Feasibility Study
Middle Yeywa
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ENVIRONMENTAL IMPACT ASSESSMENT

MIDDLE YEYWA HYDROPOWER PROJECT

ENVIRONMENTAL IMPACT ASSESSMENT

FINAL REPORT

AUGUST 2018

SN POWER

MIDDLE YEYWA HYDROPOWER PROJECT
ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

FINAL REPORT

AUGUST 2018

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sn power

အကျဉ်းချုပ်

မြန်မာနိုင်ငံ၊ ရှမ်းပြည်နယ်(တောင်ပိုင်း) ရှိ မြစ်ငယ်(နမ့်တူ) မြစ်ပေါ်တွင် တည်ဆောက်မည့် အလယ်ရဲရွာ ရေအားလျှပ်စစ်စီမံကိန်း အတွက် ပတ်ဝန်းကျင်ထိခိုက်မှု ဆန်းစစ်ခြင်း အစီရင်ခံစာ တင်ပြနိုင်ရန် ပြည်တွင်း၊ ပြည်ပ ပညာရှင်များပါဝင်သော အဖွဲ့များသည် SN Power ကုမ္ပဏီ၏ ကိုယ်စား ကွင်းဆင်းလေ့လာမှုများကို ၂၀၁၅ ခုနှစ်မှ ၂၀၁၈ ခုနှစ် အထိ လုပ်ဆောင်ခဲ့ကြပါသည်။

စီမံကိန်းလုပ်ဆောင်မည့် သတ်မှတ်ထားသော နေရာသည် ရှမ်းကုန်းမြေမြင့်ဒေသဖြစ်ပြီး နက်ရှိုင်းသော ကမ်းပါးစောက်များရှိကာ ကမ်းပါးစောက်၏ အထက်ဘက်မြစ်ကမ်းနား နေရာများတွင် သစ်တောများ ကျန်ရှိနေပြီး အထက်ပိုင်းတွင် စိုက်ပျိုးမြေများကိုတွေ့ရှိရပါသည်။ နက်ရှိုင်းသော ကမ်းပါးစောက်များမှ အောက်ခြေအထိ သစ်တောများ ဖုံးလွှမ်းထားသည်ကိုတွေ့ရပါသည်။ အလယ်ရဲရွာ ရေလှောင်တမံ တည်ဆောက်မှုသည် (၇၀) ကီလိုမီတာ ရှည်လျားမည်ဖြစ်ပြီး ကျဉ်းမြောင်းသော ရေလှောင်ကန် ပုံစံရှိ၍ မြစ်ကမ်းပါးစောက်သဖြင့် အောက်ခြေသစ်တောများသာ ရေနစ်မြုပ်မည် ဖြစ်ပါသည်။

သွယ်ဝိုက်ထိခိုက်နိုင်သောနယ်မြေတွင် ကျေးရွာများစွာ တည်ရှိနေကြပါသည်။ အဆိုပါ ရွာသားများ၏ အဓိကအသက်မွေးဝမ်းကျောင်းလုပ်ငန်းမှာ စိုက်ပျိုးရေးဖြစ်ပြီး ကြံစိုက်ပျိုးခြင်းနှင့် ပြောင်းစိုက်ပျိုးခြင်း တို့ သည် အဓိကဝင်ငွေရရှိသော စိုက်ပျိုးသီးနှံများ ဖြစ်ပါသည်။ မြစ်၏ညာဘက်ခြမ်းရှိ ကျေးရွာများသည် ကောင်းမွန်သော လမ်းပန်းဆက်သွယ်ရေးစနစ် ရှိပြီး၊ ဘယ်ဘက်ခြမ်းရှိ ကျေးရွာများ၏ လမ်းပန်းဆက်သွယ်ရေးစနစ်မှာ အလွန်ခက်ခဲ နိမ့်ကျလျက်ရှိနေပါသေးသည်။ သွယ်ဝိုက်ထိခိုက်နယ်မြေရှိ ကျေးရွာအားလုံးသည် လျှပ်စစ်ဓာတ်အားဖြန့်ဖြူးရေးစနစ်နှင့် ဆက်သွယ်ထားခြင်း မရှိပါ။ အဆိုပါ ရွာသားတို့၏ ဝင်ငွေပမာဏသည် မြန်မာနိုင်ငံအတွက် ကမ္ဘာ့ဘဏ်မှ သတ်မှတ်ထားသော ဝင်ငွေအဆင့်ထက် အနည်းငယ် မြင့်မားနေပါသည်။

စီမံကိန်း တည်ဆောက်ရေးကာလတွင် အဓိကထိခိုက်နိုင်သော အချက်များမှာ ကုန်းမြေပေါ်တွင် နေထိုင်သော သတ္တဝါများနှင့် ရေနေဂေဟ စနစ်များ ဖြစ်ပါသည်။ အဆိုပါထိခိုက်မှုများကို လျော့ပါးအောင် မပြုလုပ်နိုင်ပါက ဖော်ပြပါ ပတ်ဝန်းကျင်ထိခိုက်မှု နှစ်မျိုးသည် အသင့်အတင့် (အလယ်အလတ်အဆင့်) ထိခိုက် နိုင်ပါသည်။

လူများအတွက် သက်ရောက်နိုင်သော ထိခိုက်မှုများတွင် နေရာဒေသစီးပွားရေးကို မူတည်ဆုံးဖြတ်ရာ၌ အသွင်အပြင် အပြောင်းအလဲများ၊ စီးပွားရေးလုပ်ငန်းပြောင်းရွှေ့မှုများ ကြောင့် အနည်းငယ်မှ အလယ်အလတ် အဆင့် ထိခိုက်မှုများ ရှိနိုင်ပါသည်။ စီမံကိန်း တည်ဆောက်မှုကြောင့် လူအများအပြား ပြောင်းရွှေ့လာကြ၍ လူမှုဘဝလုံခြုံမှုများကို အလယ်အလတ်အဆင့် ထိခိုက်နိုင်ပါသည်။ နောက်ဆုံးအနေနှင့် ဒေသခံများ၏ သစ်တောသုံးစွဲနိုင်မှုများ၊ မြစ်ချောင်း အရင်းအမြစ်သုံးစွဲမှုများအပေါ် ထိခိုက်နိုင်မှုမှာ အနိမ့်ဆုံးအဆင့် ထိခိုက်နိုင်မှုမှ အလယ်အလတ်အဆင့် ထိခိုက်မှုများအထိ ရှိနိုင်ပါသည်။

စီမံကိန်းလည်ပတ်မှုအဆင့်တွင် ဖြစ်ပေါ်နိုင်သည့် ရေအရည်အသွေး၊ ကုန်းနေသတ္တဝါများ၊ ရေနေဂေဟစနစ်များတို့အပေါ် သက်ရောက်ထိခိုက်မှုများမှာလည်း လုံလောက်သော လျော့ပါးသက်သာစေမည့်အစီအမံများ မပြုခဲ့လျှင် အလယ်အလတ်အဆင့်ထိခိုက်မှုများ အထိ ရှိနိုင်ပါသည်။

လူသားများအတွက် ထိခိုက်မှုများတွင် စီမံကိန်းလည်ပတ်မှု အဆင့်၌ သိသာထင်ရှားစွာ မှန်းဆမှု မပြုနိုင်သော်လည်း မြစ်ချောင်းအရင်းအမြစ် သုံးစွဲမှုတွင် အနိမ့်ဆုံးအဆင့်ထိခိုက်နိုင်ပြီး၊ ဒေသခံစီးပွားရေး အခြေအနေတွင် အနည်းငယ်ကောင်းမွန်သော သက်ရောက်မှုများရှိလာနိုင်ပါသည်။

ထိခိုက်နိုင်မှုများကို လျော့ပါးစေရန် သုံးသပ်ခြင်း ကောင်းမွန်သော သက်ရောက်မှုများကို မှန်းဆခြင်း လုပ်ဆောင်ချက်များ၊ စီမံချက်များကို ချမှတ်သွားမည် ဖြစ်ပါသည်။

အဓိက ပတ်ဝန်းကျင်ထိခိုက်မှုလျော့ပါးစေရန် လုပ်ဆောင်ချက်တွင် ဒေသအစုအဖွဲ့ပိုင်သစ်တောများ ထူထောင်ခြင်း ရေနေဂေဟစနစ်နှင့် ငါးများထိန်းသိမ်းရေး အစီအစဉ်၊ ဇီဝဗေဒစနစ် ထိန်းသိမ်းရေးနှင့် ကာကွယ်စောင့်ရှောက်ခြင်း အစီအစဉ်၊ ရေလှောင်ကန်ရှင်းလင်းခြင်းနှင့် ပြန်လည်ဖြည့် တင်းခြင်း အစီအစဉ်များ ပါဝင်မည် ဖြစ်ပါသည်။

လူမှုဘဝဖူလုံရေးတွင် အကျိုးအမြတ် ခွဲဝေမှုနှင့် ထိရောက်သော လူမှုဘဝဖူလုံရေး အထောက်အပံ့များအတွက် သွယ်ဝိုက်ထိခိုက်နယ်မြေအတွင်းရှိ ကျေးရွာချင်းဆက်လမ်းများ ပိုမိုကောင်းမွန်အောင် အဆင့်မြှင့်တင်ပေးခြင်း၊ ဆက်သွယ်နိုင်သောရွာများနှင့် လမ်းများ ကောင်းမွန်အောင်ပြုပြင်ပေးခြင်းအားဖြင့် လျှပ်စစ်ဓာတ်အားဖြန့်ဖြူးရေး ကွန်ယက်နှင့် ချိတ်ဆက်ပေးနိုင်ရန် တင်ပြထားပြီး ဖြစ်ပါသည်။

တိုက်ရိုက်ထိခိုက်ခံရသူများအတွက်လည်း ပြောင်းရွှေ့ရမည်ဆိုပါက အဆောက်အဦများ ပြန်လည်တည်ဆောက်ပေးရေး၊ ဆုံးရှုံးသွားသောစိုက်ပျိုးမြေများ၊ စီးပွားရေးအတွက် အသုံးချမြေများကို လက်ရှိပေါက်ဈေး (အချက်အလက်များ ကောက်ယူနေစဉ်ကာလ) တွက်ချက် သတ်မှတ် လျော်ကြေးပေးသွားမည် ဖြစ်ပါ သည်။

ဆန်းစစ်လေ့လာမှုများပေါ်အခြေခံပြီး ခြုံငုံသုံးသပ်ရမည်ဆိုလျှင် အလယ်ရဲရွာ ရေအားလျှပ်စစ်စီမံကိန်း တည်ဆောက်ရေး လုပ်ငန်းစဉ်သည် ပတ်ဝန်းကျင်နှင့် လူမှုဘဝထိခိုက်မှုများအပေါ် အလယ်အလတ်အဆင့်ထိခိုက်နိုင်ချေရှိသည်ကို တွေ့ရပြီး အဆိုပါထိခိုက်မှုများလျှော့ချနိုင်သည်ကိုလည်း လေ့လာတွေ့ရှိရပါသည်။ လူမှုဘဝထိခိုက်မှုပိုင်းတွင် အချိန်နှင့် တစ်ပြေးညီ ထိခိုက်မှုလျှော့ချနိုင်သည့် လုပ်ဆောင်ချက်များကို လေ့လာတွေ့ရှိသော အချက်အလက်နှင့် လိုအပ်မည့်လုပ်ငန်းစဉ်များအရ အကောင်အထည်ဖော် လုပ်ဆောင်နိုင်မည် ဖြစ်ပါသည်။

၁။ နိဒါန်း

၁.၁. အခြေခံအကြောင်း

SN Power ကုမ္ပဏီသည် ၂၀၁၄ ခုနှစ် ဇူလိုင် ၂ ရက်နေ့တွင် ပြည်ထောင်စုသမ္မတမြန်မာနိုင်ငံ၊ လျှပ်စစ်စွမ်းအား ဝန်ကြီးဌာနနှင့် နားလည်မှုစာချွန်လွှာ ရေးထိုးခဲ့ပြီး အလယ်ရဲရွာ ရေအားလျှပ်စစ်

တည်ဆောက်ရေး စီမံကိန်းအကောင်အထည်ဖော်မည့် နေရာဖြစ်သော ရှမ်းပြည်နယ် (တောင်ပိုင်း) ရှိ မြစ်ငယ်မြစ်(နမ့်တူမြစ်) တွင် လေ့လာမှုများကို စတင်လုပ်ဆောင်ခဲ့ပါသည်။

အဆိုပြု စီမံကိန်းသည် လည်ပတ်နေပြီဖြစ်သော မြစ်အောက်ဖက်ရှိ ရဲရွာ ရေလှောင်တမံ နှင့် တည်ဆောက်ဆဲ အထက်ရဲရွာ စီမံကိန်းများ၏ကြားတွင် တည်ရှိပါသည်။ လေ့လာသုံးသပ်ခဲ့သည့် အဆိုပြု လျာထားတမံနေရာ(၇)နေရာများအနက်မှ ရေလှောင်တမံ အမြင့် (၁၆၀) မီတာ တည်ဆောက်ပြီး၊ ရေလှောင်ကန်အရှည် (၇၀)ကီလိုမီတာရှည်သော ဆည်ကို တည်ဆောက် ရန် ဆုံးဖြတ်ခဲ့ပါသည်။

ဖြစ်မြောက်နိုင်စွမ်း ကြိုတင်လေ့လာခြင်းကို ၂၀၁၅ ခုနှစ် ဩဂုတ်လတွင် အကြိုစူးစမ်းလေ့လာမှုများနှင့် အကြိုအင်ဂျင်နီယာနည်းပညာပိုင်းဆိုင်ရာ တွက်ချက်လေ့လာမှုပုံစံများကို အခြေခံပြီး အဆုံးသတ်ခဲ့ပါသည်။ SN Power သည် နောက်ပိုင်းတွင် အသေးစိတ် အင်ဂျင်နီယာနည်းပညာပိုင်းဆိုင်ရာ စူးစမ်းလေ့လာမှုများ နှင့် ပတ်ဝန်းကျင်ထိခိုက်ဆန်းစစ်ချက် လေ့လာမှုကို လုပ်ဆောင်ရန်ဆုံးဖြတ်ခဲ့ ပါသည်။

၁.၂. စီမံကိန်းအကောင်အထည်ဖော်သူ

SN Power သည် နော်ဝေနိုင်ငံအခြေစိုက် အပြည်ပြည်ဆိုင်ရာ ပြန်လည်ပြည့်ဖြိုးမြဲ စွမ်းအင်ကုမ္ပဏီ အဖြစ် စျေးကွက်လိုအပ်ချက်အရ ထွက်ပေါ်လာပါသည်။ စီးပွားရေးချိုင့်သုံးသပ်ချက်အရ ဖွံ့ဖြိုးရန်၊ တည်ဆောက်ရန်၊ ဆည်းပူးရန် ပိုင်ဆိုင်လုပ်ဆောင်ရန် စဉ်ဆက်မပြတ် ဖွံ့ဖြိုးတိုးတက်သော ပြန်လည် ပြည့်ဖြိုးမြဲစွမ်းအင်စီမံကိန်းများ၊ အဓိကအားဖြင့် ရေအားလျှပ်စစ်လုပ်ငန်းများ ကို ဆာဟာရတောင်ပိုင်းဒေသများ၊ အာဖရိက၊ အမေရိကအလယ်ပိုင်းနှင့် အရှေ့တောင်အာရှ ဒေသများတွင် လုပ်ဆောင်နေပါသည်။

၂။ ပတ်ဝန်းကျင်ထိခိုက်မှုဆန်းစစ်ခြင်းလေ့လာမှု

ပတ်ဝန်းကျင်နှင့် လူမှုဘဝ အချက်အလက်များ လေ့လာခြင်းလုပ်ငန်းကို ၂၀၁၅ ခုနှစ် မှ ၂၀၁၈ ခုနှစ် အထိ လုပ်ဆောင်ခဲ့ပါသည်။ ဖြစ်နိုင်ခြေလေ့လာခြင်း အဆင့် ၂၀၁၅ တွင် SN Power သည် MIID (မြန်မာနိုင်ငံ ဘက်စုံဖွံ့ဖြိုးရေး သုတေသနအဖွဲ့)၊ NEPS (ပြည်တွင်း အင်ဂျင်နီယာနှင့် စီမံကိန်းများ လုပ်ဆောင်မှုအဖွဲ့) များနှင့် အတွေ့အကြုံ ရင့်ကျက်သော အပြည်ပြည်ဆိုင်ရာ အကြံပေး (၂) ဦးနှင့်အတူ ပူးပေါင်း လုပ်ဆောင်ခဲ့ ပါသည်။

၂၀၁၇ ခုနှစ် မတ်လတွင် SN Power သည် နော်ဝေအခြေစိုက် Multiconsult အဖွဲ့နှင့် စာချုပ်ချုပ်ဆိုပြီး ပတ်ဝန်းကျင် ထိခိုက်မှု ဆန်းစစ်ခြင်း အသေးစိတ်လုပ်ငန်းများ ကို အလယ်ရဲရွာစီမံကိန်းဧရိယာတွင် လုပ်ဆောင်ခဲ့ပါသည်။ Multiconsult အဖွဲ့သည် ရှေးဦး စီမံကိန်းနေရာ လေ့လာခြင်းကို ၂၀၁၇ ခုနှစ် ဧပြီလတွင် လုပ်ဆောင်၍ အစီရင်ခံတင်ပြချက် (report) ကို ၂၀၁၇ အောက်တိုဘာလတွင် တင်ပြခဲ့ပြီး အချို့အချက်အလက်များကို နိုင်ငံတွင်းနှင့် အပြည်ပြည်ဆိုင်ရာ လိုအပ်ချက်များနှင့် အညီ တင်ပြခဲ့ပါသည်။ ထပ်မံလိုအပ်ချက်အရ လေ့လာရေး လုပ်ငန်းစဉ်ကို

Multiconsult နှင့် MIID တို့ ပူးပေါင်း၍ ၂၀၁၇ ခုနှစ် အောက်တိုဘာတွင် လုပ်ဆောင်ခဲ့ ပါသည်။ (လူမှုဘဝလေ့လာရေးကို အဓိက လက်ဝဲဘက်ခြမ်းရွာများ) ၂၀၁၇ ခုနှစ် ဒီဇင်ဘာတွင် ကင်မရာထောင်ချောက်များ တပ်ဆင်ခြင်း၊ လိုအပ်သော သဘာဝပေါက်ပင် နေရာများ လေ့လာခြင်း၊ သဘာဝတောတောင်များ၊ ရေနေသတ္တဝါများကို စမ်းသပ်လေ့လာခြင်း လုပ်ငန်းများ လုပ်ဆောင်ခဲ့ပါသည်။

၃။ စီမံကိန်းရှင်းလင်းချက်

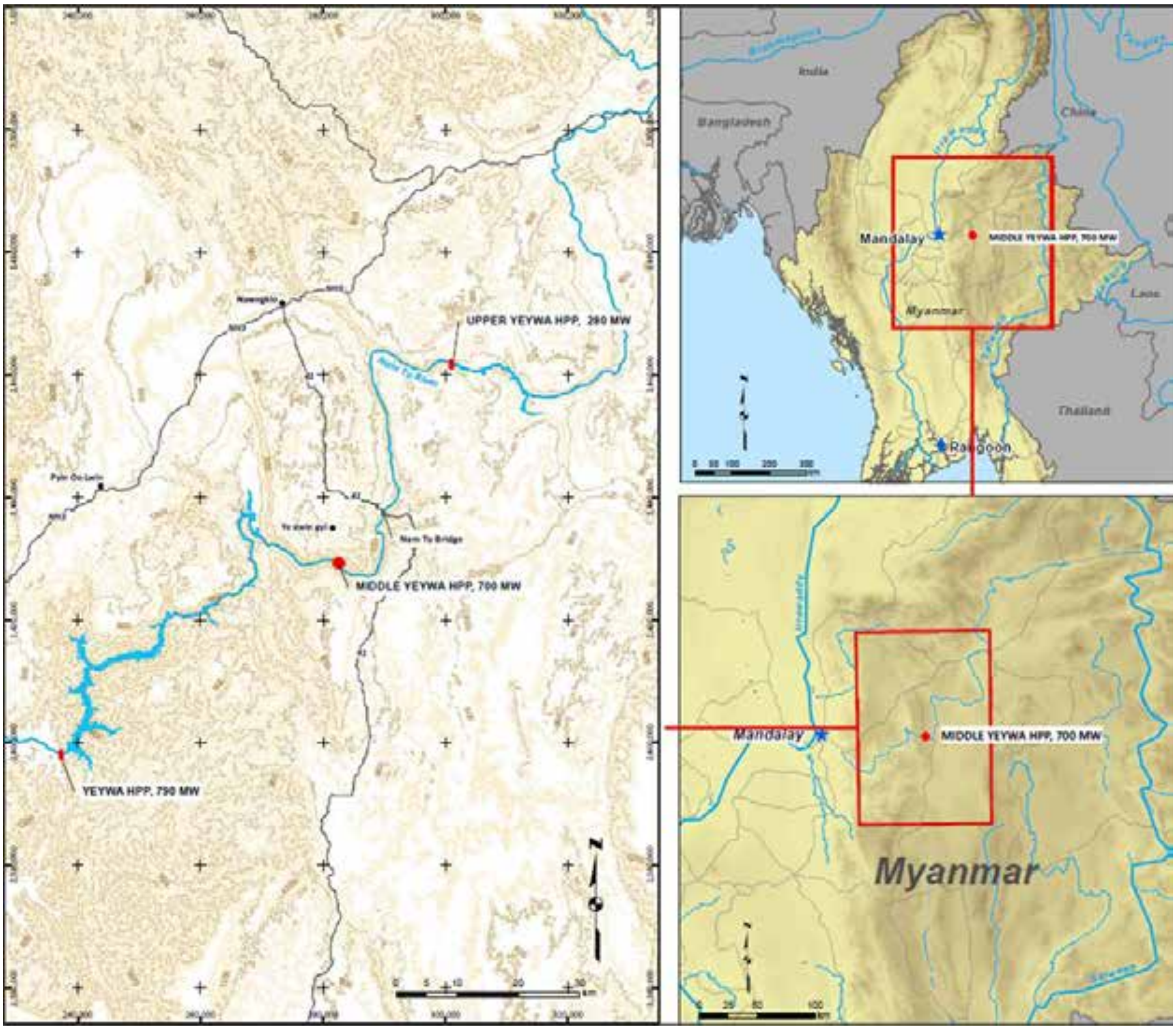
၃.၁. တည်နေရာ

စီမံကိန်းဒေသသည် ရှမ်းပြည်နယ်တွင် ရှိပြီး၊ မန္တလေးမြို့ အရှေ့ဘက် ၈၀ ကီလိုမီတာ၊ ပြင်ဦးလွင်မြို့ အရှေ့ဘက် ၅၅ ကီလိုမီတာဝေးကွာပြီး ဧရာဝတီ၏ မြစ်လက်တက် မြစ်ငယ်မြစ်ပေါ်တွင် တည်ရှိပါသည်။ (မြေပုံတွင် ကြည့်နိုင်ပါသည်)

မြစ်ငယ်မြစ်သည် အလွန်နက်ရှိုင်းစွာ ထိုးဖောက်၍ ပုံသဏ္ဍာန် ချောက်နက်ကြီးများကို ဖန်တီးပြီး မြင့်မား မတ်စောက်သော ကမ်းပါးစောင်းများရှိခြင်းကြောင့် ကျဉ်းမြောင်းသော ရေလှောင်ကန်နှင့် အလွန်အကျွံ နည်းပါးသော သက်ရှိ ဆုံးရှုံးမှုများသာ ဖြစ်နိုင်ပါသည်။ ရေလှောင်တမံနှင့် ဆက်စပ် အဆောက်အဦးများ၊ ဓာတ်အားထုတ်လုပ်ရေးစက်ရုံများ သည် နောင်ချို နှင့်ရပ်စောက်မြို့နယ်များတွင် တည်ရှိမည်ဖြစ်ပြီး၊ ၇၀ ကီလိုမီတာ ရှည်လျားသော ရေလှောင်ကန်သည် ကျောက်မဲမြို့နယ်တွင် တည်ဆောက်နေသော အထက်ရဲရွာ အခြေသို့ ရောက်ရှိမည် ဖြစ်ပါသည်။

၃.၂. ယေဘုယျဖွဲ့စည်းပုံ

စီမံကိန်းမှ အဓိက ရွေးချယ်ထားသည့် နေရာသည် အကောင်းဆုံးသော ရေလှောင်တမံ နေရာကို မူတည်ကာ လက်ရှိ ရဲရွာရေလှောင်ကန်ကန်ရေပြည့်အမှတ် (၁၈၅ မီတာ ပင်လယ်ရေမျက်နှာပြင် အထက်) နှင့် အထက်ရဲရွာ စီမံကိန်း (၃၂၃ မီတာ ပင်လယ်ရေမျက်နှာပြင် အထက်) (ရေရောက်ရှိမှု အဆုံးနေရာ) နေရာတွင် သတ်မှတ်ထားပါသည်။ ရေကာတာနေရာသည် မြစ်ငယ်မြစ်၏ အကျဉ်းဆုံး ရေတံခွန်ငယ်များ တည်ရှိရာ အခြေတွင် ရှိမှာဖြစ်ပြီး၊ လျှပ်စစ်ဓာတ်အားပေးစက်ရုံသည် မြေအောက်တွင်ရှိမှာမည်ဖြစ်၍ ရေလှောင်တမံ ၏ အောက်ဘက်ပိုင်း ၁၅၀ -၂၀၀ မီတာ အကွာခန့်တွင် တည်ရှိမည် ဖြစ်ပါသည်။



Project location (Source: Pöyry 2015). **(စီမံကိန်း တည်နေရာ)**

၃.၃ စီမံကိန်းအစိတ်အပိုင်းများ

၃.၃.၁ ရေလှောင်တမံ

ရေလှောင်တမံ ပုံစံသည် မျဉ်းကွေး ပုံစံဖြစ်မည်ဖြစ်ပြီး အမြင့်ဆုံး အခြေခံအမှတ်အားဖြင့် ၁၆၀ မီတာနှင့် ထိပ်ဖက် အကျယ် ၃၃၀ မီတာ အရှည်ရှိပါသည်။ သတ်မှတ်ထားသောရေလှောင်တမံမှာ အလယ်တွင် ရှိနေသော ထိပ်ပိုင်းရေပိုလွှဲ (၂) ခုနှင့် ဘယ်ဘက်ခြမ်း ရေပိုလွှဲ(၃) ခုပါ ရှိမည်ဖြစ်ပါသည်။ ရေပိုလွှဲမှ ထွက်ရှိလာမည့် ရေအားလုံးသည် ရေလွှဲလမ်းကြောင်းမှ တဆင့် ရေစုကန်သို့ ရောက်ရှိအဆုံးသတ်မည် ဖြစ်ပါသည်။

၃.၃.၂ လျှပ်စစ်ဓာတ်အားပေးစက်ရုံ

မြေအောက်လျှပ်စစ်ဓာတ်အားပေးစက်ရုံ ကွန်ရက်သည် ဓာတ်အားထုတ်လုပ်ရေး ရေယူလိုဏ်ခေါင်း နှင့် လျှပ်စစ်ထုတ်လုပ်ရေးအတွက်လိုအပ်သော ထရမ်စဖေါ်မာ လိုဏ်ဂူများ

ပါဝင်မည်ဖြစ်ပါသည်။ လိုအပ်သော ကားသွားလာနိုင်မည့်ပြွန်များ၊ ဆက်သွယ်ရေးပြွန်များ ပါရှိမည်ဖြစ်ပါသည်။ ပါဝါလှိုင်ဂူ (Power Tunnel) တွင် ၁၈၃.၇၅ MW ထုတ်သော ဒေါင်လိုက်ဝန်ရိုးပါ Francis တာဘိုင်စက် ၄ လုံးတပ်ဆင်မည်ဖြစ်ပြီး စုစုပေါင်း ၇၃၅ MW ရှိမည်ဖြစ်ပါသည်။

၃.၃.၃ ရေလှောင်ကန်

အလယ်ရဲရွာရေလှောင်တမံသည် ၇၀ ကီလိုမီတာ ရှည်လျားပြီး ကျဉ်းမြောင်းသော ရေလှောင်ကန် ဖြစ်ပေါ်စေမည်ဖြစ်၍ ၁၃၅-၁၄၅ မီတာ တမံ အထက်နားတွင်သာ ရေနက်မည်ဖြစ်ပြီး တဖြည်းဖြည်းရေတိမ်သွားကာ ရေလှောင်ကန် အဆုံးနေရာသို့ ရောက်ရှိမည် ဖြစ်ပါသည်။ ကန်ရေပြည့်မှတ်သည် (၃၁၇ မီတာ ပင်လယ်ရေမျက်နှာပြင် အထက်)ရှိပြီး၊ ရေလှောင်ထားသော ပမာဏမှာ ၁၁ စတုရန်းကီလိုမီတာရှိကာ စုစုပေါင်း volume ပမာဏမှာ ကုဗမီတာ သန်းပေါင်း ၄၀၀ ³ (400 million m^3) ရှိမည်ဖြစ်ပါသည်။

၃.၃.၄ ဆက်သွယ်ရေးလမ်းများ

လက်ရှိ မြေလမ်းများကို အဆင့်မြှင့်တင်ပြီး ၃.၈ ကီလိုမီတာ အရှည် ရှိသော လမ်းသစ်ဖောက်လုပ်၍ ချောက်နက်ထဲအထိ တမံအောက်ခြေသို့ အလျင်အမြန်ရောက်ရှိနိုင်ရန် အတွက် ဖောက်လုပ်မည် ဖြစ်ပါသည်။

၄. သက်ရောက်နိုင်သောနေရာ

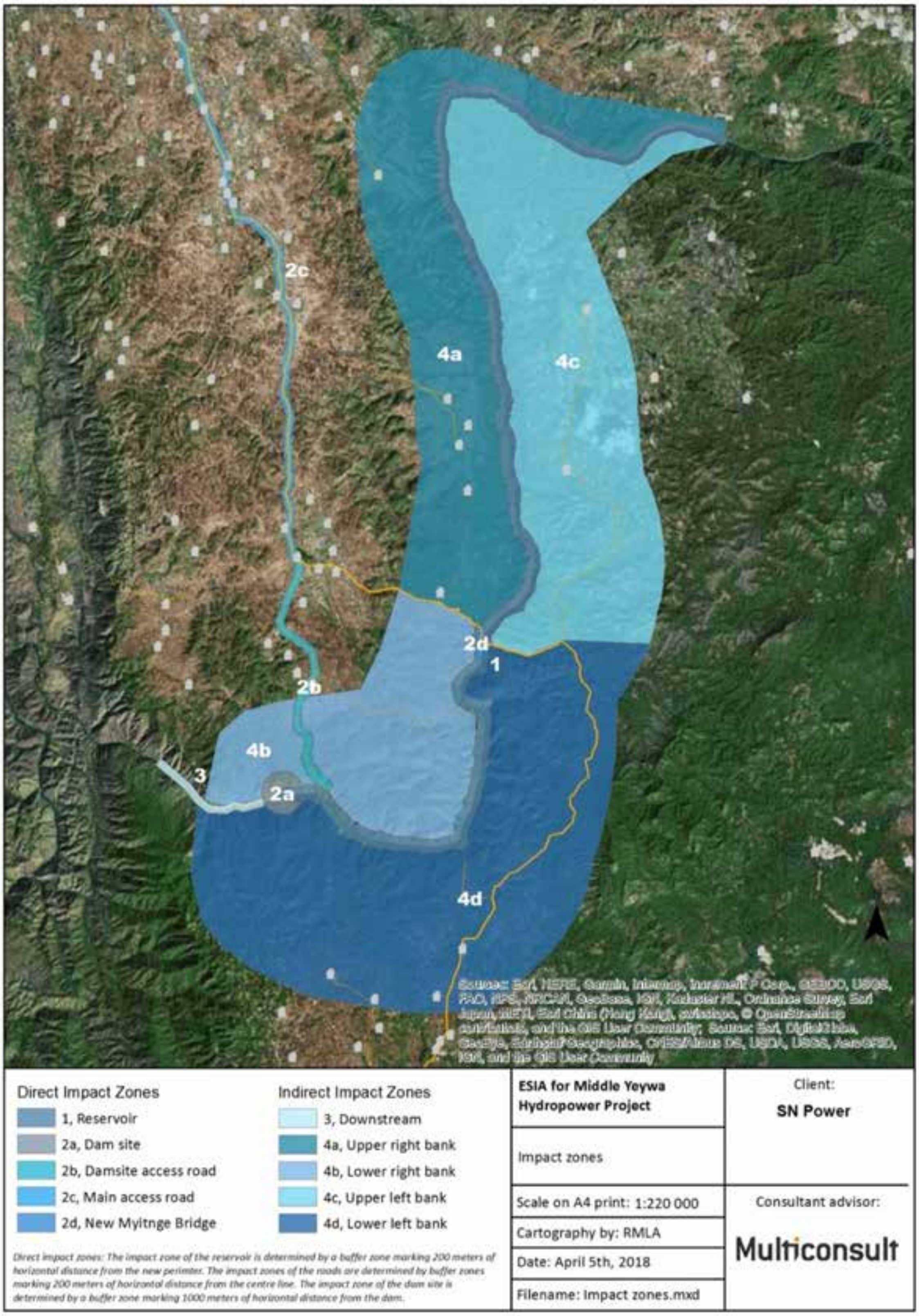
ပတ်ဝန်းကျင်ထိခိုက်မှုများ ဖြစ်ပေါ်နိုင်သော နေရာများကို ကြိုတင်လေ့လာခြင်း ရလဒ်များပေါ်မူတည်၍ သတ်မှတ်ခဲ့ပါသည်။ တိုက်ရိုက်ထိခိုက်မှု သက်ရောက်နိုင်သော နေရာနှင့် သွယ်ဝိုက်ထိခိုက်မှု သက်ရောက်နိုင်သော နေရာဟူ၍ ခွဲခြားထားပါသည်။ ထိုနေရာများကို ပေါင်း၍ စီမံကိန်း ဧရိယာ တစ်ခု သတ်မှတ်ပါသည်။ (အောက်ပါပုံတွင် ကြည့်နိုင်ပါသည်။)

၄.၁ တိုက်ရိုက်သက်ရောက်နယ်မြေ

တိုက်ရိုက်သက်ရောက်နယ်မြေသည် လုပ်ဆောင်မှုများတည်ဆောက်မှု များ၊ လည်ပတ်မှုများကြောင့် တိုက်ရိုက်ထိခိုက် သက်ရောက်နိုင်သော နေရာများကို သတ်မှတ်ပါသည်။ ထိုနယ်မြေတွင် စီမံကိန်း အစိတ်အပိုင်းများ တည်ရှိရာနေရာနှင့် ကြားခံ နေရာ ၂၀၀ မီတာ အပါအဝင်နယ်မြေတို့ပါဝင်ပါမည်။

၄.၂ သွယ်ဝိုက်ထိခိုက်နယ်မြေ

ထိုနယ်မြေသည် တိုက်ရိုက်သက်ရောက်နယ်မြေ၏ အပြင်ဘက်နေရာဖြစ်ပြီး တည်ဆောက်မှုများ၊ ဓာတ်အားပေးစက်ရုံလည်ပတ်မှုများကြောင့် ရုပ်သဘာဝများ၊ သက်ရှိများ၊ လူတို့၏ဝန်းကျင်နှင့် အခြားထိခိုက်မှုများကို ဖြစ်ပေါ်စေခြင်း၊ ဥပမာ- ရေအရည်အသွေးပြောင်းလဲမှု၊ လေထုညစ်ညမ်းမှုအဆင့်၊ သားရဲ တိရစ္ဆာန်များနေရာ ပျက်စီးခြင်းနှင့် ငါးတို့နေရာ ပြောင်းရွှေ့သွားလာမှု ပျက်ပြားခြင်း၊ လူတို့၏ စားဝတ်နေရေးပြောင်းလဲခြင်းနှင့် နီးစပ်ရာ လူ့အဖွဲ့အစည်း၏ ယဉ်ကျေးမှု အလေ့အထများ ပြောင်းလဲသွားခြင်းတို့ ပါဝင်မည်ဖြစ်ပါသည်။



Direct and indirect impact zone of the Middle Yeywa HPP.(အလယ်ရဲရွာ စီမံကိန်း တည်ဆောက်ရေး လုပ်ငန်းစဉ်၏ တိုက်ရိုက်နှင့်သွယ်ဝိုက် ထိခိုက်သက်ရောက်နိုင်သော နယ်မြေ)

၅ အခြေခံအခြေအနေများ

၅.၁ ရုပ်ပတ်ဝန်းကျင်

၅.၁.၁ မြေမျက်နှာသွင်ပြင်နှင့် ဘူမိရုပ်သွင်

စီမံကိန်းဧရိယာ ၇၀ ကီလိုတစ်လျှောက်တွင် ရှမ်းကုန်းမြင့်အလွန်နက်သော ချိုင့်ဝှမ်းကြီးဖြစ် ၍ ဒေါင်လိုက်နီးပါး ကမ်းပါးစောက်များနှင့် တောင်ကြား ကြီးများသဖွယ် မြေမျက်နှာသွင်ပြင်ရှိပါသည်။ စီမံကိန်းဧရိယာ တစ်လျှောက်တွင် ဘေးမှဝင်ရောက် စီးဝင်သော မြစ်လက်တက်များ၊ ချောင်းများ မြောက်များစွာ ရှိပြီး ဂုတ်ထိပ်ချောင်း၊ နန်းကမ်ချောင်း (ရေလှောင်ကန်တည်ဆောက်ရန်ရှိ) တို့ သည် ရေတံခွန်အဖြစ် ဖြစ်ပေါ်ပြီး နမ္မတူမြစ်ထဲသို့ စီးဝင်ပါသည်။

ရှမ်းကုန်းမြင့်သည် ဆက်တိုက်ရှိသော ဒိုလိုနိုက်ကျောက်များ၊ ထုံးကျောက်များ (အုပ်စု) သို့ ရှမ်းဒိုလိုနိုက် အုပ်စုတို့ဖြင့် ဖွဲ့စည်းထားပါသည်။

၅.၁.၂ ရာသီဥတု

မြန်မာနိုင်ငံသည် များသောအားဖြင့် အပူပိုင်း ရာသီဥတုဖြစ်ပြီး စုစုပေါင်း သုံးရာသီ ရှိပါသည်။ ဥပမာ- မုတ်သုံ (သို့) မိုးရာသီ (မေ - အောက်တိုဘာ) အေးသော ရာသီ (နိုဝင်ဘာ - ဖေဖော်ဝါရီ) နှင့် ပူသော နွေရာသီ (မတ် - ဧပြီ) တို့ ဖြစ်ပါသည်။ မြစ်ငယ် မြစ်ဝှမ်းဒေသသည် မိုးအများဆုံးလများမှာ ဒီဇင်ဘာမှ မတ်လ အထိဖြစ်ပါသည်။ ပျှမ်းမျှတစ်နှစ်တာ မိုးရေချိန်မှာ ၁၀၀၀ မီလီမီတာကို အရှေ့တောင်ပိုင်းတွင်တွေ့ရပြီး ၁၈၀၀ မီလီမီတာကို အနောက်မြောက်ပိုင်းတွင် တွေ့ရပါသည်။ နွေရာသီ နေ့စဉ် ပျှမ်းမျှ အပူချိန် ၂၇ ဒီဂရီ စင်တီဂရိတ် ဖြစ်ပြီး အအေးဆုံးလ ဇန်နဝါရီ၏ နေ့စဉ် ပျှမ်းမျှ အပူချိန်သည် ၁၇ ဒီဂရီ စင်တီဂရိတ် ဖြစ်သည်။

၅.၁.၃ ရေဗေဒနှင့် ရေအရည်အသွေး

မြစ်ငယ်မြစ်သည် မူလအစ ဧရာဝတီမြစ်ဘက်ကမ်း မြစ်လက်တက်ဖြစ်ပါသည်။ စုစုပေါင်း ရေစီးဆင်း ဧရိယာမှာ ၃၄၈၀၀ စတုရန်းကီလိုမီတာ နှင့် ၅၃၀ ကီလိုမီတာ ရှည်လျားပါသည်။ အလယ်ရဲရွာ၏ ရေစုဧရိယာမှာ ၂၅၅၁၈ ကီလိုမီတာ စကွဲယားရှိပါသည်။ စီးဆင်းမှုသည် ရာသီဥတု ပေါ်မူတည် နေပြီးအားအနည်းဆုံး စီးဆင်းမှုသည် ၁၀၀ - ၁၅၀ ကျူစက် (m^3/s) ကို မတ်လမှ မေလ တွင် တွေ့ရပြီး အများဆုံးစီးဆင်းမှုကို ၉၅၀ ကျူစက် (m^3/s) ကို ဩဂုတ်လမှ စက်တင်ဘာလအထိ တွေ့နိုင်ပါသည်။ ၈ နှစ်တာ ပျှမ်းမျှ စီးဆင်းနှုန်းသည် ၄၅၈ ကျူစက် (m^3/s) ဖြစ်ပါသည်။

စီမံကိန်းနယ်မြေအတွင်း ရေအရည်အသွေးသည် ရေနေသတ္တဝါများ ရှင်သန်နိုင်သော အနေ အထားရှိ ပါသည်။ အောက်စီဂျင်စုပ်ယူမှု ပမာဏသည် ၄.၇ မှ ၈.၄ မီလီဂရမ်ပါလီတာရှိပြီး မိုးရာသီ ရေစီးရေလာ ကောင်းချိန်တွင် အမြင့်ဆုံးဖြစ်ပါသည်။ အနယ်အနစ်ပါဝင်မှု နှုန်းသည် အမြင့်ဆုံး စီးဆင်းသည့် မိုးရာသီတွင် အမြင့်ဆုံးဖြစ်၍ ၆၉ မှ ၁၁၅ NTU ဖြစ်ပြီး စွတ်စိုသော ရာသီ၊ ပူသောရာသီတွင်

၅၀ NTU ဖြစ်သည်။ ၂၀ NTU ကို အေး၍ ခြောက်သွေ့သော ရာသီတွင် တွေ့ရသည်။ (NTU = Nephelometric Turbidity Unit)

၅.၂ ဇီဝပတ်ဝန်းကျင်

၅.၂.၁ အရေးကြီး ဇီဝမျိုးစုံမျိုးကွဲနေရာနှင့် ကာကွယ်ထားသောနေရာ

ကာကွယ်တောများသည် စီမံကိန်းနှင့် တိုက်ရိုက်(သို့မဟုတ်)သွယ်ဝိုက်ဆက်နွယ်ခြင်း ရှိ၊ မရှိ မသေချာသေးပါ။ အနီးဆုံး ကာကွယ်တော ဖြစ်သည့် ကမ္ဘာ့သတင်းအချက်အလက်များအရ ပြင်ဦးလွင် သားရိုင်းတိရိစ္ဆာန် ကာကွယ် တောသည် ရေကာတာ၏ ၃၅ ကီလိုမီတာ အနောက်ဘက်တွင် တည်ရှိပါသည်။ မြစ်ကမ်းဘက် ခြမ်းတွင် သစ်တောထိန်းသိမ်းတောများ ရှိ၊ မရှိသည်မှာ မသေချာသေးပါ။

အနီးစပ်ဆုံး သိရှိချက်အရ မယ်ဟုန်-ဒုဌဝတီမြစ် အရေးကြီး ဇီဝမျိုးစုံမျိုးကွဲနေရာ တွေ့ရပါသည်။ ဆိုက်ဧရိယာသည် ပြင်ဦးလွင်ကာကွယ်တောမှ စီမံကိန်း ရေလှောင်တမံဧရိယာအထိ ဖြစ်ပါသည်။ ထိုဒေသသည် တရားဝင်ကာကွယ်ထားသောအဆင့်ရှိသည့်ဒေသ ဖြစ်သည်ကိုတွေ့ရပါသည်။ အပြည်ပြည်ဆိုင်ရာ ငှက်ဖုံဟု သတ်မှတ်ထားပါသည်။ အဘယ်ကြောင့် ဆိုသော် ရှားပါး ဒေါင်းမျိုးစိတ်များတွေ့ရှိသောကြောင့် အပြည်ပြည်ဆိုင်ရာ ငှက်အဖွဲ့က သတ်မှတ်ထားခြင်းဖြစ်ပါသည်။ ထိုမျိုးစိတ်သည် ကင်မရာထောင်ချောက် များမှ တိုက်ရိုက်သက်ရောက်နေရာများတွင် တွေ့ရပါသည်။ သို့သော်လည်း ထိုမျိုးစိတ်များ၏ အဓိက ကျက်စားရာ နေရာများတော့ မဟုတ်ပါ။

၅.၂.၂ သဘာဝပေါက်ပင်များ

သဘာဝပေါက်ပင်အမျိုးအစား၊ တိုက်ရိုက်သက်ရောက်နေရာနှင့် သွယ်ဝိုက်သက်ရောက်နေရာ တို့၏ သစ်တောအမျိုးအစားသည် အဓိကအားဖြင့် ရွက်ကြွေအင်တိုင်း (Dipterocarp) သစ်တော များဖြစ်ပြီး၊ ယေဘုယျကျပြီး တစ်ပြည်လုံးနေရာအများစုတွင် ပေါက်ရောက်သော သစ်တော များဖြစ်ပါ သည်။ မြစ်ငယ်ကမ်းပါး တစ်လျှောက် ပေါက်ရောက်သောသစ်တောနှင့် ချုံတော များသည် ကမ်းနားနှင့် ဆိုင်သာ မြစ်ကမ်းနားသစ်တော အမျိုးအစားအစစ်များမဟုတ်ကြဘဲ၊ ကုန်းမြင့်ဒေသတွင် ပေါက်ရောက် သည့် မျိုးစိတ်များဖြစ်ပြီး၊ မြစ်ကမ်းနား သစ်တောအမျိုးအစား သီးသန့်မရှိကြပါ။ အဆိုပါ အင်တိုင်း သစ်တောများသည် မြစ်ရေစပ်ထိတိုင် ကျယ်ပြန့်ပေါက်ရောက်ကြ သည်။

စီးဆင်းသော ချောင်းငယ်လက်တက်များ၏ ထိပ်တွင် ရေမှုန်ရေမွှားထွက်၍ ဖြစ်ပေါ်လာသော စိုစွတ် နေရာများကိုလည်း တွေ့ရပြီး ရာသီအလိုက် ဖြစ်ပေါ်နေသော ရေမှုန်ရေမွှားနေရာများ ဖြစ်ပါသည်။ အလွန်စိတ်ဝင်စား ဖွယ်ကောင်းသော ရေမှုန်ရေမွှားနေရာမှာ နမ်းကမ် ချောင်းဝ ဘယ်ဘက်အခြမ်း သာစည်ရွာအနီး အမြင့်မှ ကျလာသော ရေတံခွန်မှ မြစ်ထဲသို့ မဝင်မီ ဖြစ်ပေါ်သော နေရာ ဖြစ်ပါသည်။

ဘေးအန္တရာယ်ကျရောက်နေသောအပင်မျိုးစိတ်များ၊ အပင်မျိုးစိတ်ပေါင်း ၆၂ ပင် (အခြားမျိုးစိတ် များပါ) များကို တိုက်ရိုက်နှင့်သွယ်ဝိုက်သက်ရောက် နယ်မြေများမှ ကောက်ယူနိုင်ခဲ့ပါသည်။ ထိုမျိုးစိတ်ထဲမှ ၅ မျိုးသည် ဘေးအန္တရာယ် ကျရောက်နေသော အပင်မျိုးစိတ်များအဖြစ် ကမ္ဘာ့မျိုးတုံးပျောက်ကွယ်မည့်

အပင်များ စာရင်းတွင်တွေ့ရှိရပါသည်။ ထို့အပြင် မျိုးစိတ်များကို ထပ်မံအဆင့်ခွဲခြားရာ၊ မျိုးတုံးပျောက်ကွယ် လုနီးပါး (NT), ဘေးအန္တရာယ်ကျရောက်နေသော (VU), မျိုးတုံးပျောက်ကွယ်နေသော (EN), သိသာ ထင်ရှားစွာ မျိုးတုံး ပျောက်ကွယ်နေသော (CR), ဟု အဆင့်ဆင့် ခွဲခြားထားပါသည်။ သို့ရာတွင် ကမ္ဘာလုံးဆိုင်ရာ မျိုးတုံးပျောက်ကွယ်မှု အဆင့်ရှိအပင်များသည် ပရောဂျက်သက်ရောက်နေရာပြင်ပတွင် လည်း တွေ့ရှိနေနိုင်ပါ သေးသည်။

