ကျခြင်း၊ မြေဆီလွှာ တိုက်စားခြင်း နှင့် အနယ်ပို့ချခြင်း	- သစ်တောဓရိယာများရှောင်ရှားရန် - လိုအပ်သလောက်သာခုတ်လှဲရန် - အရေးကြီးအပင်များ ရွှေ့ပြောင်းရန်
မြေမှိုခြင်း နှင့် မြေသားစုပ်ခြင်း	လယ်ယာမြေများထိခိုက်ခြင်း၊ မြစ်ချောင်းများထိခိုက်ခြင်း	- ပိုလျှံမြေအား စုပုံမည့်နေရာတွင် အသုံးပြုရန် - တူးယူစုပုံရမည်ဆိုပါက ပတ်ဝန်း ခိုက်မှုနည်းပါးသည့်နေရာတွင်စု
တံတားတည်ဆော ကခြင်း	မြစ်ချောင်းများနောက်ကျိခြင်း/ပိ တ်ဆို့ခြင်း	- မြစ်ချောင်းများထိခိုက်ခြင်းမရှိစေ စနစ်တကျတည်ဆောက်ရန်
ဥမင်လိုက်ခေါင်းတ းတည်ဆောက်ခြင်း	ဆူညံသံ နှင့် တုန်ခါမှု	- ထိန်းချုပ်ယမ်းခွဲသည့်စနစ်ကျင့်သုံ
လည်ပတ်ခြင်းလုပ်ငန်းစဉ်		
ဆူညံသံ နှင့် တုန်ခါမှု	အနီးရှိပြည်သူများ နှင့် ဇီဝမျိုးကွဲများ	- အသံကာစနစ်တပ်ဆင်ရန်/ သစ် စိုက်ပျိုးပေးရန် - ရထားနှင့် ရထားလမ်းတွင် တုန် လျော့နည်းစေသည့် စနစ်တပ်ဆ

လူမှုဝန်းကျင်အပေါ် ထိခိုက်နိုင်မှုများ

ထိခိုက်နိုင်မှု	ထိခိုက်နိုင်မည့်သူ	လျော့နည်းစေရန်နည်းလမ်း
မြေနေရာ အသုံးပြုခြင်း	စီမံကိန်းဒရိယာ အတွင်းကျရောက်သ သည့်နေရာရှိသူများ	- လိုအပ်သည့်ပမာဏအတိုင်း သာဖောက်လုပ်ရန် - အများပိုင်မြေများအားရှောင်လွှဲရန် - သင့်တော်သည့်နှစ်နာကြေးပေးရန်
ကုန်ထုတ်လမ်းများ ပိတ်ဆို့ခြင်း	လမ်းတစ်လျှောက် ကိန်နေရာရှိသူများ	- လမ်းကူးနေရာများပြုလုပ်ပေးရန်
ရေစီးကြောင်းများ/ ရေထွက်ပေါက်များ ပိတ်ဆို့ခြင်း	လမ်းတစ်လျှောက် ကိန်နေရာရှိသူများ	- ရေထွက်မြောင်းများ ပြုလုပ်ပေးရန်
ယာဉ်ကြောပိတ်ဆို့မှု	ဒေသခံပြည်သူများ	- ဝုံးကျော်လူကူးတံတား (သို့) ဝုံးကျော်ရထားလမ်းတည်ဆောက်ပေးရန်
ရထားမတော်တဆမှု	လမ်းတစ်လျှောက် ကိပြည်သူများ/ တိရစ္ဆာန်များ	- ရထားလမ်းတစ်လျှောက်ကာရံ ပေးရန်
ဒေသခံများစီးပွားရေး	ကားလမ်းဘက်ရှိ လူနေရပ်ကွက်များ နှင့် ကားဆရာများ	- မြို့မှ ဘူတာရုံသို့သွားရောက်သည့် ပို့ဆောင် ရေးဝန်ဆောင်မှုအား ဒေသခံများအားလုပ်ကိုင် ခွင့်ပေးရန် - ဘူတာရုံဘက်ခြမ်းတွင် ဆိုင်ခန်းများဖွင့်လှစ် ခွင့်ပေးရန်

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အခြားလူမှုစီးပွား ထိခိုက်နိုင်မှုများ

- လူကုန်ကူးမှုပြဿနာ
- မူးယစ်ဆေးဝါးကုန်သွယ်မှု
- နိုင်ငံခြားသားများ အလျင်အမြန်အလုံးအရင်းဖြင့်ဝင်ရောက်လာနိုင်မှု (လူမှုရေး/စီးပွားရေး/ယဉ်ကျေးမှု)

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စီမံကိန်းမှရရှိနိုင်သည့်အကျိုးကျေးဇူးများ

တည်ဆောက်ခြင်းလုပ်ငန်းစဉ်

- အလုပ်အကိုင်အခွင့်အလမ်း
- ဆောက်လုပ်ခြင်းနည်းပညာ
- မြေနေရာအသုံးပြုမှုကြောင့်မြေတန်ဖိုးပြောင်းလဲခြင်း