၅.၂.၃ ကုန်းနေသတ္တဝါများ

အဓိကကုန်းနေသတ္တဝါတို့နေထိုင်ကျက်စားရာ စားကျက်များသည် အဓိကမြစ်တစ်လျှောက် မြစ်လက်တက်များ၊ မြစ်ဘေးသစ်တောများနှင့် အထက်ပိုင်းရွက်ကြွေတောများဖြစ်ပါသည်။ အလွန်အမင်း အသွင်ပြောင်းလဲပြီးသော စိုက်ပျိုးမြေများသည်လည်း စာကျက်များဖြစ်ပါသည်။

သတ္တဝါလေ့လာရေးအဖွဲ့သည်လည်း ၂၀၁၅-၂၀၁၈ ခုနှစ် အထိ သတ္တဝါမျိုးစိတ် ၃၄၀ ကို အမျိုးမျိုးသော သတ္တဝါအုပ်စုများတွင်တွေ့ရပါသည်။ သို့ရာတွင် တစ်ချိန်က ရှိခဲ့သော မျိုးစိတ်များဖြစ်သည် မဖြစ်သည်မှာ သေချာစွာ တိုက်ဆိုင်စစ်ဆေးမှု မပြုလုပ်နိုင်ပါ။။

နို့တိုက်သတ္တဝါအုပ်စု ၄၅ မျိုးစိတ်ကို ထုတ်ဖော်နိုင်ခဲ့ပြီး၊ အချို့ကို မေးမြန်းစုံစမ်းခြင်းဖြင့်သာ ရရှိခဲ့ ပါသည်။ နို့တိုက်သတ္တဝါမျိုးစိတ်များလျော့ပါးလာရသည့် အဓိက အကြောင်းရင်းမှာ လူများ၏ နှောင့်ယှက် ဖျက်စီးမှုများကြောင့် ဖြစ်ပါသည်။

သိသာစွာမျိုးတုံးပျောက်ကွယ်လာနေသော မျိုးစိတ်တစ်ခုမှာ တရုတ်မျိုးစိတ် သင်းခွေချပ်များ ဖြစ်ကြောင်း မေးမြန်းချက်အရ သိရှိခဲ့ရသည်။ မျိုးတုံးပျောက်ကွယ်မှု စာရင်းတွင် နို့တိုက်သတ္တဝါမျိုးစိတ် ၆မျိုး ပါဝင်နေကြောင်း သိရပါသည်။ ကျား၊ အာရှတောခွေး၊ မျောက်ညို၊ သစ်ရွက်စားမျောက်၊ ဝံကြောင်၊ မျောက်လွှဲကျော် တို့ကို မေးမြန်းချက်အရသိရှိရသော်လည်း တိုက်ရိုက်တွေ့ရှိမှုတော့ မရှိခဲ့ပါ။ ကျက်စားရာနေရာ အရည်အသွေးနှင့် လူတို့၏နှောင့်ယှက်ဖျက်စီးမှုများကို အခြေခံပြီး မည်သည့် မျိုးစိတ် မှ ဦးရေတည်တံ့ရန် တိုက်ရိုက်နှင့် သွယ်ဝိုက်သက်ရောက်နယ်မြေများတွင် ထိန်းမထားနိုင်ပါ။

ကမ္ဘာ့မျိုးတုံးပျောက်ကွယ်မှုစာရင်းအရ မျိုးစိတ် ၁၂ မျိုး ပါဝင်သည်ကို တွေ့ရပါသည်။ ထိုမျိုးစိတ် အမျိုးမျိုးကို ဓါတ်ပုံ ထောင်ချောက်များမှ ရရှိခဲ့ပါသည်။ (ကျားသစ်) အင်းကျားသစ်ခြေရာများ၊ မျောက်တံ ငါနှင့် မျောက်ပုတီးတို့အပြင် သစ်တောဌာနမှထုတ်ဝေသော မျိုးတုံးပျောက်ကွယ်မည့် စာရင်းတွင် နိုင်ငံလိုက်ဆိုင်ရာ ကာကွယ်ထားသော မျိုးစိတ်များ (သတိပေးစာအမှတ် ၅၈၃/၉၄) အရလည်း ဖော်ပြထား ပါသည်။ ကောက်ယူရရှိသော မျိုးစိတ်များရှိမည်ဟုမှန်းဆရသော မျိုးစိတ်များတွင် တရုတ်သင်းခွေချပ်၊ တောနွား၊ ကျား၊ ကျားသစ်၊ ကျားတူကျားသစ်၊ မျောက်လွှဲကျော်၊ တောကျွဲများကိုလည်း ဖော်ပြထား ပါသည်။

များပြားလှသော၊ တွားသွားသတ္တဝါများသည်လည်း လူသားတို့၏ အနှောင့်အယှက် ပေးမှုကြောင့် အလျှင်အမြန် လျော့ကျနေရပါသည်။ လေ့လာမှုအရ တွားသွားသတ္တဝါ ၄၀ မျိုး၊ ရေနေကုန်းနေသတ္တဝါ ၉ မျိုးတို့ရရှိခဲ့ပါသည်။ အားလုံးသော တွားသွားသတ္တဝါမျိုးစိတ်များသည် မျိုးတုံးပျောက်ကွယ်မည့် စိုးရိမ်သတ္တဝါများ စားရင်းတွင် (**IUCN Red List**) အနည်းငယ်စိုးရိမ်နေရသော စာရင်းဝင် သတ္တဝါများ

ဖြစ်ပါသည်။ တွားသွားသတ္တဝါ (၄) မျိုးမှာ မျိုးတုံးမှု အန္တရာယ်ကျရောက် နေကြောင်း မေးမြန်းစုံစမ်းချက်အရ တွေ့ရှိရပါသည်။ မျိုးတုံးပျောက်ကွယ် နေသော အင်းကြင်းလိပ်၊ မျိုးတုံး မှုအန္တရာယ် ကျရောက်နေသော မြန်မာစပါးကြီးမြွေ၊ မျိုးတုံးမှုအန္တရာယ် ကျရောက်နေ သည့် တောကြီးမြွေဟောက်၊ မျိုးတုံးမှု အန္တရာယ်နှင့် နီးစပ်နေသော အိန္ဒိယလိပ်မဲများ ကို တွေ့ရပါသည်။

ငှက်မျိုးစိတ် ၁၁၈ မျိုးကို မြစ်၏ကမ်း ၂ ဖက်တွင်တွေ့ရှိရပါသည်။ မျိုးစိတ်အားလုံးကိုမျက်မြင်နှင့် အသံ တို့ကိုမူတည်၍ မျိုးစိတ်ခွဲခြင်းဖြစ်ပါသည်။ မျိုးတုံးပျောက်ကွယ်နေသည့် ဒေါင်းမျိုးစိတ်တစ်ခုကိုတွေ့ ရှိရပြီး၊ သစ်တောဌါနမှ ပြဒါန်းသော (သတိပေးနိုးဆော်စာအမှတ် ၅၈၄/၉၄) တွင်လည်းပါဝင်ပါသည်။ မျိုးတုံးပျောက်ကွယ်လုနီးပါးမျိုးစိတ် ၆ မျိုးဖြစ်သည့် သစ်တောက်ငှက်မျိုးစိတ်တစ်မျိုး (Olive-backed woodpecker)၊ ကုလားမကြက်တူရွေး /ကျေးကုလားမ၊ ကြက်တော /ကျေးဖောင်းကား၊ ကျေးကုလား၊ Long-tailed Parakeet (မြန်မာအမည်မရှိ) နှင့် စစ်တလိုင်း ငှက်များကို တွေ့ရှိရပါသည်။

ရေငှက်မျိုးစိတ်အနည်းငယ်ကိုလည်းတွေ့ရှိရပါသည်။ အင်းဆက်နှင့် ကျောရိုးမဲ့မျိုးစိတ်များ၊ အင်းဆက် နှင့် အချို့သောကျောရိုးမဲ့ မျိုးစိတ်များတွင် လိပ်ပြာများ၊ ပိုးတောင်မာများ၊ ပုစဉ်းများ၊ မြက်ခုတ်ကောင်များ၊ ကျိုင်းကောင်များ၊ ပင့်ကူများ၊ ကင်းမြီးကောက်မျိုးစိတ်များ၊ ရှိခိုးကောင်များ ကိုလည်း ကောက်ယူ ရရှိခဲ့ပါသည်။ မျိုးစိတ်ပေါင်း ၁၃၈ မျိုး မျိုးခွဲနိုင်ခဲ့ပါသည်။ အဆိုပါမျိုးစိတ်များသည် မျိုးတုံးပျောက်ကွယ်မှုစာရင်းတွင်သိသာစွာ ဖော်ပြထားခြင်းမရှိသေးပါ။ ထို့ကြောင့် တိကျရှင်းလင်းသော ထိန်းသိမ်းစောင့်ရှောက်နိုင်မှုပြုလုပ်ရန် မလွယ်ကူပါ။

၅.၂.၄ ရေနေဂေဟစနစ်

နေရာဒေသ တိုက်ရိုက်သက်ရောက်နေရာ၏ လူနေ နေရာဒေသများသည် ငါးများ၊ ရေအောက်နေ သေးငယ်သော ကျောရိုးမဲ့များ နှင့် အခြားရေနေသက်ရှိများအတွက် မြစ်ငယ်မြစ်တစ်လျှောက်နေရာဒေသ ၆ ခုကို ခွဲခြားသတ်မှတ်နိုင် ပါသည်။ ရေတံခွန်များ၊ ရေတံခွန်ငယ်များ၊ ရေစီးမြန်ရေတိမ်နေရာများ၊ ရေစီးမြန် ကျောက်ကြမ်း နေရာများ၊ ရေစီးမြန်ကြမ်းခြင်း မရှိသောနေရာများ၊ ရေစီးနေးသောနေရာ၊ ရေငြိမ်နေရာနှင့် စီးဝင် မြစ်ချောင်းများတို့ပါဝင်ပါသည်။

ရေနေရာများပျံ့နှံ့မှုသည် အပြောင်းအလဲ အလွန်မြန်ဆန်ပြီး မြစ်ရေစီးဆင်းမှု အရှိန်နှုန်း ၊ ရေအနက်၊ တိုက်စားမှု၊ ပုံသဏ္ဌာန် ပြောင်းလဲမှုတို့ အပေါ် မူတည်နေပါသည်။ မည့်သည့်ရေနေရာမှ သီးသန့် သတ်မှတ်၍ မရနိုင်ပါ။

ငါးမျိုးစိတ် ၃၃ မျိုး မျိုးခွဲနိုင်ခဲ့ပါသည်။ အများစုမှာ တံငါသည်များကိုမေးမြန်းခြင်းဖြင့်လည်းကောင်း၊ ထက်ဝက်ခန့်သည် တံငါသည်များဖမ်းမိသောငါးများမှ နမူနာစံပြုရယူမျိုးခွဲခဲ့ပါသည်။ ငါးမျိုးစိတ်များတွင် ငါးကြင်းမျိုးစိတ်သည် အတွေ့ရများပါသည်။ မျိုးစိတ်ပေါင်း ၁၉ မျိုးတွေ့ရှိ မျိုးခွဲနိုင်ခဲ့ပါသည်။ ငါးမျိုးစိတ် ၅ မျိုးသည် မေးမြန်းစုံစမ်းချက်အရ မျိုးတုံး ပျောက်ကွယ်လုနီးပါး မျိုးစိတ်များသတ်မှတ်နိုင်ပါသည်။ အခြားရေနေမျိုးစိတ်များဖြစ်သည့် ကဏန်း၊ ပုဇွန်နှင့် ခရုများသည်လည်း မျိုးတုံးမှုနှင့် အနည်းငယ်သက်ဆိုင် ခြင်း၊ အချက်အလက်မပြည့်စုံခြင်းနှင့် မျိုးတုံးပျောက်ကွယ်မှုစာရင်း မဝင်ခြင်း စသည်တို့ပါဝင်ပါသည်။

၅.၃ လူတို့နှင့် သက်ဆိုင်သော ပတ်ဝန်းကျင်

၅.၃.၁. နိုင်ငံရေးအင်အားစုများနှင့် အတိုက်အခံများ

ရှမ်းပြည်နယ်သည် လွတ်လပ်ရေး ရရှိပြီးချိန်မှစ၍ လက်နက်ကိုင် အတိုက်အခံများနှင့် တမ်မတော်တို့ကြား ပဋိပက္ခများဖြစ်ပေါ်ခဲ့ပါသည်။ မြစ်ငယ်မြစ်၏ဘယ်ဘက်ခြမ်းတွင် လှုပ်ရှားမှုရှိသော လက်နက်ကိုင်အဖွဲ့အစည်းမှာ ရှမ်းပြည်နယ် ပြန်လည်ထူထောင်ရေး ကောင်စီ (RCSS) နှင့် ရှမ်းပြည်နယ်တောင်ပိုင်း လက်နက်ကိုင်အဖွဲ့ (SSA-S) တို့ဖြစ်ပြီး ရှမ်းပြည်နယ် ပြန်လည်ထူထောင်ရေး ကောင်စီသည် ၂၀၁၂ ခုနှစ် ဇန်နဝါရီလတွင် အစိုးရနှင့် ငြိမ်းချမ်းရေး သဘောတူ ခဲ့ပါသည်။ သို့ပါ၍ စီမံကိန်း နယ်မြေသည် ထိုအချိန်မှစ၍ တည်ငြိမ်အေးချမ်းလျက် ရှိပါသည်။

၅.၃.၂ လူဦးရေနှင့် လူမျိုးစုများ

စီမံကိန်းနယ်မြေသည် ဓနုလူမျိုး အများစုနေထိုင်ကြပြီး၊ ရှမ်းလူမျိုး အနည်းငယ်လည်း ပူးပေါင်း နေထိုင် ကြပါသည်။ တတိယ လူမျိုးစုဖြစ်သော ပလောင်လူမျိုးစုများသည်လည်း စီမံကိန်း ဧရိယာတွင် ပျံ့နှံ့နေထိုင်ကြပါသည်။

<u>ဓနု</u>။ ဓနု ဘာသာစကားသည် မြန်မာဘာသာစကားနှင့် အလွန်နီးစပ်ပြီး တစ်ခုသော မြန်မာဘာသာ အသံကွဲ တစ်ခုဖြစ်ပါသည်။ ဓနုလူမျိုးစုသည် အစိုးရ၏ တရားဝင်သတ်မှတ်ထားသော လူမျိုးစုများတွင် တစ်ခု ပါဝင်ပြီး ကမ္ဘာ့ငွေကြေးအဖွဲ့ လုပ်ဆောင်ချက် (၇) တွင်ပါဝင်သော အချက်အလက်များနှင့် ကိုက်ညီသော တိုင်းရင်းသား လူမျိုးစုများဖြစ်ပါသည်။ လူမှုဘဝလေ့လာရေး ကျေးရွာအစည်းအဝေး မေးမြန်းချက်များအရ ဓနုလူမျိုးများသည် ဖယ်ကြဉ်ခံထားရသော၊ အတိဒုက္ခကြုံတွေ့နေရသော လူမျိုးများ မဟုတ်ကြပါ။ မြန်မာ လူမျိုးစုများနှင့် ဘာသာစကားတူ ရင်းနှီး ကျွမ်းဝင်သူများဖြစ်ကြပါသည်။

<u>ရှမ်း</u>။ ရှမ်းရွာများ၊ ရှမ်းအများစုနေထိုင်သော ရွာများသည် စီမံကိန်း၏ သွယ်ဝိုက်သက်ရောက်သောနေရာများ တွင်သာတွေ့ရှိရပါသည်။ အထူးသဖြင့် မြစ်ညာဘက်အပေါ်ခြမ်းနှင့် ဘယ်ဘက်အောက်ခြမ်းနေရာတို့တွင် နေထိုင်ကြပါသည်။ ကမ္ဘာ့ငွေကြေးအဖွဲ့ လုပ်ဆောင်ချက် (၇) တွင်ဖော်ပြချက်အရ ထင်ရှားသော လူမျိုးစု၊ သီးသန့်နယ်မြေတွင် နေထိုင်သော လူမျိုးစု၊ ယဉ်ကျေးမှု သီးသန့်ရှိ၍ လူမှုရေးလုပ်ဆောင်ချက်သီးသန့်ရှိသော ဘာသာစကားသီးသန့်ရှိသည့် တိုင်းရင်းသား လူမျိုးများဖြစ်ကြပါသည်။ သို့ရာတွင် ထိုလူမျိုးတို့သည် ဖယ်ကြဉ်ခံရသော ၊ အတိဒုက္ခကျရောက်နေသော လူမျိုးများဟု မသတ်မှတ်နိုင်ပါ။ ထိုလူမျိုးတို့၏ အခွင့်အရေး၊ စိတ်ဝင်စားမှု၊ မြေယာပြဿနာ၊ သဘာဝ အရင်းအမြစ်များနှင့် ယဉ်ကျေးမှုအမွေအနှစ်များသည်လည်း ထိန်းသိမ်းစောင့်ရှောက်နိုင်ပါသည်။

<u>ပလောင်(တအောင်း)</u>။ ပလောင်လူမျိုးစုသည်လည်း စီမံကိန်းနယ်မြေတွင် တတိယမြောက်တွေ့ရှိ ရသော လူမျိုးစုများဖြစ်ပါသည်။ ပလောင်လူမျိုးစုသည်လည်း အစိုးရက တရားဝင်သတ်မှတ်ထားသော လူမျိုးစုများ ဖြစ်ပါသည်။ ကမ္ဘာ့ငွေကြေးအဖွဲ့၏ လုပ်ဆောင်ချက် သတ်မှတ်ချက် (၇) ချက် အရလည်း တိုင်းရင်းသား လူမျိုးစုများဖြစ်ပါသည်။

၅.၃.၃ ပရောဂျက်နယ်မြေစီးပွားရေးနှင့် အချက်အလက်များ

စိုက်ပျိုးရေး- မြစ်ငယ်မြစ်၏ ၂ ဖက်လုံးသည် ရေသွင်းစိုက်ပျိုးမှုမရှိသော တောင်ပေါ်စိုက်ခင်းများဖြစ်ပါသည်။ အိမ်ထောင်စုအများစုသည် ရွှေ့ပြောင်းတောင်ယာ စနစ်ကို ကျင့်သုံးဆဲဖြစ်ပြီး၊ စွန့်ပစ်မြေအဖြစ် ၁ နှစ် မှ ၃ နှစ်ထိစွန့်ပစ်ထားတတ်ပါသည်။ ရွာများတွင် လူဦးရေတိုးပွားလာသည့်အလျောက် ပျမ်းမျှစိုက်ပျိုးမြေ အကျယ်အဝန်းမှာ သေးငယ်လာပါသည်။ သို့ပါ၍ စွန့်ပစ်ဆိုင်းငံ့ထားသော စိုက်ပျိုးမြေများ အလွန်နည်းပါး လာပါသည်။

အိမ်ထောင်စု အများစုသည် စီမံကိန်း သက်ရောက်နယ်မြေများကို ဖြတ်၍ ၎င်းတို့၏စိုက်ပျိုးမြေများဆီကို သွားရောက်ကြပါသည်။ နယ်မြေအများစုသည် လူဦးရေနည်းပါးသော်လည်း စိုက်ပျိုးမြေချဲ့ထွင် လိုမှုကြောင့် တောင်ကုန်းမြင့်စိုက်ခင်းများတိုးချဲ့မှုသည် သစ်တောများခုတ်ထွင် ရှင်းလင်းမှုကို ဖြစ်ပေါ်စေပါသည်။ လယ်သမား အနည်းငယ်သာ၊ မိရိုးဖလာ စိုက်ပျိုးမှုများလုပ်ကိုင်ပြီး၊ အများဆုံးစိုက်ပျိုးသီးနှံများ မှာ ပြောင်းဖူးနှင့် ကြံများ ဖြစ်ပါသည်။

ဝင်ငွေအဆင့်နှင့် ဆင်းရဲနွမ်းပါးမှု - စီမံကိန်းသက်ရောက်နယ်မြေအတွင်းနေထိုင်သူတို့၏ဝင်ငွေ အဆင့်အတန်းသည် ကမ္ဘာ့ဘဏ်စစ်တမ်း (သတ်မှတ်ချက်) များအရ ၁,၃၀၃ ကျပ် (၁.၁ ဒေါ်လာ) သတ်မှတ်ထားပြီး၊ ကမ္ဘာ့အဆင်းရဲဆုံး (ဝင်ငွေအနည်းဆုံး) သတ်မှတ်ချက်သည် ၂ ဒေါ်လာ ဖြစ်ပါသည်။ လေ့လာဆန်းစစ်ချက် ၁၃ ရွာ အရ သွယ်ဝိုက် သက်ရောက်နယ်မြေအတွင်း နေထိုင်သောရွာများရှိ အိမ်ထောင်စုတစ်စု တစ်နှစ်တာဝင်ငွေမှာ ၄,၁၀၅,၅၆၇ ကျပ် ဖြစ်ကြောင်းတွေ့ရပြီး၊ ဒေါ်လာတန်ဖိုးအားဖြင့် ၃,၀၅၉ ဒေါ်လာ ဖြစ်ပြီး၊ တစ်နေ့တာ ပျှမ်းမျှ ဝင်ငွေမှာ ၈.၃ ဒေါ်လာ ရှိပါသည်။ ပျှမ်းမျှအားဖြင့် စိုက်ပျိုးရေးမှ ရသောဝင်ငွေသည် ဝင်ငွေအားလုံး၏ ၈၀ ရာခိုင်နှုန်း ဖြစ်သည်ကို တွေ့ရပါသည်။

၅.၃.၄ သက်ရောက်နယ်မြေများတွင် သဘာဝအရင်းအမြစ်များသုံးစွဲမှု

သစ်တောသယံဇာတ။ သစ်တောသယံဇာတတွင် သစ်များပါဝင်ပါသည်။ ဆောက်လုပ်ရေးနှင့် လောင်စာထင်း များ အစားအစာအဖြစ်ထုတ်ယူသောအပင်များ (စားသုံးရန်၊ ရောင်းဝယ်ရန်) အမဲလိုက်ခြင်း (စားသုံးရန်၊ ရောင်းဝယ်ရန်) ပါဝင်ပါသည်။ သို့ရာတွင် ထိုဝင်ငွေမှာ ရေဘုယျအားဖြင့် အဓိကဝင်ငွေ မဟုတ်ဘဲ အထောက်အပံ့မျှသာဖြစ်ပါသည်။ အမဲလိုက်ခြင်းသည် တစ်ချိန်က တွင်ကျယ်သည့် လုပ်ငန်း တစ်ခုဖြစ်ခဲ့သော်လည်း ယခုအခါ သတ္တဝါများရှားပါးမှုကြောင့် မလုပ်နိုင်တော့ပါ။

မြစ်ရေအရင်းအမြစ်။ မေးမြန်းခဲ့သော ၁၃ ရွာလုံးသည် သွယ်ဝိုက်သက်ရောက်နယ်မြေတွင် ရှိသောကြောင့် ရေအရင်းအမြစ်အတွက် မြစ်ကိုမှီခိုခြင်းမရှိပါ။ အိမ်ထောင်စု အနည်းငယ်သာ အားလပ်သည့်အခါများတွင် အပျော်သဘော ငါးဖမ်းကြပါသည်။ သို့ရာတွင် အိမ်ထောင်စုဝင်ငွေအတွက် သိသာထင်ရှားစွာ အထောက်အပံ့မပြုနိုင်ပါ။ မည်သည့် အိမ်ထောင်စုမှ ပျှမ်းမျှဝင်ငွေ၏ ၁ ရာခိုင်နှုန်းကျော်ကို ငါးဖမ်းခြင်းမှ မရရှိပါ။ မေးမြန်းသော အိမ်ထောင်စု ၈၀၀ တွင် ၃၀ သာ ငါးဖမ်းကြသည်ကိုတွေ့ရပါသည်။

၅.၃.၄ ရှေးဟောင်းနယ်မြေနှင့် ယဉ်ကျေးမှုအမွေအနှစ်များ

စီမံကိန်း တိုက်ရိုက်သက်ရောက် နယ်မြေအတွင်း ရှေးဟောင်းနယ်မြေ နှင့် ယဉ်ကျေးမှု အမွေအနှစ်များအတွက် သီးခြားသတ်မှတ်ထားသော နေရာများ လုံးဝမတွေ့ရပါ။ သို့ရာတွင် သွယ်ဝိုက်သက်ရောက် နယ်မြေရှာများတွင် စေတီများ၊ ဘုန်းတော်ကြီး ကျောင်းများ ၊ ဘုရားကျောင်းများရှိပြီး ဒေသခံများက သွားရောက်လည်ပတ်ပြီး ပြုပြင်ထိန်းသိမ်း ကြပါ သည်။

၆။ သက်ရောက်မှုများနှင့် လျော့ပါးသက်သာစေခြင်းများ

၆.၁ ရုပ်ပတ်ဝန်းကျင်

၆.၁.၁ မြစ်ရေစီးဆင်းမှု ကောင်းမွန်စေခြင်း

အလယ်ရဲရွာ ရေလှောင်တမံ ဆောက်လုပ်နိုင်ရန်အတွက် ယာယီအားဖြင့် မြစ်ညာနှင့် မြစ်ခြေ ၂ ဖက် စလုံးကို ယာယီရေလွှဲဆည် နှင့် ရေလွှဲမြောင်းများသို့ လွှဲထားမည်ဖြစ်ပါသည်။ ထိုရေလွှဲထားမှုသည် သဘာဝ မြစ်ရေစီးဆင်းမှုကို ထိခိုက်မည်မဟုတ်ဘဲ ရေလှောင်ကန်ရေပြည့်ချိန်အထိ ကြာမြင့်မည် ဖြစ်ပါသည်။ ရေလှောင်ကန် ရေစတင်သိုလှောင်မည့် အချိန်တွင်လည်း လိုအပ်သောရေပမာဏကို စီးဆင်း စေမည်ဖြစ်ပါသည်။

လုပ်ငန်းလုပ်ဆောင်မှုအရ တမံကိုယ်ထည်ရှိ ရေပိုလွှဲမှ ရေလွှတ်ချိန် သို့မဟုတ် ရေပိုလွှဲတံခါးများ ဖွင့်လွှတ်သည့်အချိန်များမှ လွဲ၍ ရေလှောင်တမံ အောက်ဖက်မှ တာဘိုင်စက် ရေထုတ်ပြွန်နေရာအထိ ခန့်မှန်း ၂၀၀ မီတာ အကွာအဝေး အတွင်းရှိ ယာယီရေထုတ်ပြွန်နေရာ အနည်းငယ်သည်သာလျှင် အပြည့်အဝ (သို့မဟုတ်) တစ်စိတ်တစ်ပိုင်း ခြောက်သွေ့နေမည်ဖြစ်ပါသည်။

နေ့စဉ်အမြင့်ဆုံးလုပ်ဆောင်နိုင်ချိန်သည် အမြင့်ဆုံးထုတ်လုပ်နိုင်စွမ်းကို ရောက်ရှိမည် ဖြစ်ပြီး၊ ဥပမာ- မြေအောက်ခြေရေစီးဆင်မှုနှင့် ရေအနိမ့်အမြင့် အမြန်အဆန် အတက်အကျကို ဖြစ်ပေါ်စေနိုင်ပါသည်။ စက်ရုံ၏လည်ပတ်စွမ်းအားသည် အဆက်မပြတ်ရေစီးဆင်းမှု ကွာခြားချက်ပေါ်မူတည်သော်လည်း အမြင့်ဆုံး ရေစီးအားသည် တစ်စက္ကန့်လျှင် ၆၈၈ မီတာ ဖြစ်ရပါမည်။ အထူးသဖြင့် မိုးတွင်းကာလတွင်ဖြစ်ပြီး၊ အပြည့်အဝ လည်ပတ်မှုသည် နာရီအနည်းငယ်သာ ဖြစ်ပေါ်ပါမည်။

၆.၁.၂ ရေလှောင်ကန် အလွှာကွဲပြားခြင်း

အလယ်ရဲရွာ ရေကာတာသည် ကြီးမားနက်ရှိုင်းသော ရေလှောင်ကန်ပြုလုပ်မည် ဖြစ်၍ မြစ်၏ ရုပ်ဂုဏ်သတ္တိများ ပြောင်းလဲသွားမည်ဖြစ်ပါသည်။ ရေလှောင်ကန်ဖြစ်နေပြီးသောအချိန်တွင် ရေလှောင်ကန် အောက်ခြေသည် အောက်စီဂျင်ကင်းမဲ့သော ရေအလွှာဖြစ်ပေါ်လာမည်ဖြစ်ပါသည်။

အောက်စီဂျင်မဲ့သောရေများ မြစ်အောက်ဖက်သို့စွန့်ပစ်ရာတွင် အဆင့်ဆင့်ရှိသော ပြန်လည်စုပ်ယူ သည့် ကိရိယာများကို တပ်ဆင်ရမည် ဖြစ်ပါသည်။ ရေလွှတ်မြောင်းတွင် ရေကာတာ အနိမ့်များ ကို အောက်စီဂျင် စုပ်ယူနိုင်ရန် တပ်ဆင်နိုင်ပါသည်။ သို့ရာတွင် တာဘိုင်မှ ထုတ်လွှတ်လိုက်သော ရေများ သည် အောက်ဖက်ရှိ ရဲရွာတမံ၏ မြစ်ညာပိုင်းကို ရောက်ရှိသွားပြီး၊ ရေအရည်အသွေး ထိန်းနေရာသို့ရောက်ရှိမည်ဖြစ်၍ ဒီဇိုင်းသီးသန့် ပြင်ရန် အထူးမလိုအပ်ပါ။

၆.၁.၃ ရေညစ်ညမ်းမှု

တည်ဆောက်ရေးကာလတွင် မြေသားလုပ်ငန်းများ လုပ်ဆောင်ရမည် ဖြစ်၍ ယာယီရေထိန်းတမံ တည်ဆောက်ခြင်း၊ မြေကျင်းဖောက်ခြင်း၊ မိုင်းခွဲခြင်း၊ ကျောက်ခွဲခြင်းများကြောင့် မြစ်အတွင်းတမံနေရာ တစ်ဝိုက်တွင်လည်းကောင်း၊ လက်ရှိရဲရွာရေလှောင်ကန်၏ အခြားနေရာများတွင် လည်းကောင်း အနယ်အနှစ်များကျရောက် ဖြစ်ပေါ်မည်ဖြစ်ပါသည်။ ထို့အပြင် လုပ်ငန်းသုံး ယန္တရားများမှ၊ မတော် တဆ လောင်စာဆီ ယိုဖိတ်မှုများ၊ အမိုးနီးယားနှင့် နိုက်ထရိုဂျင်ယိုဖိတ်မှုများသည်လည်း ရေညစ်ညမ်း မှုကို ဖြစ်ပေါ်စေနိုင်ပြန်ပါသည်။ သို့ပါ၍ ထိရောက်သောကာကွယ်မှုများကို လုပ်ဆောင်ရမည်ဖြစ်ပါသည်။

အလုပ်သမားတန်းလျားများမှထွက်သော အညစ်အကြေး စွန့်ပစ်ပစ္စည်းများ၊ သက်ရှိအညစ်အကြေးများသည် မြေပြင်ပေါ်ရေများကို ညစ်ညမ်းစေမည် ဖြစ်ပါသည်။ စွန့်ပစ်ပစ္စည်းများ၊ စွန့်ပစ်ရေများမှာ နေအိမ်များနှင့် ဆောက်လုပ်ရေးလုပ်ငန်းများမှ ထွက်ရှိလာနိုင်သဖြင့် ထိရောက်စွာ ထိန်းသိမ်းထားရပါမည်။ (ဥပမာ-အကြွင်းအကျန်သတ္တု၊ သစ်သား၊ ပလတ်စတစ်၊ ဘိလပ်မြေအိတ်၊ သုံးပြီးကားတာယာများ၊ ဖုန်းဘက်ထရီဟောင်းများ စသည်ဖြင့်) ထိုအညစ်အကြေးများသည် မြေပေါ်နှင့် ရေထဲတွင်ပါ ညစ်ညမ်းမှုများ ဖြစ်စေပါသည်။ အလုပ်သမားများနေထိုင်သော အတိအကျနေရာများပေါ် မူတည်၍ ထိုညစ်ညမ်းမှုများသည်နေရာ ဒေသအတွင်းကျရောက်ခြင်း သို့မဟုတ် မြစ်ငယ်အတွင်း ကျရောက်ခြင်းများ ဖြစ်နိုင်ပါသည်။

၆.၁.၄ အနည်အနှစ်ဖမ်းခြင်းနှင့် စွန့်ထုတ်ခြင်းရေကာန်

အလယ်ရဲရွာမှ ရေစွန့်ထုတ်ပြွန်သည် အောက်ရဲရွာ၏ တာဘိုင်တို့နှင့် ဝေးကွာခြင်းမရှိဘဲ၊ အထက်ရဲရွာမှ အနည်အနှစ်များဖမ်းယူပြီးဖြစ်၍ အလယ်ရဲရွာစီမံကိန်းသည် အကျိုးဆက် သက်ရောက်မှု နည်းပါးသွားမည်ဖြစ်ပါသည်။

၆.၁.၅ မြေတိုက်စားခြင်းနှင့် မြေပြိုခြင်းဖြစ်နိုင်ခြေ

တည်ဆောက်ရေးကာလတွင် မြေပေါ်အပင်များ ကိုရှင်းလင်းခြင်း၊ မြေခြစ်ခြင်း၊ မြေဖို့ခြင်း၊ မြေသိပ်ခြင်း၊ မြေတူးခြင်း၊ မြေပုံများပုံခြင်း၊ မြေဖယ်ရှားခြင်း၊ စသည်တို့ကို ပြုလုပ်မည် ဖြစ်ပါသည်။ လမ်းများအဆင့်မြှင့်တင်ခြင်းနှင့် တည်ဆောက်ခြင်းတို့ကိုလည်း မတ်စောက်သော မြစ်ငယ်ချိုင့်ဝှမ်းတွင် ပြုလုပ်မည်ဖြစ်ပါသည်။ လျှပ်စစ်ထုတ် စက်ရုံတည်ဆောက်ပြီးသောအခါ၊ အမြင့်ဆုံးလုပ်ဆောင်ချိန်တွင် ရေဆွဲယူမှု အားကောင်းခြင်းကြောင့် မြစ်အထက်ပိုင်းကမ်းစပ်များ ပြိုကျခြင်းများ နေရာကျယ်ကျယ်ပြန့်ပြန့် ဖြစ်နိုင်ပါ သည်။

၆.၁.၆ ဖန်လုံအိမ် ဓါတ်ငွေ့ထုတ်လွှတ်မှု

တည်ဆောက်ရေးကာလတွင် ဖန်လုံအိမ်ဓါတ်ငွေ့ထုတ်လွှတ်မှုသည် ကားများမောင်းနှင်မှုကြောင့် လည်းကောင်း၊ ဒီဇယ်စက်များမောင်းနှင်မှုကြောင့်လည်းကောင်း ထွက်ပေါ်နိုင်ပါသည်။ ထို့အပြင် ရေလှောင် ကန်အတွင်း သစ်ပင်များ ရှင်းလင်းမှုမှ ဖြစ်ပေါ်လာသော သစ်တောပြုန်းတီးမှုကြောင့် ကာဗွန်ဒိုင်အောက်ဆိုက် ခန့်မှန်း ၄၇၈,၀၀၀ တန်ခန့် ထုတ်လွှတ်နိုင်ပါသည်။ မြေအသုံးချ

အပြောင်းအလဲကြောင့် ဖန်လုံအိမ် ဓါတ်ငွေ့ ထုတ်လွှတ်မှု မြင့်မားသော်လည်း ရာသီဥတုပြောင်းလဲမှု အပေါ်တွင် သက်ရောက်မှု နည်းပါး ပါသည်။

အလယ်ရဲရွာစီမံကိန်းသည် ပြန်လည်ဖြည့်တင်းမြဲ စွမ်းအင်ကို နည်းပညာဖြင့် ထုတ်ယူပံ့ပိုးပေးမည့် အစီအစဉ်ဖြစ်၍ ဖန်လုံအိမ်ဓါတ်ငွေ့ထုတ်လွှတ်မှုကို ပမာဏ နည်းပါးရန် လျှော့ချထားနိုင်ပါသည်။

၆.၁.၇ ဖုန်နှင့် အသံထုတ်လွှတ်မှု

တည်ဆောက်ရေးကာလတွင် လေထုညစ်ညမ်းမှု၊ ဖုန်များပါဝင်မှုသည် တည်ဆောက်ရေး ယန္တရားများ ဖောက်ခွဲမှုများ၊ ကျောက်တူးဖော်ခြင်းများ၊ မြေတူးခြင်း၊ မြေလုပ်ငန်းများလုပ်ကိုင်ခြင်း၊ ဘိလပ်မြေ ရောခြင်း၊ လမ်းဖောက်လုပ်ခြင်းအပြင် ကားများအသွားအလာများကြောင့် ထွက်ပေါ်လာမည် ဖြစ်ပါသည်။ ၎င်းအပြင် ထွက်ပေါ်မှု့သည် ယန္တရားများ၊ ကားများနှင့် ဒီဇယ်အင်ဂျင်များမှ အခြားဓါတ်ငွေ့များ (NO_2 and SO_2) လည်း ထွက်ပေါ်လာနိုင်ပါသည်။

၆.၂ ဇီဝပတ်ဝန်းကျင်

၆.၂.၁ မြေပေါက်ပင်များ ရှင်းလင်းခြင်း

ရေလှောင်တမံတည်ဆောက်ခြင်းကြောင့် အင်းတိုင်းသစ်တောများ၊ ဘယ်ဘက်ခြမ်းရှိ ထူထပ် သစ်တောများ အပါအဝင် ဇီဝအရင်းအမြစ်ဆုံးရှုံးမှု့များ၊ ရေမြုပ်ခြင်းများ ဖြစ်ပေါ်မည်ဖြစ်ပါ၍၊ သစ်တော ၈၁၆ ဟက်တာ ခန့်ဆုံးရှုံး မည်ဖြစ်ပါသည်။ ထို့အပြင် နမ်းကမ်ချောင်းမှ ရာသီအလိုက်ဖြစ်ပေါ်နေသော ရေမှုန်ရေမွှားနယ်မြေ ရေမြုပ် ဆုံးရှုံးမည်ဖြစ်ပါသည်။

အပင်မျိုးစိတ်အများစုသည် အင်တိုင်း သစ်တောအမျိုးအစား များဖြစ်ပြီး၊ နယ်မြေအတော် များများတွင် ပျံ့နှံ့ပေါက်ရောက်နိုင်၍ မျိုးတုံးပျောက်ကွယ်မည့် မျိုးစိတ်စာရင်းတွင် ပါဝင်သော်လည်း အဓိက ကာကွယ်တားဆီးရေးအဖြစ် စဉ်းစားရန် မလိုအပ်သေးပါ။

၆.၂.၂ ကုန်းမြေနေသတ္တဝါတို့၏ နေထိုင်ရာနေရာများကို အနှောင့်အယှက်ပေးခြင်း

တည်ဆောက်ခြင်းအတွက် ရှင်းလင်းခြင်းခံရသော တိုက်ရိုက်သက်ရောက် နေရာသည် ကုန်းနေသတ္တဝါတို့အတွက် အမှန်တကယ် ဆုံးရှုံးသောနေရာဖြစ်ပါသည်။ အလုပ်သမား များနှင့်ပေါင်း ပြီး ဒေသခံများသည် တရားမဝင်သစ်ခုတ်ခြင်းများလည်း ဖြစ်ပေါ်လာနိုင်ပါသည်။ ထိုနေရာတွင် ထိန်းသိမ်းစောင့်ရှောက်ရန် အရေးတကြီးလိုသော မျိုးစိတ်များမတွေ့ရှိရပါ။

တည်ဆောက်ရေးကာလတွင် အလုပ်သမားများ၊ မိသားစုဝင်များကြောင့် အထူးသဖြင့် ချေများ၊ တောကြက်များအား တရားမဝင်အမဲလိုက်ခြင်းများ ဖြစ်ပေါ်နိုင်ပါသည်။ အန္တရာယ်ဖြစ်စေသောပစ္စည်းများ ကြောင့် အထူးသဖြင့် ဆောက်လုပ်ရေးနယ်မြေများတွင် စွန့်ပစ်မှုများကြောင့် ထိခိုက်နိုင်ပါသည်။

မြစ်ရိုးတစ်လျှောက်ရှိအင်းဆက်များ၊ လိပ်များအတွက် အရေးကြီးသော သဲသောင်ခုံများသည် ရာသီအလိုက် ရေလွှမ်းမိုးမှုများ ရှိလာနိုင်ပါသည်။ နမ့်ကန်ချောင်းရှိ ရေမှုန်ရေမွှားဇုန်သည် အစိတ်အပိုင်း

အားဖြင့် နစ်မြုပ်မည်ဖြစ်ပါသည်။ သို့ရာတွင် ထိုနေရာတွင် သီးသန့်ပေါက်သောအပင်မျိုးစိတ်များ မရှိပါ။ ရေမမြုပ်သော အထက်ပိုင်းနေရာများတွင် တူညီသော ရေမှုန်ရေမွှားဇုန်များရှိလာနိုင်ပါသည်။

၆.၂.၃ ရေဂေဟစနစ်

ရေလှောင်တမံတည်ဆောက်ခြင်း၊ ရေလှောင်ကန် ပြည့်ခြင်းများကြောင့် မြစ်ကမ်းဘေး သစ်တောနေရာများပျောက်ဆုံးသွားပြီး၊ ကြီးမားသောရေကန်သဘာဝ ဖြစ်ပေါ်လာမည်ဖြစ်ပါသည်။ အချို့မျိုးစိတ်များသည် စီးဆင်းရေတွင် ရှင်သန်နိုင်ကြသော်လည်း ၎င်းတို့အလေ့အကျင့် နေရာများ ပျောက်ဆုံးသွားမည်ဖြစ်ပါသည်။ အကန့်အသတ်သာရှိသော ချောင်းလက်တက် နေရာများတွင် မြစ်ကမ်း ဘေး သစ်တောများ အကွက်လိုက် ကျန်ရှိမည်ဖြစ်ပါသည်။

ယာယီရေထိန်းဆည် တည်ဆောက်ရာတွင်၊ ထိုလုပ်ငန်းများကြောင့် မြစ်ညာသို့ သွားရောက်ကြမည့် ငါးများ၏လမ်းကြောင်းကို အနှောင့်အယှက် ဖြစ်စေပါသည်။ မြစ်ညာမြစ်ခြေမှ မည်သည့်ငါးမျိုးမဆို အတားအဆီးဖြစ်မည်ဖြစ်ပါသည်။ သို့ရာတွင် အောက်ဖက်ရှိ ရဲရွာနှင့် အထက်ရဲရွာတည်ဆောက်မှုကြောင့် ငါးလမ်းကြောင်းများ အလိုအလျောက် တားဆီးခြင်းခံရပြီးဖြစ်ပါသည်။ အလယ်ရဲရွာတည်ဆောက်ခြင်းအတွက် အထူးအထွေထပ်မံ ထိခိုက်နိုင်ဖွယ်မရှိပါ။ သို့ပါ၍ မြစ်ညာသို့သွားရန် ရေကာတာတွင် ငါးလမ်းကြောင်းထည့်သွင်း တည်ဆောက်ရန် စဉ်းစားဖို့မလိုအပ်တော့ပါ။

လုပ်ငန်းအကောင်အထည်ဖော်သူသည် လိုအပ်သော ကျောက်တုံးပမာဏကို ရေလွှတ်ပေါက် ၁ ကီလိုမီတာ အဝေးတွင် ချထားပြီး မြန်မာအစိုးရ၏ လိုအပ်ချက်အရ ဖြစ်၍ လွတ်လပ်စွာစီးဆင်းခြင်းကို အလယ်ရဲရွာနှင့် အောက်ရဲရွာအကြားတွင် ဖန်တီးထားခြင်း ဖြစ်ပါသည်။ အခြားကျန်ရှိသော ဂေဟစနစ်နှင့် ဆိုင်သောအချက်များကို ဆိုးကျိုး မဖြစ်ပေါ်နိုင်ရန် သေချာစဉ်းစားဆောင်ရွက်သွားမည် ဖြစ်ပါသည်။

မြစ်တွင်နေထိုင်သော မျိုးစိတ်များသည် ရေလှောင်ကန်အတွင်း နေထိုင်နိုင်ရန် အထူးပင် ကြိုးစားအားထုတ်ရပေမည်။ အဘယ်ကြောင့်ဆိုသော် မြစ်အသွင်မှကန်အသွင် ပြောင်းလဲဖြစ်ပေါ်လာမည့်ရေလှောင်ကန်သဘာဝကြောင့် ဖြစ်ပါသည်။ အပင်မွှားလေးများ၊ အကောင်မွှားလေးများ ထူးကဲစွာပေါက်ပွားများပြားလာမည်ဖြစ်၍ ထိုအရာများကိုစားသော မျိုးစိတ်များအတွက် များပြားသော အထောက်အပံ့များ ရရှိစေမည်ဖြစ်ပါသည်။ ငါးအမျိုးမျိုးသည်လည်း မျိုးစိတ်ဖွဲ့စည်းပုံများ ပြောင်းလဲဖြစ်ပေါ်လာပြီး ကန်နှင့်တူသော ရေနေသဘာဝ ဖြစ်ပေါ်လာမည်ဖြစ်ပါသည်။

စီမံကိန်းသည် ရရှိမည့် ရေအားကို အပြည့်အဝ အသုံးပြုလည်ပတ် မည့်ပုံရသော်လည်း၊ ထုတ်လုပ်မှု ကွပ်ကဲထိန်းချုပ်ရေး အဖွဲ့သည် နောက်ပိုင်းမှ မည်သို့ထုတ်လုပ်မည်ကို အသေးစိတ်စဉ်းစားမည်ဖြစ်ပါသည်။ အဓိကနေ့စဉ်ရေစီးဆင်းမှု ခြားနားချက်ကို ရေလွှတ်ပေါက်မှ အောက်ရဲရွာအကြား တစ်နစ်အတွက် တိုင်းတာသွားမည်ဖြစ်ပါသည်။ စီးဆင်းမှုနှင့် မြစ်ရေအတက်အကျသည် သိသာထင်ရှားသော ဆိုးကျိုးများကို ရေနေသတ္တဝါတို့အပေါ် အချိန်တိုအတွင်း ဖြစ်စေနိုင်ပါသည်။ မြစ်ကြမ်းပြင်ကို လုံးဝခြောက်သွေ့သွားခြင်း မဖြစ်ပေါ်စေဘဲ၊ အနည်းဆုံးရေစီးဆင်းမှုကို အဆက်မပြတ်ဖြစ်ပေါ်စေခြင်းသည် ပတ်ဝန်းကျင်သဘာဝကို ထိန်းသိမ်းပေးရာရောက်ပါသည်။ (ဥပမာ။ ငါးများရှင်သန်နိုင်မှု ခက်ခဲအောင် ဖန်တီးခြင်းများ ကင်းဝေးစေရန်နှင့် လူများမြစ်ကမ်းအနီးသို့ အနီးကပ်လာရောက်မှု ကိုကင်းဝေးစေရန်အတွက်)

၆.၃ လူတို့၏ပတ်ဝန်းကျင်

၆.၃.၁ စီမံကိန်းနေရာ၏ စီးပွားရေးအခြေအနေ

အလယ်ရဲရွာ ရေအားလျှပ်စစ်စီမံကိန်းသည် ဒေသခံလူများအတွက် အလုပ်အကိုင်ရရှိရေးကို တိုက်ရိုက် သော်လည်းကောင်း၊ သွယ်ဝိုက်၍သော်လည်းကောင်း ဖန်တီးပေးနိုင်မည် ဖြစ်ပါသည်။ တည်ဆောက်ရေးကာလသည့် ဒေသခံများအတွက် ကောင်းမွန်သော အကျိုးသက်ရောက်မှုများကိုသာ ပေးမည် ဖြစ်ပါ သည်။

၆.၃.၂ နေရာရွှေ့ပြောင်းခြင်းနှင့် ပြန်လည်နေရာချထားခြင်း

လက်ရှိအနေအထားသည် စီမံကိန်းအစီအစဉ်ရေးဆွဲခြင်းနှင့် အကျယ်အဝန်းနှင့် နေရာများ အတိအကျ ဆုံးဖြတ်မှု မပြုရသေးပါ။ လမ်းအမှတ် (၄၁) သည် နောင်ချိုမှ တောင်ရှည်ရွာ၊ တောင်ရှည်ရွာလမ်းဆုံမှ ရေတွင်းကြီးသည် စီမံကိန်းအဓိကလမ်းကြောင်း ဖြစ်မည် ဖြစ်ပါသည်။ ထိုလမ်းကြောင်းသည် ရွာအများအပြားကို ဖြတ်သန်းသွားပြီး၊ လမ်းကျယ်ဘောင် ချဲ့မည်ဖြစ်၍ ရုပ်ပိုင်းဆိုင်ရာအနေဖြင့် စီးပွားရေးအသုံးချမြေ နှင့် အိမ်နေရာများအချို့ ရွှေ့ပြောင်း ပေးရမည်ဖြစ်ပါသည်။

ရေလှောင်ကန်ဧရိယာကို စဉ်းစားရာတွင် အလွန်နက်သော ချောက်ကမ်းပါးများဖြစ်၍ အခြေချ နေထိုင်သော နေရာများ မရှိပါ။ သို့သော် ယာယီငါးဖမ်းတဲများ၊ တရားမဝင်သစ်ခုတ်တဲ များသာရှိပါသည်။

၆.၃.၃ လူဦးရေအဆမတန်တိုးပွားခြင်း

အဓိက ဆောက်လုပ်ရေး အချိန်ကာလအတွင်း ယာယီလူဦးရေတိုးပွားမှု အလျင်အမြန် ဖြစ်ပေါ် လာမည် ဖြစ်ပါသည်။ လူဦးရေအဆမတန်တိုးပွားမှုသည် ယာယီဖြစ်သော်လည်း ဒေသခံအဆောက်အဦး မလုံလောက်မှု၊ အထောက်အပံ့၊ အသုံးအဆောင်များ၊ လူအဖွဲ့အစည်း ကျန်းမာရေးအခြေအနေနှင့် သန့်ရှင်း မှုများကို ထိခိုက်မည် ဖြစ်ပါသည်။ ဒေသခံပံ့ပိုးမှုများသည် ဒေသခံပြည်သူများ အပေါ် လျော့ကျသွား သလို ပြောင်းရွှေ့လာ သူများ အတွက်လည်း မလုံမလောက် ဖြစ်မည်ဖြစ်ပါသည်။

၆.၃.၄ လူမှုအသိုင်းအဝိုင်းလုံခြုံမှု

လုပ်ငန်းခွင် အန္တရာယ်ကင်းရှင်းရေး အစီအမံများကို အလယ်ရဲရွာ စီမံကိန်းတွင် ထည့်သွင်း စဉ်းစားရမည် ဖြစ်ပါသည်။ လမ်းပန်းဆက်သွယ်ရေး မတော်တဆဖြစ်ပွားမှုများ၊ အညစ်အကြေး ထိန်းသိမ်းမှုများကို စီမံရပါမည်။ အသွားအလာ များပြားလာသည်နှင့်အမျှ မတော်တဆမှုများလည်း များပြားလာမည် ဖြစ်ပါ သည်။ ကြီးမားပြင်းထန်သော မတော်တဆမှုများလည်း အဓိကလမ်းမကြီးများတွင် ဖြစ်ပေါ်နိုင်ပါသည်။

အကယ်၍ အန္တရာယ် ဖြစ်စေနိုင်သော စွန့်ပစ်ပစ္စည်းများ၊ အသုံးပြုပစ္စည်းများနှင့် အသုံးပြုပစ္စည်းများ သယ်ဆောင်ရာတွင် လုံခြုံရေး အစီအမံများ အထူးလိုအပ်ပါသည်။ ထိုပစ္စည်းများသည် ရေထု၊ လေထုနှင့်မြေထုပေါ်တွင် ပြင်းထန်သော ပျက်စီးညစ်ညမ်းခြင်းများ ဖြစ်ပေါ်နိုင်ပါ သည်။

sn power

၆.၃.၅ သစ်တောသယံဇာတ အသုံးပြုခြင်း

တည်ဆောက်ရေးကာလ အဆောင်များ ဆောက်လုပ်ခြင်း၊ လမ်းများဖောက်လုပ်ခြင်းသည် ရှည်လျားမတ်စောက်သော ကမ်းပါးယံမှ ရေကာတာနေရာအထိ ဖောက်လုပ်မည်ဖြစ်၍ သစ်တောများ ပျက်စီးဆုံးရှုံးမည် ဖြစ်ပါသည်။ နီးစပ်ရာ ကျေးရွာများမှ အသုံးပြုသော ထိခိုက်မှုနှင့် ကွာခြားပါသည်။ ရွာသားများသည် သစ်ခုတ်ခြင်း၊ အမဲလိုက်ခြင်းများကို သွားလာရန် အလွန်ခက်ခဲသော နေရာများတွင် လုပ်ဆောင်ခြင်းမရှိပါ။

ငါးဖမ်းခြင်းကြောင့်ရရှိသော ဝင်ငွေသည် ၁ ရာခိုင်နှုန်း ထက်နည်းသော စုစုပေါင်းဝင်ငွေ ပမာဏ သာ ရရှိသည်ဟု လူမှုဘဝလေ့လာရေးရလဒ်၌ ဖော်ပြထားပါသည်။ သို့ရာတွင်ဆည်ကြီးတည်ဆောက် ပြီးပါက ရေတွင်းကြီးကဲ့သို့သော နီးစပ်ရာရွာများသည် ငါးဖမ်းခြင်းလုပ်ငန်းကိုတွင်တွင် ကျယ်ကျယ်လုပ်ကိုင် နိုင်ပြီး၊ အစာအာဟာရအထောက်အပံ့များပို၍ ရရှိလာနိုင်သည့် အခွင့်အရေးများ ရှိပါသည်။

၆.၃.၅ ထိခိုက်မှုအကျဉ်းချုပ်

အောက်ပါဇယားသည် ထိခိုက်မှုများ လျော့နည်းပပျောက်အောင် လျှော့ချနိုင်သည် နှင့် မလျှော့ချ နိုင်သည့် အကြောင်းကို အကဲဖြတ်ထားသော ဇယားဖြစ်ပါသည်။

အကြောင်းအရာ	တန်ဖိုး/ထိခိုက်လွယ်သည့် အခြေအနေ	သက်ရောက် သည့် ပမာဏ	သက်ရောက်မှု	
			လျှော့ချခြင်း မပါဝင်ပါ။	လျှော့ချခြင်း ပါဝင်သည်။
တည်ဆောက်ရေးကာလ				
သဘာဝပတ်ဝန်းကျင်				
မြေမျက်နှာသွင်ပြင်နှင့်ရှုခင်း	**အသင့်အတင့်**	နည်း-အသင့်အတင့် (ဆိုးကျိုးဘက်သို့)	-/- -	-
မြေကြီးနှင့်မြေဆီလွှာ	**မသက်ဆိုင်ပါ**	အသင့်အတင့် (ဆိုးကျိုးဘက်သို့)	- -	-
ရာသီဥတု	**များ**	နည်း (ဆိုးကျိုးဘက်သို့)	-	0 /-
လေအရည်အသွေး	**များ**	နည်း-အသင့်အတင့် (ဆိုးကျိုးဘက်သို့)		-
ဆူညံမှုနှင့်တုန်ခါမှု	**များ**	နည်း-အသင့်အတင့် (ဆိုးကျိုးဘက်သို့)	-/- -	-
ရေဂုဏ်သတ္တိနှင့်ရေစီးကြောင်း	**မသက်ဆိုင်ပါ**	နည်း (ဆိုးကျိုးဘက်သို့)	-/- -	-
အနည်စီးကြောင်း	**များ**	နည်း-အသင့်အတင့် (ဆိုးကျိုးဘက်သို့)	-/- -	-
ရေအရည်အသွေး	**အသင့်အတင့်များ**	နည်း-အသင့်အတင့် (ဆိုးကျိုးဘက် သို့)	-/- -	-

အကြောင်းအရာ	တန်ဖိုး/ထိခိုက်လွယ်သည့်အခြေအနေ	သက်ရောက် သည့် ပမာဏ	သက်ရောက်မှု	
			လျှော့ချခြင်း မပါဝင်ပါ။	လျှော့ချခြင်း ပါဝင်သည်။
ဇီဝပတ်ဝန်းကျင်				
ကာကွယ်နေရာများ	နည်း	မသိသာပါ	0	0
အပင်ပေါက်ရောက်မှု	အသင့်အတင့်	နည်း-အသင့်အတင့် (ဆိုးကျိုးဘက်သို့)	-	0/-
မြေပြင်ပေါက်ပင်များ	အသင့်အတင့်	အသင့်အတင့် (ဆိုးကျိုးဘက်သို့)	- -	-
ရေပိုင်းဆိုင်ရာဂေဟာဗေဒဝန်ဆောင်မှုများ	အသင့်အတင့်	အသင့်အတင့် (ဆိုးကျိုးဘက်သို့)	- -	-
လူမှုပတ်ဝန်းကျင်				
စီမံကိန်းဒေသစီးပွားရေး	များ	နည်း-အသင့်အတင့် (ကောင်းကျိုး)	++	++/+++
ရွှေ့ပြောင်းရေးနှင့်ပြန်လည်နေရာချထားရေး	များ	နည်း-အသင့်အတင့် (ဆိုးကျိုးဘက်သို့)	-/- -	0
စီးပွားရေးရွှေပြောင်းခြင်းနှင့်လူမှုနေထိုင်ပုံစံဆုံးရှုံးမှု	များ	နည်း-အသင့်အတင့် (ဆိုးကျိုးဘက်သို့)	-/- -	0
လူဦးရေတိုးပွားခြင်းနှင့် အချိုးအစားပြောင်းလဲမှုများ	များ	အသင့်အတင့် (ဆိုးကျိုးဘက်သို့)	- -	-
လူ့အဖွဲ့အစည်း လုံခြုံမှု	များ	အသင့်အတင့် (ဆိုးကျိုးဘက်သို့)	- -	-
သစ်တောအရင်းအမြစ်များအသုံးပြုမှု	များ	မသိသာပါ - နည်း (ဆိုးကျိုးဘက်သို့)	-	- /0
မြစ်အရင်းအမြစ်များအသုံးပြုမှု	များ	နည်း-အသင့်အတင့် (ဆိုးကျိုးဘက်သို့)	- /- -	-
ရှေးဟောင်းနေရာများနှင့်ယဉ်ကျေးမှုနှင့်သက်ဆိုင်သောနေရာများ	များ	မသိသာပါ	0	0
လုပ်ငန်းလည်ပတ်သည့်ကာလ				
သဘာဝပတ်ဝန်းကျင်				
မြေမျက်နှာသွင်ပြင်နှင့်ရှုခင်း	အသင့်အတင့်	နည်း-အသင့်အတင့် (ဆိုးကျိုးဘက်)	- -	-
မြေကြီးနှင့်မြေဆီလွှာ	မသက်ဆိုင်ပါ	နည်း-အသင့်အတင့် (ဆိုးကျိုးဘက်)	- -	-
ရာသီဥတု	များ	နည်း-အသင့်အတင့် (ကောင်းကျိုး)	+	++
လေအရည်အသွေး	များ	မသိသာပါ	0	0
ဆူညံမှုနှင့်တုန်ခါမှု	များ	မသိသာပါ	0	0

အကြောင်းအရာ	တန်ဖိုး/ထိခိုက်လွယ်သည့် အခြေအနေ	သက်ရောက် သည့် ပမာဏ	သက်ရောက်မှု	
			လျှော့ချခြင်း မပါဝင်ပါ။	လျှော့ချခြင်း ပါဝင်သည်။
ရေဂုဏ်သတ္တိနှင့်ရေစီးကြောင်း	မသက်ဆိုင်ပါ	နည်း-အသင့်အတင့် (ဆိုးကျိုးဘက်သို့)	- /- -	- /- -
အနည်စီးကြောင်း	များ	နည်း-အသင့်အတင့် (ဆိုးကျိုးဘက်သို့)	-	0 /-
ရေအရည်အသွေး	အသင့်အတင့် - များ	အသင့်အတင့် (ဆိုးကျိုးဘက်သို့)	- -	- /- -
ဇီဝပတ်ဝန်းကျင်				
ကာကွယ်နေရာများ*	နည်း	မသိသာပါ (သို့) နည်း (ဆိုးကျိုးဘက် သို့)	0 (သို့) -	0 (သို့) -
အပင်ပေါက်ရောက်မှု	အသင့်အတင့်	နည်း (ဆိုးကျိုးဘက် သို့)	-	0 / -
မြေပြင်ပေါက်ပင်များ	အသင့်အတင့်	အသင့်အတင့် (ဆိုးကျိုးဘက်သို့)	- -	- -/ -
ရေပိုင်းဆိုင်ရာ ဂေဟဗေဒ ဝန်ဆောင်မှုများ	အသင့်အတင့်	အသင့်အတင့် (ဆိုးကျိုးဘက်သို့)	- -	- - / -
လူသားပတ်ဝန်းကျင်				
စီမံကိန်းဒေသစီးပွားရေး	များ	နည်း-အသင့်အတင့် (ကောင်းကျိုး)	+	++
ရွှေ့ပြောင်းရေး နှင့် ပြန်လည်နေရာချထားရေး	များ	မသိသာပါ	0	0
စီးပွားရေး ရွှေ့ပြောင်းခြင်း နှင့် လူမှု နေထိုင်မှုပုံစံ ဆုံးရှုံးမှု	များ	မသိသာပါ	0	0
လူဦးရေ တိုးပွားခြင်း နှင့် အချိုးအစား ပြောင်းလဲမှုများ	များ	နည်း (ဆိုးကျိုးဘက်)	-	-
လူမှု အဖွဲ့အစည်း လုံခြုံမှု	များ	မသိသာပါ	0	0
သစ်တောအရင်းအမြစ်များအသုံးပြုမှု	များ	နည်း (ဆိုးကျိုးဘက်)	0	+
မြစ်အရင်းအမြစ်များအသုံးပြုမှု	များ	အသင့်အတင့်-နည်း (ဆိုးကျိုးဘက်)	-	0
ရှေးဟောင်းနေရာများ၊ယဉ်ကျေးမှုနှင့် သက်ဆိုင်သောနေရာများ	များ	မသိသာပါ	0	0

* ဆန်းစစ်လေ့လာမှုသည် လက်ဝဲဖက်ကမ်းရှိ အချို့သော နေရာများ၏ သစ်တောထိန်းထိမ်းထားရှိ/မရှိ အခြေအနေပေါ်တွင်မူတည်နေပါသည်။

၇။ ပါဝင်ပတ်သက်သူများနှင့် ညှိနှိုင်းတိုင်ပင်မှု

၇.၁ ပထမအကြိမ် ညှိနှိုင်းတိုင်ပင်ခြင်း

၂၀၁၅ ခုနှစ် ဖေဖော်ဝါရီ နှင့် မတ်လတွင် မြစ်ညာဘက်ခြမ်းကျေးရွာ ၆ ရွာနှင့် တွေ့ဆုံဆွေးနွေး ခဲ့ပါသည်။ ယေဘုယျအားဖြင့် ဆန့်ကျင်ကန့်ကွက်ခဲ့သူ မရှိဘဲ ရေအားလျှပ်စစ်လုပ်ငန်းကို သဘောကျ နှစ်သက်ကြပါသည်။ လျှပ်စစ်လိုအပ်မှု၊ ရေရရှိမှု၊ လမ်းပန်းဆက်သွယ်ရေး ကောင်းမွန်မှုနှင့် အလုပ်အကိုင် အခွင့်အလမ်း များကို တောင်းဆိုခဲ့ကြပါသည်။

ရေလွှမ်းမိုးမှုနှင့်ပတ်သက်၍ ကျေးရွာများမှ စိုက်ပျိုးမြေများသည် ရေလှောင်တမံ တည်ဆောက်ခြင်း ကြောင့် လုံးဝဆုံးရှုံးမှုမရှိပါ။ အချို့သော မြေယာအချို့သာ လမ်းဖောက်လုပ်ခြင်းကြောင့် ဆုံးရှုံးနိုင်ပါသည်။ ရေလှောင်တမံ အနီးဝန်းကျင်နှင့် ရေတွင်းကြီးရွာအနီးတဝိုက် တွင် စခန်းများ ဆောက်လုပ်ခြင်း ကြောင့်မြေများ ဆုံးရှုံးရနိုင်သည်။

၇.၂ ဒုတိယအကြိမ်ညှိနှိုင်းတိုင်ပင်ခြင်း

၂၀၁၆ ခုနှစ် မေလတွင် ဆည်အနီးပတ်ဝန်းကျင် ရွာသားများကို ဖိတ်ခေါ်၍ အစည်းအဝေးများပြုလုပ်ခဲ့ ပါသည်။ ပါဝင်တက်ရောက်လာသူများက လုပ်ငန်းများအကြောင်း ကြိုတင်အသိပေး၍ ကျေးဇူးတင်ကြောင်း ပြောကြားမှုကို ကြားသိခဲ့ရပါသည်။ ရွာသားများက လျှပ်စစ်မီးရရှိမှုကို စိတ်ဝင်စားကြောင်း ထပ်တလဲလဲပြောဆိုပြီး အခြားအကျိုးရလဒ်များ မည်မျှရရှိနိုင်မည်ကို မေးမြန်းခဲ့ပါသည်။ အချို့ရွာများမှ မြစ်ငယ်မြစ်ကူးတံတားနစ်မြုပ်နိုင်မှု ရှိ/မရှိ မေးမြန်းခဲ့ပါသည်။ ထိုညှိနှိုင်းဆွေးနွေးမှုမှ ရွာသားများကို လေ့လာရေးလုပ်ဆောင်မှုများနှင့် ၎င်းတို့နစ်နာချက်များကို တင်ပြနိုင်ရန် အသိပေးခဲ့ပါသည်။

၈။ ပတ်ဝန်းကျင်နှင့်လူမှုရေးစီမံခန့်ခွဲမှု အစီအစဉ်

၈.၁ အသင်းအဖွဲ့ နှင့် အလုပ်သမားများဖွဲ့စည်းပုံ

လုပ်ငန်းအကောင်အထည်ဖော်သည့်အဖွဲ့သည် ပတ်ဝန်းကျင်နှင့် လူမှုရေးဆိုင်ရာအဖွဲ့အစည်းတစ်ခု ဖွဲ့စည်း မည်ဖြစ်ပါသည်။ ပြည်တွင်းမှ မန်နေဂျာတစ်ဦးကဦးဆောင်၍ ထိုသူက စီမံကိန်းမန်နေဂျာကို တိုက်ရိုက်တင် ပြမည်ဖြစ်ပါသည်။ ထိုအဖွဲ့တွင် သီးခြားအဖွဲ့ ၅ ဖွဲ့ထားရှိပြီး သက်ဆိုင်ရာတာဝန်အလိုက် စောင့်ကြည့်လေ့လာပြီး ပတ်ဝန်းကျင်နှင့် လူမှုရေး စီမံခန့်ခွဲမှု အစီအစဉ်သို့ ရှင်းလင်းတင်ပြမည် ဖြစ်ပါသည်။ အဖွဲ့တစ်ခုချင်း စီတွင် အဖွဲ့ခေါင်းဆောင်တစ်ဦးစီရှိမည်ဖြစ်ပြီး အဖွဲ့ဝင်ကျွမ်းကျင်သူ ၃ဦး မှ ၄ဦးပါဝင်မည် ဖြစ်ပါသည်။ ပတ်ဝန်းကျင်နှင့် လူမှုရေးဆိုင်ရာအဖွဲ့အစည်းတွင် ပါဝင်မည့်အဖွဲ့ခွဲများမှာ- (၁) လျော်ကြေးပေးခြင်းနှင့်နစ်နာချက်များအဖွဲ့၊ (၂) လူမှုရေးအစီအမံနှင့်ညှိနှိုင်းရေးအဖွဲ့၊ (၃) ပတ်ဝန်းကျင် ထိန်းသိမ်းရေးအဖွဲ့၊ (၄) အစုအဖွဲ့ပိုင်သစ်တောအဖွဲ့၊ (၅) အခြေခံအဆောက်အဦများ ထောက်ပံ့ရေး အဖွဲ့တို့ ဖြစ်ပါသည်။

၈.၂ ပတ်ဝန်းကျင်ဆိုင်ရာစီမံခန့်ခွဲမှုအစီအစဉ်

ပတ်ဝန်းကျင်ဆိုင်ရာစီမံခန့်ခွဲမှုအစီအစဉ်တွင် ဆင့်ပွါးအစီအစဉ်များ နှင့် စီမံချက်များပါဝင်ပါသည်။ ၎င်းတို့မှာ

- **ပတ်ဝန်းကျင်ဆိုင်ရာစီမံခန့်ခွဲမှုနှင့်ကြီးကြပ်မည့်အစီအစဉ်ကိုတည်ဆောက်ခြင်း**
  ကန်ထရိုက်တာသည် တင်ဒါစာရွက်စာတမ်းများတွင်ရေးသားဖော်ပြထားသော အန္တရာယ်ရှိ စွန့်ပစ်ပစ္စည်းများ၊ အန္တရာယ်မရှိစွန့်ပစ်ပစ္စည်းများ၊ လေထုညစ်ညမ်းမှုကို ထိန်းသိမ်းခြင်း၊ မြေတိုက်စားမှုကို ထိန်းသိမ်းခြင်း၊ အရေးပေါ် ကိစ္စများ၊ ကျန်းမာရေး၊ လုံခြုံရေးများနှင့်သက်ဆိုင်သော အကြောင်းအရာများကို စီမံကိန်းနေရာနှင့် သင့်လျော် သောတိကျသည့်အစီအစဉ်များအတိုင်းသော်လည်းကောင်း၊ တင်ဒါတွင် ဖော်ပြရေးသား ညွှန်ကြားထားချက်များအတိုင်း လိုက်နာအကောင်အထည်ဖော်လုပ်ဆောင်ရပါမည်။
- **ရေအရည်အသွေးကိုကြီးကြပ်မည့်အစီအစဉ်**
  အလယ်ရဲရွာစီမံကိန်းကြောင့် ပြောင်းလဲသွားသောရေအရည်အသွေးကို မှတ်တမ်းကောက်ယူရန် ရေအရည်အသွေးကို ကြီးကြပ်မည့်အစီအစဉ်ကို လက်တွေ့လုပ်ဆောင်ရပါမည်။ ထိုအစီအစဉ်မှ ထွက်လာသည့်ရလဒ်များကို နှစ်လတစ်ကြိမ် အစီရင်ခံစာများ ပြုစုထားရှိပြီး သက်ဆိုင်သော ဌာနဆိုင်ရာ အဖွဲ့အစည်းအသီးသီးနှင့် ပူးပေါင်းဆောင်ရွက်သွားရပါမည်။
- **ရေပိုင်းဆိုင်ရာဂေဟဗေဒစနစ်နှင့်ငါးလုပ်ငန်းများကိုစီမံခန့်ခွဲမည့်အစီအစဉ်**
  ရေပိုင်းဆိုင်ရာဂေဟစနစ်များနှင့် ငါးလုပ်ငန်းများကို စီမံခန့်ခွဲမည့်အစီအစဉ်သည် စစ်တမ်းများ ကောက်ယူပြီးပါက သင့်လျော်သောအစီအမံများကိုဆုံးဖြတ်ပြီး လုပ်ဆောင်ရပါမည်။ တည်ဆောက်ရေးလုပ်ငန်းလုပ်ဆောင်နေစဉ် နှင့် အထူးသဖြင့် လုပ်ငန်းလုပ်ကိုင်နေစဉ်များအတွင်း မျိုးတုံးလုနီးပါးမျိုးစိတ်များကို မထိခိုက်စေရန်၊ ငါးလုပ်ငန်းများလုပ်ကိုင်ရာတွင် အန္တရာယ်ရှိသော ငါးဖမ်းနည်းများကို မကျင့်သုံးမိစေရန် (ဥပမာ အဆိပ်၊ ဒိုင်းနမိုက်များ အသုံးပြုခြင်း)နှင့် တာရှည်ခံသော ငါးဖမ်း လုပ်ငန်း ကျင့်ထုံးများကိုသာ ကျင့်သုံးနိုင်စေရန် ဒေသခံပြည်သူများ၏ ခံစားချက်များကို တာဝန်ခံကာ လုပ်ဆောင်ရပါမည်။
- **ရေလှောင်ကန်များရှင်းလင်းခြင်းနှင့် ပြန်လည်ဖြည့်မည့်အစီအစဉ်**
  ရေလှောင်ကန်များရှင်းလင်းခြင်း နှင့် ပြန်လည်ဖြည့်မည့် အစီအစဉ်တွင်ပါဝင်သည်များမှာ (၁) ရေလှောင်ကန်ဧရိယာ သတ်မှတ်ခြင်း၊ (၂) ရောင်းတန်းဝင် သစ်များကို ယူဆောင်ခြင်း (ကန်ထရိုက်စနစ် (သို့မဟုတ်) ဌာနဆိုင်ရာအစီအစဉ်များဖြင့်) (၃) ရွေးချယ်ထားသော နေရာများကို ရှင်းလင်းခြင်းနှင့် မီးလောင်မှုများကို ထိန်းချုပ်ခြင်း (ကန်ထရိုက်တာမှ ဒေသခံများကို အခကြေးငွေပေး၍ ဆောင်ရွက်စေခြင်း) (၄) ပထမအဆင့် ရေလှောင်ကန် ရေစတင်သိုလှောင်ရာတွင် အနည်များကိုစုစည်းပြီး ဖယ်ရှားခြင်း။
- **ဇီဝမျိုးစုံမျိုးကွဲများနှင့်ပတ်ဝန်းကျင်ထိန်းသိမ်းရေးအစီအစဉ်**
  ဇီဝမျိုးစုံမျိုးကွဲများနှင့် ပတ်ဝန်းကျင်ထိန်းသိမ်းရေး အစီအစဉ် တွင်ပါဝင်သည်များမှာ သစ်တောပိုင်းဆိုင်ရာ အာဏာပိုင်အဖွဲ့အစည်းများ၊ ဒေသတွင်းရှိ အာဏာပိုင်အဖွဲ့အစည်းများ၊ ဒေသခံ ကျေးရွာလူထု တို့နှင့် ညှိနှိုင်းတိုင်ပင် ဆွေးနွေး၍ မြစ်ကမ်းနှစ်ဖက်ပေါ်ရှိ ရေလှောင်ကန်

ဝန်းကျင်တွင် တစ်ခု(သို့) တစ်ခုထက်ပိုသော ကာကွယ်တောများကို ဖြစ်မြောက်အောင် ဆောင်ရွက်နိုင်မည့် အလားအလာများကို အစီအစဉ်ရေးဆွဲခြင်းများပါဝင်ပါသည်။ ဤအစီအစဉ်တွင် မျိုးတုံးလုနီးပါးဖြစ်နေသောမျိုးစိတ်များကို ထိန်းသိမ်းခြင်း လုပ်ငန်းများ၊ အထူးသဖြင့် စီမံကိန်းနေရာနှင့်တစိတ်တပိုင်း ထပ်တူကျနေသော မယ်ဟုန်-ဒု၄၀တီ အနီးတဝိုက်ဒေသ၏ ဇီဝမျိုးစုံမျိုးကွဲများထိန်းသိမ်းသည့် ပင်မဧရိယာတွင်တွေ့ရသည့် မျိုးတုန်းလုနီးပါးဖြစ်သည့် ဒေါင်းမျိုးစိတ်များကို ထိန်းသိမ်းခြင်းများ ပါဝင်ရပါမည်။

- **အစုအဖွဲ့ပိုင်သစ်တောအစီအစဉ်**
  အစုအဖွဲ့ပိုင်သစ်တောအစီအစဉ်တွင် သဘာဝအလျောက်ပေါက်သောအပင်များကို ထိန်းသိမ်းသည့် အစီအစဉ်နှင့် လူအကူအညီဖြင့် သစ်ပင်မျိုးစိတ်များ ပြန်လည်ပျိုးထောင်သည့်အစီအစဉ်များ၊ လက်ရှိ သစ်တောများကို ဆက်လက်ထိန်းသိမ်းခြင်းနှင့် သစ်တောရောစိုက်ပျိုးကျင့်သုံးမှုများကို ပြန်လည် မြှင့်တင်ခြင်းများ ပါဝင်ပါသည်။ ရည်ရွယ်ချက်များမှာ (၁) စီမံကိန်းနှင့် တိုက်ရိုက်သက်ရောက်နေသော နေရာ ပြင်ပရှိ ဦးစားပေး သစ်တောများကို ပြန်လည်ထိန်းသိမ်းခြင်းဖြင့် အလယ်ရဲရွာ ရေလှောင်ကန်အနီး ဆုံးရှုံးသွားသော သစ်တောများကို ပြန်လည်အစားထိုးခြင်း။ (၂) ရေမြေ ထိန်းသိမ်းခြင်းနှင့် ဇီဝမျိုးစုံမျိုးကွဲများကိုထိန်းသိမ်းခြင်းအပြင် ဒေသခံပြည်သူများ ဦးဆောင်သော တာရှည်ခံမည့် သစ်တောစီမံကိန်းများလုပ်ဆောင်ကာ ဒေသခံပြည်သူတို့၏ ဂေဟဗေဒစနစ် ဝန်ဆောင်မှုများကို အသုံးပြုနိုင်စွမ်းတိုးတက်စေခြင်း တို့ပါဝင်ရပါမည်။
- **စတင်လုပ်ဆောင်ကာလ - ပတ်ဝန်းကျင်စီမံခန့်ခွဲမှုနှင့်သက်ဆိုင်သော မူဘောင်**
  စတင်လုပ်ဆောင်ကာလ - ပတ်ဝန်းကျင်စီမံခန့်ခွဲမှုနှင့်သက်ဆိုင်သော မူဘောင်သည် လုပ်ဆောင်သည့်ကာလ မစတင်ခင်ကတည်းက ပြည့်စုံစွာတည်ဆောက်ပြီးဖြစ်ရပါမည်။ ဤမူဘောင်သည် ဆောက်လုပ်ရေးကာလတွင် စတင်သည့်လျှော့ချရေးအစီအစဉ်အမျိုးမျိုးပေါ်တွင် တည်ဆောက်ထားရပါမည်။ ထို့အပြင် အောက်ပါပတ်ဝန်းကျင်ဆိုင်ရာပြဿနာများ အကြမ်းဖျင်း ပါဝင်ရပါမည်။ (၁) စွန့်ပစ်ပစ္စည်းများကို စီမံခန့်ခွဲခြင်းနှင့်လေထုညစ်ညမ်းမှုကိုထိန်းသိမ်းခြင်း။ (၂) ရေအရည်အသွေးကို ကြီးကြပ်ခြင်း။ (၃) ငါးလုပ်ငန်းများကိုစီမံခန့်ခွဲခြင်းနှင့် ရေပိုင်းဆိုင်ရာ ဂေဟဗေဒစနစ်များ ကြီးကြပ်ခြင်း။ (၄) ပတ်ဝန်းကျင်ဆိုင်ရာ ထိန်းသိမ်းသည့်လုပ်ငန်းများ နှင့် (၅) သစ်တောစီမံခန့်ခွဲမှုများ။

၈.၃ လူမှုလုပ်ငန်းများစီမံခန့်ခွဲခြင်းအစီအစဉ်

လူမှုလုပ်ငန်းများစီမံခန့်ခွဲခြင်းအစီအစဉ်တွင်အောက်ပါအစီအစဉ်များနှင့်ပရိုဂရမ်များပါဝင်ပါသည်။

- **ပါဝင်သူများစေ့စပ်ညှိနိုင်းဆွေးနွေးခြင်းအစီအစဉ်**
  လုပ်ငန်းမစမီကာလနှင့် စပြီးကာလများတွင် ဆက်လက်လုပ်ဆောင်နေသည့် ပါဝင်သူများနှင့် တိုင်ပင် ဆွေးနွေးခြင်းများတွင် ဒေသခံပြည်သူများ၏တိုးတက်မှု အစီအစဉ်များကို ဦးစားပေး ဆွေးနွေးရပါမည်။ တိုးတက်မှုအစီအစဉ်ဆိုရာတွင် လမ်းပန်းဆက်သွယ်ရေး တိုးတက်အောင်

ပြုလုပ်ခြင်း၊ SN Power မှ ရန်ပုံငွေပေးသော လျှပ်စစ်မီးဆက်သွယ်မှုများ တိုးတက်အောင် ပြုလုပ်ခြင်းတို့ ပါဝင်ပါသည်။

- **ဆုံးရှုံးသွားသောမြေများ၊ လုပ်ငန်းများနှင့် ပုံသေပိုင်ဆိုင်မှုများအတွက် အလျော်ပေးခြင်းအစီအစဉ်**
  လမ်းဆက်သွယ်မှုများကို အသေးစိတ်ဆုံးဖြတ်ပြီးသည်နှင့် တစ်ပြိုင်နက် ဆုံးရှုံးမည့်မြေပမာဏနှင့် လမ်းပန်းဆက်သွယ်ရေးများ တည်ဆောက်ရာတွင်ကုန်ဆုံးမည့် ပမာဏများကိုစစ်တမ်းများ ကောက်ယူရပါမည်။ ပြောင်းလဲနေထိုင်ရသည့်အတွက် ကုန်ဆုံးမည့်ပမာဏများကို အပြည့်အဝ လျော်ကြေး ပေးဆောင်ရပါမည်။
- **ဆောက်လုပ်မည့်နေရာများတွင် ပြုလုပ်မည့်လူမှုလုပ်ငန်းများအစီအစဉ်**
  စီမံကိန်းကြောင့် ရွှေ့ပြောင်းလာမည့် လူပမာဏပေါ်မူတည်၍ လိုအပ်ပါက ရေပေးဝေခြင်းနှင့် သန့်ရှင်းရေး လုပ်ငန်းများကို စီမံကိန်းနှင့်သက်ဆိုင်သော ဝန်ထမ်းများ(သို့)လုပ်သားများ နေထိုင်မည့်ရွာများတွင် တိုးတက်စေရန်လုပ်ဆောင်ရပါမည်။ လုပ်ငန်းသုံး ယာဉ်၊ စက်ယန္တရား အသွားအလာများကြောင့် ဖြစ်ပေါ်လာမည့် မတော်တဆထိခိုက်မှုများ လျှော့ချရန် အရှိန်ထိန်းစနစ်များနှင့် ကျောင်းများတွင် ယာဉ်အန္တရာယ်ကင်းရှင်းရေး၊ ယာဉ်စည်းကမ်း၊ လမ်းစည်းကမ်းဆိုင်ရာဟောပြော ပို့ချပေးမည့် အစီအစဉ်များ လုပ်ဆောင်ပေးရပါမည်။

- **လူမှုအဖွဲ့အစည်း တိုးတက်စေမည့်အစီအစဉ်**
  လူမှုအဖွဲ့အစည်း တိုးတက်စေမည့်အစီအစဉ်တွင် လမ်းများအဆင့်မြှင့်ခြင်း၊ စီမံကိန်းနှင့်တိုက်ရိုက် မသက်ရောက်သော ရွာများတွင်လျှပ်စစ်မီးများ တပ်ဆင်ပေးခြင်းတို့ပါဝင်ရပါမည်။ လူမှုအဖွဲ့အစည်း တိုးတက် စေမည့်အစီအစဉ်ကို သက်ဆိုင်ရာ အစိုးရအဖွဲ့များနှင့် အတူတကွ ညှိနှိုင်းတိုင်ပင် လုပ်ဆောင်ပြီးမှ အသေးစိတ်အစီအစဉ်များ ရေးဆွဲနိုင်ပါမည်။
- **အလုပ်သမားများခေါ်ယူခြင်းနှင့်အလုပ်အကိုင်ပေးခြင်း**
  စီမံကိန်းသည် လုပ်ငန်းဆောင်ရွက်မည့် ကန်ထရိုက်တာများအား ဒေသခံ ပြည်သူများကို ဦးစားပေး၍ အလုပ်အကိုင်ပေးရန် စီစဉ်ညွှန်ကြားပေးရပါမည်။ အလုပ်အကိုင်ပေးရာတွင် စီမံကိန်းနေရာ အတွင်း နေထိုင်နေသောရွာများရှိ လုပ်ငန်းကျွမ်းကျင်သော ဒေသခံရွာသားများနှင့် အနည်းငယ်ကျွမ်းကျင်သော ရွာသားများကို စာရင်းကိုပြုစုကာ ကန်ထရိုက်တာများထံ ကြိုတင် ပေးပို့ထားရမည် ဖြစ်ပါသည်။

၈.၄ ပတ်ဝန်းကျင်နှင့် လူမှုလုပ်ငန်းများစီမံကိန်း (ESMP) အတွက် ဘတ်ဂျက်စာရင်း

အောက်ပါဇယားသည် ESMP အတွက်ခန့်မှန်းဘတ်ဂျက်စာရင်းဖြစ်ပါသည်။

အမှတ်စဉ်	အကြောင်း အရာ	တည်ဆောက်ရေးလုပ်ငန်း မစခင်ကာလ	တည်ဆောက်ရေးလုပ်ငန်း ဆောက်ရွက်စဉ်ကာလ						စုစုပေါင်း (USD)
		ပထမနှစ်	ပထမနှစ်	ဒုတိယနှစ်	တတိယနှစ်	စတုတ္ထနှစ်	ပဥ္စမနှစ်	ဆဌမနှစ်	
၁	စီမံကိန်းတိုက်ရိုက်ကျသင့်ငွေ (ESU)	၃၉၉,၆၀၀	၄၄၅,၂၀၀	၄၄၅,၂၀၀	၃၉၂,၄၀၀	၃၉၂,၄၀၀	၃၉၂,၄၀၀	၃၉၂,၄၀၀	၂,၈၅၉,၆၀၀
၂	ဌာနဆိုင်ရာကိစ္စရပ်များ အတွက်ကျသင့်ငွေ	၅၀,၃၀၀	၅၀,၃၀၀	၃၉,၅၀၀	၃၉,၅၀၀	၃၉,၅၀၀	၃၉,၅၀၀	၃၉,၅၀၀	၂၉၈,၁၀၀
၃	ပတ်ဝန်းကျင်ထိန်းသိမ်းရေး စီမံကိန်းအတွက် ကျသင့်ငွေ	၁၃၀,၀၀၀	၁၀၀,၀၀၀	၁၀၀,၀၀၀	၁၁၀,၀၀၀	၂၆၅,၀၀၀	၂၆၅,၀၀၀	၁၈၅,၀၀၀	၁,၁၅၅,၀၀၀
၄	လူမှုရေး လုပ်ငန်းများ နှင့် ဒေသဖွံ့ဖြိုးရေးလုပ်ငန်း အတွက်ကျသင့်ငွေ	၄၉၂,၀၀၀	၁,၈၅၃,၀၀၀	၂,၄၁၈,၇၅၀	၁,၉၈၇,၅၀၀	၁,၀၀၂,၅၀၀	၁,၀၀၂,၅၀၀	၁၈၂,၅၀၀	၈,၉၃၈,၇၅၀
	EMP/SMP စုစုပေါင်း ကျသင့်ငွေ (USD)	**၁,၀၇၁,၉၀၀**	**၂,၄၄၈,၅၀၀**	**၃,၀၀၃,၄၅၀**	**၂,၅၂၉,၄၀၀**	**၁,၆၉၉,၄၀၀**	**၁,၆၉၉,၄၀၀**	**၇၉၉,၄၀၀**	**၁၃,၂၅၁,၄၅၀**

လက်ရှိတွင် စီမံကိန်းတစ်ခုလုံးအတွက် အရေးပေါ်အစီအစဉ်များအတွက် အရန်ငွေကြေးသတ်မှတ်မှုများ မဆုံးဖြတ်ရသေးပါ။

EXECUTIVE SUMMARY

This Environmental Impact Assessment (EIA) for the Middle Yeywa Hydropower Project on the Myitnge (Nam Tu) River located in the Shan State, Myanmar was produced by a combined team of international and national experts on behalf of SN Power, based on field work carried out from 2015 to 2018.

The project is proposed in an area characterised by a plateau landscape with a deeply incised river valley. Most of the surrounding plateau consists of agricultural fields while some forest left on the upper slopes of the valley. The steeper slopes towards the lower part of the valley are forested. The construction of the Middle Yeywa Hydropower Project will create a 70 km long and narrow reservoir that will submerge the forest at the lower part of the valley.

There are a number of villages in the indirect impact zone of the project. These villages rely on agriculture as their main source of income with sugar cane and maize as the main cash crops. The villages on the right bank of the river have reasonably good road access while the tracks that connect to the villages located on the upper left bank are in a very poor state. None of the indirect impact zone villages have electricity grid connections. The income levels in the villages are considerably higher than the World Bank's poverty line for Myanmar.

The main impacts on the natural environment during the construction phase are related to terrestrial fauna and aquatic ecosystems. Without mitigation measures, the impacts on these two environmental components have been assessed as medium negative.

For human environment, the impact on local area economy has been assessed as medium positive while impacts in terms of physical and economic displacement have been assessed as low to medium negative. Impacts during the construction phase on community safety as well as impacts caused by population influx have been assessed as medium negative. Finally, the impacts of the project on the local population's use of forest and river resources have been assessed as low negative and low to medium negative.

The most important impacts during the operation phase are likely to be impacts on water quality, terrestrial fauna and aquatic ecosystems which, without mitigation measures, have been assessed as medium negative. For the human environment, operation phase impacts will be insignificant except for a low negative impact for use of river resources and a low positive impact for local economy.

Programmes and plans for mitigation of negative impacts and enhancement of positive impacts were identified. The main environmental mitigation interventions include a Community Forest Programme, an Aquatic Ecology and Fisheries Management Plan, a Biodiversity and Conservation Protection Plan and a Reservoir Clearance and Filling Plan.

In terms of social mitigation and benefit sharing, comprehensive Community Development Initiatives aiming to improve and upgrade access roads to a number of indirect impact zone villages, as well as connecting villages along the improved roads to the electricity grid, have been proposed.

Directly affected people who will have to relocate building infrastructure, or will be losing agricultural or commercial land, will receive full compensation based on market prices after implementation of an asset surveys and valuation process.

In an overall perspective, it may be concluded that the Middle Yeywa Hydropower Project has moderate environmental and social impacts which can be reduced, and with regard to social impacts, fully mitigated through timely implementation of the identified mitigation plans and programmes.

1. Introduction

1.1. Background

SN Power (SNP) signed on the 2nd of July 2014 with MoEP (Ministry of Electric Power of Myanmar) a Memorandum of Understanding (MoU) for the study and possible development of the Middle Yeywa Hydropower Project on the Myitnge (Nam Tu) River located in the Shan State, Myanmar.

The proposed project is located between the Lower Yeywa hydropower project in operation and the Upper Yeywa hydropower project currently under construction, forming a cascade. Among the seven considered alternatives the main project alternative involves a 160 m high arch dam that will create a reservoir of about 70 km length.

A Pre-Feasibility ESIA (Environmental and Social Impact Assessment) was finalised in August 2015, based on a preliminary engineering design (Pre-Feasibility Study by Pöyry). SN Power subsequently decided to proceed with a full engineering Feasibility Study and an Environmental Impact Assessment (EIA).

1.2. Project Developer

SN Power (SNP) is a Norwegian-owned international renewable energy company with focus on emerging markets. The overall business concept is to develop, build, acquire, own and operate sustainable renewable energy projects, with a main focus on hydropower, throughout sub-Saharan Africa, Central America and South-East Asia.

2. The EIA Study

Environmental and social baseline data have been collected over an extended period from 2015 to 2018. In the pre-feasibility phase (2015), SN Power retained the services of two companies in Myanmar, MIID (Myanmar Institute for Integrated Development) and NEPS (National Engineering and Planning Services), supervised by two experienced international consultants.

In March 2017, SNP signed a contract with Multiconsult of Norway for the purpose of completing a full EIA for the Middle Yeywa Hydropower Project. Multiconsult conducted an initial site visit in April 2017 and prepared a Gap Report in October2017 which recommended that certain aspects be studied in further detail in order to meet both national and international requirements. Additional field studies were carried out by Multiconsult and MIID in October 2017 (socio-economic surveys and consultations mainly in left bank villages) and in December 2017 (installation of wildlife camera traps and supplementary sampling of vegetation, wildlife and testing of methods for potential further aquatic studies).

3. Project Description

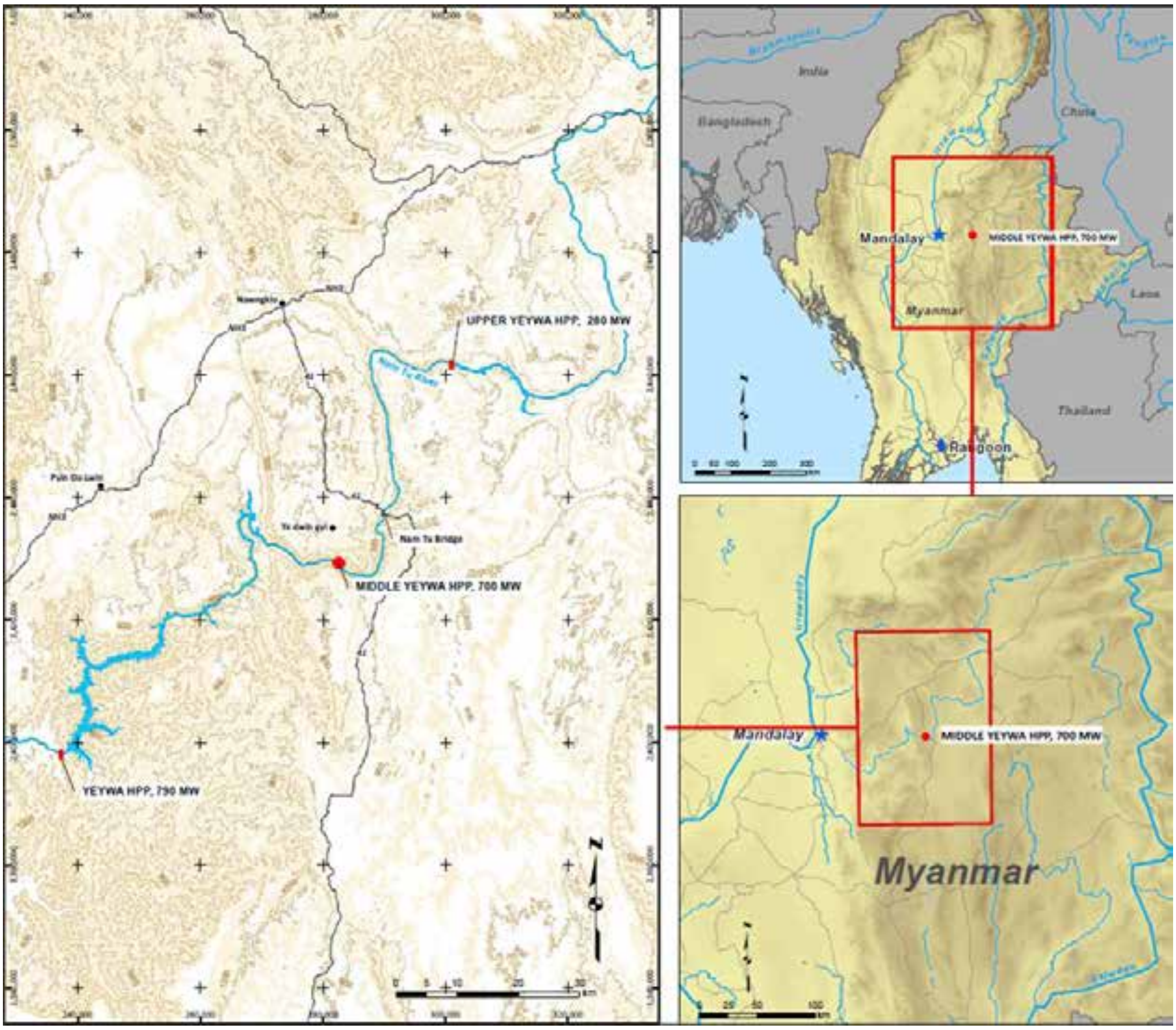
3.1. Location

The area of the Middle Yeywa Hydropower Project is located in Shan State, approximately 80 km east of Mandalay, 55 km east of Pyin Oo Lwin town, on the Myitnge River, a tributary of the Ayeyarwady (Irrawaddy) River (see figure below).