လည်ပတ်ခြင်းလုပ်ငန်းစဉ်

- အလုပ်အကိုင်အခွင့်အလမ်း
- စုပေါင်းသွားယာဉ်အကျိုးကျေးဇူး
- လမ်းပိတ်ဆို့ခြင်း နှင့် ယာဉ်အွန္တရာယ်လျော့ချနိုင်ခြင်း
- အချိန်တိုအတွင်းသွားလာနိုင်ခြင်း
- လမ်းပန်းဆက်သွယ်ရေးကောင်းမွန်မှုကြောင့်ဖွံ့ဖြိုးတိုးတက်မှုများ

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လူထုပူးပေါင်းပါဝင်ခြင်းလုပ်ငန်းစဉ်များ

(၁) လူနေရပ်ကွက်များအတွင်းသို့ကွင်းဆင်းဆောင်ရွက်ခြင်း၊

(၂) လူထုတွေ့ဆုံပွဲပြုလုပ်ခြင်း နှင့် သဘောထားမှတ်ချက်များခံယူခြင်း၊

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လူနေရပ်ကွက်များအတွင်းသို့ကွင်းဆင်းဆောင်ရွက်ခြင်း

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ကျင်းပပြီးစီးခဲ့သော လူထုတွေ့ဆုံပွဲဆိုင်ရာ မှတ်တမ်းဓါတ်ပုံများ (မြစ်ငယ်မြို့ - ၂၅၊ ၆၊ ၂၀၁၉)




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တွေ့ဆုံဆွေးနွေးပွဲများမှတွေ့ရှိချက်အကျဉ်းချုပ်

- လယ်မြေ၊ စိုက်ပျိုးမြေများအား ထိခိုက်မှုအနည်းဆုံးဖြစ်စေချင်
- နယ်ထိခိုက်မှုရှိပါက သင့်တော်/ထိုက်သင့်/လုံလောက် ဖော နစ်နာကြေးပေးရန်
- သစ်ပင်များခုတ်လှဲခြင်းမပြုရန် (သို့) လိုအပ်သရွေ့သာ ခုတ်ယူရန်၊
- လမ်းကူးအွန္တရာယ်အား ဂရုစိုက်ပေးရန် (ကာရံထားရှိရန်)
- သဘာဝ ရေစီးကြောင်းများနှင့် ရေထွက် များအား မပိတ်ဆို့စေရန်၊
- လူသွားလမ်းများ/ကုန်ထုတ်လမ်းများအားမပိတ်ဆို့စေရန်၊
- ကျေးရွာသွားလမ်းများ၊ ရွာချင်းဆက်လမ်းများ မပိတ်ဆို့စေလို၊
- ကျွဲနွားများ စားကျက်မြေများသို့သွားသောလမ်းများအား မပိတ်ဆို့စေလို၊
- ကားလမ်းဆုံသည့်နေရာများကို ဝုံးကျော်အဖြစ်တည်ဆောက်ပေးစေလို၊
- ရထားလမ်းဝန်းကျင်ရှိသတိပေးစာသားများကို ဒေသခံဘာသာဖြင့်ရေးသားပေးရန်၊
- ရထားလက်မှတ်ခ သင့်တင့်စေရန်၊
- ဒေသခံအလုပ်အကိုင်အခွင့်အလမ်း ဝေချာမှုရှိစေရန်
- ရွှေ့ပြောင်းလုပ်သားများကြောင့် ဒေသခံများမထိခိုက်စေရန်၊
- နိုင်ငံတော်ပိုင်သယံဇာတများဆုံးရှုံးမှုမရှိစေရန် (လမ်းခင်းကျောက်၊ သစ်တော၊ ပိုလျှံမြေသားများ၊
- တာဝန်ယူမှုတာဝန်ခံမှုရှိစေရန် (တည်ဆောက်ရေးကာလ၊ လည်ပတ်ခြင်းကာလ)

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နိဂုံး

- နိုင်ငံတော်ဖွံ့ဖြိုးတိုးတက်ရေး အတွက်စီမံကိန်းများ၊
- တာဝန်ယူမှုတာဝန်ခံမှုရှိသောစီမံကိန်း၊
- ယခင်အတွေ့အကြုံများအား သင်ခန်းစာယူရန်လိုအပ်၊
- ရင်းနှီးမြုပ်နှံသူများဘက်မှ အသာစီးယူမည့်အခြေအနေများ အား လေးဦးလေးဖက် ထိန်းသိမ်းရန်လိုအပ်
- နိုင်ငံတော်အတွက် နစ်နာမှုနည်းပါးပြီး အကျိုးရှိသည့်စီမံကိန်း

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အချိန်ပေးတက်ရောက်ဆွေးနွေးပေး
သည့်အတွက် ကျေးဇူးအထူးတင်ရှိပါသည်။

ဆက်သွယ်အကြံပြုရန်
ဒေါက်တာကျော်စွာတင့်
၀၉ - ၅၀၉၉၂၃၂
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APPENDIX B

EXAMPLE OF SUGGESTION LETTER DURING PCMs