The Myitnge generally flows through deeply incised V-shape gorges with steep slopes, which will result in a narrow reservoir with a very limited live storage. The dam and related structures and facilities will mostly be located in the townships of Nawnghkio and Lawksawk, while the 70 km long reservoir will extend into the township of Kyaukmae where the Upper Yeywa Hydropower Project is being constructed.

3.2. General Layout

The main project alternative is to take advantage of the head available between the existing Yeywa reservoir (185 masl. at FSL) and the Upper Yeywa hydropower project (323 masl. tailwater level). The dam will be located at the bottom of a series of rapids in a narrow section of the Myitnge River, while the powerhouse will be located underground about 150 - 200 m downstream of the dam site.



Project location (Source: Pöyry 2015).

3.3. Project Components

3.3.1. Dam

The type of dam will be an arch dam with a maximum height above foundation level of 160 m and a crest length of 330 m. The proposed dam will support a centrally located crest spillway of two (2) bays and a left bank located spillway with three (3) bays. All the spillway bays are gated and composed of a conventional concrete chute channel ended by a flip bucket.

3.3.2. Powerhouse

The underground powerhouse complex will consist of a power cavern and a transformer cavern, as well as the required bus duct and access tunnels. The power cavern will contain four 183.75 MW vertical axis Francis turbines with a total installed capacity of 735 MW.

3.3.3. Reservoir

The Middle Yeywa dam will create an approx. 70 km long and narrow reservoir that will be around 135-140 m deep immediately upstream of the dam and gradually shallower towards the upper end. At the full supply level of 317 masl the total area impounded by the reservoir will be about 11 km^2 with a total volume of 400 million m^3.

3.3.4. Roads

The existing unpaved roads and village tracks/footpaths will be upgraded and a new road of 3.8 km length will be built into the gorge to arrive immediately downstream of the project location

At full supply level the Middle Yeywa reservoir will submerge the existing Myitnge Bridge which therefore has to be replaced. The new bridge will be 300 m long and be constructed immediately downstream of the existing bridge. The main road will be realigned accordingly.

4. Area of Influence

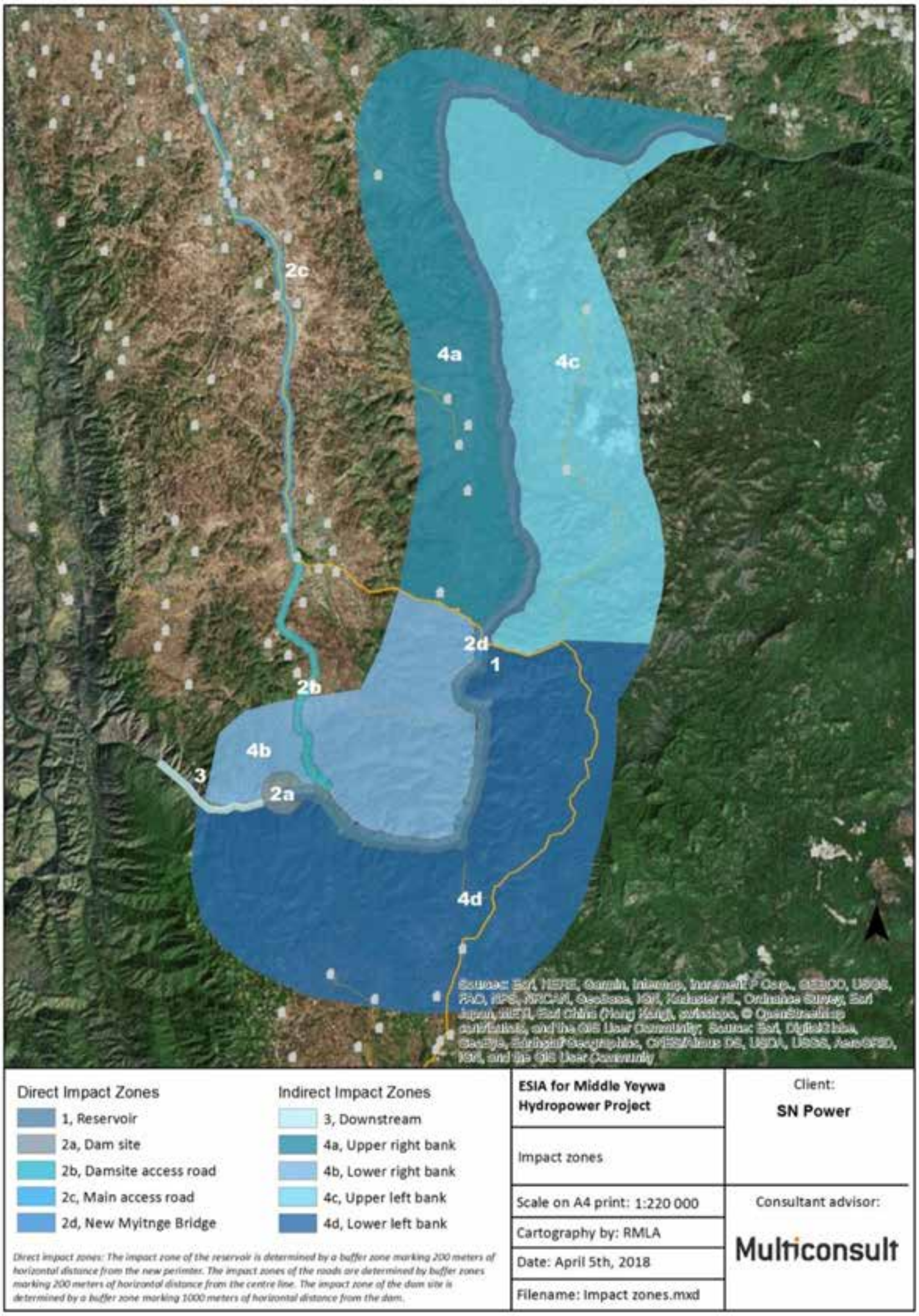
The spatial boundaries of EIA study have been defined based on a preliminary analysis of the direct (primary) and indirect (secondary) impacts of the proposed project and consequently divided into a direct and indirect impact zones. These zones constitute the project's area of influence (see figure below).

4.1. Direct Impact Zone

The direct impact zone covers all areas that will be physically affected by the construction and operation of the Middle Yeywa Hydropower Project. This zone includes the following areas as well as an approximately 200 m buffer zone surrounding each project component.

4.2. Indirect Impact Zone

The indirect impact zone consists of an area beyond the direct impact zone where the construction or operation of the power plant may indirectly affect the physical, biological and human environment through, among others, changes in water quality characteristics, air pollution levels (in the "airshed"), long-distance wildlife and fish migrations, and livelihoods and cultural behaviour of neighbouring communities.



Direct and indirect impact zone of the Middle Yeywa HPP.

5. Baseline Conditions

5.1. Physical Environment

5.1.1. Topography and Geology

The project area covers 70 km of river reach in a deeply incised valley through the Shan Plateau with several near vertical cliffs creating a canyon-like topography. Several tributary rivers and streams join the main Myitnge River within the affected reaches, including the Gohteik River in the upstream end of the planned reservoir and Namkam River which flows down a cascade of waterfalls before emptying into the main river further downstream.

The Shan Plateau is built up of a sequence of dolomites, limestones, and some shales, referred to as Plateau Limestones (Group) or the Shan Dolomite Group.

5.1.2. Climate

Myanmar has a largely tropical climate with three seasons, i.e. the monsoon or rainy season (May-October), the cool season (November-February) and the hot season (March-April). In the Myitnge basin, rainfall maximum occurs in June to August, whilst the driest months are December to March. Mean annual precipitation ranges from 1,000 mm in the south-eastern part of the basin to 1,800 mm in the north-western part. Mean daily temperature during the summer months is around 27 °C, while the coolest month is January with a mean monthly temperature of approximately 17 °C.

5.1.3. Hydrology and Water Quality

The Myitnge River is a primary left tributary of the Ayeyarwady River. The total drainage area is 34,800 km^2 and the river is about 530 km long. The catchment area at the Middle Yeywa dam site is approx. 25,518 km^2. The inflows are characterised by a marked seasonal variability with low flows of about 100-150 m^3/s in March to May and high flows of about 950 m^3/s in August to September. The mean annual inflow is 458 m^3/s.

The water quality in the affected reaches of Myitnge River is generally favourable to aquatic life. Dissolved oxygen (DO) values range from 4.7 to 8.4 mg/l with consistently higher values during the monsoon season at peak river flow. Turbidity levels are higher during high flows (monsoon season) with values ranging from 69 to 115 NTU, compared to less than 50 NTU in the wet/hot season and less than about 20 NTU in the cold/dry season.

5.2. Biological Environment

5.2.1. Key Biodiversity Areas and Protected Areas

There are no confirmed protected areas in the direct or indirect impact zones. The nearest protected area recorded in the World Database on Protected Areas is Pyin Oo Lwin Wildlife Sanctuary located approximately 35 km west of the dam site. There is an unconfirmed forest reserve in parts of the project area on the left bank.

The closest recognised area of particular biodiversity importance is the Mehon-Doke-hta Wady River key biodiversity area (KBA). This KBA is found between the Pyin Oo Lwin Wildlife Sanctuary and the dam site. The area does not have any legal status but is considered an International Bird Area (IBA) by Birdlife International due to occurrence of the endangered Green Peafowl. This species was recorded in the direct impact zone towards the dam site using wildlife camera traps, but the project's direct impact zone is not considered a key habitat for this species.

5.2.2. Vegetation

Vegetation types: The vegetation in the project's direct and indirect impact zones is predominantly deciduous Indaing (*Dipterocarp*) forest, common and widespread throughout most of the country. The forest and shrubs growing along the Myitnge River do not form a true riparian or riverine vegetation type, as the dominant species are similar to those growing at higher elevation and there is no distinct riverine zone due to the steep topography. Thus, the Indaing forest generally extends all the way down to the edge of the river.

There are some small spray wetlands along tributaries, all of which appear to be seasonal spray zones. The most interesting of these are on the Namkam River which flows down a cascade of waterfalls before emptying into the main river on the left bank near Thar Si village.

Threated plant species: A total of 462 species of flora (including some fungus species) were identified within the project’s direct and indirect impact zones. Of these, five (5) species are classified as threatened according to the IUCN Red List, that is, species in the categories ‘near threatened’ (NT), ‘vulnerable’ (VU), ‘endangered’ (EN), and ‘critically endangered’ (CR). The globally threatened species all have a wide occurrence far beyond the project’s impact zone.

5.2.3. Terrestrial Fauna

The main habitat types for terrestrial fauna are the main river, small tributaries, riverine forest along the main river and tributaries, and dry deciduous forest above the riverine forest. There are also heavily modified habitats such as cultivated areas.

Fauna surveys undertaken in the period 2015-2018 identified more than 340 species across several groups, but there is uncertainty about correct identification as reported species may reflect historical presence.

Mammals: More than 45 mammal species were identified in the surveys; some only through interviews rather than direct observations. Mammal species’ abundance has been greatly reduced by human disturbance.

One species, categorised as critically endangered, the Chinese pangolin was only reported through an interview. A total of six mammals identified were categorised as endangered on the IUCN Red List: Tiger, Dhole/Asiatic wild dog, Banteng , Pharyre’s langur , Cappet langur, and White handed gibbon. Except for the Dhole, none of these were confirmed through direct observation. Based on habitat characteristics and human pressures in the project area, it is considered unlikely that any of these species maintain resident populations in the project’s direct and indirect impact zone.

Twelve species were categorised as vulnerable by IUCN. Several of these species were identified through camera traps (Leopard), skin found locally (Clouded leopard) or foot prints (Long-tailed macaque and Pig tailed macaque).

In addition to the IUCN Red List, the Forest Department has published a list of nationally protected species (Notification No. 583/94). Among the mammal species recorded or reported in the project’s impact zone, several appear on this list such as Chinese Pangolin, Banteng, Tiger, Leopard, Clouded Leopard, White handed gibbon, and Gaur.

Amphibians and reptiles: Abundance of amphibians and reptiles was also greatly reduced by human disturbance. The surveys identified 40 reptile species and nine amphibian species. All amphibian species are categorised as of least concern on the IUCN Red List. Four reptile species are threatened, all identified through interviews: Elongated Tortoise, the vulnerable Burmese Python, the vulnerable King cobra, and the near threatened Indian Black Turtle.

Birds: A total of 118 bird species were recorded across the two river banks. All species were identified through visual observation or birds calls. One endangered species was recorded, the Green Peafowl, which is also included on the Forest Department list of nationally protected species (Notification No. 583/94). Six near threatened species were observed: Olive-backed Woodpecker, Red-breasted Parakeet, Alexandrine Parakeet, Grey-headed Parakeet, Long-tailed Parakeet, and River Lapwing. A striking characteristic was that very few water birds were observed.

Insects and other invertebrate species: A range of insects and other invertebrate species were identified, including butterflies, beetles, dragonflies, grasshoppers, locusts, spiders, a species of scorpion and a species of praying mantis. A total of 138 species were identified. These species are typically not yet assessed in the IUCN Red List and therefore no clear overviews of conservation concern are available for these groups.

5.2.4. Aquatic Ecosystems

Habitats: The aquatic habitats in the direct impact zone that support fish, benthic macroinvertebrates and other aquatic life were categorised into six main habitats along the Myitnge River, including falls and rapids, fast-flowing shallows, fast-flowing rocky deep sections, fast-flowing without turbulence; slow-flowing areas, stagnant water and tributaries.

The distribution of the aquatic habitats is likely to be dynamic and change with varying river flows including water speed, water depth, erosion and deposition. None of these habitats are considered as unique.

Species: A total of 33 species of fish were identified, many through interviews with local respondents and approximately half of the species by voucher specimen caught by local fishermen. The fish fauna was dominated by cyprinids (family Cyprinidae) with 19 species. Five fish species identified primarily through the interview survey were categorised as near threatened. Other aquatic species included crabs, shrimps and snails which were either categorised as of least concern, data deficient or not evaluated in the IUCN Red List.

5.3. Human Environment

5.3.1. Political Factions and Conflict

The Shan State has since independence seen armed conflict, mainly between the Union Government/national army and the ethnically based armed factions. The dominant armed faction that claims control over the part of the project area east of the Myitnge River (left bank) is the Restoration Council of Shan State (RCSS) with its armed wing, the Shan State Army-South (SSA-S). The RCSS entered into an agreement with the Government in January 2012 and the project area has largely been peaceful since then.

5.3.2 Population and Ethnic Groups

The project area is dominated by the Danu with a limited number of the Shan also present. A third group, the Palaung, is also present in the wider project area.

Danu: The Danu language is quite close to Burmese, and is one of numerous Burmese dialects. The Danu are officially classed as an ethnic minority among the groups listed by the government, and they meet all of the criteria for qualifying as an indigenous group set forth in IFC's Performance Standard 7 on Indigenous Peoples. However, the findings and evidence from socio-economic surveys, village meetings and consultations clearly indicates that the Danu are not marginalized or vulnerable because they are the dominant ethnic group in the project and also because of their close ethnic and linguistic affiliation with the Myanmar majority of the country.

The Shan: Shan villages or villages with substantial Shan populations are only found in the indirect impact zone of the project area, predominantly in the upper right bank and lower left bank area. With respect to IFC's Performance Standard 7, they can be identified as an ethnic minority as they see themselves as distinct group, are attached to a geographically distinct area, have separate cultural and social institutions, and have a distinct language. However, they cannot be characterised as "marginalised or vulnerable" and their economic, social and legal status does not "limit their capacity to defend their rights to, and interest in, lands and natural and cultural resources".

Palaung (Ta-ang): The Palaung is the third notable ethnic group that is present in the wider project area but not in the direct impact zones. The Palaung are officially classified as an ethnic minority by the government, and are likely to meet all of the criteria for qualifying as an indigenous group set forth in IFC's Performance Standard 7- Indigenous Peoples.

5.3.3. Project Area Economy and Characteristics

Agriculture: On both sides of the Myitnge River, farmland consists of non-irrigated uplands fields. Many households rely on slash and burn techniques and have traditionally left the land fallow for 1-3 years between plantings. However, as population has grown in the villages and average plot sizes have decreased, the ability to leave the land fallow is decreasing.

Most households across the impact zones have access to their own land. In large part, this is a reflection of the low population density and the ability of households to clear forest land and create new upland agriculture plots. Very few farmers have any formal rights to their farmland. The most common crops are maize and sugar cane.

Income levels and poverty: Declared income levels within the project's impact zones are substantially above the World Bank's poverty line for Myanmar of 1,303 MMK (US$ 1.1) per adult per day as well as well as above the global poverty line of US$2/day. Average income across 13 surveyed indirect impact zone villages was MMK 4,105,567 per year, or US$ 3,059, which corresponds to US$ 8.3 per day. On the average, the on-farm income share represents around 80%.

5.3.4. Natural Resource Use in the Impact Zones

Forest resources: Forest resources include timber (for construction as well as firewood), foraged plants (for consumption and sale), and hunting (consumption and sale), but these contribute only marginally to income in general. Hunting was once popular but this is no longer the case due to the scarcity of animals.

River resources: None of the surveyed 13 villages within the indirect impact zones rely on the river as a water source. A limited number of households engage in recreational fishing, but this does not contribute in any significant way to household incomes. In no village did fishing account for more than 1% of average income, and only 30 of the 800 households in the survey reported any fishing income.

5.3.4. Archaeological Sites and Cultural Heritage

No archaeological or cultural heritage sites have been identified or reported in the project's direct impact zone. However, villages in the indirect impact zone have temples and sometimes more local Buddhist shrines that are visited and maintained by the local population.

6. Impacts and Mitigation Measures

6.1. Physical Environment

6.1.1. River Flow Modifications

To allow for the construction of the Middle Yeywa dam, the Myitnge River will be temporarily diverted by means of upstream and downstream cofferdams and a diversion tunnel. However, this bypass arrangement will not affect the "natural" flow regime until the time of initial filling of the reservoir. The reservoir filling plan will allow for a release of a continuous minimum flow.

Upon commissioning, the short diversion reach (less than 200 m from the dam axis to the turbine outlets) will be completely or partially dried out, except when there is spilling of water over the dam or the gates are open

The daily peaking operation will cause high ramping rates, i.e. rapid fluctuations in downstream river flows and water levels. The operation of the plant will most likely vary from running continuously at full capacity (688 m^3/s), especially in the rainy season, to running at full capacity only for a few hours.

6.1.2. Reservoir Stratification

The Middle Yeywa dam will create a large and deep reservoir changing many physical, chemical and biological characteristics of the river. Dependant on the reservoir residence time, there is a certain risk of development of an anoxic zone (water without oxygen) at the bottom layer of the reservoir.

The potential problem of releasing anoxic water downstream can be mitigated by installing multi-level withdrawal structures (power intakes) on the dam, or constructing aerating weirs in the tailrace. However, due to the fact that the turbine outflow will be released upstream of the existing Yeywa reservoir – an already modified water body that can act as a water quality buffer zone, there may be less need for design modifications.

6.1.3. Water Pollution

During the construction phase, soil erosion from earthworks, cofferdams, and runoff from rock material from drilling, blasting, stone crushing, etc. are expected to cause increased sediment load, and hence increased turbidity in the river reaches between the dam site and the tail of the existing Yeywa reservoir. In addition, accidental fuel and oil spills from construction machinery, and leaching of ammonia and nitrogen from the blasting and soil rock deposits, may cause pollution of the river unless effective mitigation measures are put in place.

The workers' camp will generate sanitary effluents which are potential sources for microbiological and organic pollution of surface and ground water. Unless the waste and wastewater from domestic or construction origin (e.g. scrap metal, wood, plastic, cement bags, used tires and batteries, etc.) is adequately managed, it may result in pollution of both surface and ground water sources. Depending on the exact location of the workers' housing facilities, such pollution may either be localised or enter the Myitnge River.

6.1.4. Sediment Trapping and Flushing

The fact that the tailrace outlet is located a short distance upstream of the existing Yeywa reservoir, combined with the trapping of sediments behind the Upper Yeywa dam, suggests that the relative contribution of the Middle Yeywa dam in altering sediment transport in the Myitnge River is relatively less than it would be without those cumulative impacts.

6.1.5. Soil Erosion and Landslide Risks

During construction, soil will be impacted by activities like vegetation stripping, grading, soil removal, backfilling, compacting, excavation and disposal of surplus soil, etc. This applies especially to the road upgrade/construction works on the steep slopes of the Myitnge valley. After commissioning of the power plant, peaking operations will create a narrow drawdown zone with some risk of shoreline erosion over a wide area.

6.1.6. Greenhouse Gas Emissions

During the construction phase, greenhouse gas (GHG) emissions will be generated from increased traffic and from diesel generators. In addition, pre-impoundment clearing of trees in the reservoir will cause emissions from deforestation, calculated to ca. 475,000 tonnes CO_2. This land use conversion represents a source of GHG emissions although the overall impact in terms of climate change is low.

The operation of the Middle Yeywa power plant is intended to supply renewable energy using a technology which is not generally considered to cause GHG emissions.

6.1.7. Dust and Noise Emissions

The main impact to air quality during construction will be from increased dust levels arising from construction machinery, blasting, quarrying, excavations, earthworks, cement mixing and road construction, as well as vehicular traffic. In addition to emissions of particles, there will be emissions of NO_x and SO_2 from construction machinery, vehicles and from diesel power generators.

6.2. Biological Environment

6.2.1. Vegetation Clearing

The construction of the hydropower plant will involve loss of about 816 ha of Indaing forest below FSL, including relatively intact forests on the left bank due to biomass clearing and inundation. In addition, the seasonal spray zone at the lower Namkam waterfalls will be submerged and lost.

Most of the trees that will be cut are common species of the Indaing forest vegetation type with a wide geographical distribution and that are not subject to major conservation risks, including those classified as threatened.

6.2.2. Disturbance and Loss of Habitat for Terrestrial Wildlife

Clearing of areas for construction will result in direct loss of habitat for terrestrial fauna. Workers and associated in-migration could result in illegal tree cutting for timber. No species of conservation concern are expected to lose significant parts of their habitats.

The presence of a large workforce and camp followers represents a threat to mammal species in particular (e.g. Muntjac) and partly species of birds (e.g. Red Jungle Fowl) due to a possible increase in illegal hunting during construction. Pollution risks in the form of hazardous materials will be experienced in virtually all construction sites but are expected to be localised.

Seasonally inundated sandbanks scattered along the river will also be inundated and these may be important for insect species and turtle species if they still exist in the area. At the Namkan tributary, a spray zone will be partly inundated. However, no unique species were found in this unusual habitat. There are similar spray zones available above the inundation area.

6.2.3. Aquatic Ecosystems

The construction of the dam and filling of the reservoir will result in loss of riverine habitats and creation of a larger lake habitat. Species adapted to flowing water will largely lose their habitats except in a limited number of tributaries along the reservoir that will provide small pockets of riverine habitat.

From the time of construction of coffer dams, the construction works will be a barrier to upstream fish migration. This will limit access to upstream river reaches for any fish downstream the dam. The presence of Yeywa dam downstream and Upper Yeywa upstream means long-distance fish migration in this river system has already been blocked and will not be further impacted by Middle Yeywa HPP. It is not considered feasible to construct an upstream fish passage at the dam.

The Developer is considering placement of substantial volumes of rocks in the river for a 1 km distance downstream of the tailrace in order to meet a potential requirement from the Government of Myanmar for a ‘free flowing’ river section between the Yeywa reservoir and the Middle Yeywa dam. Unless carefully designed with ecological objectives in mind, this will further impact the limited remaining riverine habitats negatively.

The typical river species will be largely outcompeted in the reservoir assuming the reservoir will be colonised by species well adapted to a lake-like system. Phytoplankton and zooplankton communities are likely to expand considerably and also provide the basis for an increased biomass of other species that feed on plankton. The fish community will change in species composition towards species favouring lake-like aquatic environments.

The project is likely to be run for hydro-peaking though the operational regime will only be determined later. This will introduce major daily flow variation between the tailrace and the downstream Yeywa reservoir for most of the year. This flow variation will have substantial negative impacts on aquatic life in the short but varying length of affected river section. Complete drying out of the river should be prevented by releasing a continuous minimum flow as well as identifying ramping rates that are acceptable in terms of environmental and safety concerns (e.g. avoiding excessive risks of stranding of fish and avoiding risks to people close to the river).

6.3. Human Environment

6.3.1. Local Project Area Economy

The Middle Yeywa HPP is likely to generate possibilities for employment for the local population, both directly and indirectly. The impact on local economy is assessed as positive for the local population and local businesses in the construction phase.

6.3.2. Displacement and Resettlement

At the present stage of planning and project development, the size and accurate location of the project lands have not yet been determined in detail. Road No. 41 from Nawnghkio to Taung Shey and further on from the junction on a local unpaved village road down to Yae Twin Gyi is likely to be chosen as the main project access road. This access passes through a number of villages and its widening may lead to some physical displacement of commercial and residential buildings located close to the roads.

With regard to the reservoir, it will be confined within the steep river valley where there are no settlements except for temporary fishing and illegal logging camps.

6.3.3. Population Influx

During construction, there will be a temporary increase in population in the area surrounding the main construction site. Population influx, even though temporary, will put considerable pressure on the local infrastructure, services and utilities, especially on community health and sanitation. This may lead to a reduction of the capacity of the local services to meet the needs of the local population as well as the needs of the in-migrants.

6.3.4. Community Safety and Security

A number of safety issues are likely to be caused by the Middle Yeywa HPP. These include traffic accidents and management of waste. Increased traffic is likely to lead to an increase in road incidents and serious accidents and injuries along the main access route.

If hazardous waste and materials generated in connection with project activities are not appropriately and safely managed, they may lead to serious contamination and pollution of water sources and ground water.

6.3.5. Forest Resource Use

During the construction phase, some forest resources may be lost due to building of the access road down the escarpment to the main construction site comprising the dam and powerhouse areas. This is unlikely to affect the forest resource use of the nearby villages. Villagers do not extract resources (timber or wild meat) in any significant degree due to difficulties in accessing the steep slopes of the valley.

The income from fishing appears to be insignificant constituting less than one percent of the total average income according to the socioeconomic survey. However, for some households in the villages surrounding the future Middle Yeywa reservoir, fishing appears to be a source of dietary supplement and for some also a source of income, including Yae Twin Gyi, closest to the dam site.

6.3.5. Summary of Impacts

The table below summarises the impact assessment without and with mitigation/enhancement measures.

Theme	**Value/ Vulnerability**	**Impact Magnitude**	**Overall Impact**	
			Without Mitigation	**With Mitigation**
CONSTRUCTION PHASE				
Physical Environment				
Topography and landscape	**Medium**	**Low - medium negative**	**–/– –**	**–**
Geology and soils	**N/A**	**Medium negative**	**– –**	**–**
Climate	**High**	**Low negative**	**–**	**0/–**
Air Quality	**High**	**Low - medium negative**		**–**
Noise and vibration	**High**	**Low - medium negative**	**–/– –**	**–**
Hydrology	**N/A**	**Low negative**	**–/– –**	**–**

Theme	Value/ Vulnerability	Impact Magnitude	Overall Impact	
			Without Mitigation	With Mitigation
Sediment transport	**High**	**Low - medium negative**	**–/– –**	**–**
Water quality	**Medium-high**	**Low - medium negative**	**–/– –**	**–**
Biological Environment				
Protected areas	**Low**	**Insignificant**	**0**	**0**
Vegetation	**Medium**	**Low - medium negative**	**–**	**0/–**
Terrestrial fauna	**Medium**	**Medium negative**	**– –**	**–**
Aquatic ecosystems	**Medium**	**Medium negative**	**– –**	**–**
Human Environment				
Local project area economy	**High**	**Low - medium positive**	**++**	**++/+++**
Physical displacement and resettlement	**High**	**Low - medium negative**	**–/– –**	**0**
Economic displacement and loss of livelihoods	**High**	**Low - medium negative**	**–/– –**	**0**
Population Influx and social fabric	**High**	**Medium negative**	**– –**	**–**
Community safety and security	**High**	**Medium negative**	**– –**	**–**
Forest resource use	**High**	**Insignificant - low negative**	**–**	**–/0**
River resource use	**High**	**Low - medium negative**	**–/– –**	**–**
Archaeological sites and cultural heritage	**High**	**Insignificant**	**0**	**0**
OPERATION PHASE				
Physical Environment				
Topography and landscape	**Medium**	**Low - medium negative**	**– –**	**–**
Geology and soils	**N/A**	**Low-medium negative**	**– –**	**–**
Climate	**High**	**Low - medium positive**	**+**	**+ +**
Air Quality	**High**	**Insignificant**	**0**	**0**
Noise and vibration	**High**	**Insignificant**	**0**	**0**
Hydrology	**N/A**	**Low - medium negative**	**–/– –**	**–/– –**
Sediment transport	**High**	**Low - medium negative**	**–**	**0/–**
Water quality	**Medium-high**	**Medium negative**	**– –**	**–/– –**
Biological Environment				
Protected areas*	**Low**	**Insignificant or low negative**	**0 or –**	**0 or –**
Vegetation	**Medium**	**Low negative**	**–**	**0/ –**
Terrestrial fauna	**Medium**	**Medium negative**	**– –**	**– –/–**
Aquatic ecosystems	**Medium**	**Medium negative**	**– –**	**– –/–**

Theme	Value/ Vulnerability	Impact Magnitude	Overall Impact	
			Without Mitigation	With Mitigation
Human Environment				
Local project area economy	**High**	**Low - medium positive**	**+**	**++**
Physical displacement and resettlement	**High**	**Insignificant**	**0**	**0**
Economic displacement and loss of livelihoods	**High**	**Insignificant**	**0**	**0**
Population influx and social fabric	**High**	**Low negative**	**–**	**–**
Community safety and security	**High**	**Insignificant**	**0**	**0**
Forest resource use	**High**	**Low negative**	**0**	**+**
River resource use	**High**	**Medium - Low negative**	**–**	**0**
Archaeological sites and cultural heritage	**High**	**Insignificant**	**0**	**0**

* Assessment depends on confirmation whether parts of the left bank have a forest protection status or not.

7. Stakeholder Consultations

7.1. First Consultation Campaign

Initial community meetings were held in the six right bank villages in February/March 2015. The general reactions to the proposed hydropower project were generally positive and nobody expressed opposition to the project. Issues raised included demands for electricity, water supply, roads and jobs.

With regard to flooding and loss of land, the villagers were assured that no farmland would be lost due to creation of the reservoir but that some limited land could be taken for access roads and camps in Yae Twin Gyi, the village nearest to the dam site.

7.2. Second Consultation Campaign

Consultation continued in selected villages surrounding the reservoir and the dam site in May 2016. Again, the consultations were well received by communities, and participants expressed thanks for keeping them informed. Villagers reiterated their interest receiving electricity and what other benefits the project could give the communities. Some villages were also concerned about the Myitnge Bridge and whether it would be flooded. These consultations also informed villagers of survey activities and established a grievance mechanism.

8. Environmental and Social Management Plan

8.1. Organisational Set-up and Staffing

In the project organisation of the Developer, an Environmental and Social Unit (ESU) will be established. The ESU will be headed by an expatriate manager who will report directly to the project Manager. The ESU will include five separate teams that will take responsibility for implementing the different mitigation activities and programmes described in in the ESMP. Each of the teams will have a Team leader who will be assisted by 3- 4 specialists. The proposed ESU teams are: 1) Compensation and Grievance Team; 2) Social Management and Consultation Team; 3) Environmental Management Team; 4) Community Forestry Team and 5) Infrastructure Team.

8.2. Environmental Management Plan

The Environmental Management Plan Comprises a number of sub-plans and programmes, including:

- *Construction Environmental Management and Monitoring Plan:* The Contractor will develop and implement site specific plans in accordance with standards and indicators in the Tender Documents for hazardous and non-hazardous waste, pollution control, erosion control, emergencies and health and safety.
- *Water Quality Monitoring Plan*: A water quality monitoring program will be implemented to document the water quality changes resulting from the Middle Yeywa project. The results of the water quality monitoring will be summarised in bi-monthly reports and made available to relevant GoM agencies.
- *Aquatic Ecology and Fisheries Management Plan:* The aquatic ecology and fisheries management plan will recommend measures that will be determined and refined after additional surveys. During construction and particularly during operation, sensitisation of local communities will be undertaken to avoid catching any threatened species, avoid use of harmful or unsustainable fishing methods (e.g. poison, dynamite), and promote sustainable fishing practices.
- *Reservoir Clearance and Filling Plan*: The Reservoir Clearance and Filling Plan includes (i) reservoir demarcation, (ii) harvesting of commercial timber (by contractor or State Enterprise), (iii) clearance of selected areas and controlled burning (by contractor employing local people), and (iv) residue collection and removal during initial filling of the reservoir.
- *Biodiversity and Conservation Protection Plan:* The Biodiversity and Conservation Protection Plan includes consultations with forest authorities, local authorities and communities to assess and consider possibilities for supporting establishment of one or more forest protected areas around the reservoir on both river banks. The plan also proposes conservation activities for selected species, particularly the endangered Green Peafowl (*Pavo muticus*) that is found in the Mehon - Doke-hta Wady River Key Biodiversity Area (KBA) that partly overlaps with the project's indirect impact zone.
- *Community Forest Program:* The Community Forest Program will consist of both natural and assisted regeneration of tree species as well as protection of existing forests and promotion of agro-forestry practices. The objectives are to (i) compensate for the loss of forest in the Middle Yeywa reservoir by restoring priority forests outside of the project's direct impact zone, and (ii) contribute to watershed management and biodiversity conservation whilst also improving the communities' access to ecosystem services through sustainable community-led forest management.
- *Operation Phase Environmental Management Framework*: An Operation Phase Environmental Management Plan will be developed well ahead of the start of the operation phase. The plan and should build on the different mitigation programmes initiated in the construction phase and should tentatively cover the following environmental issues: (i) waste management and pollution control, (ii) water quality monitoring, (iii) fisheries management and aquatic ecology monitoring, (iv) conservation protection activities, and (v) community forest management.

8.3. Social Management Plan

The Social management Plan is composed of the following plans and programmes:

- *Stakeholder Engagement Plan*: The continued stakeholder consultations in the pre-construction and the construction phase will focus on the planning of the community development initiatives (CDI), including access road improvement and grid connection which SN Power will be funding.

- *Compensation for Lost Land, Production and Fixed Assets*: Asset surveys to register and quantify loss of land and building infrastructure along the access roads will be carried out as soon as the road alignments have been determined and planned in detail. Full compensation at replacement cost will be provided.
- *Social Management for Construction Areas*: Depending on the actual number of in-migrants the project will attract, measures to improve water supply and sanitary conditions in the villages that receive in-migrants will be implemented if necessary. Measures to reduce traffic related accidents, including speed bumps and implementation of a road safety programme for schools, will also be implemented.
- *Community Development Initiatives*: Community Development initiatives will include upgrade and improvement of access roads as well as electrification for a number of villages in the indirect impact zone. The community development programme will be planned in detail in coordination with the government.
- *Workforce Recruitment and Employment:* The project will require contactors to give preference to employment of local labour. The employment process will also be facilitated by compiling lists of skilled and semi-skilled workers from project area villages that will be presented to the contractors.

8.4. Environmental and Social Management Plan Budget

The table below summarises the estimated budget for the ESMP:

No	Item	Pre-constr	Construction Phase						Total
		Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	
1	Pesonnel Costs - ESU	399 600	445 200	445 200	392 400	392 400	392 400	392 400	2 859 600
2	Government of Myanmanr Costs	50 300	50 300	39 500	39 500	39 500	39 500	39 500	298 100
3	Environmental Management Plan Costs	130 000	100 000	100 000	110 000	265 000	265 000	185 000	1 155 000
4	Social Management Plan and Community Initiatives	492 000	1 853 000	2 418 750	1 987 500	1 002 500	1 002 500	182 500	8 938 750
	Total EMP/SMP Costs	**1 071 900**	**2 448 500**	**3 003 450**	**2 529 400**	**1 699 400**	**1 699 400**	**799 400**	**13 251 450**

At this point contingency arrangements for the project as a whole have not been decided.

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ACRONYMS

BOD	Biological Oxygen Demand
CE	Critically endangered
CITES	Convention on International Trade of Endangered Species
COD	Chemical Oxygen Demand
DIZ	Direct Impact Zone
DO	Dissolved Oxygen
EMP	Enviromental Management Plan
EN	Endangered
EIA	Environmental Impact Assessment
ESIA	Envirommental and Social Assessment
ESMP	Environmental AND Social Management Plan
E&S	Environmental and Social
FAO	Food and Agricultural Organization of the United Nations
FSL	Full supply Level
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GIS	Geographic Information Systems
GOM	Government of Myanmar
GPS	Global Positioning System
GWh	Gigawatt hours
HH	Household
HPP	Hydropower Project
IFC	International Finance Corporation (World Bank Group)
ILO	International Labour Organisation
INDIZ	Indirect Imapct Zone
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for the Conservation of Nature
kg	Kilogram
km	Kilometre
km^2	Square Kilometre
kWh	Kilowatt hours
LC	Least Concern
masl	Metres above sea level
MoEP	Ministry of Electric Power
MOL	Minimum Oerating Level
MoNREC	Ministry of Natural Resources and Environmental Conservation
MTE	Myanmar Timber Enterprise
MW	Megawatt

NT	Near Threatened
NTFP	Non-timber-forest. product
MoU	Memorandum of Understanding
NE	North East
O&M	Operation and Maintenance
PAPs	Project Affected Persons
PMF	Probable maximum Flood
PS	Performance Standard
RCC	Roller Comapcted Concrete
RCP	Representative Concentration Pathway
RCSS	Restoration Council of Shan State
SIA	Social Impact Assessment
SNP	SN Power SS
SSA-S	Shan State Army South
SSE	South South-East
TSS	Total Suspended Solids
TN	Total Nitrogen
TWh	Terawatt hours
VU	Vulnerable

1 INTRODUCTION

1.1 Background

SN Power signed a Memorandum of Understanding (MoU) on the 2nd of July 2014 with MoEP (Ministry of Electric Power of Myanmar) for the study and possible development of the Middle Yeywa Hydropower Project on the Myitnge River located in the Shan State. In Shan language, the river is called Nam Tu. Hereafter in this EIA Report, Myitnge will be used as the name for the river on which development of the Middle Yeywa Hydropower Project is being planned.

The Project is located between the Lower Yeywa Hydropower Project in operation and the Upper Yeywa Hydropower Project currently under construction, potentially forming a cascade. The main project alternative involves a dam of 160 m height that will create a reservoir of about 70 km in length.

A Pre-Feasibility ESIA (Environmental and Social Impact Assessment) was finalised in August 2015, based on a preliminary technical design (Pre-Feasibility Studies by Pöyry). At the present stage in the project development, SN Power (SNP) has decided to proceed with a full technical feasibility study and Environmental Impact Assessment (EIA).

1.2 Project Developer

SN Power is an international renewable energy company with focus on emerging markets. The overall business concept is to develop, build, acquire, own and operate sustainable renewable energy projects, with a main focus on hydropower, throughout sub-Saharan Africa, Central America and South-East Asia. SNP was founded in 2002 by Statkraft (Norwegian State Utility) and Norfund (Norwegian Investment Fund for Developing Countries). After an agreement between Statkraft and Norfund in September 2017 to swap shares in their jointly owned international hydropower assets, SN Power is now fully owned by Norfund. Norfund is Norway's state-owned Development Finance Institution.

1.3 EIA Process

The present feasibility level EIA study is intended to meet the requirements of the Environmental Impact Assessment Procedure (ratified by the Burmese parliament in December 2015) as well as environmental compliance certificate and related permitting conditions under the Ministry of Natural Resources and Environmental Conservation (MoNREC). The ESIA shall also be "bankable" and comply with IFC Performance Standards for Environmental and Social Sustainability (2012).

Environmental and social baseline data have been collected over an extended period from 2015 to 2018. In the pre-feasibility phase (February-May 2015), SNP retained the services of two local companies; MIID (Myanmar Institute for Integrated Development) covering social aspects and NEPS (National Engineering and Planning Services) covering environmental aspects. These local consultants were supervised by two experienced international consultants, Mr. Ettore Romagnoli and Ms. Karen Jacob. A Pre-Feasibility EIA Report was produced in June 2015, and further comments and analysis were incorporated into the final report in August 2015.

Additional environmental data collection was undertaken from September to October 2015 (on the right bank of the Myitnge River) and from July to August 2016 (on the left bank). The environmental data thus cover the dry season (March-May, right bank), the rainy season (July-August, left bank) and the transition period after the rainy season (September-October, right bank).

On the 7th of March 2017, SN Power signed a contract with Multiconsult of Norway for the purpose of completing a full EIA for the Middle Yeywa Hydropower Project (see Annex 1 for Detailed Terms of Reference). The scope of work included an update of the Pre-Feasibility EIA Report by incorporating the additional baseline data (and consultation proceedings) that had been collected by the local consultants in late 2015 and 2016 combined with a gap analysis to identify the need for further investigations. Multiconsult conducted an initial site visit (from 3rd to 7th of April 2017) and prepared a

Gap Report in June 2017 which recommended that certain aspects be studied in further detail in order to meet both national and international requirements.

The additional fieldwork was carried out in October and December 2017 with short field visits in January, February and April 2018 to download pictures from deployed camera traps. The field work in October 2017 included socioeconomic surveys and village meetings in mainly left bank villages while in December further baseline data on fish and aquatic ecology, riparian vegetation, terrestrial fauna (including deployment of camera traps) were collected.

1.4 Report Structure

The EIA Report has been organized in 10 chapters covering all the required chapters and content of an EIA Report as specified in the Environmental Impact Assessment (EIA) Procedure of 2015. The report structure also includes all the items required by the IFC and other potential financing institutions.

The ESIA Report is structured in chapters as listed below:

- Executive Summary in English and Myanmar language
- Chapter 1: Introduction
- Chapter 2: Project Description
- Chapter 3: Approach and Methodology
- Chapter 4: Policy, Legal and Administrative Framework
- Chapter 5: Stakeholder Analysis and Consultation
- Chapter 6: Environmental Baseline Conditions
- Chapter 7: Social Baseline Conditions
- Chapter 8: Project Impacts and Mitigation Measures (including Cumulative Impacts)
- Chapter 9: Analysis of Alternatives
- Chapter 10: EMP and SMP Overview
- Chapter 11: Environmental Management Plan
- Chapter 12: Social Management Plan

The annexes of the EIA report include:

- Annex 1: Scope of Services
- Annex 2: Biodiversity Reports
- Annex 3: Indigenous Peoples Report
- Annex 4: Socioeconomic Survey Results and Village Profiles

1.5 ESIA Team of Experts

In the following, the social and environmental experts that have participated in studies and the preparation of the ESIA Report are briefly presented:

1.5.1 Multiconsult Team

Team Leader / Social Specialist: Jens Laugen

Mr. Laugen has more than 20 years of experience within the field of social development planning and assessment. Since joining Multiconsult in 2001 he has worked on a number of hydropower development project, including being full time Social and Environmental Manager (SED) for the Theun-Hinboun Hydropower Project in Laos from 2011 to 2015.

Environmental and Flora / Forestry Specialist: Dr. Jørn Stave

Dr. Stave holds a Ph.D. and M.Sc. in tropical ecology / botany and has more than 15 years of work experience in natural resource management. In his current position, Dr. Stave works as a Senior Environmental Advisor in Multiconsult's Natural Resources Division, where he has delivered a wide range of environmental consultancy services, especially to hydropower developers, including environmental assessments (EIA/ESIA), management plans (ESMP), resettlement plans (RPF/RAP), compliance monitoring/auditing, and due-diligence appraisals.

Water Resource and Aquatic Ecology Specialist: Leif Lillehammer

Mr. Lillehammer has a Cand. Scient Dissertation in Ecology from 1991, and an Assistant Professor qualification from 1994. Lillehammer has more than 25 years of experience in water resources, energy/hydropower projects as well as environmental management and research. He has worked five years as a researcher within the field of freshwater ecology and water resources.

Since 1996 he has worked as a consultant, carrying out a number of assignment in different fields such as integrated basin and water resources management, water and environmental strategy development, policy and vision formulation, strategic, cumulative and project specific environmental and socio-economic impact assessment, and institutional and regulatory assessment and strengthening of water resources and river basin organizations.

Fauna / Conservation Specialist: Svein Erik Hårklau

Mr. Hårklau has M.Sc. in Management of Natural Resources and Nature Conservation from the Norwegian University of Life Sciences. He has more than 17 years of work experience in natural resource management and environmental issues integrating ecological, economic and socio-cultural concerns while addressing problems and opportunities and finding workable solutions in infrastructure projects, including large and small hydropower projects. From 2001 to 2009 Mr. Hårklau worked for the World Wide Fund for Nature (WWF) as a program manager with responsibility for developing and following up field projects in Africa (natural resources management, conservation, energy and climate change). Mr. Hårklau's experience also includes numerous environmental and social studies at various stages of infrastructure development projects (e.g. hydropower, roads, railways, tunnels, transmission lines, mining, oil and gas). He has also worked extensively with conservation and sustainable use of biodiversity as well as protected areas management.

Anthropologist / Ethnic Minority Specialist: Dr. Jim Chamberlain

Dr. Chamberlain has had 45 years professional experience in Lao studies, including more than 45 years of experience in the field in SE Asia. He is fluent in the written and spoken forms of the Lao and Thai languages. In Laos, he has carried out numerous surveys and social analyses, including the Participatory Poverty Assessments, social impact assessments, socio-economic studies, ethnic group development plans, public involvement plans, institutional and policy analyses, evaluations, and technical studies for a number of international agencies, including the World Bank and Asian Development Bank.

GIS Expert: Rasmus Meyer Liebig-Andersen

Mr. Liebig-Andersen is an environmental geographer with experience from early phase planning to technical design of infrastructure, including impact assessments, risk assessments and environmental management planning. He holds a B.Sc. in Geography and a M.Sc. in Environmental Planning and Management with supplementary courses in freshwater ecology and resources. Mr. Liebig-Andersen has wide experience with spatial studies and application of GIS tools, including determining of Areas of Influence from physical interventions of infrastructure development, hydropower dams and flood management projects.

1.5.2 MIID Team

Social Team

Social Expert: Samuel J.A. Purch

Mr. Purch has a Master of Arts from Kings College in London and has worked as a consultant providing services to a number of international NGOs as well as private sector clients within the fields of research and analysis on political, economic and social issues. He has since 2015 been based in Yangon.

Social Expert: May Pannchi

Ms Pannchi is a social researcher with more than five years of experience conducting quantitative and qualitative research throughout in Myanmar across various sectors, such as nutrition, natural resources management, access to information and governance. She holds MSc in International relations from Dagon University.

Biodiversity Team

Ecologist / National Team Leader: Dr.Win Myint (Associated Professor, ex.)

Dr. Win Myint has a PhD in ethnobotany from the University of Yangoon and a MSc form the same university in Ecology. As a consultant he has conducted Biodiversity Impact Assessments and contributed to a number of EIA studies for infrastructure development projects in Myanmar, including hydropower development such as the Minhla and Nankam hydropower projects. Dr. Win also led the biodiversity studies that were carried out during the pre-feasibility phase for the Middle Yeywa Hydropower project.

Taxonomist: U Nyo Maung (Retired Professor)

U Nyo Maung has a MSc in plant taxonomy from the University of Mandalay and a BSc in plant biology from the same University. He was a member of the team that carried out the pre-feasibility biodiversity study for the Middle Yeywa Hydropower Project and has also worked on a number of other biodiversity impact studies, including hydropower projects

Taxonomist: Dr. Ei Ei Phyoe

Dr. Ei Ei Phyoe has a MSc in environmental studies as well as a PhD in Plant Taxonomy from the University of Yangon. His was team leader and supervisor for the plant identification studies and flora surveys in connection with the proposed national park of Lenya, located in the Taninthayi Region of Myanmar. Other notable project experience include biodiversity studies for the Middle Yeywa Hydropower project (pre-feasibility stage) and biodiversity studies for the Minhla and Nankam hydropower projects.

Botanist and GIS Expert: U Tun Thura

Mr. U Tun Thura has a BSc in botany and MSc in environmental science from the University of Yangon. In addition he has a BSc in computer science from the University of Computer Studies in Yangon. Hi project experience include biodiversity studies for the Middle Yeywa Hydropower project (pre-feasibility stage) and biodiversity impact assessments for the Minhla, Nankam and Baluchaung hydropower projects.

Assistant Taxonomist: U Thein Phyoe Aung

Mr. Thein Phyoe Aung has a BSc degree in biology from University of Yangon. He has participated as assistant taxonomist in many botanical surveys and vegetation surveys in connection with EIA studies in Myanmar. Among these are surveys undertaken for hydropower projects in the Shan State and the botanical survey in the Taninthayi forest. Through the participation in many projects Mr. Thein Phyoe Aung Even has thus proven himself as a highly qualified field taxonomist providing quick and accurate identification of vegetation types and plant species.

Bird and Mammal Specialist and Fauna Team Leader: U Tin Aung Tun

Mr Tin Aung Tun has a BA degree in biology from Shwebo University. Through his work experience and participation in fauna surveys he has gained expertise within the fields of ornithology as well as mammalogy. He worked for FFI (Fauna and Flora International) as a conservation biologist for four years and also had the position as species officer at BANCA (Biodiversity and Nature Conservation Association). From his work with FFI and the Myanmar Primate Conservation Program he gained comprehensive experience and expertise with installation and operation of wildlife camera traps

Amphibians and Reptiles Specialist: U Min Thein Htet

Mr Min Thei Htet has a BSc degree in zoology from Dagon University. He has participated in a number of EIA studies and is an experienced field zoologist. He has cooperated with BANCA (Biodiversity and

Nature Conservation Association) and participated in an number of conservation projects in Myanmar. His experience also includes herpetofauna studies undertaken for the Myit Son Hydropower Project.

Insect and Invertebrates Specialist: U Kyaw Naing Oo

Mr Kyaw Naing Oo has BSc degree in zoology from Ma U Bin University. He has participated in a number of EIA studies with responsibility for the entomology studies. Many of the EIA studies have been undertaken for hydropower projects in Myanmar.

2 PROJECT DESCRIPTION

2.1 Geographical Location

2.1.1 Environmental Setting

The area of the Middle Yeywa Hydropower Project is located in Shan State, approximately 80 km east of Mandalay and 55 km east of Pyin Oo Lwin town, on the Myitnge River, a tributary of the Ayeyarwady (Irrawaddy) River. The Project is located between the Lower Yeywa Hydropower Project already in operation and the Upper Yeywa Hydropower Project currently under construction, forming a potential cascade.

Between the Upper Yeywa dam site and the planned dam site for the Middle Yeywa HPP, the Myitnge River flows through a deeply incised river valley with an average width at river level of around 70 m. The minimum width of the valley is approximately 25 m and the maximum width approaches 160 m. The river valley sides raise up some 300 to 600 meters from the river with the steepest gradients found in the lower part of the valley. The shape of the valley will result in an around 70 km long and narrow reservoir with only a limited storage capacity when compared to the mean yearly inflow.

Access to the central part of the project is by National Highway No. 3 to Nawnghkio, which is located some 125 km northeast of Mandalay. From Nawnghkio, Road No. 41 leads into the central project area with around 45 km down to the bridge spanning the Myitnge River. The bridge lies around 22 – 23 km upstream of the planned dam site.

The terrestrial biodiversity found in the project area is not unique and has been considerably affected and degraded by human activities such as logging and conversion of forested areas into to agricultural land. However, there are some steep and less accessible areas on the slopes down towards the river that retains more of the original biodiversity of the area. The vegetation of lower valley that will be inundated is mainly composed of riverine forest and Indaing (dipterocarp) forest.

There are no protected areas in the Project's impact zones, the nearest being the Pyin Oo Lwin Wildlife Sanctuary which is located approximately 35 km west of the dam site.

2.1.2 Social Setting

The Middle Yeywa Hydropower Project lies fully within the borders of the Shan State. The dam and other related structures and facilities will mostly be located in the townships of Nawnghkio and Lawksawk while the reservoir will be stretching into the township of Kyaukmae where the Upper Yeywa Hydropower dam is located.

The economy in the project area is dominated by agriculture with sugar cane and maize as the most important commercial crops. The majority of inhabitants are farmers and regional townships provide services and markets for the local population. Other important crops include rice, peanuts and different kind of vegetables and fruits.

The local socioeconomic conditions are higher than average for rural Myanmar with considerable integration into a monetized system, relatively good infrastructure and reliance on cash crops. Water supply systems are found in most villages but do not always provide enough water over the whole year.

There are health clinics or health posts in the some of the project area villages but as elsewhere in rural Myanmar they are often struggling with lack of equipment and medicines. Although health care services nominally are free in Myanmar patients have to pay for the medicines and treatment. Malaria is common in the project area although the prevalence has been significantly reduced over the last years. Because of lack of clean water supply and sanitation facilities, diarrhoea is still a considerable problem, especially among young children. Other serious diseases that are occurring in the project area include tuberculosis and dysentery.

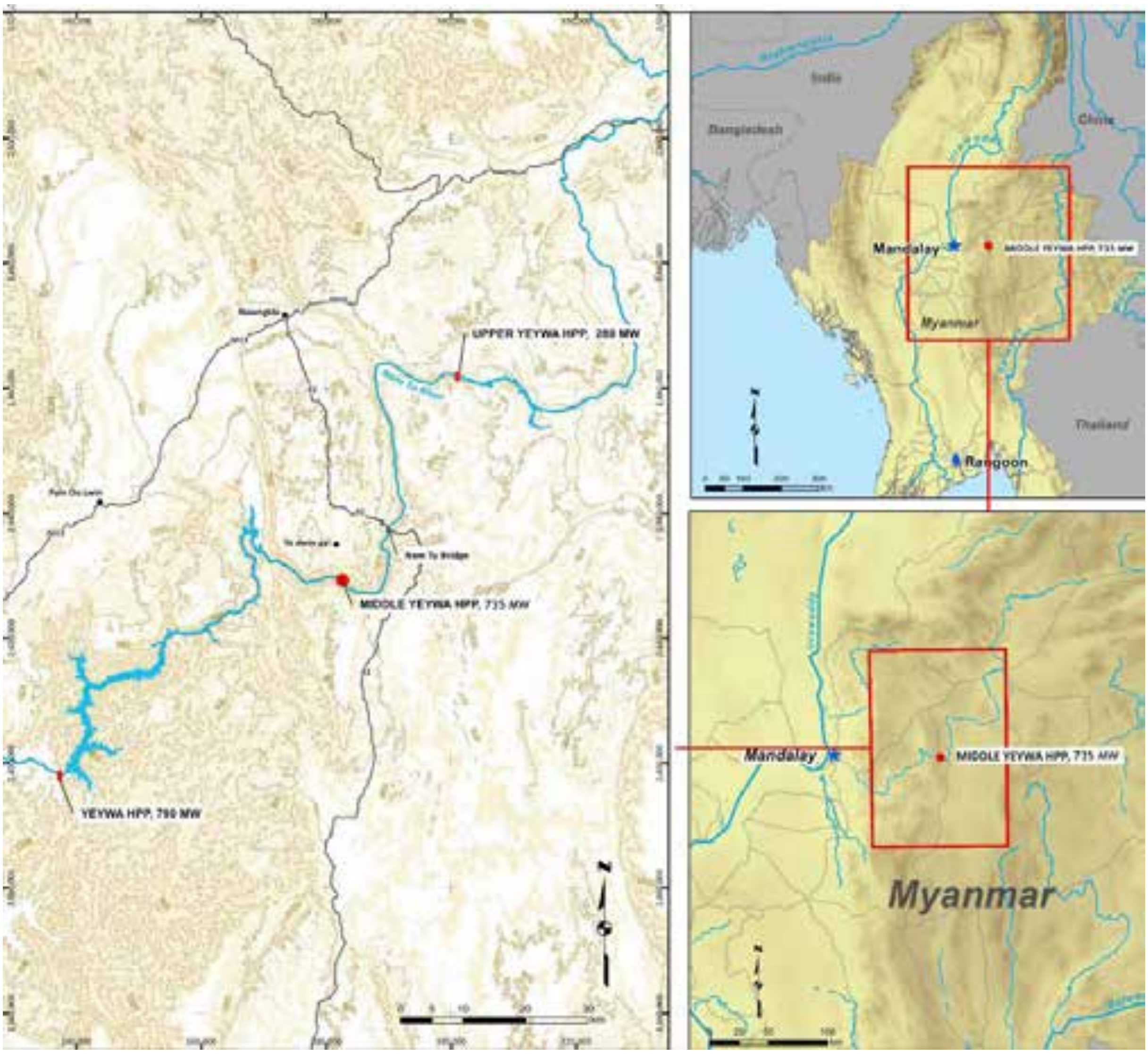

Figure 7-1: Project location (Source:Tractebel-Lahmeyer 2018).

2.2 General Layout and Salient Features

The layout for the Project presented here corresponds to the layout described in the Feasibility Studies Report (Tractebel-Lahmeyer 2018). The project will take advantage of the head available between the existing Yeywa reservoir (185 masl at FSL) and the Upper Yeywa HPP (323 masl. tail-water level), while keeping the constraint to have a 5 m difference between the tailwater of Middle Yeywa and the Full supply level of Yeywa as well as between the Full Supply level of Middle Yeywa and the Tailwater level of Upper Yeywa, during normal operations (
Figure ***7-2***). The Middle Yeywa HPP will have an installed capacity of 735 MW. The tailwater level is designed at 190 masl and the Full supply level at 317 masl.

The general layout of the main components in the dam and powerhouse area is shown in ***Figure 7-3***.

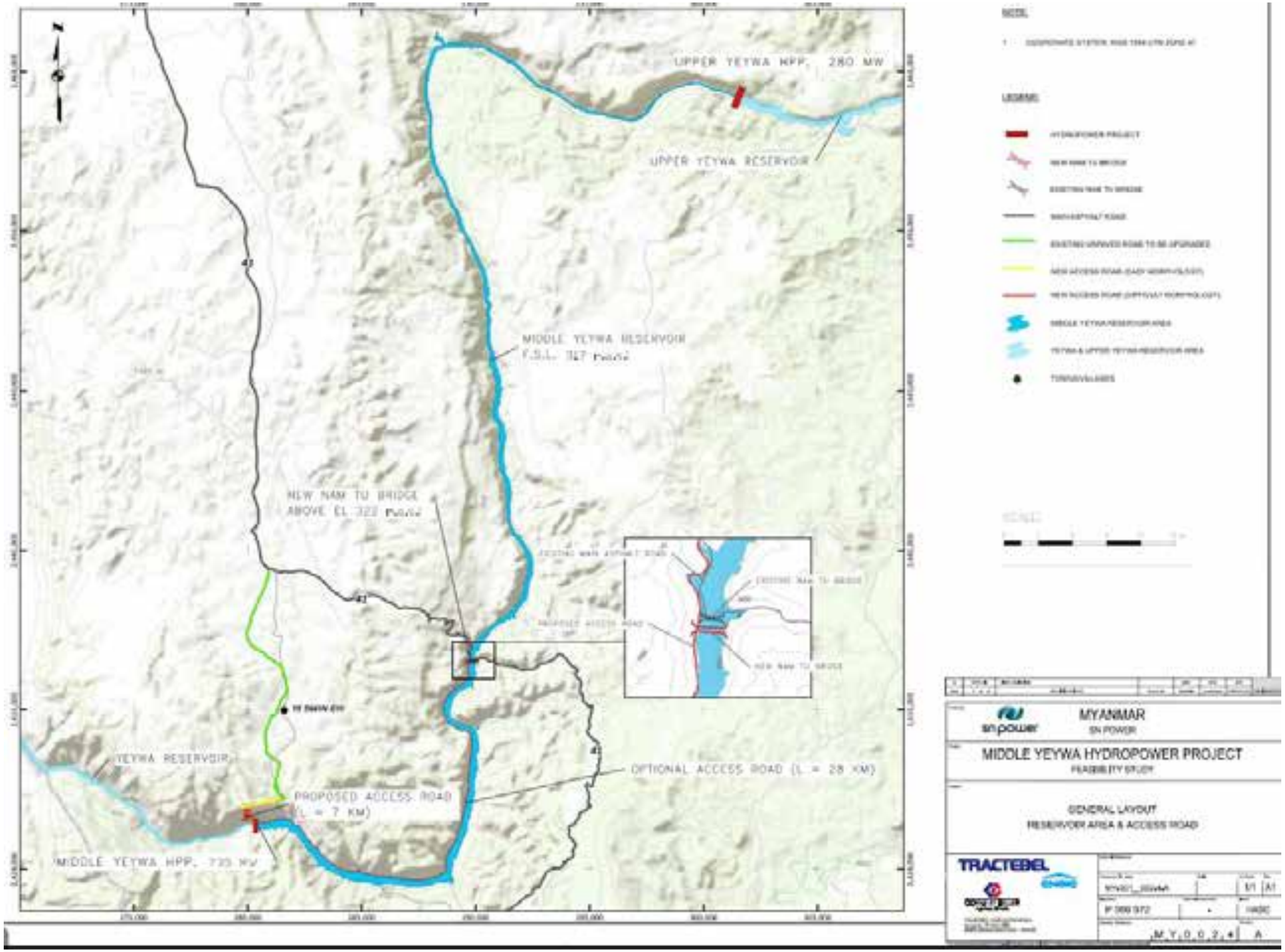

Figure 7-2: Overview of the Middle Yeywa HPP (Source: Tractebel-Lahmeyer 2018).

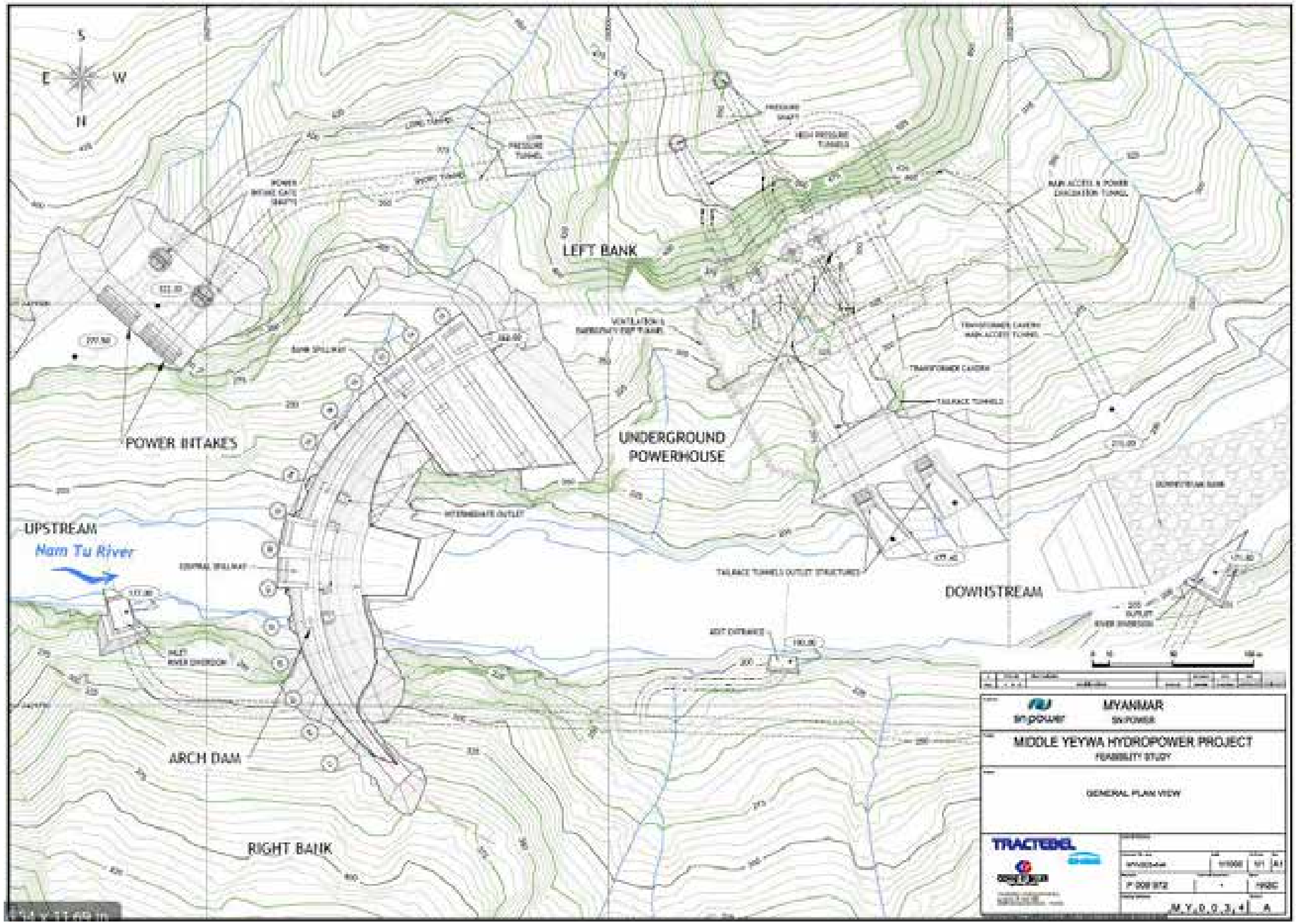

Figure 7-3: General layout of the Middle Yeywa HPP (Source: Tractebel-Lahmeyer 2018).

The dam and powerhouse will be located at the bottom of a series of rapids in the Myitnge River. The narrow river valley at this dam location does not allow the spillway structure and power intake to be constructed side by side on the dam unless large excavation works of one of the abutments is undertaken. The powerhouse will be located underground on the left bank of the river, in-between the main dam and the downstream cofferdam. To take up less space, the downstream cofferdam could possibly be constructed with hard-fill which will provide for a smaller and cheaper structure that than an embankment cofferdam. The upstream cofferdam, possibly to be made of roller-compacted concrete (RCC), may be positioned less than 50 m from the main dam. The diversion tunnel inlet structure will be constructed on the right bank of the river upstream of the cofferdam. The spillway plunge pool will be constructed between the main dam and the downstream cofferdam.

The salient features of the main alternative for the Middle Yeywa HPP are as follows:

- Reservoir FSL: 317 masl.
- Dam type: Arch dam
- Dam height: 160 m
- Spillway: 2 crest and 3 bays
- Powerhouse: 4 units (735 MW)
- Turbine type: Vertical axis Francis
- Powerhouse type: Underground
- Design discharge: 688 m3/s
- Design gross head (at FSL): 128,85 m
- Tail-water level: 190 masl
- Transmission Line: 2 double circuit 230 kV, 190 km
- Mean power production per year: 3,616.5 GWh

2.3 Project Components

2.3.1 Dam Type

The dam site is located at the tail end of (Lower) Yeywa Reservoir in an area with steep slopes. The topography his location is characterised by a V-shaped valley while the geological conditions are favourable with the whole river valley section consisting of consolidated and karst free dolomite rocks.

The chosen dam type is chosen is an arch dam since the valley shape is quite favourable.

The main characteristics and dimensions of the proposed Middle Yeywa arch dam are listed below:

- Dam type: Arch dam
- Maximum height above foundation level: 160 meters
- Crest length: 330 meters
- Width of the dam crest: 6,5 meters
- Width of the dam foundation: 37 meters
- Volume of foundation excavation (rock): 630 000 m3
- Volume of the dam (including bank spillway): 635 000 m3

The proposed dam will support a centrally located crest spillway of two (2) bays and a left bank located spillway with three (3) bays. All the spillway bays are gated and composed of a conventional concrete chute channel ended by a flip bucket. It must be noted that the discharge of the crest and left bank spillway impact the foundation on two separated areas. When the reservoir level is at 319.0 masl the spillway's total discharge with all gates open is about 12,000 m^3/s. An intermediate outlet conduit will be provided to enable the reservoir to be drawn down as may be required, and to pass the sediments in the Myitnge River thereby prolonging the life of the scheme. When the reservoir level is at 319.0 masl (3 meters below crest elevation), the intermediate outlet will be able to discharge about 3.000 m^3/s of water.

Lower level outlets will be constructed to enable the reservoir to be drawn down as may be required, and to pass the sediments in the Myitnge River to prolong the lifespan of the reservoir.

The following flexible sediment management plan is proposed in Middle Yeywa for the time being:

1. In general, close observations of sedimentation related phenomena at the reservoir, sediment sampling as well as a regular reservoir survey is recommended to get an understanding of the sedimentation processes and the propagation of the sediment foreset in the Middle Yeywa reservoir.
2. For the time being, a flushing interval of 4 years is recommended after the first necessity of flushing (the first necessity for flushing to occur in the fifteenth year of operation of Middle Yeywa).
3. In particular after the first flushing the new bed levels at the head of the Middle Yeywa reservoir as well as the change of the rating curve needs to be examined carefully.
4. If the simulated depositions downstream of the Upper Yeywa dam would really occur and effectively lead to a reduction of the available head at Upper Yeywa.
    a. local measures (determined based on the findings gained during the execution of point 1) should be taken, or
    b. a (time-)limited reservoir drawdown needs to be carried out in addition to the flushing itself in order to remobilize the sediments deposited in the upper reach of the reservoir. Since the maximum top elevation of the sediment delta is calculated to be approx. 321.0, a drawdown to MOL in Middle Yeywa - without a discontinuation of power generation - is expected to be sufficient.
5. If the above measures would not help to maintain at least the tailwater elevation at rated discharge at Upper Yeywa, the flushing frequency must be increased, in the worst case up to an annual flushing which has proven satisfactory according to the simulation results.

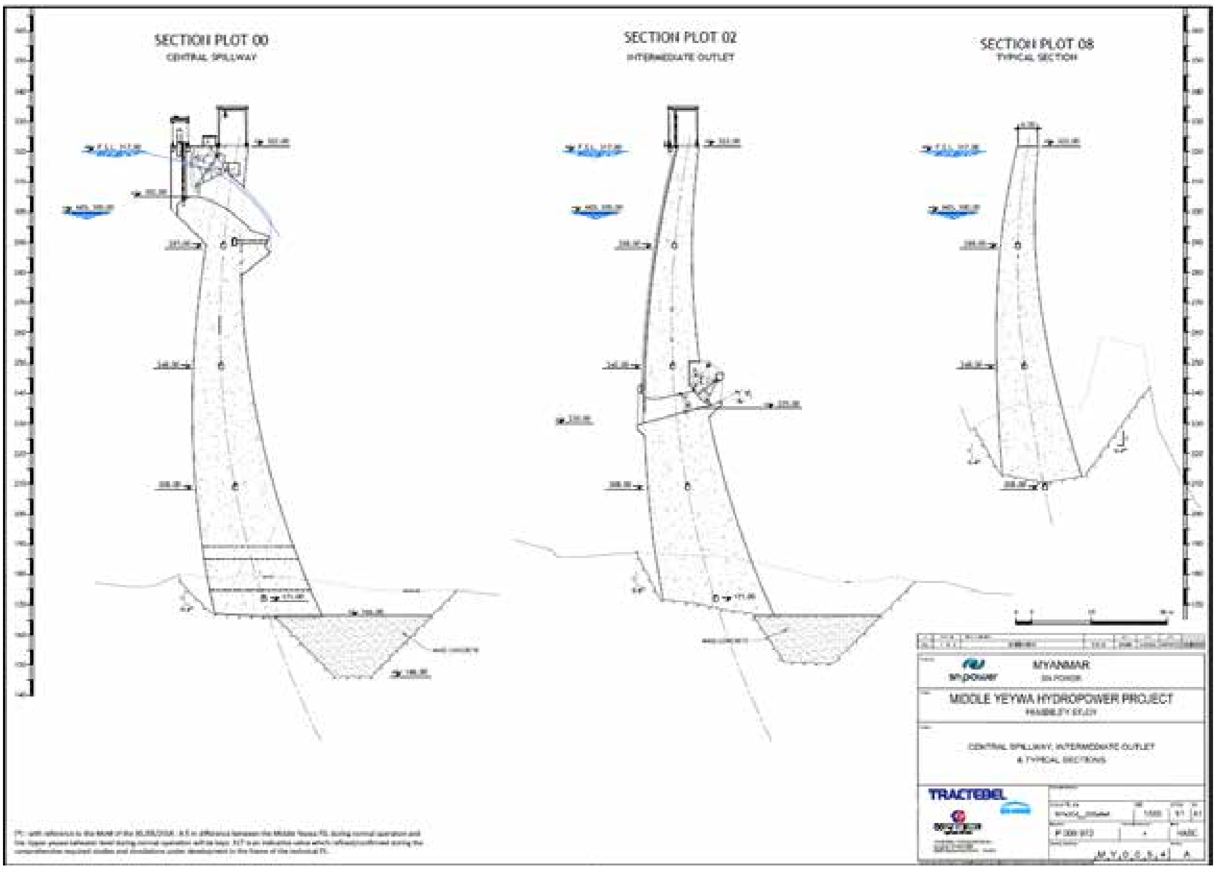

Figure 7-4: Cross-section of dam and spillway (Source:Tractebel-Lahmeyer 2015).

2.3.2 Intake and Power Waterways

There will be two power intakes on the right bank conveying the water through a pressurised twin power tunnel with concrete and steel lined sections designed to control and efficiently pass the reservoir water into the two power tunnels. Both intakes consist of an inclined bellmouths with trashracks leading to a transition section upstream of the gate shafts.

The invert of the power intake is placed at elevation 278.5 masl. for a Minimum Operation Level (MOL) of 300 masl., corresponding to a minimum submergence of 19,5 m. The nominal discharge for the intakes is 2 x 344 m 3 /s. The total trashrack net area for the two intakes is 2 x 405 m 2, giving a net velocity of circa 0.9 m/s. The trash-rack is supported by intermediate cross beams made of reinforced concrete. A 100 m long twin tailrace tunnel will lead the water from the powerhouse and into Lower Yeywa reservoir.

Because of the relatively low head of the Middle Yeywa power plant (maximum gross head of 128,85 m) and the short distance between the intake structure and the powerhouse, expensive and technically challenging surge chambers will not be required if reasonable limitations are imposed on the start-up and shut-down times of the turbines.

2.3.3 Powerhouse

The Feasibility study has confirmed that, due to the morphology of the dam site with a narrow gorge, construction of underground powerhouse is technically and economically preferred solution. The construction of the outdoor powerhouse would require massive excavation.

During the feasibility study the necessary geotechnical investigations (core drillings) could not be performed, since Consultant had limited access to the project site. However, based on the available geology it is assumed that the rock conditions are suitable for the construction of the underground powerhouse. This solution also allows works to progress at the power plant independently to any river diversion requirements, need of high cofferdam along the banks and dam construction.

The powerhouse complex will consist of a power cavern and a transformer cavern, as well as the required bus duct and access tunnels. The transformer cavern will be located approximately 40 m downstream of the power cavern and the two caverns are connected by two bus duct tunnels and one connection tunnel.

The power cavern will consist of the machine hall with machine blocks, an erection bay, a control room and rooms for the electro-mechanical auxiliaries. The transformer cavern contains the three phase step-up transformers and the GIS switchgear. The power cavern will be 105.9 m long, 31.8 m wide and 51.8 m high while the transformer cavern will measure 87.3 m x 17,2 m x 22.6 m.

The main access tunnel will cross the transformer cavern and enter the erection bay of the power cavern directly at the level of the machine hall floor. It will be 10 m high and 16 m wide and have a length of 220 m. The power evacuation route will be separated from the access section by reinforced concrete.

2.3.4 Reservoir

The building of the dam will establish a 70 km long and narrow reservoir that will be around 135-140 m deep immediately upstream of the dam. Over the 70 km towards the Upper Yeywa dam, the reservoir becomes gradually shallower with only a few metres depth at the upper end. The total area impounded by the reservoir will be around 11 km^2. Its long and narrow shape and limited depths will limit the residence time of the reservoir water and in that way reduce the risk for serious water quality issues after commissioning of the Project.

The geological investigations that have been carried out so far indicate that the risk for leakages through karstic formations is limited but further investigations are needed to confirm this assumption.

According to the Pre-Feasibility Study Consultant (Pöyry), the sediment load in the river flow is ranging between 200 to 400 $m^3/year/km^2$. Using the latest data from the Upper Yeywa HPP and using the highest sediment load figure, the life expectancy has been estimated to more than 50 years with the worst assumption of 0% trap efficiency at Upper Yeywa and 0% efficiency of the desilting facilities at the Middle Yeywa dam.

2.3.5 Roads

Access from Mandalay to the dam site is by National Highway No. 3 to Nawnghkio and from there continuing south on Road No. 41 down to Yae Twin Gyi village. The last section of Road No. 41 is unpaved with improvement works ongoing. From Yae Twin Gyi village to the dam site there is a village track that leads onto a footpath.

To reach the project site, the existing unpaved roads and village tracks/footpaths will be upgraded and a new road of around 3.8 km length will be built down the escarpment to the dam. A bridge will have to be built across the river downstream of the dam to access the dam and ancillary structure locations on the left bank. Due to the morphology on the left bank, it is foreseen that this bridge will also be used during operation with a deck at a higher elevation than the PMF level downstream the dam (206.6 masl.). A network of temporary access roads will also have to be constructed on both sides of the valley to provide good access to the construction sites, stockpile and spoil areas, site installations, etc.

The main design criteria for the access road design will be as follows:

- Overall width: 7.5 m to 9.0 m
- Carriageway width: 5.5 m to 7.0 m
- Maximum vertical gradient: 12 %
- Minimum horizontal radius: 30 m

The Middle Yeywa reservoir at FSL 317 masl will submerge the Myitnge Bridge which therefore has to be replaced. The new bridge will be 320 m long and will be constructed immediately downstream of the existing bridge. The main road will be realigned accordingly.

2.3.6 Auxiliary Components

The project will require housing facilities for workers and plant operators, storage areas for construction materials (including spoil tips) and equipment, crushing and batching plant(s), quarry, borrow pits, etc. However, at the present stage of project design, the exact locations of these components have not yet been determined. For the purpose of this ESIA study, it is assumed that all auxiliary components will be sited in the immediate vicinity of the dam/powerhouse and the access road on top of the plateau in the vicinity of Yae Twin Gyi village.

2.3.7 Associated Facilities

Before making a final decision on the connection point for Middle Yeywa a grid analysis will have be carried out. Nevertheless, it has been agreed with MOEE to use Miektila substation as connection point for the purpose of preparing a complete study and cost estimate for Middle Yeywa HPP. Two bays of Miektila substation will be equipped to accommodate the 2 incoming 230 kV transmission lines from the plant.

It should be noted that separate EIA reports will be prepared for the transmission line corridor, the quarries and the Myitnge Bridge.

2.4 Construction Schedule

2.4.1 Time Requirements

The construction work components which will determine the overall construction schedule are:

- Site access roads.
- Location and construction of the site facilities, contractor camp and yard,
- Batching plant and aggregate & cement stockpile.
- Diversion tunnel and cofferdams.
- Construction of the arch dam in different sections (river bed, spillway and abutment sections).
- Construction of the power caverns and the installation of the turbines and generators.

Before the main construction activities can commence, a number of pre-construction activities will have to be carried out, including construction of the access roads and preparation of the areas for other project infrastructure such as camps, workshops and batching plant. It is expected that the pre-construction works will take around one to one and a half year to complete and that they will be tendered as one separate Advance Contract. A new bridge will also have to be constructed across the Myitnge River before the filling of the reservoir.

The main construction works, which is expected to be awarded under one main contract, will then commence and continue for around five years. The total construction time for the Middle Yeywa Project, including the preparatory works, will consequently be six years.

The Feasibility Consultant has estimated the construction time requirements for the different woks as shown in the table below.

Table 7-1: Principal construction quantities and time requirements (Source: Feasibility Study Report, Tractebel-Lahmeyer 2018)

Activity	Quantity	Time (months)	Production Rate
Advance contract			
Access roads	7 km	9.0	25 m/d
Main contract			
Excavation of river diversion and temporary adit	750 + 100	3.0*	5.0 m/d
Concrete lining in diversion tunnel	750 m	3.0*	5.0 m/d
Excavation for dam foundation on abutments (including LB spillway)	530,000	5.9	3,000 m 3 /d
Excavation for dam foundation in river bed area	100,000	6.5	2,000 m 3 /d****
Production and placing of concrete in the main dam, including galleries, u/s and d/s facing, etc.	500,000	17.0	1,000m 3 /d**
Placing of central spillway concrete (crest, chute and ski-jump, piers & walls)	28,000	1.9	500 m 3 /d**
Placing of left bank spillway concrete (crest, chute and ski-jump, piers & walls)	80,000	5.3	500 m 3 /d**
Excavation of tunnels (on average)	1,625 m	11.0	5.0 m/d
Excavation of pressure shafts	160 m	1.5	2.0 m/ day
Concrete lining	1,625 m	11.0	5.0 m/d
Steel lining to pressure shaft	160 m	1.8	3.0 m/day
Excavation of power and transformer caverns	181,000	12.0	500 m 3 /d
Placing of structural concrete in power caverns	36,500	12.0	100 m 3 /d

* There are at least two excavation faces, and two starting points for the concrete lining.
** Average placement rate.
*** This volume is tentative since it mainly depends on the acceptable dam foundation level which will not be known before the completion of the site investigations.
**** Average rate including excavation in the river pit as well as at low elevation in the banks.

2.4.2 Preparatory Works

The most critical aspect of the preparatory works will be the construction of the access road to the project site, which will enable start-up of the main project components such as the dam and the diversion tunnel. The construction of the access road is estimated to take 9 months. Prior to the commencement of concrete works, a quarry will have to be established in order to provide for concrete aggregates. An aggregate crushing and screening plant, together with a concrete batching plant, would also need to be installed. Finally, camps and storage areas will have to be sited and constructed.

2.4.3 Diversion Works

The critical activities prior to the commencement of the diversion tunnel works are completion of the main access road to the Project location, and the site access road to the tunnel (and adit) portals (Advance Contract). Access to the inlet portal could be from the main access road above, or along the river from the outlet structure.

The diversion tunnel will be excavated from a temporary adit located about the flood level to enable the diversion tunnel to be excavated on 2 faces (from the adit intersection with the diversion tunnel alignment towards downstream, and from the inlet structure towards downstream to the adit intersection).

The construction programme currently considers tunnel excavation and concrete lining from these two faces.

It is noted that prior to the commencement of any concrete works, a quarry would need to be opened (together with a quarry access road) to provide concrete aggregates. An aggregate crushing and screening plant, together with a concrete batching plant, would also need to be installed (in addition to camps and storage areas, etc.).

2.4.4 Dam Excavation and Construction

During the first rainy season, the dam abutment excavations will proceed down to the elevation of the predicted maximum flood level in the river (El 190.0 masl). It will not be possible to go below this elevation without working in water. Accordingly, a large volume of material will still require removal in the “river bed” area following river diversion (which will take place at the commencement of the second dry season).

The arch dam concrete placement will require 2 years. In this regard, it is noted that when the river passes through the site (as well as the diversion tunnel) during the second rainy season (after the main contract award), the dam foundation excavation will be complete. Accordingly, levelling concrete and the initial placement of arch dam concrete will take place at the end of the preceding dry season to provide protection to the excavated surface. Concrete will be placed in the riverbed, and across the full width of the valley, up to El. 190 masl. Temporary openings will be left in the arch dam bottom during the whole construction period to allow water passing during the whole rainy season (in addition to the diversion tunnel).

Arch dam concrete can be placed during wet season: an average production rate of 1 000 m3 / day has been considered.

The time-consuming installation of the spillway/outlet structures are on the critical path for the dam.

Accordingly, concrete placement will focus on bottom outlet blocks, from El. 190 masl to El 250 masl, which is the elevation of the bottom outlet construction.

When El 250 masl has been reached, concrete placement will move to the right and left abutment sections. These activities will run in parallel with the installation of the steel liner and conventional concrete of the outlet structures. The construction time of the four bottom outlets is estimated to 6 months.

As soon as the outlet structures are completed, concrete placement will continue above, within the central spillway blocks. Once the central spillway elevation is reached, structural concrete and equipment installation will start: the construction time of the central spillway is estimated to be 5 months.

Then the left bank spillway will be completed: construction time is estimated to be 9 months.

2.4.5 Powerhouse and Underground Works

The underground works include the following components/ activities:

- Power intake structure and intake shaft excavation and concreting.
- Low pressure tunnel excavation and concrete lining (2 nr).
- Pressure shaft excavation and lining (2 nr).
- Pressure tunnel excavation and concrete lining (2 nr).
- Power cavern excavation and concreting.
- Transformer cavern excavation and concreting.
- Excavation and concrete lining of two bus duct tunnels and an access tunnel between the power cavern and the transformer cavern.
- Power cavern main access tunnel and emergency exit/ ventilation tunnel excavation and concrete lining.
- Bypass tunnel from the main access tunnel to the high-pressure tunnel location.
- Tailrace tunnel excavation and concrete lining (2 nr).
- Tailrace tunnel outlet structure excavation and concreting.

The power cavern activities are on the project's critical path and delays in the execution will impact the total project construction.

2.4.6 Summary of Construction Schedule and Programme

The whole construction phase from construction of the site access road and the new bridge across Myitnge River through to commercial operation of the Middle Yeywa is expected to be around 6 years (see 2.4.1).

It is expected that the following main sequences of activities will be on the critical path in the construction programme, including:

- Construction of the site access road;
- Completion on time of the diversion tunnel;
- Completion of the dam excavation in the river bed during a single dry season;
- Commencement of concrete placement at the end of the second dry season (March in Year 2 of main contract),
- Concreting of the spillway crest and the installation of the gates;
- Underground works for the power caverns, including installation and testing of electro-mechanical equipment.

It needs to be noted that prior to the start-up of construction activities, the environmental assessment and permitting phase must have been successfully concluded. This will include the following the following steps and milestones:

1. Submission and approval by the Ministry of Natural Resources and Environmental Conservation of the EIA Report, including environmental and social management plans;
2. Issuance of a Environmental Compliance Certificate (ECC) by the Ministry;
3. Asset survey of land areas and building infrastructure affected by project components such as access roads and camps based on technical detailed plans and siting, and with identification of all persons/households that will be entitled to compensation;
4. Calculation of compensation amounts and acceptance of the offered compensation by the project affected persons households;
5. Transfer of awarded compensation to all entitled persons/households.

In the figure below, the timing of the EIA schedules, including Environmental and Social Management Programmes, in relation to the construction schedule, is illustrated.

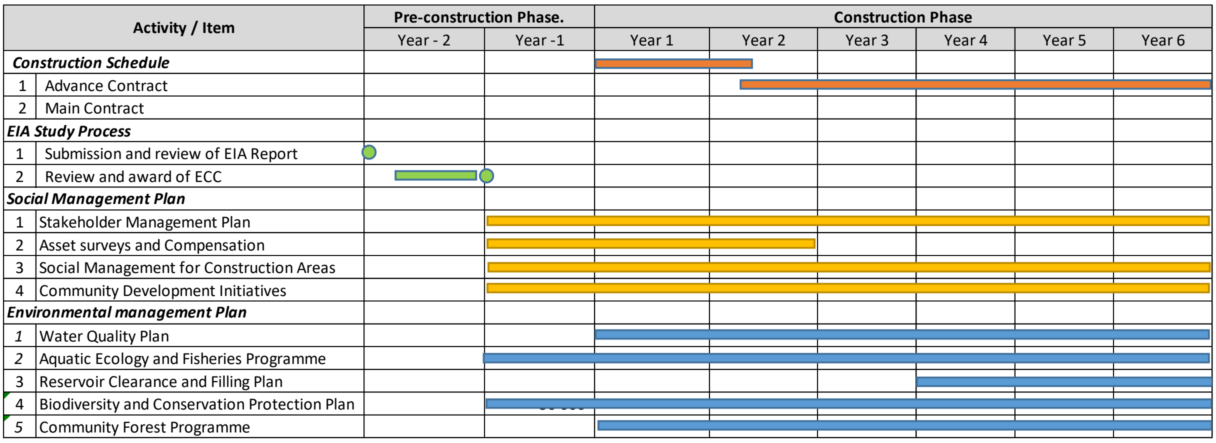

Figure 7-5: Timing of EIA Process and Mitigation Programme activities in relation to construction schedule

2.5 Construction Materials

The dolomite constitutes by far the predominant rock in the surroundings of the dam sites. The dominant facies are massive to bedded, but with bed joints relatively tight. The brecciated facies are quite frequent, but the rock is still well cemented and hard.

The most favourable setting for quarry should correspond to one of the numerous cliffs, which indicate already good strength characteristics. Rocks from excavations and much of the thick, blocky colluvium, could be also used.

As far as the strength is concerned, these rocks are expected to perform conveniently for their use as concrete aggregates. The durability tests and, especially, the alkali-reactivity shall be dully verified with the adequate tests.

At this stage, the construction materials are not considered as a discriminating criterion in the process of dam site selection.

2.6 Manpower Requirements

At this stage of planning, the number of workers that will be necessary for construction of the Middle Yeywa HPP has not been estimated. However, experience from other hydropower projects of a similar size and nature in the region indicate that the number of workers may reach more than 1,000 people during the peak of Construction Phase. According to the Construction Schedule, the construction activities may reach a peak in the second and third year of the 6-year construction phase.

2.7 Power Plant Operation

The reservoir operation is generally determined according to energy purchase price policies by the off-taker together with the energy tariff structure defined in the Power Purchase Agreement (PPA). However, it is assumed that the PPA to be negotiated by SN Power will be based on a fixed tariff. The simulation results show that Middle Yeywa HPP should be operated as a run-of-river plant as close as possible to FSL with daily peaking to achieve the highest revenues since head losses due to reservoir drawdown are minimised by this mode of operation.

2.8 Project Costs

The Feasibility Consultant has made a cost estimate based on the quantities and unit rates for the main cost items.

The total direct costs excluding contingencies for the current project layout has been estimated at 705 million USD with the electro-mechanical works and equipment, including the switchyard, being the largest cost component amounting to around 188 million USD. The second most expensive project component is the dam and spillway with around 159 million USD.

In addition to the direct costs, there will be indirect costs for the following items and services:

- Technical Management Services;
- Client Administration and Project Management;
- Owner's Engineering and Site Supervision;
- Detailed Design Engineering;
- Lender's Engineer and Project Insurance;
- Land Acquisition and EIA Mitigation Costs.

2.9 Project Alternatives

2.9.1 Powerhouse location study

As a part of the technical Feasibility study, a preliminary comparison analysis for the choice of powerhouse type, i.e. in cavern in the bank or open air in dam toe, based on preliminary costs estimation and technical considerations was carried out.

As a result of this study, an underground powerhouse appears to be the most suitable option, provided that the geological conditions are favourable. Those conditions shall be checked by relevant geotechnical investigations carried out, at the future powerhouse location.

2.9.2 Grid connection point

The final connection point, and hence the transmission line corridor, will be decided at a later stage based on:

- Grid analysis to confirm capacity and flow in the grid;
- Land acquisition;
- Total costs.

3 APPROACH AND METHODOLOGY

3.1 Impact Zones and Study Area

The study area has been defined based on a preliminary analysis of the direct (primary) and indirect (secondary) impacts of the proposed project. Accordingly, it has been divided into a direct impact zone and an indirect impact zone. These zones constitute the project's area of influence where risks and impacts will be further analysed.

The *direct impact zone* covers all areas that will be physically affected by the construction and operation of the Middle Yeywa hydropower plant. It includes the following areas as well as an approximately 200 m buffer zone surrounding each project component:

- *Middle Yeywa reservoir*, i.e. the area that will be inundated by the Middle Yeywa dam up to the full supply level (FSL)
- *Infrastructure footprint*, including the Middle Yeywa dam (and coffer dams during construction phase), the power station and its ancillary structures, all access roads, boat landings, construction camps, office buildings, housing camps, etc.
- *Bypassed river reaches,* i.e. the river environment between the dam/intake and the outlet from the power station
- *Downstream river reaches between the power station outlet and the existing Yeywa reservoir,* which will be subject to modifications and flow alterations due to hydropower peaking
- *Extraction sites for construction materials*, such as quarries and borrow pits
- *Spoil disposal areas*
- *Off-site areas* required for resettlement or compensatory measures (e.g. tree planting, conservation areas)

It should be noted that, at the current stage of project development, the exact delineation of the direct impact zone beyond the dam and reservoir area is not known due to the preliminary nature of the project design. In particular, the siting of camps, quarries, spoil disposal areas and possible compensation areas will not be determined until the completion of the feasibility study or even at later stage (detailed design).

The *indirect impact zone* consists of an area beyond the direct impact zone where the construction and operation of the power plant may indirectly affect the physical, biological and human environment through, among others, changes in water quality characteristics, air pollution levels (in the "airshed"), long-distance wildlife and fish migrations, and livelihoods and cultural behaviour of neighbouring communities. This zone should be defined such that unplanned developments induced by the project can also be captured (e.g. spontaneous settlement and land use change). The exact size of this zone depends on the themes being studied but is generally assumed to include the south-eastern part of Nawnghkio Township, the southern part of Kyaukme Township and the north-western part of Lawksawk Township. The map presented in ( ) shows the project area and the identified impact zones.

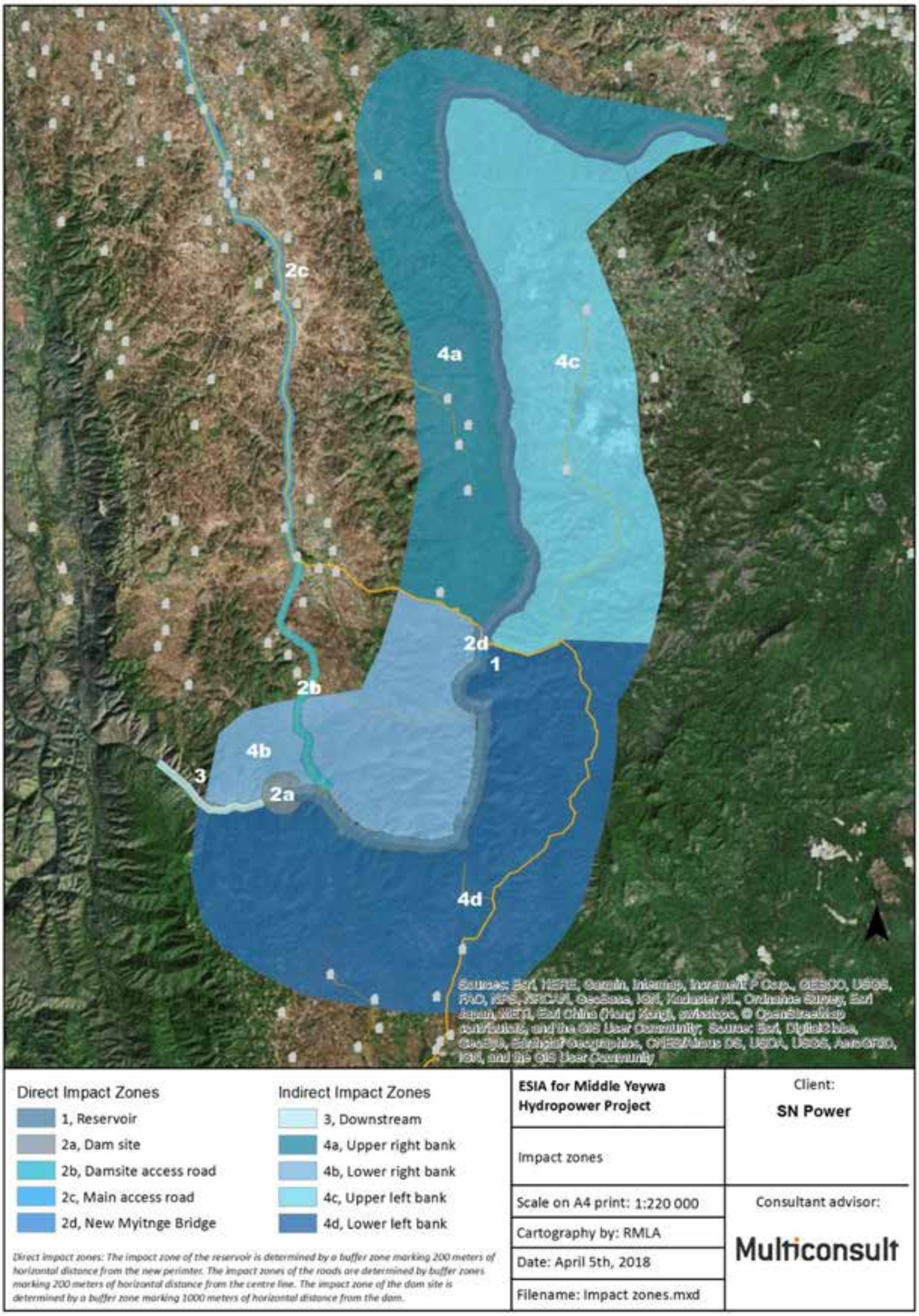

Figure 7-6: Map of Middle Yeywa HPP Impact Zones

3.2 General Approach

This EIA employs a standardised three-step approach to impact assessment in order to make the findings, conclusions and recommendations more objective and transparent. The key principle of the procedure is to combine the 'value' of the affected environment and the 'magnitude' of impacts to arrive at an overall assessment of impact.

- Step 1 attempts to attach a 'value', as judged from the baseline situation, for that specific issue or theme within the project area, giving a ranking on a scale from "low" to "high". The setting of value is based on the absolute value, if applicable, and its value in the local, regional, national and international perspective. It also takes into account uniqueness and vulnerability.
- Step 2 consists of a description and an identification of the 'magnitude' of the potential impacts on that specific issue or theme. The magnitude is considered in terms of the extent (local, regional, national, international), duration, severity/intensity, reversibility, and probability/risk of the different impact sources. The magnitude is measures on a scale from "large positive" to "large negative" (see ***Table 7-2***).
- Step 3 combines the results from the two first steps based on the criteria illustrated in Figure 7-7. The outcome of this exercise is the final 'impact assessment' and results in a ranking of the impacts on a scale from "very large positive" to "very large negative". In the summary tables, this ranking is illustrated by "plusses" and "minuses". Uncertainty will be indicated with the symbol **?,** and no impact or irrelevant is marked with a **0**.

Table 7-2: Definitions of Different Levels of Impact Magnitude.

Impact		Definition
None or Minimal		No detectable change to the environment.
Positive and Negative	Low	A small but detectable and permanent change to the environment; or A larger short-term / temporary change to the environment.
	Medium	A larger, but non-fundamental permanent change to the environment; or A short-term / temporary large change to the environment.
	Large	A fundamental change to the environment.

Note: Fundamental changes are those which are permanent, detrimental and would result in widespread change to the baseline environment.

The three steps are reported in Chapters 6 and 7 (Baseline conditions) and Chapter 8 (Impact assessment):

- Baseline situation: The value is derived from an assessment of the existing environment (physical, biological and human) at the inception of the construction works. Given the nature of the proposed works and the likely short lead time, the baseline can be considered as the current environmental and social conditions. For themes that cannot easily be valued, such as parts of the physical environment (e.g. geology and soils) and the human environment (e.g. population, livelihoods and economic activities), the value is by default assumed to be high.
- Assessment of impacts: Based on available knowledge of hydropower projects in general and the proposed project in particular, potential impacts can be predicted for each theme under the physical, biological and human environment. Following the identification and description of each of these impacts, the magnitude of the impacts on each theme is determined (see ***Figure 7-7***). The final impact assessment is then summarised at the end of the chapter by combining the baseline value and the impact magnitude, as described above.

The assessment of impacts in Chapter 8 also includes the relevant mitigation measures, i.e. all actions that can eliminate, offset, or reduce potentially adverse environmental and social impacts to acceptable levels. The net impact remaining with mitigation measures in place is referred to as "residual impact".

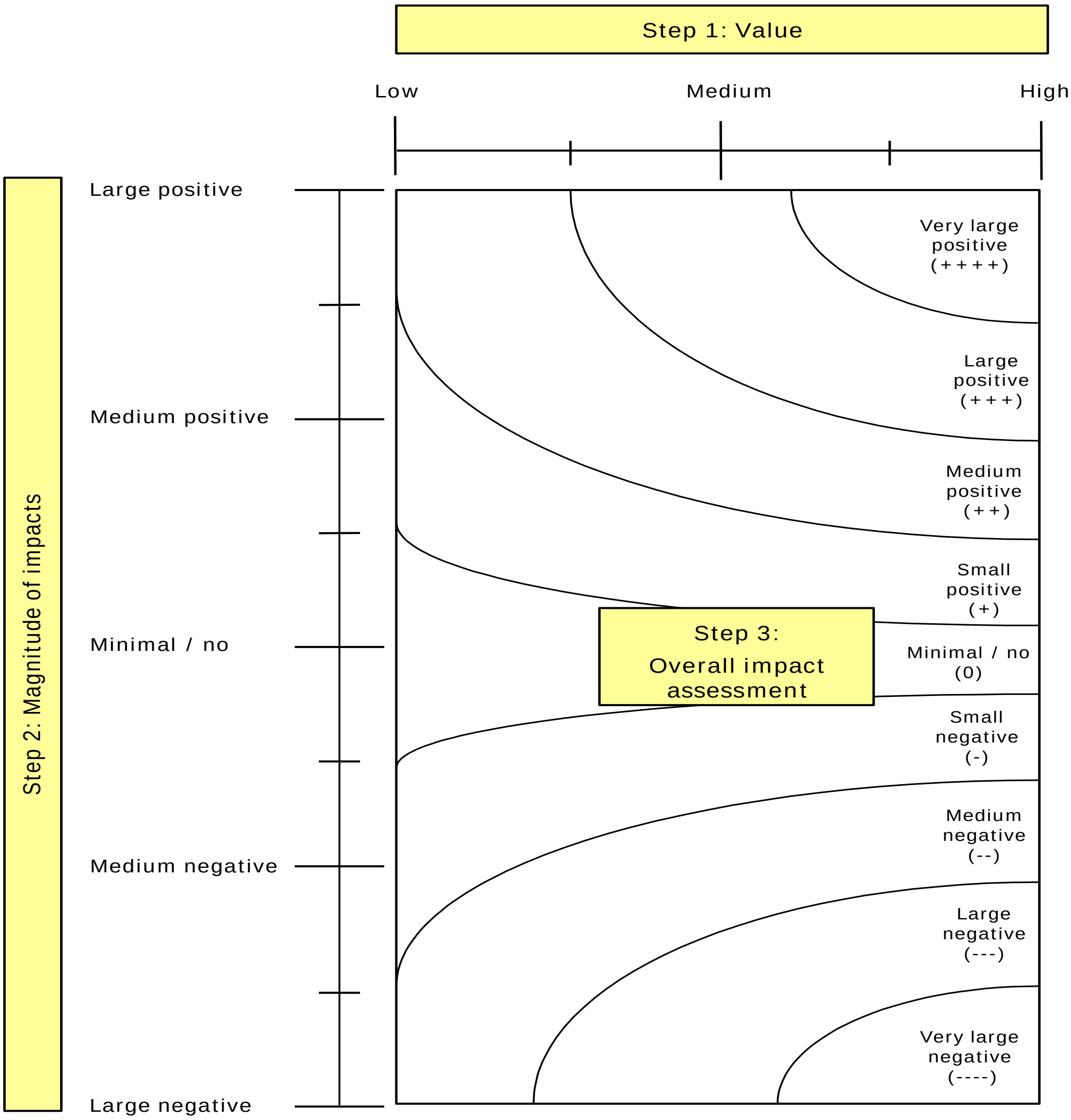

Figure 7-7: Impact Assessment Methodology.

3.3 Limitation and Data Quality

3.3.1 Limitations

The methodology for data collection and analysis is described in the respective sections and appendices. Limitations at the current stage of project planning are the lack of a detailed project description (technical feasibility studies are still at an early stage) and some gaps in the baseline data, first and foremost regarding the aquatic biodiversity. It is recommended that further studies of this environmental component is carried out.

Other limitations include:

- Some of the baseline data have been collected and analysed by other consultants than the current EIA consultant;
- Some groups residing in the wider project area may be sub-optimally represented in the socio-economic survey that was more focused on the villages located nearest to the reservoir and the dam site area.

3.3.2 Data Quality

The data quality for each of the main topics is evaluated in ***Table 7-3***. Further collection and studies will improve the data quality for a number of environmental and social components, most notably with respect to aquatic ecosystems and physical and economic displacement.

Table 7-3: Data Quality for Baseline Valuation.

Issue	Baseline Value
Environmental Baseline/Impacts	
Topography and landscape	High
Geology and soils	Medium-High
Climate	Medium
Air quality	Low
Noise	Low
Hydrology	Medium-High
Water quality	Medium
Protected areas	High
Vegetation	Medium-High
Terrestrial fauna	Medium
Aquatic ecosystems	Low
Social Baseline/Impacts	
Land use and land tenure	High
Natural resource use (river and forest resources)	Medium
Livelihoods and household income level	High
Vulnerable groups	Medium
Literacy and education status	Medium
Public infrastructure and services	Medium
Physical displacement	Low
Economic displacement	Low

4 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

4.1 Review of Existing Legislation on Hydropower in Myanmar

A number of laws, regulations and policies govern the power sector and hydropower development in Myanmar. In the following sections, these laws and regulations are briefly described, including laws and regulations that govern land acquisition, environmental conservation and the environmental assessment processes in Myanmar. Some of this legislation is relatively new and there may still be some lack of experience with the implementation and interpretation of the new laws.

4.1.1 Laws and Regulations

Myanmar Constitution (2008)

Sections of the Constitution that are especially relevant for hydropower development include:

- Section 37(a): The Union is the ultimate owner of all lands and all natural resources above and below the ground, above and beneath the water and in the atmosphere in the Union;
- Section 45 : The Union shall protect and conserve natural environment;
- Section 356: The Union shall protect according to law movable and immovable properties of every citizen that are lawfully acquired;
- Section 365: Every citizen shall, in accord with the law, have the right to freely develop literature, culture, arts, customs and traditions they cherish. In the process, they shall avoid any act detrimental to national solidarity. Moreover, any particular action which might adversely affect the interests of one or several other national races shall be taken only after coordinating with and obtaining the settlement of those affected;
- Section 371: The Union may assist the access to technology, investment, machinery, raw material, so forth, for national economic development.

Myanmar Electricity Law of 2014

The Myanmar Electricity Law of 2014 repeals the previous Electricity Law of 1984 and provides the legal basis for the establishment of the Electricity Regulatory Commission. The Commission is tasked with creating an environment conducive to investment in the power sector, and for overseeing compliance with electric power rules. The Electricity Law also authorises the Ministry of Electricity and Energy, region and state governments, and leading bodies of self-administrated zones and self-administrated divisions, to grant permits to entities to engage in electricity-related works such as generation, transmission, and distribution, thereby encouraging foreign and domestic investments in power projects.

The Electricity Law will be one of the key laws for SN Powers to consider as it is provides the legal basis for granting permits for development of energy projects.

Environmental Conservation Law (2012)

The Environmental Conservation Law has eight objectives, including:

- To provide the legal basis for implementation of the Myanmar National Environmental Policy;
- To provide the basic principles for systematic integration of environmental conservation considerations in the sustainable development process;
- To promote a healthy and clean environment and conserving natural and cultural heritage for the benefit of current and future generations;
- To reclaim ecosystems that have started to degenerate and disappear as far as possible;
- To reduce losses and promote sustainable use and management of natural resources;
- To promote public awareness and environmental education programmes;
- To promote international, regional and bilateral cooperation on environmental conservation;
- To promote cooperation among government departments, government organizations, international organizations, non-government organizations and individuals in matters of environmental conservation.

The Environmental Conservation Law enables the Union Government to form an Environment Conservation Committee with the Union Minister of President Office Ministry as Chairman (Chapter 3 paragraph 4). The other members are not specified, but it is stated that a Vice Chairman, Secretary and Joint Secretary shall be nominated among the members. The Committee is charged with promoting environmental conservation education, and guiding other government departments and agencies on conservation issues.

The Law further specifies the tasks and duties of the Ministry assigned by the Union Government to be responsible for environmental matters (Ministry of Natural Resources and Environmental Conservation). The most important tasks listed include:

- Implementing the environmental conservation policies;
- Preparation of national and regional plans for environmental management;
- Establishing monitoring programmes for the conservation and enhancement of the environment;
- Preparing and stipulating environmental quality standards (e.g. noise, water quality, solid waste);
- Give guidance related to mitigation and adaptation of climate change;
- Specifying categories and classes of hazardous wastes and prepare rules for safe management, treatment and storage;
- Promoting and carrying out the establishment of necessary factories and stations for the treatment of solid wastes, effluents and emissions which contain toxic and hazardous substances;
- Setting terms and conditions for discharge permits for effluents and air emissions for companies and factories;
- Implementation of the international, regional and bilateral agreements accepted by Myanmar for environmental conservation and enhancement of environmental quality;
- Preparation and implementation of a system of environmental impact assessment and social impact assessment for projects that may cause a significant impact on the environment to be undertaken by companies/persons and government organisations;
- Prepare guidelines for the management, conservation and enhancement of environment with respect to protection of ozone layer, conservation of biological diversity, conservation of coastal environment, mitigation and adaptation of global warming and climate change, combating desertification and management of non-depleting substances and management of other environmental matters.

Chapter 9 of the Law requires government departments and organisations to conserve and manage natural resources sustainably while in paragraph 19 it is stated that the Ministry (MONREC) shall be responsible for protecting and conserving cultural and natural heritage sites and cultural monuments in cooperation with other government departments and organisations.

The Environmental Conservation Law also establishes an Environmental Management Fund for implementation of conservation projects and programmes.

The Environmental Conservation Law requires sustainable development and systematic integration of environmental conservation considerations in project developments and is as such relevant for the Middle Yeywa HPP

Environmental Conservation Rules (2014)

The Environmental Conservation Rules provide more detailed descriptions of the duties and powers of the Environment Conservation Committee and the Ministry of Natural Resources and Environmental Conservation with regard to environmental conservation. Duties and functions of the departments under the Ministry are specified with the most important tasks being:

- Carrying out research and data collection regarding conservation and enhancement of the environment, as well as conducting training programs;
- Drawing up of plans for mitigation of climate change and climate adaptation;
- Dissemination of environmental information for raising environmental awareness;
- Promotion of environmental conservation education in schools and among the public;
- Environmental permitting and issuing of licenses for government organisation and businesses that operate factories and projects that has an impact on environmental quality;
- Regulating hazardous substances which can damage the environment and are restricted or prohibited by international agreements and local existing laws;
- Implementation of an Environmental Impact Assessment system;
- Preparation of environmental situation reports for the regions and for the country.

EIA Procedure (2015)

The Environmental Impact Assessment Procedure was adopted in December 2015 by the Ministry of Environmental Conservation and Forestry (superseded by the Ministry of Natural Resources and Environmental Conservation from April 2016). The procedure provides the practical framework for carrying out environmental assessment of projects that require an approval/licence or are regulated by any part of the Union Government of Myanmar.

Projects are divided into three categories according to their potential for causing adverse impacts to the natural or human environment:

- EIA Type Project (high risk of significant and adverse impacts)
- Initial Environmental Examination (IEE) Type Project (impacts that are local and temporary and can be mitigated)
- Projects that requires neither IEE nor EIA

Annex 1 of the EIA Procedure, *Categorization of Economic Activities for Assessment Purposes,* identifies hydropower projects with installed capacity from 15 MW and upwards or with a reservoir volume and reservoir area above 20 million m^3 and 400 ha (4 km^2) respectively, as EIA type of projects. The Middle Yeywa HPP qualifies as an EIA Type Project according to all these three criteria.

Chapter II of the EIA Procedure initially refers to the relevant sections and articles of the Environmental Conservation Law and the Environmental Conservation Rules and states in Article 3 that: *Pursuant to Section 21 of the Law and Articles 52, 53 and 55 of the Rules, all Projects and Project expansions undertaken by any ministry, government department, organization, corporation, board, development committee and organization, local government or authority, company, cooperative, institution, enterprise, firm, partnership or individual (and/or all Projects, field sites, factories and businesses including expansions of such Projects, field sites, factories and businesses identified by the Ministry, which may cause impact on environmental quality and are required to obtain Prior Permission in accordance with Section 21 of the Law, and Article 62 of the Rules) having the potential to cause Adverse Impacts, are required to undertake IEE or EIA or to develop an EMP, and to obtain an ECC in accordance with this Procedure.*

Most importantly, Article 7 requires project proponents to adhere to certain standards and practices if the project involves involuntary resettlement and indigenous peoples by stating that: *Projects that involve Involuntary Resettlement or which may potentially have an Adverse Impact on Indigenous People shall comply with specific procedures separately issued by the responsible ministries. Prior to the issuance of any such specific procedures, all such Projects shall adhere to international good practice (as accepted by international financial institutions including the World Bank Group and Asian Development Bank) on Involuntary Resettlement and Indigenous Peoples*.

Article 13 requires the project proponent to undertake an appropriate public consultation process and to disclose publically all relevant project-related information.

Chapter V describes and sets out the requirements for the EIA process, including the Scoping and the EIA Investigation phases. The project proponent is required to disclose information about the project and to hold public consultations during both phases (Articles 50 and 61).

Articles 55 to 61 describe the requirements for the EIA Investigation including baseline data collection (Article 57) and analysis of alternatives (Article 58). Most importantly, Article 60 requires that the EIA *investigations consider the views, concerns, and perceptions of stakeholders, communities and individuals that could be affected by the Project or who otherwise have an interest in the Project, and furthermore that the EIA shall include the results of consultations with the public, affected populations and other stakeholders on the environmental and social issues.*

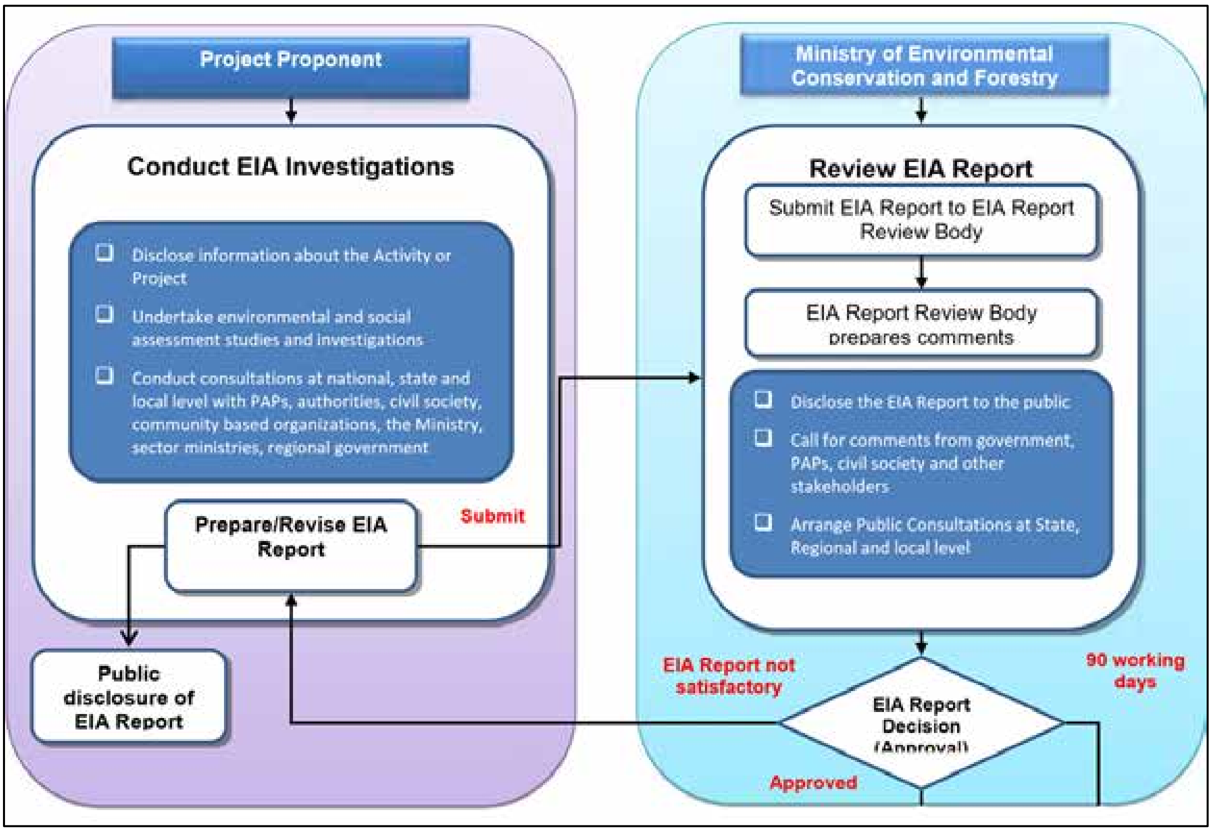

Figure 7-8: EIA investigation and review process in Myanmar (Source Environmental Impact Procedure, 2015).

The review and approval process for the EIA Report is described in Articles 67 to 70. After submission of the EIA Report, the Ministry appoints an EIA Report Review Body which invites comments from all stakeholders and relevant parties and arranges public consultation meetings at national, regional, state and local levels where the EIA Report is presented. The Review Body collects and reviews all submissions and comments and prepares a report for the Ministry with their recommendations. The Ministry subsequently takes the final decision within 90 days on whether to approve or reject the EIA Report. If rejected, the project proponent will have to amend the EIA Report before it is resubmitted, while if approved, the Ministry will issue an Environmental Compliance Certificate (ECC). The Ministry may attach conditions to the ECC obliging the project proponent to implement mitigation measures to eliminate or reduce the environmental impacts caused by the project.

The rejection or approval of the EIA Report by the Ministry may be appealed by the project proponent or any person or organisation that are negatively impacted by the project (Articles 71 - 75).

Chapter VIII describes the requirements for project approval and the award of the ECC. Article 83 requires the project proponent to obtain an ECC before any other permits can be granted by other ministries or authorities to proceed with implementation of a project.

After the ECC has been issued, the project proponent has to start the implementation of the project within the two years (Article 88). If implementations does not commence within the two year timeframe, a new EIA Report will have to be prepared and submitted to the Ministry, unless the project proponent has applied for an extension with an explanation of why the project is delayed and indicating the additional time needed before implementation can start (Article 89).

Article 102 places the full legal and financial responsibility on the project proponent for all of his actions and omissions, including those of his employees, contractors and consultants that have been hired for carrying out work on the project. Most importantly, Article 102 also requires the project proponent to restore the livelihoods of all project affected persons (PAPs) and support them until they have achieved socio-economic stability at a level not lower than that in effect prior to the commencement of the project.

Finally, Article 103 makes it clear that the project proponent is responsible for fully implementing the Environmental Management Plan (EMP) along with all project commitments and ECC conditions. Furthermore, the project proponent is responsible for ensuring that all contractors and subcontractors comply with all applicable environmental laws and regulations, project commitments and conditions.

For the SN Power the EIA Procedure is a key piece of legislation as it gives specifications for the EIA study requirements and the process for issuing an Environmental Compliance Certificate (ECC) for the Middle Yeywa HPP.

The Land Acquisition Act (1894)

The Land Acquisition Act of 1894 is the main legal instrument that presently governs the process of land acquisition in Myanmar. Part II sets out the procedures for initial investigation of the land that is considered for acquisition for public purposes, as well as procedures for how to raise objections to acquisition. Before any investigations and surveys can be made, Article 4(1) requires that *a notification to that effect shall be published in the Gazette, and the Collector shall cause public notice of the substance of such notification to be given at convenient places in the said locality.* Article 5A allows a thirty day period after the notification for any person who is entitled to claim compensation to object to the acquisition of the land. The objection must be made in writing to the Collector who is required to give the objector an opportunity of being heard. The Collector, after hearing the objections, makes a report summing up the objections and his recommendations regarding these and submits the case to the President of the Union for a final decision.

If the President of the Union decides to acquire the land a declaration of the acquisition is made and published in the *Gazette.*

Regarding valuation of the land, Article 11 states that the Collector is responsible for establishing the area of land to be acquired and for determining the compensation that shall be paid for the land. Article 12 stipulates that the award of compensation by the Collector is final while Article 15 requires the Collector to take into account the market value of the land (Article 23). If the awarded amount is not accepted by those who are entitled to compensation, Article 18 provides a possibility for referral to the Court. However, this has to be done through an application to the Collector within 6 weeks of the notification of the compensation award.

Part VII of the Act deals with acquisition of land for companies. Article 40(1)(b) allows for the acquisition of land for public purposes by a government agency from individual landowners when it is *likely to prove useful to the public.* Article 41 specifies that when the President of the Union has approved the company's plans and is satisfied that the project will prove useful to the public, the company is required to enter into an agreement with the Government for the acquisition of the land. After payment, the Government acquires the land and transfers it to the company. The Government has the responsibility for distributing the compensation to the owners or occupants of the land. The agreement between the company and the Government is to be disclosed in the National Gazette (Article 42).

It needs to be noted that land acquisition in Myanmar is an issue that is currently much debated due to the way land acquisition previously has been handled and implemented. The Myanmar Centre for Responsible Business notes the following regarding the legal framework for land acquisition[1]:

- *Myanmar does not have detailed procedures on land acquisition and appears primarily to be using outdated laws as the basis for land acquisition.*
- *The current legal framework, including even the more recent Farmland and VFV Laws, provides only general authorisations on expropriation "in the public interest" with no further procedural or substantive restrictions, leaving this process open to abuse. The Government has wide discretion to expropriate land "in the interests of the public" or even if "likely to prove useful to the public." The 1894 Land Acquisition Act permits expropriation because the Government "is or was bound" to provide land under an agreement with a company, without any additional requirement of public interest.*
- *The laws and rules provide limited specifications on the process of expropriation and as noted, limited safeguards for those whose property is being acquired. Only under the 1894 Act is there a process for objections. There are no procedures for objections to acquisitions or compensation for VFV land or farmland. Apart from these laws, there are no other laws on expropriation or resettlement.*

The Land Acquisition Act provides the legal basis for the land acquisition process and will therefore be an important piece of legislation for the Middle Yeywa HPP. However, the Project's need to acquire land for project purposes is expected to be relatively limited.

The Farmland Act (2012)

The 2012 Farmland Act provides the legal basis for land registration and provision of land use certificates (LUCs) that give farmers the right to sell, exchange, access credit, inherit and lease the land over which they hold user rights under customary law. Tenure rights awarded under the Farmland Act may be revoked by the Government if any of its conditions are not fully complied with. It also allows for the repossession of farmland in the interests of the State or the public but requires that the farmland rights holder must be fully compensated (Article 26).

The Farmland Act makes it clear that those who apply for registration of their land must be Myanmar citizens. Furthermore, it states that organisations are also permitted to apply, including government departments or organisations, nongovernmental organisations (NGOs) as well as companies.

Farmland rights granted under the Farmland Act are freely transferable except for the fact that there are restrictions on transfers to foreign investors.

The Farmland Act does not provide for any procedures for objections to be made to the acquisition or compensation awarded.

The Farmland Rules - Notification No. 62 (2012)

The Farmland Rules provides the procedures for applications for land use certificates under the Farmland Act as well as for applications for changes in land use. It also specifies procedures for dispute resolution and for leasing and mortgaging of land.

The Vacant Fallow and Virgin (VFV) Lands Management Law and Rules (2012)

The Vacant Fallow and Virgin (VFV) Lands Management Law and Rules provides a legal framework for implementing Government land policies to maximise the use of land as a resource for generating agricultural income and tax revenues. The law allows the Government the flexibility to do what they believe is needed for development.

[1] *Myanmar Centre for Responsible Business, 2015: Land, Briefing Paper, pages 12-13*

Article 55 gives the Central Committee for VFV Land Management the right to repossess VFV land that had been granted to others for, among other things, the *implementation of basic infrastructure projects or special projects required in the interests of the state*, and also where natural resources are discovered on VFV lands. Article 56 specifies that compensation shall be based on current values of the land.

The Farmland Act, the Farmland Rules and the VFV Lands Management Law and Rules will be important if the Project will be required to provide replacement land as a part of the compensation for loss of agricultural land.

4.1.2 Policies

National Land Use Policy (2016)

This new policy aims to harmonize existing laws and guide development of a new land law. The policy assures equitable land access for smallholders and landless people, with consideration of customary tenure and gender equality. Regarding projects that entails land use changes, it requires the proponent to carry out and pay for an independent environmental and social impact assessment out to identify and minimize the impacts of land use changes. The policy also aims at protecting common land resources shared by neighbouring communities.

Regarding resettlement, the policy specifies that involuntary resettlement shall be avoided as far as possible by amending and changing the plan for the project. However, it states that if the project is in the interest of the state and relocation is unavoidable, resettlement shall be negotiated and be carried out in a sustainable manner with sufficient resources to be provided for those who have to relocate. The policy also requires that project affected persons are consulted and involved in the relocation planning in a systematic manner. Finally, the policy requires that housing and infrastructure in the resettlement sites shall be in place before the actual relocation of the project affected persons. There is also a requirement that the housing and infrastructure facilities in the resettlement sites are at least of the same standard, preferable better, than the resettlers had before the relocation.

Section 46 of the policy deals with settling of land disputes and provides for establishment of local land dispute settlement bodies at the local administrative levels including at village-tract and community level. The policy also allows for appointment of monitors to oversee the settlement of disputes relating to land use.

The policy also requires that affected ethnic groups are duly consulted regarding traditional land use rights and that these shall be recognised irrespective of whether they are recorded and registered or not. Traditional land use rights may be registered according to existing laws.

4.2 Comparison with IFC Standards – Gap Analysis

Table 7-4: Gap analysis of Myanmar legal framework in relation to IFC performance standards.

IFC Performance Standards	Comments / Identified Gaps	Recommendations
Performance Standard 1: Assessment and Management of Environmental Risks and Impacts *Requires the project developer to carry out environmental and social assessment, and establish and maintain an Environmental and Social Management System to manage and minimise environmental and social risks and impacts.*	The Environmental Impact Assessment Procedures of December 2015 requires the EIA to cover social as well as environmental impacts. Although the Myanmar regulatory framework still has gaps when it comes to social safeguards, such as the rights for resettlers and indigenous peoples, the Procedure (Article 7) states that *projects that involve Involuntary Resettlement or which may potentially have an Adverse Impact on Indigenous People shall comply with specific procedures separately issued by the responsible ministries. Prior to the issuance of any such specific procedures, all such Projects shall adhere to international good practice (as accepted by international financial institutions including the World Bank Group and Asian Development Bank) on Involuntary Resettlement and Indigenous Peoples.*	It is recommended to adhere to IFC standards with respect to further assessment of and planning, especially with regard to consultations with project-affected persons, public disclosure and compensation process.
Performance Standard 2: Labour and Working Conditions *Requires the project developer to provide reasonable working conditions and terms of employment, treat migrant and non-migrant workers equally and allow workers to organise.*	Occupational health and safety and working conditions, including terms of employment, are relatively well covered in the Workman's Compensation Act, Leave and Holidays Act, Payment of Wages Act, Social Security Act and the Factory Act. However, issues and areas that are not sufficiently covered compared to the PS2 requirements include child labour, non-discrimination and equal opportunity. Child labour is not explicitly prohibited while legislation providing for equal opportunity was repealed in 1964 (*Law Defining the Fundamental Rights and Responsibilities of the People's Workers*).	As current labour legislation only provide basic principles and do not cover issues like child labour and non-discrimination and equal opportunity sufficiently, it is recommend that the Developer adheres strictly to the IFC Performance standard 2 as well as ILO's Labour Standards The Developer should also make sure that the contactor and sub-contractors comply with IFC and ILO labour requirements.
Performance Standard 3: Resource Efficiency and Pollution Prevention *Requires application of techniques that are adapted to the pollution hazards and risks specific for the project. The applied techniques shall be consistent with good international industry practices (GIIP) such*	Pollution control is addressed in the Environmental Policy of 1994 and in the National Environmental Quality Guidelines issued alongside the Environmental Impact Assessment Procedures. Energy efficiency is implicitly dealt with at policy level in the National Strategy for Sustainable Development (NSDS), as one of its goals is sustainable management of natural resources.	As high-level policy strategies on resource efficiency and pollution prevention are insufficiently backed up by legislation it is recommended that IFC General Health and Safety Guidelines on environmental standards (No.1) are strictly adhered to.

IFC Performance Standards	Comments / Identified Gaps	Recommendations
as those described in the World Bank Group Environmental, Health and Safety Guidelines (EHS Guidelines). *For resource efficiency it is required that cost effective measures are applied for improving conservation of energy consumption, water and other resource inputs.*	With regard to resource efficiency, a gap exists as it is only expressed at the policy level and not backed up by enforceable legislation.	
Performance Standard 4: Community Health and Safety *Requires the project developer to minimize the risk that local communities are exposed to hazardous materials and substances. It is furthermore requires that measures are taken to avoid or minimize the risk for transmission of communicable diseases associated with influx of temporary or permanent project labor. Finally, measures shall be taken to prevent the loss of access to ecosystem services for the local population.*	Community health and safety is regulated by a number of laws and regulations focusing on food and drugs, transport, unsafe material and land resource utilization and negative environmental practices. In the Myanmar legal framework there are gaps with regard to design safety and hazardous materials management. There are also shortcomings with regard to wider community health legislation.	Because there are gaps with regard to legislation governing waste as well as requirements for consideration of wider community health and safety, it is recommended that IFC's General Health and Safety Guidelines for Community Health and Safety (No.3) with their waste management principles and emission standards are adopted by the Project.
Performance Standard 5: Land Acquisition and Involuntary Resettlement *Requires that the project developer seeks to avoid or minimize physical and economic displacement through alternative project designs. It is further required that a continuous consultation and stakeholder engagement process with affected communities is carried out. If physical displacement is unavoidable, a Resettlement Action Plan shall be prepared. Regarding compensation, it requires that*	Regarding physical displacement, there are no clauses in the present Myanmar legislation that requires a project developer to actively seek to avoid involuntary resettlement (although it is mentioned in the new Land Use Policy). There is no reference in the legal framework corresponding to the requirement that developers should be encouraged to use negotiated settlements to avoid expropriation and eliminate the need to use governmental authority to enforce relocation. There are no provisions in the laws and regulations that require consideration of feasible alternative designs to avoid or minimise physical and or economic displacement. However, in the National Land Use Policy, it	As there are gaps and uncertainties in the legislation with regard to compensation and resettlement it is recommend that the Developer follows the recommendations set out in IFC's PS 5 and Resettlement Handbook regarding full compensation and minimisation of displacement.

IFC Performance Standards	Comments / Identified Gaps	Recommendations
loss of land and other assets are compensated at full replacement cost and that a grievance mechanism is put in place.	is stated that that involuntary resettlement shall be avoided as far as possible by amending and changing the plan for the project. IFC PS 5 requires compensation for loss of assets at full replacement cost. The Land Acquisition Act provides for market value compensation (Article 9 and 23) but there are no references to full replacement cost except for in Article 26 of the Farmland Act that requires the farmland rights holder to be fully compensated. There are no references in the laws and regulations to the requirement that a resettlement action plan shall be developed apart from the statement in Article 7 of the EIA Procedures that project that involve resettlement should adhere to international good practice. In addition, the National Land Use Policy states that if the project is in the interest of the State and relocation is unavoidable, resettlement shall be negotiated and be carried out in a sustainable manner.	
Performance Standard 6 - Biodiversity Conservation and Sustainable Management of Living Natural Resources *Requires that the project developer seeks to avoid impacts on biodiversity and ecosystem services. If this is unavoidable, measures to minimize impacts and restore biodiversity and ecosystem services shall be implemented. In response to changes in conditions and monitoring outcomes, adaptive management of mitigation measures should be applied.* *Requires a project developer to put in place verification practices and a system for evaluation of primary suppliers in his supply chain to reduce the risk for significant conversion of natural and critical habitats.*	The main piece of legislation for biodiversity conservation in Myanmar is the Environmental Conservation Law of 2012. In addition, the Freshwater Fisheries Law of 1991 and the Conservation of Water Resources and Rivers Law of 2006 provide for the protection of fish biodiversity and riverine areas. However, the legislation only differentiates between critical and legally protected areas and not between natural and modified habitats as the PS 6 does. Regarding supply chain, the present legislation in Myanmar does not explicitly require companies to put in place verification systems to reduce risks for contributing to loss of natural and critical habitats in their supply chains and procurement process.	As requirements of distinguishing between natural and modified habitats as well as supply chain management are not covered in the Myanmar legislation, it is recommended that the Developer adheres and complies with the requirements set out in IFC's PS 6.

IFC Performance Standards	Comments / Identified Gaps	Recommendations
Performance Standard 7: Indigenous Peoples *Requires that adverse impacts on affected communities of Indigenous Peoples should be avoided where possible. If impacts are unavoidable, the project developer is required to minimize, mitigate and compensate for these impacts in a culturally appropriate manner.*	Article 7 of the EIA Procedure requires that *projects that involve Involuntary Resettlement or which may potentially have an Adverse Impact on Indigenous People shall comply with specific procedures separately issued by the responsible ministries. Prior to the issuance of any such specific procedures, all such Projects shall adhere to international good practice (as accepted by international financial institutions including the World Bank Group and Asian Development Bank) on Involuntary Resettlement and Indigenous Peoples.* In the absence of any specific procedures from other ministries, Article 7 would appear to ensure compliance with Performance Standard 7 requirements.	It is recommended that the Project adopts the recommendations in IFC's PS7 regarding carrying out consultations and compensation in a culturally appropriate manner on affected communities of Indigenous Peoples.
Performance Standard 8: Cultural Heritage *Requires the project developer to identify and protect cultural heritage by ensuring that internationally recognized practices for the protection, field-based study, and documentation of cultural heritage are implemented.* *Furthermore, if there is a risk of impacts to cultural heritage, it is required that competent professionals are engaged to assist in the identification and protection of cultural heritage.*	The Protection and Preservation of Cultural Heritage Region Law of 1998 is the main piece of cultural heritage legislation in Myanmar. It mainly focuses on protection of existing sites and largely lacks provisions for investigations at sites prior to commencement of project activities. Additionally, it does not specify requirements for 'chance finds' and procedures for how these should be handled. Finally, the Law does not explicitly mention any requirement for consultations in connection with project planning and potential impacts to cultural heritage sites.	It is recommended that the Developer adopts IFC PS 8 requirements for pre-survey and management of "chance finds" as this is not fully covered by Myanmar legislation.

4.3 Middle Yeywa Hydropower Project Policy Framework

The following section presents the Middle Yeywa Hydropower Policy Framework. The policy will be translated into Burmese and will be distributed to all villages in the project area and to Government organizations prior to the commencement of construction activities.

4.3.1 Objectives of the Policy

- Outline basic principles for resettlement and compensation for Project Affected Persons
- Ensure that Project Affected Persons participate in consultations, planning and preparation processes in a culturally-sensitive manner;
- Ensure that special measures are provided to vulnerable or disadvantaged groups so as to foster self-reliance;
- Provide compensation for all losses of production, land or assets;
- Provide for improved infrastructure in the project area in the best interests of the Project Affected Persons and in cooperation with government authorities.

4.3.2 Compensation Policy

- Cash compensation for losses of private land or production not exceeding 10% of total assets or production;
- Replacement of private land for losses exceeding 10% of land holdings or production value;
- Cost of removal of private structures (labour costs) and replacement of materials or cash compensation, as agreed with impacted households;
- Compensation based on the principle of replacement cost for the loss of immoveable private assets, including fruit trees and production trees;
- All Project Affected Persons will be entitled to fair and prompt compensation or replacement of lost assets;
- Development of social forestry and nurseries for indigenous tree species and Non-Timber Forest Production for the loss of community lands and resources in the reservoir area;
- Cash compensation and/or fishing equipment for households engaged in small-scale fishing activities along the affected reaches of the Myitnge River;
- Disturbance allowance (cash payment) for households living along access roads, construction sites, quarries and spoils areas (within 50 metres of project activities).

4.3.3 Other Provisions

- All Project Affected Persons will have the same basic rights, but specific entitlements may vary depending on the extent and duration of impacts in the different Project Zones;
- Proof of residency and use of agricultural land and natural resources from the village authorities is required in order to establish the right to compensation;
- The social and cultural aspects will be taken into consideration when planning and implementing programs, and special measures will be planned and implemented for vulnerable households;
- Traffic safety, dust control mechanisms and noise control mechanisms for all construction site activities in the vicinity of villages;
- All Project Affected Persons will have effective access to the grievance procedures that will deal with problems that may arise at the household or village level;
- Development programs in the form of infrastructure improvements and maintenance in cooperation with government authorities;

- The compensation and development programs will be linked to the Project construction program and the reservoir impoundment.

4.3.4 Implementation

- The Environmental and Social Unit of the Middle Yeywa Hydropower Project will be responsible for compensation and development activities in coordination with the government authorities;
- The Middle Yeywa Hydropower Project Policy will be approved by the Ministry of Energy and Electrical Power (MoEE) and Ministry of Natural Resources and Conservation (MoNREC) for effective implementation.

4.4 Middle Yeywa Hydropower Entitlements

This section presents the entitlements for all villages in Project Zones. The following Project Affected Persons (PAP) will be entitled to compensation under the Middle Yeywa Hydropower Project Policy:

- All households who will lose private lands, structures and production due to direct project impacts;
- All households who reside less than 200 metres from construction areas, access roads, quarries or spoil tips;
- All households engaged in small-scale fishing activities along the affected reaches of the Myitnge River;
- Communities adjacent to the future Middle Yeywa reservoir that will lose community lands and resources.

Entitlements are described in detail in the Concession Agreement and summarised in the table below.

Table 7-5: Summary of entitlements.

Impact / Issue	Entitlements
Permanent loss of agricultural land	• Cash compensation for the loss of land or production of less than 10% of land or production of the household; • Replacement land of at least the same size and equal productive value at a location acceptable to the Project Affected Person (PAP) for loss of more than 10% of land or production; • Replacement land will be cleared, fenced and prepared by the PAP at project cost; • In cases where replacement land is not available in sufficient quantities, the PAP will be given an option of a cash payment.
Permanent loss of commercial land	• Replacement land of at least equal value at a location that will be acceptable to the PAP in order to continue viable commercial activities; OR • Cash payment for the value of land if commercial activities cannot be continued or PAP does not wish to do so.
Loss of structures	• Labour costs for dismantling of structure and cost for transporting materials to new location; • Provision for new materials and construction of new house (of at least the same standard) or the cost of labour for construction; OR • Cash payment for the value of land if commercial activities cannot be continued or PAP does not wish to relocate the structure.

Impact / Issue	Entitlements
Loss of fruit trees and production trees	• Cash compensation based on 5 years of production or estimated return on investment (based on professional studies and agreed by government authorities); • Replacement seedlings at a new location in agreement with the PAP.
Loss of common property resources	• Development of social forestry and reforestation program in areas allocated by authorities adjacent to the reservoir; • Establishment of village nurseries for indigenous tree species and Non-Timber Forest Products.
Loss of community infrastructure and infrastructure improvements	• Replacement of all community infrastructure of at least the same value and function if directly impacted by construction activities or access road construction; • All-weather road to selected villages closest to the project on the right and left bank (villages adjacent to the reservoir in Zone 4a, 4b, 4c and 4d); • Expansion of electricity grid and connections to selected villages closest to the project on the right and left bank (villages adjacent to the reservoir in Zone 4a, 4b, 4c and 4d).
Training and support	• Priority for labour opportunities on project construction sites; • Skill training programs in preparation for construction for villages in right and left bank (villages adjacent to the reservoir in Zone 4a, 4b, 4c and 4d).
Vulnerable households	• Households with insufficient labour force will receive special assistance in relation to compensation and replacement programs; • Vulnerable households will receive special attention to ensure their participation in development programs and initiatives in relation to their needs and capacity.
Grievance	• All household to have access to Grievance Committee for complaints; • Prompt and fair handling of all complaints in a transparent manner.

5 STAKEHOLDER ANALYSIS AND CONSULTATIONS

5.1 Consultation Requirements and Benefits

Requirements for stakeholder engagement and consultations are set out in IFC Performance Standard 1, paragraph 25 to 33. Briefly summarised, a project developer is required to:

- Identify all stakeholders that may have an interest in the project and in particular communities that will be adversely affected by the project;
- Prepare and implement a Stakeholder Engagement Plan that is adapted to the risks and potential impacts of the project, as well as to the characteristics and interests of affected communities;
- Disclose relevant project information that will help affected communities and other stakeholders understand the risks, impacts and opportunities of the project. Important information will include nature and scale of the project, potential social and environmental impacts and possible mitigation measures, the planned stakeholder process and envisioned the grievance mechanism;
- The project developer shall undertake a consultation process that allows affected communities to express their concerns and views regarding potential impacts and possible mitigation. For projects with potentially significant adverse impacts the developer is required to carry out an Informed Consultation and Participation (ICP) which involves a more in-depth process that will allows for taking the affected communities concerns and views into the project planning process;
- The consultation process should be conducted in a gender sensitive way so that the views and concerns of both women and men are noted and taken into account;
- When indigenous peoples are adversely impacted by the project the project developer is required to conduct an ICP process and in certain circumstances also to obtain their Free, Prior, and Informed Consent (FPIC) as described in Performance Standard 7.

The benefits of conducting consultations with stakeholders are many, and the consultation process is essential for ensuring the successful planning, construction and operation of a project. Important benefits include:

- It provides a means of taking into account the views and perceptions of people who may be affected or have an interest in a development project;
- Project impacts may be avoided or minimised through stakeholder inputs through improved project design and implementation;
- Data obtained from other sources can be verified and complemented, thereby improving the quality of environmental and social impact assessments;
- Affected people and communities are enabled to understand their rights in relation to a project so that they are aware of their entitlements and can claim them through the specified grievance mechanism;
- Involvement of stakeholders and directly affected communities provides greater transparency and enhances project sustainability through creating project acceptance and local ownership.

IFC and other international financial institutions require that the stakeholder consultations should be meaningful and this means that the process in general needs to meet several criteria. Important requirements for the process to be considered meaningful are:

- The stakeholder consultation process should not be a “one off” event but should start as early as possible and continue throughout all phases of the project;
- All interested and/or affected groups should be included in the process with special care taken to ensure that vulnerable groups are given the opportunity to raise their concerns;

- The consultations should be conducted in a non-threatening manner that it is understandable for all stakeholders while stakeholders who express concerns or criticism against the project or authorities should be protected from retaliation;
- The consultation process should be systematically documented, and relevant aspects of it should be disclosed publicly.

5.2 Stakeholder Mapping and Analysis

The IFC's Stakeholder Engagement Handbook (IFC 2007) identifies stakeholders as *persons or groups who are directly or indirectly affected by a project, as well as those who may have interests in a project and/or the ability to influence its outcome, either positively or negatively*.

Stakeholders comprise different groups such as project affected persons/people (PAPs), locally affected communities, government authorities and civil society organizations, including non-governmental organisations (NGOs) and individuals with special interests in a project.

Through the consultation process, stakeholders are invited to make inputs into the planning and decision making process of a project so that their concerns and points of view can be taken into consideration.

The stakeholder groups for the Middle Yeywa Hydropower Project have been identified through an analysis of the Project's geographic sphere of influence and impact zones. In addition, interest based analysis have been applied in order to identify stakeholders outside of the project area that are not directly or indirectly affected but who have an interest in the Project that determines them as stakeholders such as different central and local government ministries and departments.

The table below lists the main stakeholder groups that have been identified for the Middle Yeywa Hydropower Project.

Table 7-6: Main Stakeholder Groups for the Middle Yeywa HPP

Stakeholder	Role	Concern / Expectations	Interest	Influence
Union Government				
Ministry of Electricity and Energy (MOEE) with its Departments of Electric Power Hydropower Planning and Hydropower Implementation	Awards MOUs for studies and planning of hydropower projects Awards Concessions for construction and operation of hydropower projects	Project completed on time providing reliable supply electricity to the national grid	High	High
Ministry of Natural Resources and Environmental Conservation (MONREC)	Screens and decides on EIA study requirement Reviews and approves the EIA reports for the Project	Compliance with environmental regulations and capacity building for local agencies	High	High

Stakeholder	Role	Concern / Expectations	Interest	Influence
State and Township Government				
Shan State Government: Ministries of Road and Communications; Natural Resources and Environment; Electricity, Energy and Technology; and Planning and Economy	Responsible for infrastructure planning (roads and rural electrification), local natural resource management and protected areas / forest reserves	Improvement of local road and electricity distribution network	High	High
Nawnghkio Township Kyaukme Township Lawksawk Township	Participation in the consultation and public disclosure process Provides statistics and information on local conditions Participates in ESMP implementation	Improved local roads infrastructure Increased economic activity and employment opportunities and opportunities for local businesses Increased tax incomes and revenue for the township government	High	Medium
Villages				
Villages along the reservoir – right and left bank	Village population likely affected by changes in access to natural resources (fish and forest products) as well as indirect social impacts	Benefits to villagers in the form of employment and market opportunities Improved road access and local electricity supply	High	Low
Yae Twin Gyi – dam site and camp area	Likely to be affected in terms of temporary or permanent loss of land, changes in access to natural resources and changes in the social environment	Negative social impacts due to influx of construction workers Compensation for loss of assets Benefits to villagers in the form of employment and market opportunities Improved road access and local electricity supply	High	Low
Villages along main access roads	Village population likely to be affected by increased dust and noise emissions as well as increased risks for traffic accidents	Injuries and fatalities resulting from increased heavy traffic	High	Low

Stakeholder	Role	Concern / Expectations	Interest	Influence
Other Stakeholders				
Local business and local contractors	Offering services that will be required by the Project	Opportunities for providing services and supplies during construction	Medium	Low
Lenders and Funding Agencies	Provision of project financing	Compliance with international standards (IFC).	High	High
Local NGOs	Represents interests of national civil society	Concerns about sustainability, benefits to impacted communities and implementation of international standards.	Medium	Medium
International NGOs	Represents interests of the international civil society	Concerns about sustainability, benefits to impacted communities and implementation of international standards.	Medium	Low
Advocacy Groups	Hinder or restrict hydropower development	Concerns about political reform, human rights and	Medium	Low

5.2.1 Directly and Indirectly Affected People

People that will be directly affected by the Middle Yeywa HPP will include the persons and households that directly utilize the resource base in the reservoir area and at the sites where project infrastructure, such as contractors’’ camps and project access roads, will be located.

There are a number of villages located along the prospective project access roads (Zone 2b and 2c) whose inhabitants will experience impacts in terms of increased dust and noise emissions due increased traffic loads, most notably by heavy trucks carrying construction material and equipment. Those who live closest to the road will experience the greatest exposures but the increased noise and dust emissions are likely to be noticeable in a wider corridor zone adjacent to both sides of the roads. In addition to noise and dust impacts, upgrading and widening of access roads will most probably cause both physical and economic displacement for some households and individuals who reside and operate businesses within the existing right-of-way or the new expanded corridor of the roads.

Another group of people that will experience direct impacts will be a limited number of individuals and households in the right and left bank villages located along the reach of the Myitnge River that will be converted into a reservoir (Zone 4a, 4b and 4d). Among the village population, only those who still practise fishing for food supplementation, income generation or for recreational purposes will be directly impacted. As indicated in the socio-economic survey results, this is a relatively small group in terms of numbers. Another potentially directly affected group among the village population will be those who collect forest products or utilize wood and timber resources in the lower valley that will be submerged. However, all indications from village consultations suggest that this will also be a very restricted group of people in terms of numbers because forest products are normally not collected and, while the timber resources are indeed utilized, the logging is mainly done in the forested zone above the steep lower valley, and some activities are carried out with proper permits.

5.3 Vulnerable Groups

The vulnerable groups in the project area include: 1) households with disabled persons, 2) poor households (income below the national poverty line), 3) female headed households, 4) and landless households (no residential land). The household surveys carried out in 2105 and 2017 sampled only 30 percent of the total number of households in the villages and hence the table below only gives the number of vulnerable households in the sampled group, not for the whole village. However, the figures should give an indication of the prevalence of vulnerable households in project area villages

Table 7-7: Vulnerable households in the surveyed project area villages.

Village	Zone	Sample %	Disabled Persons	Poor HHs	Female-Headed	Landless	Total
Nawng Lin	4a	33	6	0	7	3	16
Yae Maung Tan	4a	33	0	0	1	0	1
Me Poke	4a	33	4	3	2	1	10
Nawnghkio Kone	4a	33	2	2	0	0	4
Ma Gyi Yae	4a	41	0	4	0	0	4
Yae Twin Gyi	4a	33	5	0	3	1	9
Nawnghkio Gyi	4a	33	0	4	4	0	8
Kone Nyaung	4c	33	1	5	7	1	14
Pin Ping	4c	33	7	19	11	4	41
Thar Si	4c	33	2	10	4	2	18
Hpet Yin Kone	4d	33	1	8	3	1	13
Kyauk Hson	4d	33	0	1	5	1	7
Tawng Hkan	4d	33	1	4	1	3	9
Total			**29**	**60**	**48**	**17**	**154**

The total number of persons/households in the villages indicate that the largest vulnerable group in the area is poor households followed by female-headed households, while there are relatively few landless households. In the case of resettlement, vulnerable groups would be prone to be disproportionally impacted by the stress and disruption to their lives that that relocation would represent.

5.4 Overview of Consultation Issues and Concerns

In the following, an overview of consultations that have been conducted so far in the project planning process is provided.

5.4.1 Scoping Phase / Pre-feasibility Consultations

February - March 2015

Initial community meetings were held in the six right bank villages where socio-economic surveys were also conducted. The consultations took place from 26th of February to 1st of March 2015 and were well attended with good participation by women and youths. The average attendance was around 50% of the village households except for one village (Ma Gyi Yae) where only 5 % of the households attended because the meeting day coincided with the market day. The consultation meetings took place in the following villages:

1. Nawng Lin
2. Yae Maung Tan
3. Me Poke
4. Nawnghkio Kone
5. Ma Gyi Yae
6. Yae Twin Gyi

The general reactions to the proposed hydropower project of all the six villages were generally positive and nobody expressed opposition to the project. The most common questions and issues raised during the meetings were:

- Will they (village) get electric power from the project (connection to the grid)?
- Will there be other benefits such as village road, village water supply; and will these be provided by the project as well?
- Will land be taken from the villagers by the project?
- What kind of compensation for loss of properties will be offered?
- Will there be support for infrastructure development of community facilities and social services?
- Will the dam cause flooding to the villages?
- What areas will be flooded/affected?
- Will the villages/households get free electricity?

Regarding the questions concerning what type of benefits the villages would be receiving, no definite answers could be provided but the villagers were assured that different types of support were being considered, including road construction and support for rural electrification.

With regard to flooding and loss of land, the villagers were assured that no farmland would be lost due to creation of the reservoir but that some limited land could be taken for access roads and camps in Yae Twin Gyi, the village nearest to the dam site.

Figure 7-9: Village Consultations

May 2016

Consultation continued in selected villages surrounding the reservoir and the dam site in May 2016 with consultation conducted in the following villages:

1. Me Huong (10 May)
2. Nawnghkio Gyi (11 May)
3. Yae Twin Gyi and Ma Gyi Yae Village with representatives from Taung Shay and Tawng Hkam (11 May)
4. Me Poke with representatives from Yae Maung Tan and Nawnghkio Kone (13 May)
5. Thar Si and Pin Ping (14 May)
6. Tawng Hkan with representatives from Hpet Yin Kone and Kyauk Ku with representatives from Kyauk Hson Village (15 May)
7. Nawng Lin Village (16 May)

Overall, the consultations were well received by communities, and participants expressed thanks for keeping them informed. During the consultations, participants posed several questions about the Project in general. These were similar to the questions posed in previous meetings with the villagers. They were mostly interested in whether or not they would receive electricity and what other benefits the project could give the communities (i.e. funding and support for community projects). Some villages were also concerned about the Myitnge Bridge and whether it would be flooded.

The consultation moderators stated that it is not yet known whether the villages will receive electric power and that this would depend on the decision of the government. It was also explained that there may be funding for community development projects but the nature and extent of these projects are not yet decided. Furthermore, the extent of village support would be proportionate to the impact of the project on the villages and will be used to offset negative impacts. Villagers also asked about employment opportunities. The moderators stated that there is potential for employment but this is not yet certain and would need to be handled carefully so as not to distort local labour prices and agricultural production.

Figure 7-10: Village Consultations in Nawng Lin in May 2016

In Pin Ping, the villagers were particularly concerned about forced labour, as this has been a common practice in government projects in the past. The villagers became more open and relaxed after being repeatedly assured that this would not be the case in this project, and it was entirely their decision whether to participate in the project or not.

In addition to providing general information about the project, villagers were also informed about the various surveys that were to be undertaken by geo-technical teams along the reservoir and around the potential dam sites. All villages along the reservoir were consulted about these surveys and provided information about how to contact project staff and report any grievances. This was an opportunity to introduce elements of a transparent grievance mechanism that should be further elaborated prior to construction. Information posters were distributed to all villages after consultations.

Figure 7-11: Village Information regarding Geotechnical Surveys, showing appropriate behaviour and a simplified grievance mechanism

5.4.2 Feasibility / EIA Phase 2017 -2018

April 2017

The EIA Consultant undertook an initial site visit in April 2017 during which meetings were held in seven right and left bank villages. These meetings with the village leadership focused more on the local population's resource use in the reservoir area and were not set up and conducted as public consultation meetings. However, the meetings provided a good opportunity to inform the village leadership about the project planning process and to take note of any concerns they might have with regard to the Project. Since consultation meetings had been held once or twice in all of the villages already (except for in Hpet Yin Kone), few concerns were raised in the meetings. Again, the main interest was more focused on what kind of benefits the villages could expect to receive. No definite answers regarding benefits could be provided at that stage other than indicating that some of the most likely benefits would involve local road infrastructure and possibly also rural electrification and connecting villages to the grid.

The table below lists the visited villages and the main information on livelihoods and natural resource dependency collected in the meetings.

Table 7-8: Villages visited and consulted in April 2017.

Village	Date Visited	Ethnic Group	Livelihoods and Natural Resource Use
Nawnghkio Gyi Zone 4a	3 April 2017	50% Shan50% Danu	Limited timber extraction, some fishing for household consumption; Agriculture based livelihoods with sugar cane (contract farming) and maize as the main cash crops.
Nawng Lin Zone 4a	3 April, 2017	Danu	Collecting bamboo, fishing for household consumption; Sugar cane (contact farming) and maize main sources of cash income.
Me Poke Zone 4a	3 April, 2017	Danu	Extracting timber from the lower river valley for house building, Fishing for household consumption in the off agricultural season; Harvesting of wild bee honey from beehives placed in the forest; Sugar cane (contact farming) and maize main sources of cash income.
Pin Ping **Zone 4c**	4 April 2017	Danu	Around 15 households fish for household consumption; A number of crops are cultivated with maize as the most important cash crop; Sugar cane not commonly cultivated; Each family has around 10 acres of cropping land.
Thar Si Zone 4c	4 April; 2017	Danu	15 – 20 persons fish for household consumption at the start of the rainy season; Largest fishes caught are around 1.5 kg; Fish migration in middle of March; A variety of crops is cultivated with maize as the main cash crop; Expects benefits such as improved road access, grid connection and improved water supply.
Hpet Yin Kone Zone 4d	5 April; 2017	Danu	Around 10 people go for fishing in March and April; Rotational cropping with maize, sesame and peanuts; Shifting cultivation with 8 years of fallow, maize is the main cash crop; Upland rice cultivated for household consumption; Around 30 households keep large livestock; Expects support for improving village access road.
Yae Twin Gyi Zone 4d	6 April, 2017	Danu	No timber extraction by villagers as there is no valuable timber left; Around 10–15 people go for fishing in the river, staying for to up to 5 days and getting catches of 20-30 kg for each trip; Cultivates sugar cane (contract farming) and maize as cash crops; Fruit trees such as mango and papaya are common.

Figure 7-12: Meeting with villager leaders and elders at Pin Ping in April 2017

5.4.3 Consultations and Meetings with Government Conducted by SN Power

Representatives for SN Power have since the project planning started held regular meetings with Central Government and State Ministries to inform them about the project and to collect information about the Government's infrastructure development plans within the project area which the project potentially could link up with in terms of impact mitigation and benefit sharing.

There have also been regular meetings and follow-up by the SN Power's local representative on a range of issues including field investigations. SN Power has also participated in regional meetings organized by various parties, including recently a Workshop on the finalization of the Sector Environmental Assessment (SEA) report and the Planning of Cumulative Impact Assessment (CIA) for the Myitnge Basin Workshop, both of which were organized by IFC in August 2017.

SN Power has had a series of coordination and update meetings with the Ministry of Natural Resources and Conservation (MoNREC) during the Pre-Feasibility and Feasibility Studies. Representatives from the Department of Forestry and Environmental Conservation Departments have attended regional and union meetings and provided input and comments.

Meetings have also been held with NGOs and various members of Civil Society for insights into the EIA process and to register concerns. These include meetings with World Wildlife Fund (WWF), World Conservation Society (WCS) and Myanmar Centre for Responsible Business in May 2017, among others.

The table below summarises the issues discussed in the meetings held with Shan State officials.

Table 7-9: Overview of issues discussed with Shan State officials.

Date and Venue	Officials Met With	Issues Discussed
11 and 14 September 2017, Ministry of Electricity and Energy, Taunggyi	Chief Engineer, Superintendent	• Government standards and requirements for the construction of electricity lines and rural distribution networks; • Rates for compensation; • Extension of grid connection system from Yak Sauk to Kyauk Ku (Phase 1 – 2019-20) and Kyauk Ku to Naung O (Phase 2 – 2020-21); • Government practice for house connections; • Priority classification for project area villages; • Government practises regarding contracts, tendering and construction of transmission lines.
12 September, 2017; Taunggyi	Director of Department of Border Affairs and Development of National Races	• Prioritization of infrastructure plans in the project area; • Division of responsibilities between Department of Border Affairs and Development of National Races and Department of Rural Development; • Possibilities and costs for improvement of village access roads; • Possibilities for engaging the Department's mobile team to carry out training and capacity building (vocational and technical training).
12 September, 2017; Taunggyi	Director of Forestry and Environmental Conservation Departments	• Naung Lon Reserve Forest on left bank (Zone 4d) and possibilities for implementation of programmes; • Possibilities for enforcement of regulations and better protection of the reserve forest; • Training activities carried out under the present Community Forestry Program; • Ongoing programs to relieve pressure on the forests through the introduction of more efficient charcoal ovens and solar panels.
12 September, 2017; Taunggyi; 14 September, 2017 Nawnghkio	Staff from Ministry of Construction; Kyaukme District representative in Nawnghkio	• Requirements and load limitations on the on access roads; • Plan to upgrade of the Nawnghkio-Lawksawk section of Route 41; • The Government procedures for selection of local suppliers for construction materials such as sand, gravel and rocks; • The Right of Way (ROW) that was fixed during the construction of the original road and the Highway Law's stipulation of 150 foot ROW for rural roads. • Compensation in connection with access road improvement if the current ROW is exceeded
13 September, 2017; Taunggyi;	Chief Minister and Cabinet (including other ministers and directors of departments)	• The technical planning and progress and EIA progress; • Establishment of a protected area downstream of the dam site and the establishment of a forestry research centre; • The possibility of including the protected forest initiatives as a part of the Environmental Management Plan of the Middle Yeywa HPP; • The design and schedule for the construction of the new bridge across the Myitnge River;

Date and Venue	Officials Met With	Issues Discussed
		• The need for seismic studies and surveys of the geological conditions of the reservoir and the risks of landslides into the reservoir; • Tender document specifications in terms of access road widths and other details that should be included in Tender Documents for construction of the access roads; • The power supply needs for construction activities.
7 June, 2018; Taunggyi	Chief Minister and Cabinet (including other ministers and directors of departments)	• Update on the status of the EIA studies and main recommendations • Discussion at the Dept. of Forestry on proposed Reserve Forest Area (Mehon DokeHta Wady River RFA) being established using new procedures for public announcement and approvals. This RFA is located near our dam site and as Multi recommends, we should work with this initiative. An extension of this area to around the dam site where the best forest is located would be a practical solution from a conservation perspective.

5.4.4 Assessment of Local Government Capacity

In connection with the first round of consultations held in 2015, several Nawnghkio Township offices were visited by the consultant team from MIID. The purpose of the visits was to find out how the villages in the project area interact with the government and to collect information for an assessment of local government capacity. The majority of the interviews were with government offices whose roles and function are related to the economic activities of the population of the villages. These include the offices of Land Settlement and Registration, Irrigation, and Planning and Economic Development. Part of the purpose of the visits was also to introduce the proposed hydropower project, to hear their opinions about it and what kind of role they could have during project implementation.

In addition to the local government offices, private sector businesses, hospitals and markets were also visited to understand the interaction between the villagers and these institutions.

The table below summarises the collected information about the roles and the capacity of the government offices visited.

Table 7-10: Collected information on roles and capacities of Local Government Offices.

Organization	Initial Assessment of the Organization’s Capacity
Land Settlement & Records (LSR) Office	LSR is responsible in registering: (i) farmland, virgin land and vacant land. It takes around 3 months to register land. The LSR Office covers 35 village tracts and has only 18 staff, something that limits their capacity to process land registrations.
Department of Agriculture	The Department of Agriculture are tasked with extension services and provision of agricultural inputs (seeds) to farmers. Together with the Township Management Committee, the Township Development Support Committee and the Municipal Committee they determine compensation rates for different types of land.

Organization	Initial Assessment of the Organization's Capacity
Township Office of Ministry of Cooperatives	The Ministry of Cooperatives organises and provides support for the 58 Agricultural Cooperatives with 7,261 farmer members in Nawnghkio Township. Each cooperative is entitled to a credit loan from the Ministry at an interest rate of 1.5% per month and payable after 6 months.
Myanmar Agricultural Development Bank (MADB)	MADB is one of the 9 departments under the Ministry of Agriculture and provides farmers with loans ranging from Myanmar Kyats (MMK) 20,000 to 100,000 per acre at an interest of 5% per year. Because of the limitation on loan amounts farmers go to local moneylenders to get bigger loans but has to pay higher interest rates. MADB has a bank agent in each village to facilitate processing of loan application of farmers.
Township Office of Ministry of Natural Resources and Environmental Conservation (MONREC)	MONREC's role and responsibilities include management of nurseries for the township from which villagers can receive seedlings for planting (20 trees per household) MONREC also conducts resource usage surveys and monitors and control usage of forest resources.
Township Office of Department of Planning	The office is responsible for development plans for village tracts, townships and districts. Development plans for the project area include: • Meh Poke village tract (education, bridge, electrification, and drinking water, budget MMK 58,500,000); • Yae Twin Gyi village tract (schools and roads, budget MMK 4,000,000); • 5-year plan for Kyaukme District (the expansion of Nawnghkio Township and a bridge on the road between Nawnghkio and Kyaukme).
General Administration Department, Ministry of Home Affairs	Manages land in villages and towns
Nawnghkio Hospital	Has 25 beds and a medical staff consisting of 2 doctors, 12 nurses and 8 health workers.
Taung Shae Hospital	Serves 13 village tracts and is under the management of Nawnghkio Central Hospital. Medical staff consists of 2 doctors, 6 nurses and 3 health workers. The hospital has sub-health centres in 4 villages with 1 midwife and 1 public health staff for each sub-health centre.

6 ENVIRONMENTAL BASELINE CONDITIONS

6.1 Topography and Landscape

The project area covers 70 km of river reach in a deeply incised valley with steep slopes in the range of 30° to 60° and no significant widening. The river valley cuts through the Shan Plateau to a depth of 900 m (on average) with a bottom width of around 70 m. The minimum width of the valley at river level is approximately 25 m and the maximum width approaches 160 m.

The Myitnge River originates from the northern Shan State mountain ranges and flows from east to west in the upper reaches of the proposed reservoir area before turning south near Nawnghkio Gyi village. The river then turns again in a westerly direction about 9 km upstream of the proposed dam site.

The river valley is generally V-shaped but with several near vertical cliffs creating a canyon-like topography. Several tributaries join the main Myitnge River downstream of the Upper Yeywa dam (under construction), including Gohteik River (at the river bend near Nawnghkio Gyi village) and another river about 4 km downstream of the Myitnge Bridge which forms a small alluvial fan at the confluence point where the river valley is widening. There are, however, no floodplains or alluvial terraces along the riverbanks because of the steep topography and the generally high water velocity.

From a landscape perspective, the most interesting tributary is the Nam-kam River which empties into the main river at the bend near Thar Si village (left bank). The Myitnge flows down a cascade of waterfalls, some of which create small spray zones at the foot of the falls (***Figure 7-15***, right). This location is the only one that is visited by people from outside the villages for recreational purposes, while the rest of the river valley is either inaccessible (due to topography) or only visited by local fishermen or hunters. The Myitnge Bridge is the only crossing point along the affected reaches of the Myitnge River (***Figure 7-14***, left).

The Myitnge River has a regular slope between a succession of smaller rapids of a few metres in height in the upper and middle reaches. However, in the downstream reaches the river profile is steeper with a drop in elevation of 50-55 m over a 1.5 km distance. This section is characterised by a series of fast-flowing rapids (***Figure 7-13***, right). Local fishermen are taking advantage of these rapids by catching fish at the downstream end of the rapids.

Figure 7-13: Myitnge River at Me Poke (left) and the rapids in the downstream reaches (right).

Figure 7-14: Myitnge Bridge (left) and Myitnge River immediately downstream of the bridge (right).

Figure 7-15: Myitnge River downstream of the rapids (left) and waterfall at Nam-kam River (right).

6.2 Geology and Soils

6.2.1 Regional Geology of Myanmar

The Myanmar region originates from[2]:

- lifting caused by the subduction of the northward moving Indian Plate below the Euro-Asian Plate in the East along the Andaman Megathrust Zone, and
- sea floor spreading centred in the Andaman Sea (see ***Figure 7-16***)[3].

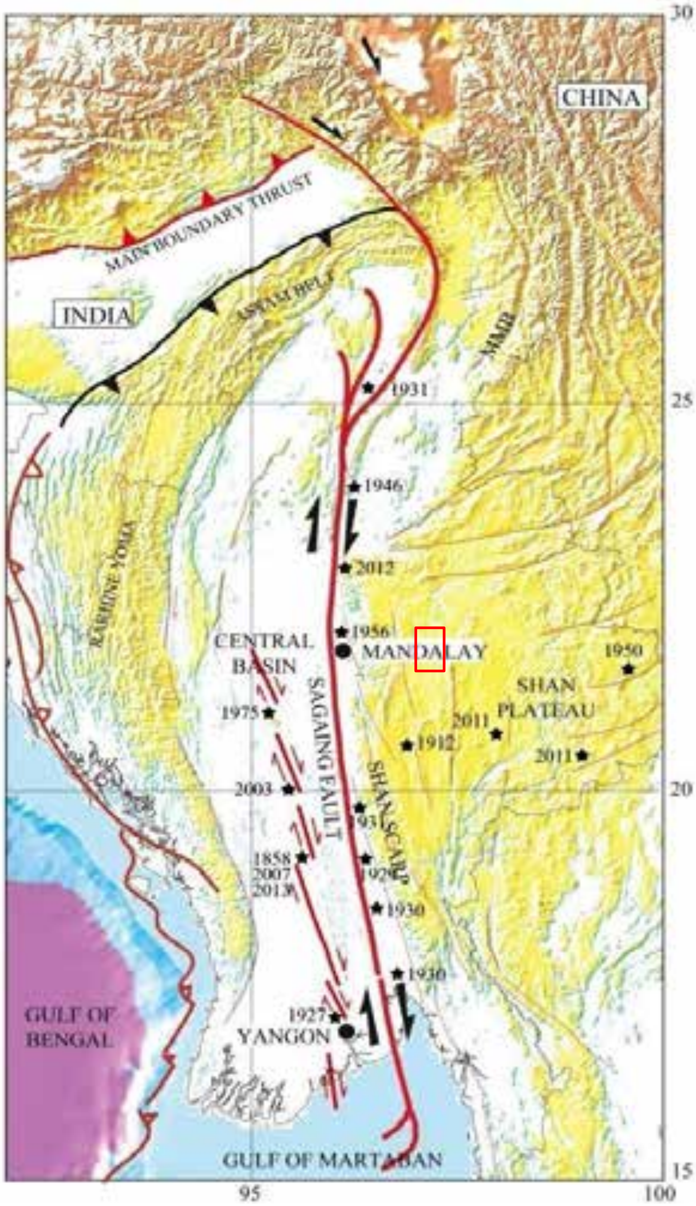

Figure 7-16: Generalised seismo-tectonic map of Myanmar with project area marked in red frame.

[2] Report on Regional Geology of Myanmar; Department of Geological Engineering, Faculty of Engineering, Gadjah Mada University, Jogjakarta, Indonesia, April 2010.

[3] Bender, F.: Geology of Burma; Beiträge zur regionalen Geologie der Erde, Band 16; Gebr. Bornträger, Berlin Stuttgart, 1983. Geology and Mineral Resources of Myanmar: Atlas of Mineral Resources of the ESCAP Region, Volume 12; Economic and Social Commission for Asia and the Pacific, United Nations, New York, 1996.

The north-south trending Sagaing Fault forms the major fault system of Central Myanmar and runs close to the west of the city of Mandalay. The same fault is often referred to as the Shan Boundary Fault. Close to the east of Mandalay, the Panlaung Fault approaches the Sagaing Fault from the SSE, and in the north the Lashio Fault approaches from the NE.

The Middle Yeywa project area is located to the east of Mandalay and to the east of the above-mentioned main fault zones, and to the south of the Lashio Fault within the Shan Plateau (Northern Shan State of the Sino-Burman Ranges).

Litho-stratigraphically, the Shan Plateau is built up of a sequence of dolomites, limestones, and some shales, referred to as Plateau Limestones (Group) or the Shan Dolomite Group and has a thickness of more than 3,000 m. The age of these sedimentary bedrock units ranges from Devonian (approximately 410 million years old) to Middle Triassic (approximately 230 million years old).

Small-scale geological maps of Myanmar also indicate that the Middle Yeywa project area has a uniform covering of the above-mentioned Plateau Limestones or Shan Dolomite Group (***Figure 7-17***).

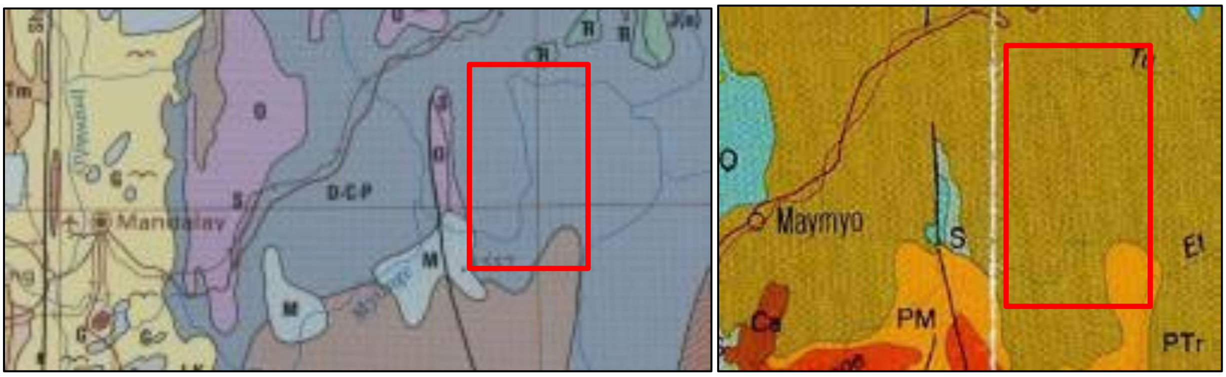

Figure 7-17: Extract from the geological map of 1977 (left) and 1980 (right). The project area is indicated by the red frame.

6.2.2 Geological Features of the Project Area

<u>Geomorphology</u>

The geomorphology of the relief of the Myitnge valley is the combined result of the lithological characteristics of the area, the geo-structural control and the effects of erosion.

The Myitnge River intersects and erodes the Shan Plateau in different phases which easily can be recognised in the middle section of the right river bank (***Figure 7-18***):

- The rim of the highest plateau level (between elevation 800 to 1100 masl) is clearly marked in the central part to the west (right bank) of the river, but far away from the current river path (red line) in the left bank;
- Below this uppermost plateau level a smaller intermediate plateau level (700 to 800 masl) with a less pronounced rim can be observed (blue line);
- The third level is marked with a wide plateau (500 to 700 masl.) ending in a rim to the narrow, deep and V-shaped gorge of the current Myitnge flow path (green).

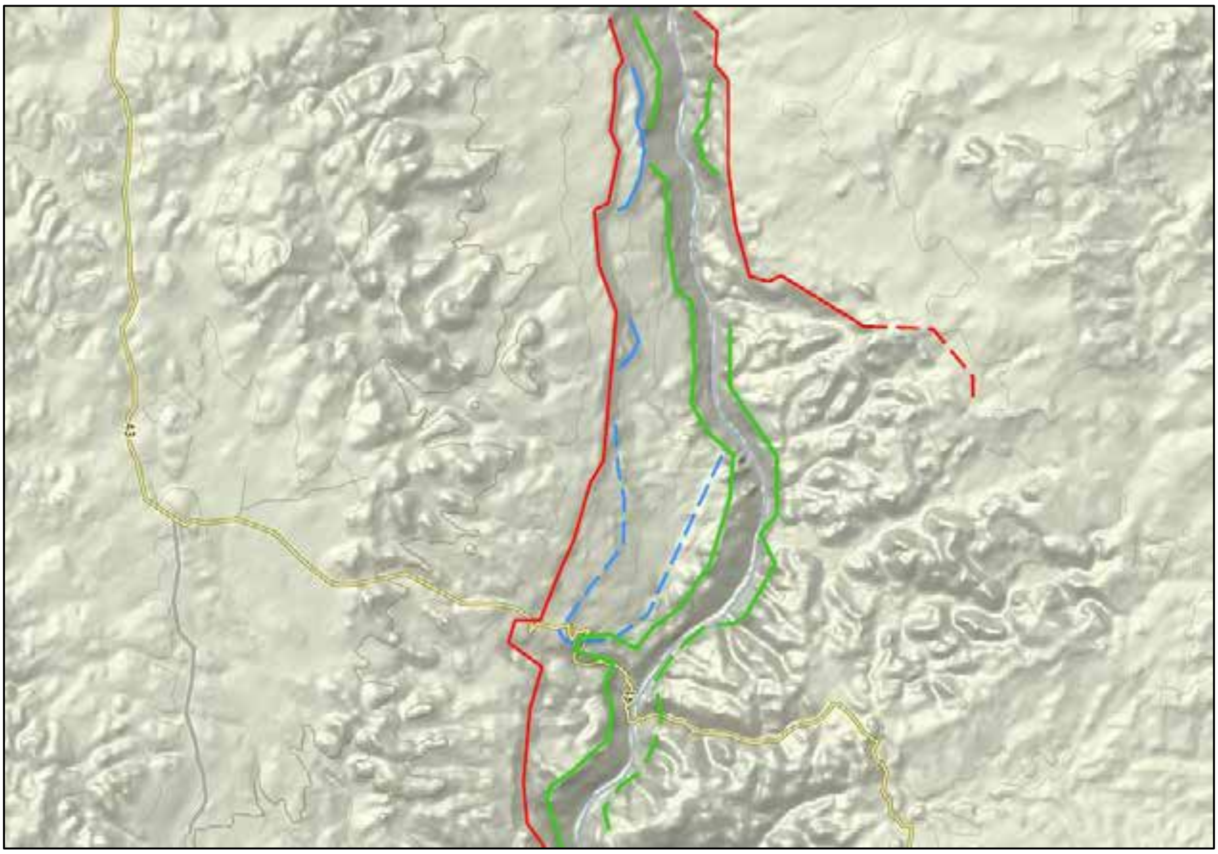

Figure 7-18: Main geomorphological features in the middle section of the project area.

In the area several karst phenomena (dissolution of carbonate bedrock by running water) were observed. On the uppermost plateau, limited by the red line in ***Figure 7-18***, no single karst-feature was observed. This is due to the thick cover by residual soils and agricultural land. In the cliffs of the dolomitic limestone below the red line, widespread caves of a few centimetres to several metres in width/ depth are observable. These caves are formed from the karst dissolution of limestone.

The caves observed within the dolomite (below the green line in ***Figure 7-18***) are solely a result of mechanical erosion of heavily brecciated areas by river water. In some areas the surface of the dolomite shows small karrens of only a few millimetres to a few centimetres in depth (***Figure 7-19***, left).

On the widely outcropping dolomite area along the Myitnge River valley, numerous vertical pots in the dolomite are present (***Figure 7-19***, right). They have a diameter and depth of several tens of centimetres, up to around one metre. These features are not of karst origin, but of mechanical erosion by cobbles and small boulders due to turbulent water flow.

Figure 7-19: Karren bedrock surface due to surface water corrosion (left) and mechanically excavated pots in hard dolomite due to turbulent flowing river water with cobble/boulders (right).

<u>Litho-Stratigraphy</u>

From the top of the plateau to the river bottom, four main geological units can be briefly described as follows:

Dolomitic Limestone: (***Figure 7-20***, left): A bedrock with varying shades of grey and texture. The limestone ($CaCO_3$) is partly dolomitized ($CaMg\ (CO_3)_2$), and brecciated with a heterogeneous distribution, and has widely spread cavities of several metres in size. This unit, which is several tens of metres in thickness, forms the uppermost cliff and rim of the geomorphology (red line in ***Figure 7-18***). Its base is probably widespread, brecciated and easily erodible, and forms the intermediate level of the middle platform and less prominent rim (blue line in ***Figure 7-18***) well above the project footprint and the future reservoir level (400 to 500 masl.).

Red Residual Soil: Layer covering the surface of the dolomitic limestone except on steep cliffs (***Figure 7-20***, right). This clayey material derives from tropical weathering of the bedrock and its thickness varies widely.

Dolomite: (***Figure 7-21***, left): Very thick (>100 m), mainly massy, partly moderately bedded bedrock of varying shades of grey and heterogeneously affected by tectonic impact. It can be moderately to densely jointed, with the joints being tight or healed by white thin calcite. As is the case with the dolomitic limestone, the dolomite is also partly heterogeneously brecciated and thus partly weakened from its usually high strength. Such zones or pots of a few centimetres to few metres in size are easily eroded by flowing (river) water and can form caves. All high cliffs and the V-shaped river valley below the green line in ***Figure 7-18*** are formed of this carbonatic rock.

Travertine: (***Figure 7-21***, right): This material can cover the three geological units described above from below the top cliff down to the Myitnge River. When ground water, oversaturated with dissolved calcite, dissipates or flows out of the bedrock, pressure and temperature conditions suddenly change and calcite precipitates at the surface, either on rock or on the vegetation, and forms the typical appearance of travertine sediments, which are varying considerably.

Figure 7-20: Dolomitic limestone with karst caves on left bank of Myitnge River (left) and red residual soil on top of the dolomitic limestone (right).

Figure 7-21: Massive dolomite with no signs of karst (left) and travertine outcropping along the Myitnge River close to the proposed dam site (right).

Hydrogeology

According to villagers, there are two different (and probably independent) groundwater levels in the Shan Plateau. The **shallow wells** are only a few metres deep (the well in ***Figure 7-22*** is 3 m deep) and end in the red residual soil. Some interconnected channels with gravelly material might collect rainwater penetrating the ground and feed the wells with young groundwater. During the rainy season, the groundwater level is reported to be higher than during dry season, but there is generally only a small fluctuation. The **deeper wells** (one well was reported to be approx. 50 m deep) are assumed to end in the dolomitic limestone underneath the residual soil and represent the karst groundwater in the rock unit.

Figure 7-22: Shallow water well ending in the residual soil.

The water supply for the villages on the Shan Plateau is secured by the following different sources:

- Collecting rainwater from the house roofs;
- From classical water wells only few metres deep;
- Collecting the groundwater in the residual soil and from boreholes several tens of metres deep by pumping groundwater from the dolomitic limestone.

According to Pöyry (2015), the hydrogeological features of the Shan Plateu and Myitnge valley are characterised by the following phenomena:

- There are two, probably independent, groundwater levels. The lower one is on a relatively high level within the Shan Plateau and within the dolomitic limestone;
- Running rivers with travertine deposits are observable from elevations at the level of the dolomitic limestone and thus most probably derive from karst springs within the dolomitic limestone;
- The main volume of bedrock eroded by the Myitnge River consists of dolomite, not showing typical karst phenomena (except some very superficial and small karrens due to thin joints healed with calcite). The only weak areas within this very strong bedrock are brecciated zones, prone to mechanical erosion;
- The extent and role of the brecciated layer between the dolomitic limestone and the dolomite are yet not clearly understood. Their geometry and impact on the karstification process, its presence, if it is a horizon prone for karstification or a barrier to karstification, are unknown at this moment. The current depth/base of karstification seems to be located somewhere inside the dolomitic limestone or directly above the upper limit of the dolomite, at the level of the groundwater level; and
- The dolomite seems not to be affected by the karstification process.

6.2.3 Seismicity

Myanmar is located within a tectonically complex and active region. ***Figure 7-23*** represents a structural interpretation of the Central Myanmar Basin and adjacent Shan Plateau from various satellite images. The figure shows that the Shan Plateau, where the Middle Yeywa Project is located, forms an island of considerably lower fault density than the surrounding areas.

Between the tail of the existing Yeywa reservoir and the Upper Yeywa dam site, only eight potential tectonic lineaments less than 1 km long could be identified. These lineaments are probably correlated with major local joints or faults but as far as observable, these lineaments could not be linked to the known active earthquake lineaments.

In Northern Myanmar most earthquakes occur to the west of and along the Shan Sagaing Fault (SSF) (***Figure 7-25***). The strongest historically recorded earthquake (Ms 7.8, 1946) was located on the Shan Sagaing Fault north of Mandalay. The reason for this concentration of earthquakes is the subduction of the Indian Plate underneath the Burma Sub-Plate (***Figure 7-24***).

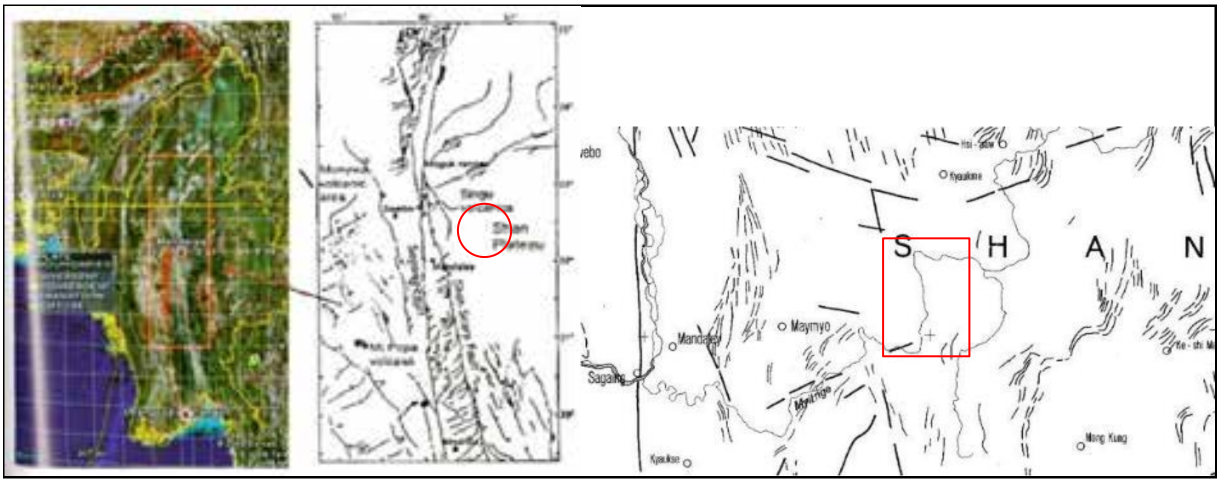

Figure 7-23: Left: Structural interpretation of the Central Myanmar Basin and adjacent Shan Plateau from various satellite images; Right: Extract from the Structural Map of Burma.

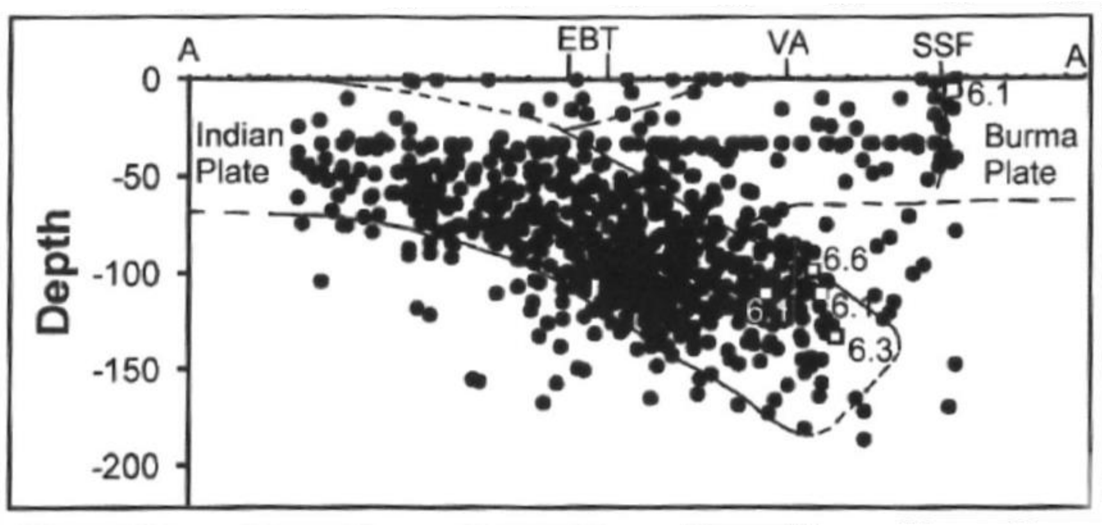

Figure 7-24: Seismic cross section along a W-E traverse; SSF = Shan Sagaing Fault.

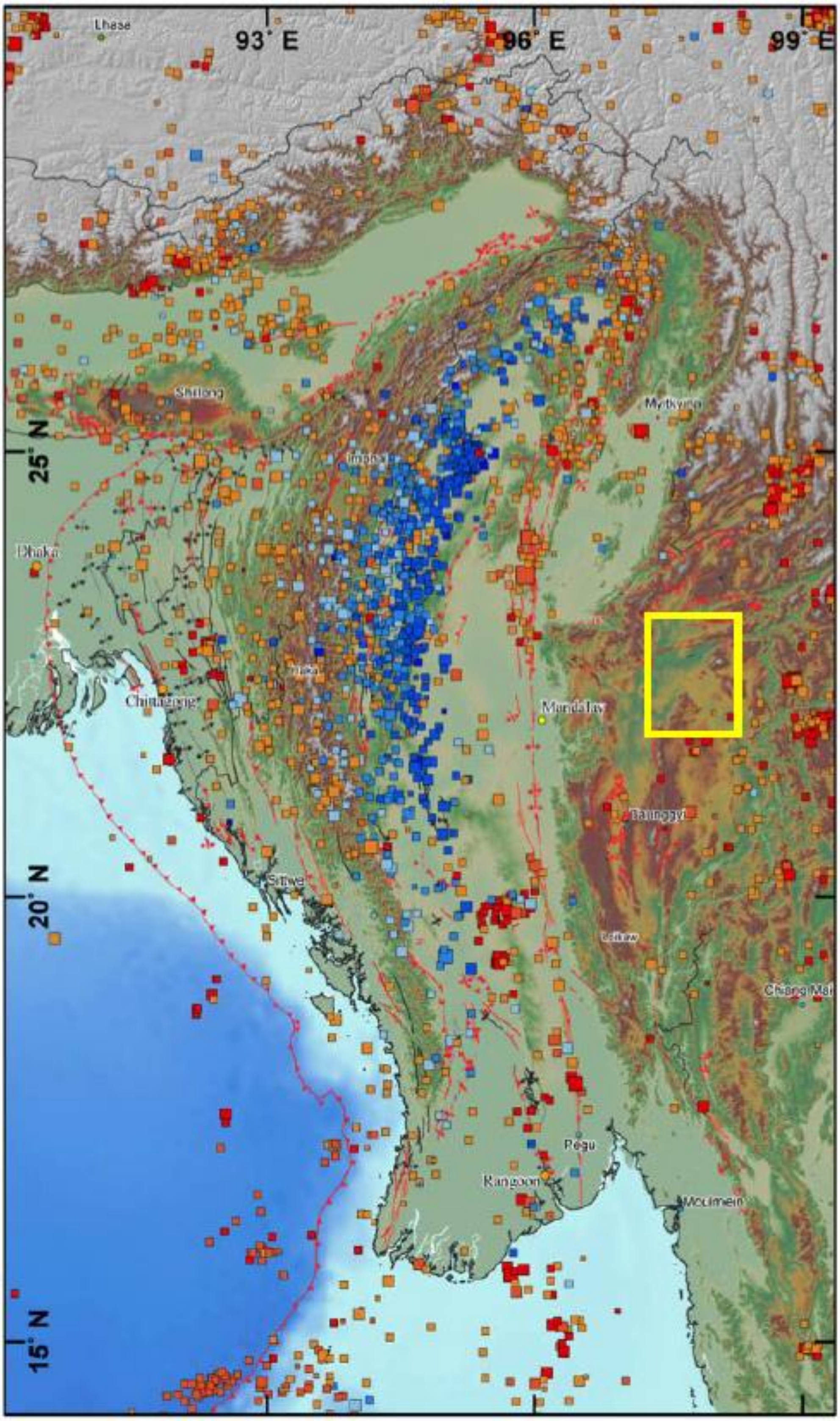

Figure 7-25: USGS/NEIC catalogue 1973-2008 showing earthquakes recorded in Myanmar. The project area is located within the yellow rectangle.

According to the Seismic Zone Map of Myanmar (revised version, 2012), the Middle Yeywa project area is located in the Seismic Zones III, near to Zones IV and V (Seismic Zone V is the maximum).

The Zone III indicates area of high damages, equivalent to MMI VII, and indicating PGA from 0.1g to 0.2g.

The Probabilistic Seismic Hazard Map of Myanmar (2012) for 10% probability of exceedance in 50 years (475 years recurrent interval) indicates for the Middle Yeywa project area peak ground acceleration (PGA) between <0.11g and 0.2g.

6.2.4 Mineral Resources

There are no known mineral deposits in the impact zone of the Middle Yeywa project (***Figure 7-26***). According to SN Power, the project will seek a waiver from the Department of Mines.

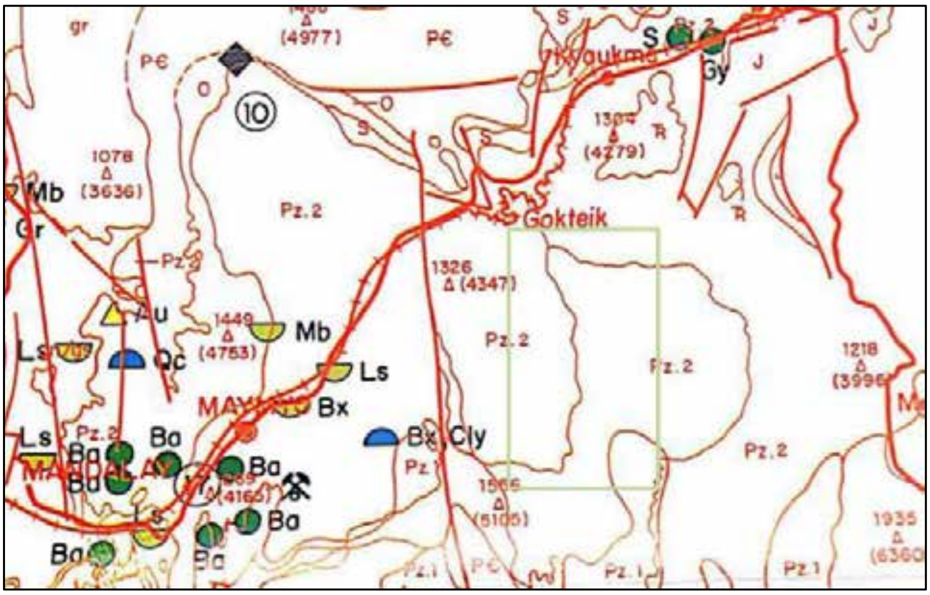

Figure 7-26: Extract from the Mineral Resource Map of Myanmar (scale 1:1,500,000). The project area is marked with a green rectangle.

6.2.5 Soils

Based on the FAO soil map (***Figure 7-27***), the dominant soils in the project area belong to the acrisol group. Such kind of soils is clay-rich and is associated with humid, tropical climate and often supports forested areas.

Acrisols have little weatherable minerals left. The contents of Fe-, Al- and Ti-oxides are comparable to those of Ferralsols or somewhat lower; the SiO_2/Al_2O_3 ratio is 2 or less. The clay fraction consists almost entirely of well-crystallized kaolinite and some gibbsite.

Acrisols under a protective forest cover have porous surface soils. If the forest is cleared, the valuable A-horizon degrades and slakes to form a hard surface crust. The crust allows insufficient penetration of water during rain showers with devastating surface erosion as an inevitable consequence. Many Acrisols in low landscape positions show signs of periodic water saturation.

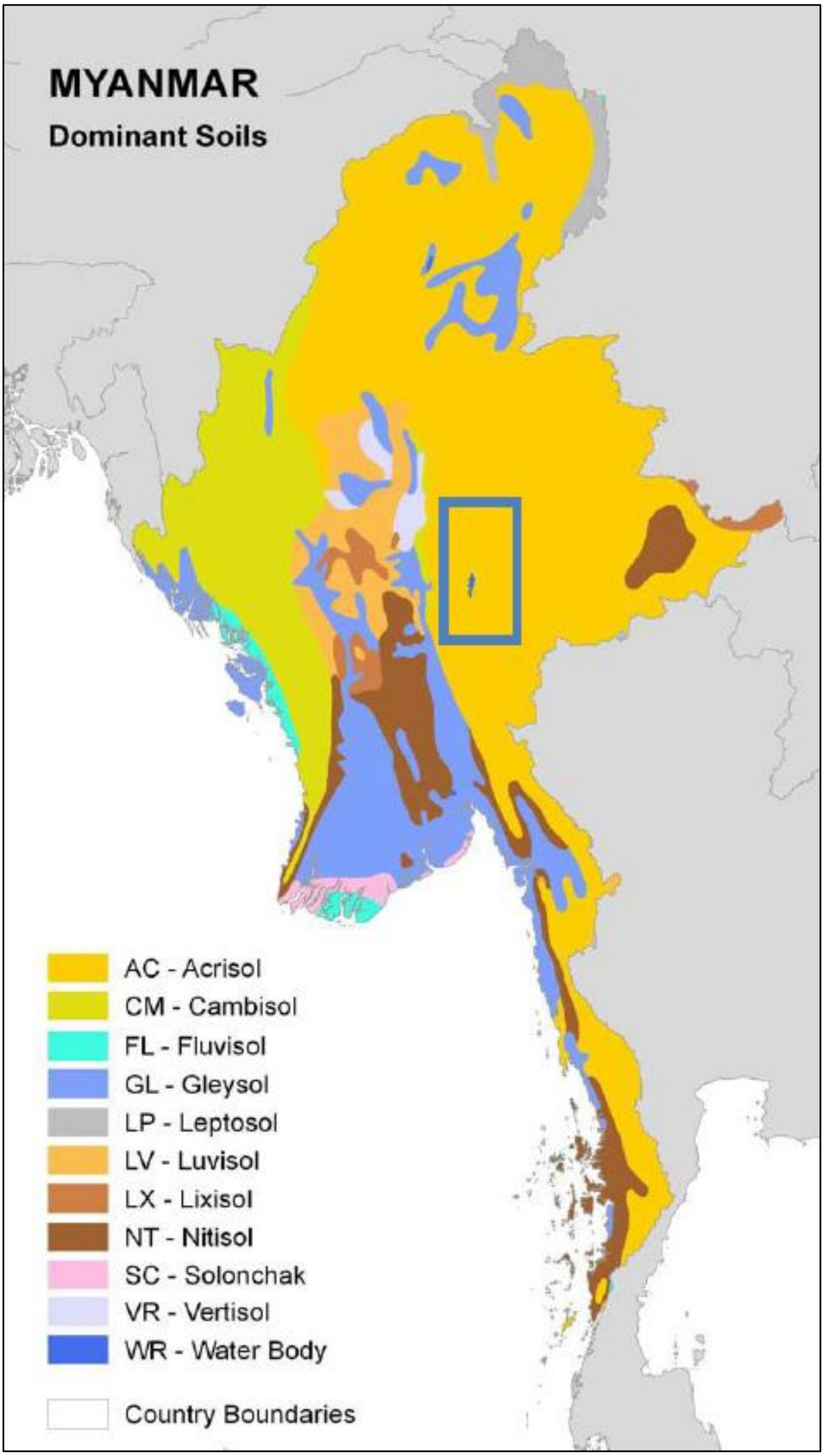

Figure 7-27: FAO soil map of Myanmar. The project area is shown by the blue rectangle.

Preservation of the surface soil with its important organic matter is a precondition for farming on Acrisols. Mechanical clearing of natural forest by extraction of roots and filling of the holes with surrounding surface soil produces land that is largely sterile because toxic levels of aluminium (the former subsoil) kill any seedlings planted outside the filled-in spots.

Adapted cropping systems with complete fertilization and careful management are required if sedentary farming is to be practiced on Acrisols. The widely used 'slash and burn' agriculture ('shifting cultivation') may seem primitive at first sight but is really a well-adapted form of land use, developed over centuries of trial and error. If cropping periods are short (one or a few years only) and followed by a sufficiently long regeneration fallow period (up to several decades), this system is a sustainable way of making use of resources of Acrisols.

Low-input farming on Acrisols is not very rewarding. Undemanding, acidity-tolerant cash crops such as pineapple, cashew or rubber can be grown with some success. Large areas of Acrisols are (still) under forest, ranging from high, dense rain forest to open woodland. Most of the tree roots are concentrated in the humus surface horizon with only few tap roots extending down into the subsoil.

Acrisols are suitable for production of rain-fed and irrigated crops only after liming (as practiced in the project area) and full fertilization. Rotation of annual crops with improved pasture maintains the organic matter content.

According to the Myanmar agricultural atlas, the project area is covered with mountainous red forest soil, mountainous brown forest soil and red earth and yellow soil (***Figure 7-28***):

- **Red-brown forest soils** develop under tropical evergreen forests and wet tropical monsoon forests mostly at altitudes between 300 m and 1,300 masl. These soils have the average humus content of 2% and the pH value is between 5.5 and 6.5.
- **Red earths** occur at altitudes around 1,000 masl. and mountain red earths are found at relatively higher altitudes. These soils cover the area from eastern Mandalay division, eastern Kayin, Kayah to, large parts of Shan Plateau. The humus content is between 2 and 4% in the light red earths and may be up to 8% in dark red earths. The pH value is between 6 and 7. Such soils are suitable for diversified agriculture. **Yellow earths** occur on level surfaces or slopes at lower altitudes on the Shan limestone plateau. They are less suited for agriculture when compared to red earths.

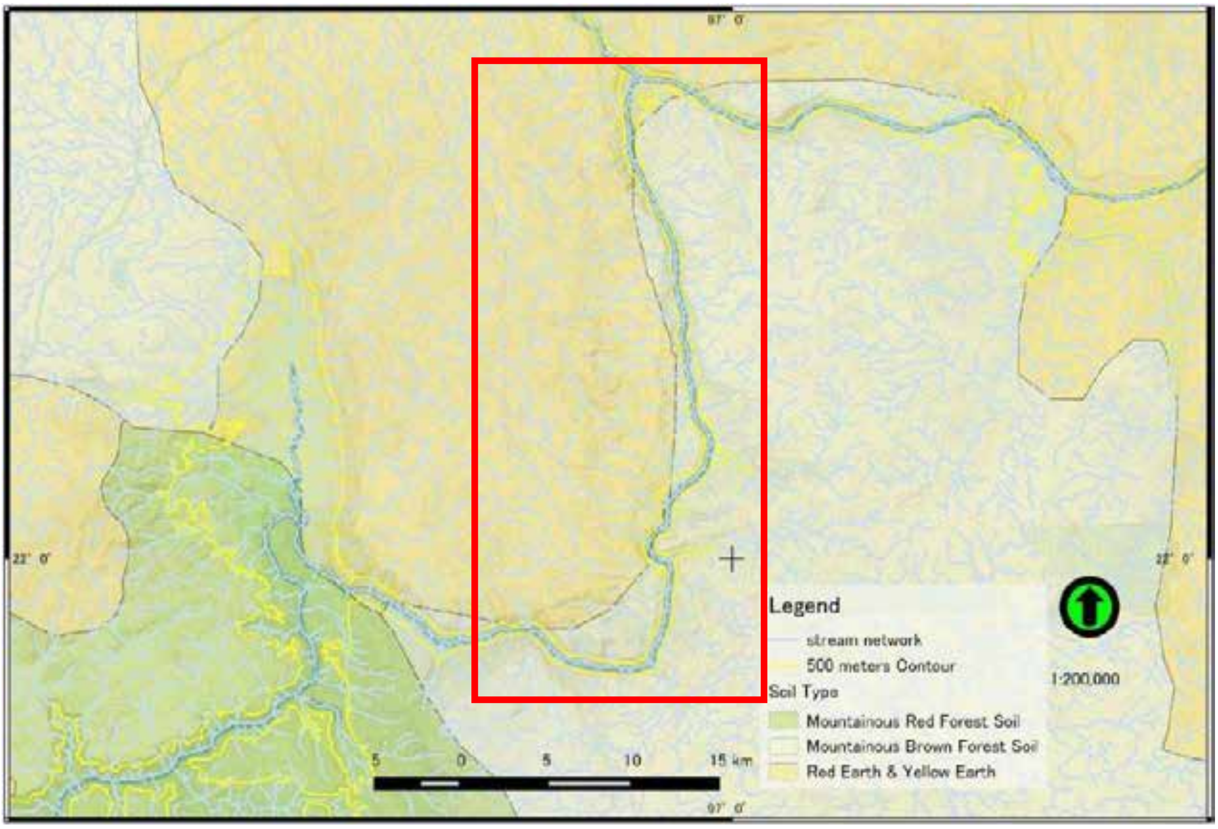

Figure 7-28: Myanmar agricultural atlas map. The project area is shown by the red rectangle.

6.3 Climate

6.3.1 Metrological Conditions

The Myitnge River basin has a subtropical monsoon climate. It is characterised by two seasons:

- A rainy season from mid-May to October where the monsoon of the Indian Ocean leads to overcast and rainy conditions, and
- A dry season from November to mid-May where continental dry west wind is prevailing in the upper air, with many sunny days and limited rain.

The period from November to February is cold and the period from March to April is hot. The southwest and the northeast monsoons distinguish the climate of the basin between dry and wet seasons. The southwest monsoon brings most rainfall (about 90% of the total annual rainfall) from mid-May until October.

The meteorological data at the Upper Yeywa Dam site is considered as the most representative for the Middle Yeywa project's impact zone thought the data only cover the period from 2010. Other metrological data exist from the Kyaukme station, north of Upper Yeywa, for the period 1985-1997. Mean monthly rainfall, temperature, evaporation and relative humidity for these two stations have been summarised in Tractebel (2017) and are detailed in ***Table 7-11***. Rainfall and evaporation for the Upper Yeywa station are illustrated in ***Figure 7-29***.

Table 7-11: Meteorological data near the Middle Yeywa dam site.

Parameters	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Annual
Upper Yeywa													
Rainfall (mm)	8	2	14	33	135	191	261	360	164	121	27	10	1,327
Temp. (°C)	15	16	19	24	25	25	24	24	24	22	20	16	21
Evap. (mm)	78	97	138	174	152	115	100	98	105	107	97	81	1,343
Humidity (%)	90	86	82	77	86	90	90	91	90	79	92	90	87
Kyaukme													
Rainfall (mm)	3	8	12	60	173	179	205	241	147	138	48	8	1,223
Temp. (°C)mean daily max	25.6	27.9	32.4	33.9	32.7	29.9	30.2	30.1	30.5	29.3	27.2	24.2	29.5
Temp. (°C)mean daily min	4.9	6.5	9.8	13.7	17.7	21.0	20.0	20.5	19.7	15.7	11.2	6.5	13.9
Evap. (mm)	96	118	181	194	176	145	148	144	137	131	98	80	1,648

Source: Tractebel (2017)

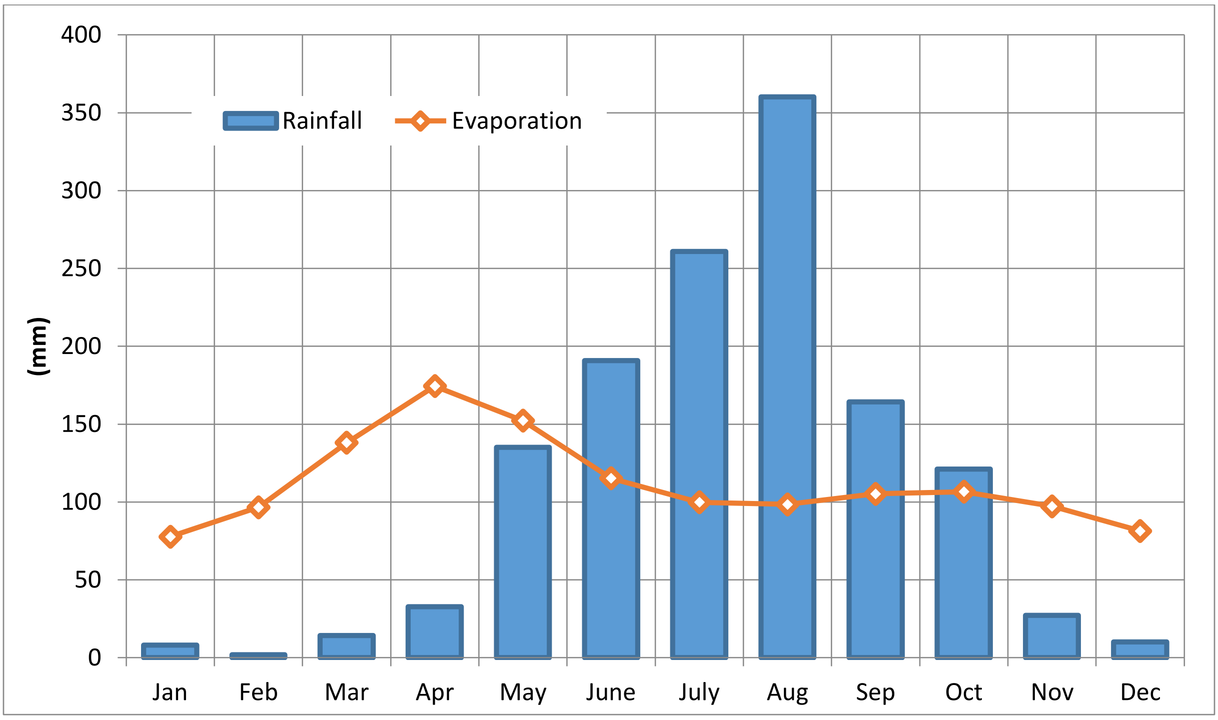

Figure 7-29: Rainfall and evaporation at the Upper Yeywa dam site.
Source: DHPI (in Tractebel 2017)

The distribution of mean annual precipitation within the Myitnge River basin is shown in ***Figure 7-30***. Mean annual precipitation ranges from 1,000 mm in the south-eastern part of the basin to 1,800 mm in the north-western part. Average basin precipitation is in the order of 1,300 mm.

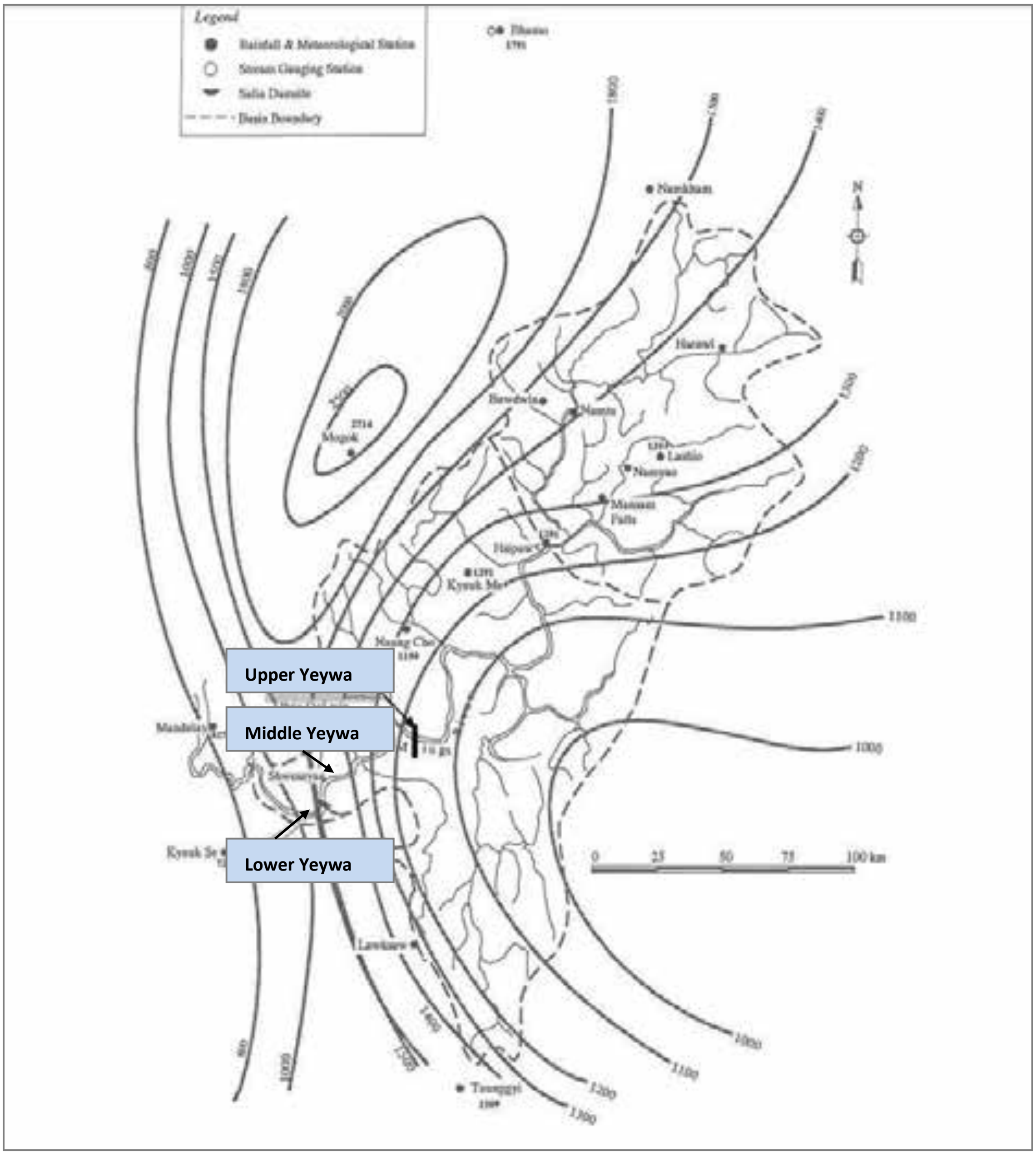

Figure 7-30: Isohyetal map of the project area.
Source: Colenco (2007)

6.3.2 Climate Change Projections

The salient features of the observed climate change in Southeast Asia are presented by the Intergovernmental Panel on Climate Change (IPCC 2014) as follows:

- It is very likely that mean annual temperature has increased over the past century over most of the Asia region.
- Across Southeast Asia, temperature has been increasing at a rate of 0.14°C to 0.20°C per decade since the 1960s, coupled with a rising number of hot days and warm nights, and a decline in cooler weather;
- In Southeast Asia, annual total wet-day rainfall has increased by 22 mm per decade, while rainfall from extreme rain days has increased by 10 mm per decade, but climate variability and trends differ vastly across the region and between seasons;

- In Southeast Asia, between 1955 and 2005 the ratio of rainfall in the wet to the dry seasons increased.

Projected climate change in Southeast Asia is forecasted by the IPPC (2014) as follows:

- Warming is very likely in the mid- and late-21st century. Ensemble-mean changes in mean annual temperature exceed 2°C above the late 20th-century baseline over most land areas in the mid-21st century under the worst case scenario (RCP8.5), and exceed 3°C over Southeast Asia in the late 21st-century.
- Precipitation increases are likely by the mid-21st century and very likely by the late-21st century under the RCP8.5 worst case scenario over southern areas.
- Future increases in precipitation extremes related to monsoon are very likely in Southeast Asia. More than 85% of the CMIP5[4] models show an increase in mean precipitation in the East Asian summer monsoons, while 95% of models project an increase in heavy precipitation events.
- The future influence of climate change on tropical cyclones is likely to vary by region, but there is low confidence in region-specific projections of frequency and intensity.

The observed and projected climate change more specific in Myanmar is presented in the Myanmar Climate Change Strategy and Action Plan (Ministry of Natural Resources and Environmental Conservation, 2016). The main features are as follows:

- Over the last six decades there was overall an increase in mean temperature of 0.08°C per decade while the observed increase in temperature during the last three decades was 0.35°C per decade for inland region.
- The annual total precipitation increased slightly between 1981 and 2010 with a rate of 37 mm/decade in inland according to some authors (Center for Climate Systems Research at Columbia University, WWF-Us and WWF-Myanmar, 2017) while recent DMH study showed on the contrary a decrease on annual precipitation with increase in average intensity.
- There was an increase in the intensity and frequency of cyclones and strong winds. Mala (2006), Nargis (2008) and Giri (2010) were the most severe and damaging cyclones experienced in Myanmar.
- In general, the duration of the monsoon has decreased with 125 day today against the previous 144 days resulting from a late on-set and early withdraw.

The more recent climate change projections for Myanmar revealed:

- A general increase in temperature with more extremely hot days.
- The Eastern and Northern Hilly Regions are likely to see the most dramatic warning among all regions of Myanmar, with hot season average temperatures rising by up to 3°C.
- An increase in rainfall variability during the rainy season including a most likely increase across the whole country from March-November, and a probable decrease between December and February.
- An increase in the occurrence and intensity of extreme weather events; including cyclones/strong winds, flood/storm surge, intense rains, extreme high temperatures and droughts.

The results of the climate projections for the Myitnge River basin are detailed in ***Table 7-12*** and ***Table 7-13***.

Overall, it can be observed that the increase in temperature is virtually certain since the climate projections for temperature are consistent. The magnitude of the increase in temperature is more uncertain as it depends on the RCP (Representative Concentration Pathway).

In contrast, the level of confidence regarding the change in rainfall is medium since the climate projections are not consistent except for the long term time horizon. Overall, an increase in

[4] Coupled Model Intercomparison Project Phase 5

precipitation is more likely than a decrease in precipitation whatever the time horizon. The results are thus consistent with the AR5 Report which states that "the increase in seasonal mean precipitation is pronounced in the East and South Asian summer monsoons" and that "there is medium confidence that monsoon-related inter-annual rainfall variability will increase in the future".

Table 7-12: Change in seasonal temperature with respect to 1986-2005.

Horizon		2016-2035			2046-2065			2081-2100		
		near term			mid term			long term		
	RCPs	25%	50%	75%	25%	50%	75%	25%	50%	75%
		Change in temperature (˚C) with respect to 1986-2005								
DJF	RCP4.5	1.00	1.25	1.50	1.50	2.00	2.50	2.00	2.50	3.00
	RCP8.5	1.00	1.25	1.50	2.50	3.00	3.50	3.50	4.50	6.00
MAM	RCP4.5	0.75	1.00	1.50	1.50	2.00	2.50	1.75	2.50	3.00
	RCP8.5	0.75	1.25	1.50	2.50	2.75	3.25	3.75	4.50	6.00
JJA	RCP4.5	0.75	1.25	1.50	1.50	1.75	2.25	1.75	2.00	2.50
	RCP8.5	0.75	1.25	1.50	2.25	2.75	3.00	3.75	4.50	5.50
SON	RCP4.5	0.75	1.25	1.50	1.50	1.75	2.25	1.75	2.25	2.75
	RCP8.5	0.75	1.25	1.50	2.25	2.75	3.00	3.75	5.00	6.00

Source: Tractebel (2017);
DJF = December, January, February; MAM = March, April, May; JJA = June, July, August; SON = September, October, November.

Table 7-13: Change in seasonal precipitation with respect to 1986-2005.

Horizon		2016-2035			2046-2065			2081-2100		
		near term			mid term			long term		
	RCPs	25%	50%	75%	25%	50%	75%	25%	50%	75%
		Change in precipitation (%) with respect to 1986-2005								
Oct-Mar	RCP4.5	-5%	-5%	5%	-5%	0%	5%	-5%	5%	15%
	RCP8.5	-5%	5%	5%	-5%	5%	10%	-5%	5%	15%
Apr-Sep	RCP4.5	-5%	5%	5%	5%	5%	15%	5%	5%	10%
	RCP8.5	-5%	5%	5%	5%	5%	15%	5%	15%	20%

Source: Tractebel (2017)

6.4 Air Quality

There are no industrial air pollution sources in the project's impact zone, and the traffic and transportation density on the local roads is relatively low with no significant dust pollution. Forest fires occur in the dry season, creating localised air pollution where the burning is taking place (away from settled areas). Background air quality measurements have been undertaken, but it is highly unlikely that the airshed is degraded under present conditions.

6.5 Noise and Vibration

No data exist on the present noise situation. However, due to the remoteness of the proposed construction sites, the low traffic volumes on the local roads, and the absence of major industrial activities in the direct impact zone, noise levels are considered insignificant and/or within the normal range of natural sounds.

6.6 Hydrology

6.6.1 Basin Characteristics

The Myitnge River, one of the tributaries of the Ayeyarwady River, originates from Mount Loi Swang at an elevation of 1,460 m on the northern Shah Plateau. The total drainage area is 34,800 km^2 and the river is about 530 km long. ***Table 7-14*** gives an overview of the areal dimension of the various catchments (see also ***Figure 7-31***).

Table 7-14: Estimation of the areal extension of the different sub-catchments.

Location	Catchment Area (km^2)
Hsipaw Gauging Station	12,289
Dam axis – Upper Yeywa	22,671
Dam axis – Middle Yeywa Alt. 1	24,585
Dam axis – Middle Yeywa Alt. 2	24,931
Dam axis – Middle Yeywa Alt. 4.2&5.2	25,490
Dam axis – Middle Yeywa Alt. 3,4.1&5.1	25,518
Dam axis – Lower Yeywa	28,710
Shwesayan Gauging Station	29,197
Confluence with Ayeyarwady River	34,800

Source: Pöyry (2015)

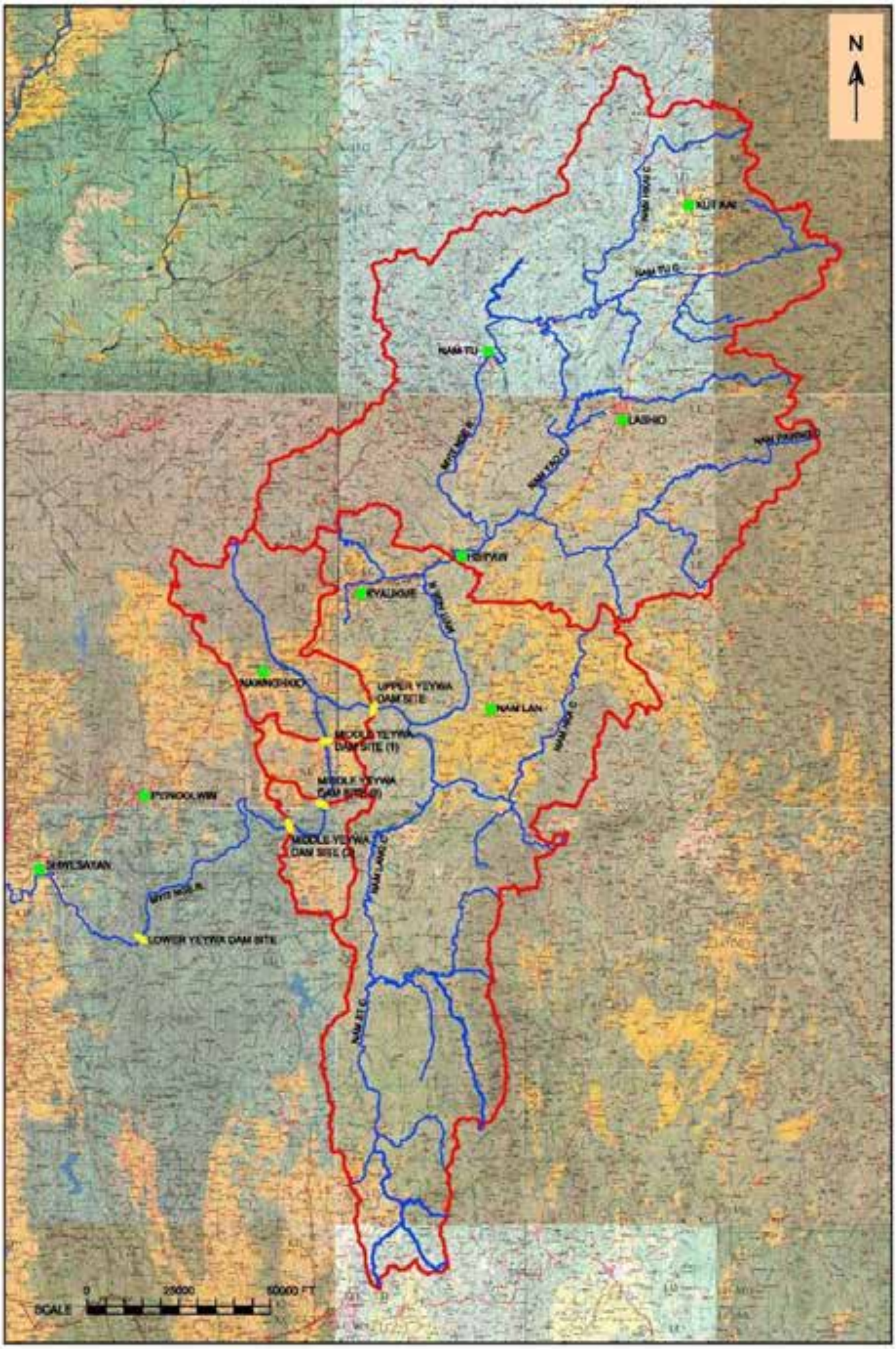

Figure 7-31: Myitnge river basin at the Middle Yeywa most downstream dam location.

6.6.2 Inflows

<u>Seasonal Variability</u>

The daily natural inflow series at Middle Yeywa (1984-2016) was obtained through hydrological modelling (Tractebel 2017). The inflows are characterised by a marked seasonal variability with low flows of about 100-150 m^3/s in March to May and high flows of about 950 m^3/s in August to September. The mean annual inflow is 458 m^3/s and the 95% exceedance frequency inflow is near 100 m^3/s.

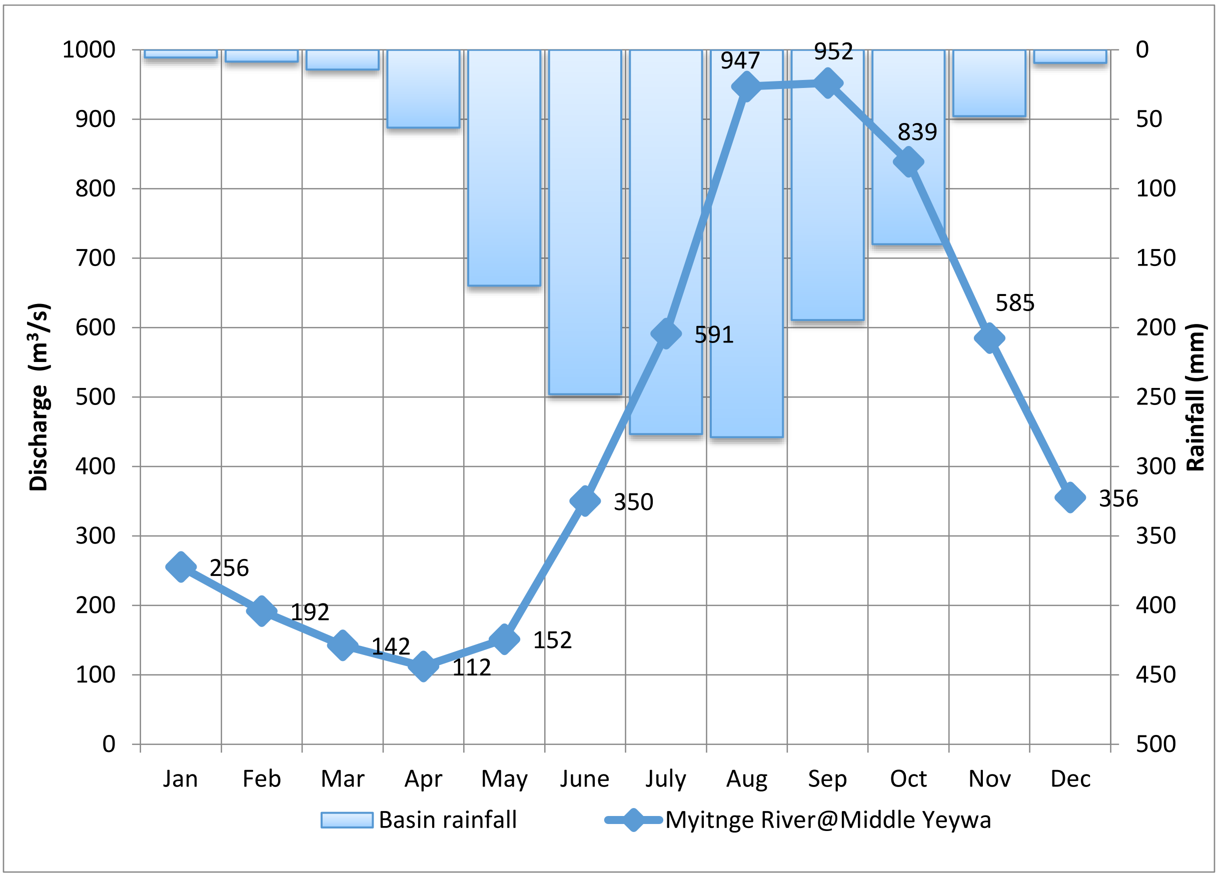

Figure 7-32: Mean monthly discharge and rainfall at Middle Yeywa.
Source: Tractebel (2017)

Table 7-15: Monthly series of inflows at Middle Yeywa (1984-2017).

	Monthly series of inflows at Middle Yeywa (25,400 km²) (m³/s)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**June**	**July**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Q5%	188	142	108	85	86	169	360	573	616	548	349	247	**356**
Avg	256	192	142	112	152	350	591	947	952	839	585	356	**458**
Q95%	329	235	176	161	243	676	979	1377	1327	1247	845	465	**571**

Source: Tractebel (2017)

The daily inflow series at Middle Yeywa is represented in ***Figure 7-33***. Individual years are represented by a thin grey line. The daily inflows associated with an exceedance frequency of 5%, 50% and 95% are also represented by red color lines.

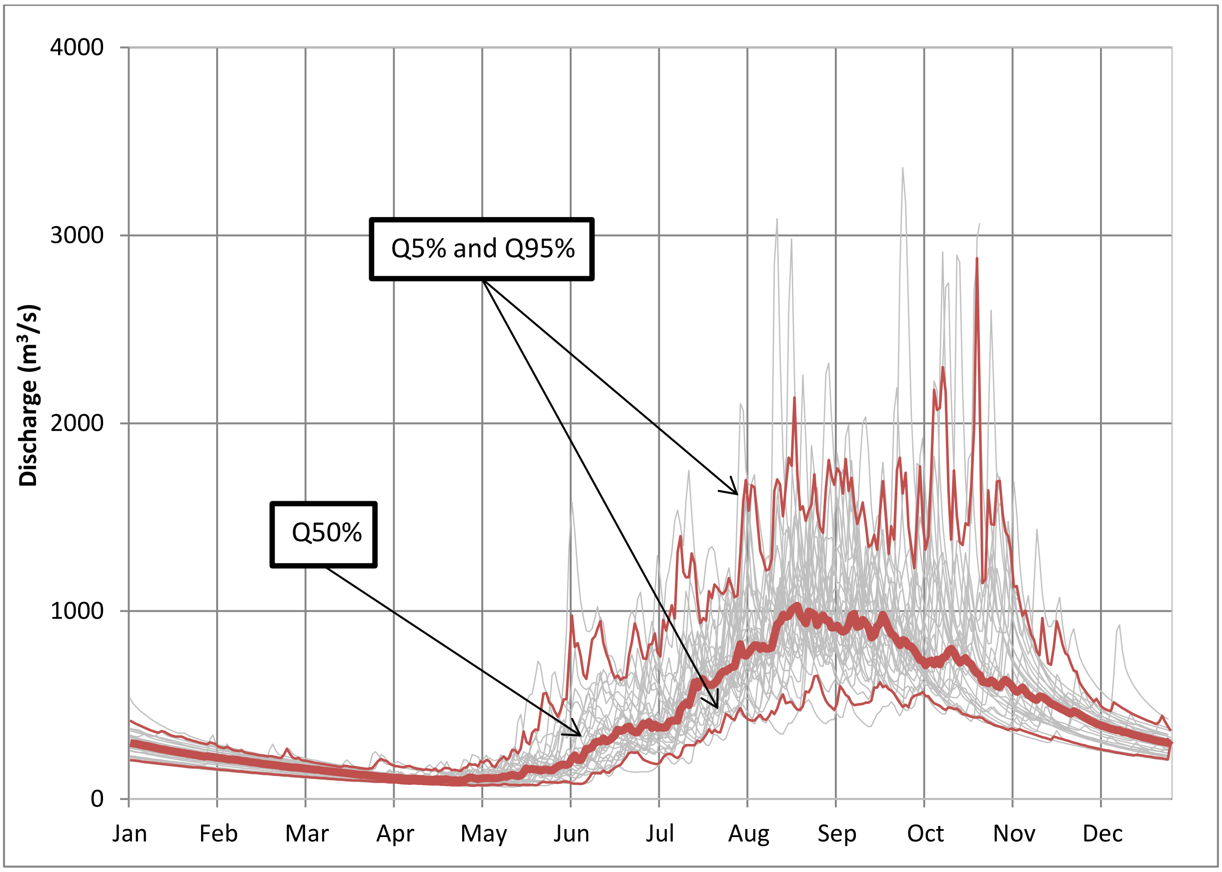

Figure 7-33: Daily inflow series at Middle Yeywa.
Source: Tractebel (2017)

<u>Flow Duration Curve</u>

The flow duration curve is calculated from the daily series of inflows at Middle Yeywa (Tractebel 2017). The results are given in ***Table 7-16*** hereafter.

Table 7-16: Daily inflows at Middle Yeywa - flow duration curve. Source: Tractebel (2017).

Exceedance frequency (%)	Daily inflow (m^3/s)	Exceedance frequency (%)	Daily inflow (m^3/s)	Exceedance frequency (%)	Daily inflow (m^3/s)
0	3,360	35	490	70	192
5	1,163	40	425	75	168
10	967	45	375	80	150
15	839	50	325	85	130
20	742	55	283	90	115
25	650	60	247	95	97
30	567	65	218	100	65

Source: Tractebel (2017)

The flow duration curves at Middle Yeywa are illustrated in ***Figure 7-34***. Individual years are represented by thin grey lines. The flow duration curve calculated for the entire period is represented by the marked red curve.

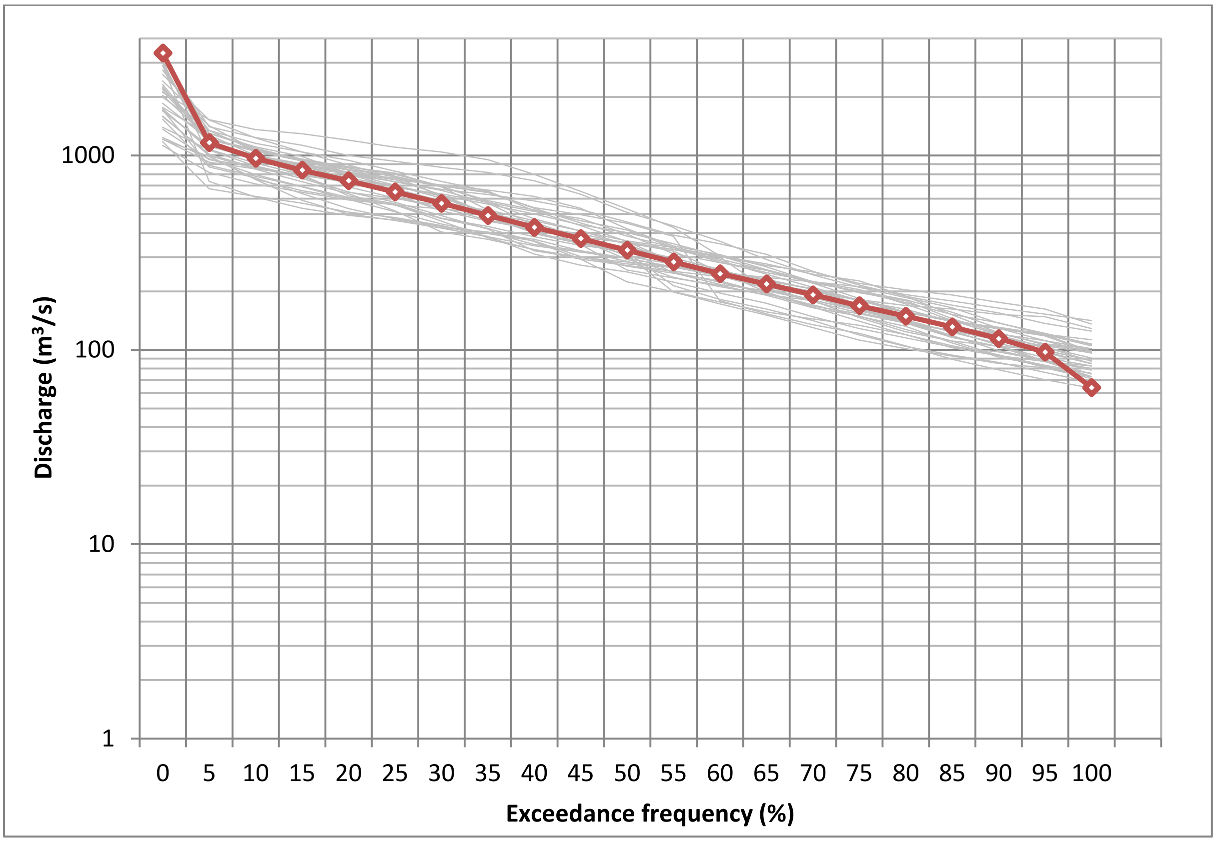

Figure 7-34: Daily inflows at Middle Yeywa – Flow duration curves.
Source: Tractebel (2017)

6.6.3 Floods

The flood assessment relies on both observed flood discharge statistical analysis and rainfall-runoff approach (Tractebel 2017). The major flood events in the Myitnge River are caused by long and spatially extended rainfalls. In addition, the soil moisture conditions (affecting the retention capacity) as well as the base flow play a major role. The analysis of the major flood events shows that the relevant duration for flood calculations is 7 days.

The hydrographs of the major flood events observed at Shwesayan Gauging Station (downstream of the existing Yeywa dam) reveal that more than 95% of the annual maximum flood events occur between August and November, with the majority occurring in September (37%) and August (33%). The modelled flood hydrographs for some selected return periods and for the Probable Maximum Flood (PMF) at Middle Yeywa are illustrated in ***Figure 7-35***. The PMF is estimated at 15,000 m^3/s.

Table 7-17: Flood volumes at Middle Yeywa for 7, 15 and 31 days.

Return period (years)	7 days flood volume at Middle Yeywa (million m³)	15 days flood volume at Middle Yeywa (million m³)	31 days flood volume at Middle Yeywa (million m³)
10	1,350	2,200	3,400
100	2,140	3,300	4,900
1,000	3,540	5,300	7,450
10,000	4,930	7,300	10,050
PMF	7,750	11,300	15,250

Source: Tractebel (2017)

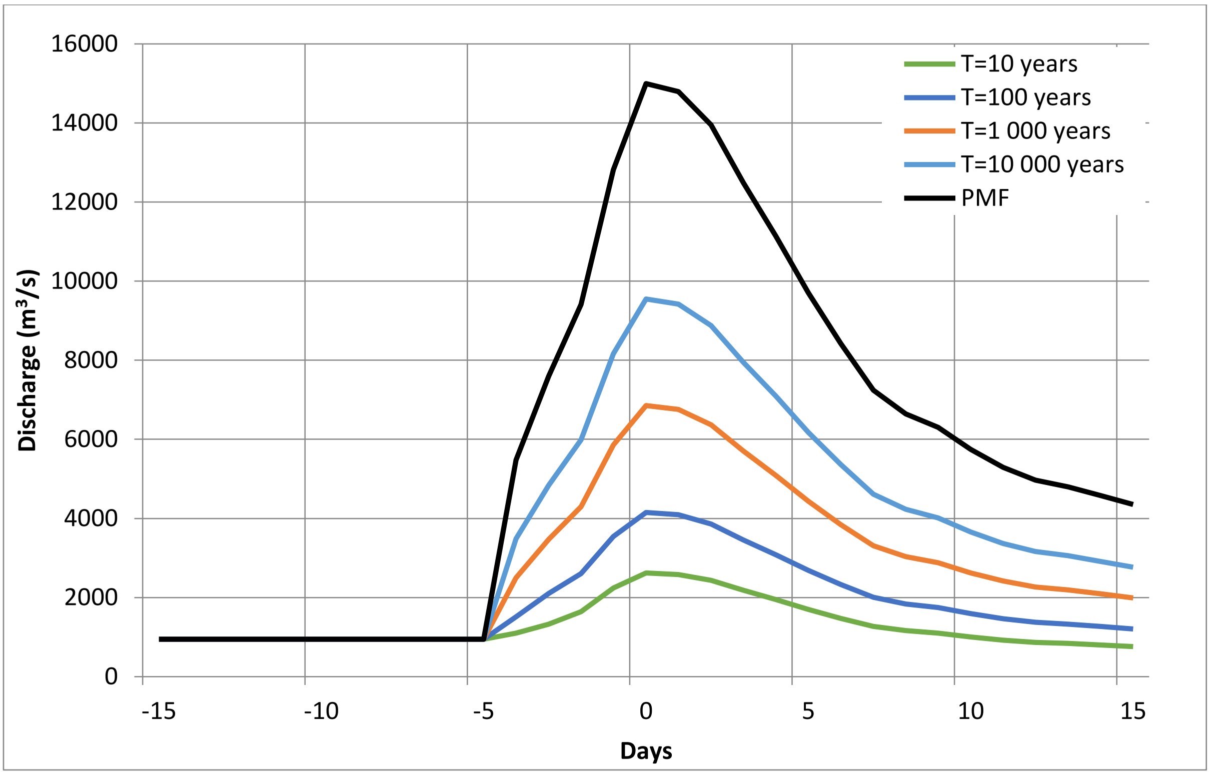

Figure 7-35: Flood hydrographs at Middle Yeywa.
Source: Tractebel (2017)

6.7 Sediment Transport

Sediment transport consists of suspended sediments and bedload. Unfortunately, few data are available on the sediment transport in the Myitnge River, but Tractebel (2017) has reviewed the existing documentation and conducted modelling of sediment loads. The total specific sediment yield has been estimated at 773 m^3/km/year. The assumed grain size distribution is 13% sand, 42% silt and 45% clay. In addition, it has been assumed that the bed load is 20% of the suspended load, i.e. 16.7% of the total load.

6.8 Water Quality

The sampling sites for water quality are shown in ***Figure 7-36*** and the recorded water quality data are presented in Table 7-18, Table 7-19 and

Table ***7-20***. For comparison, the classification of river water adopted by ASEAN is given in Table 7-21.

The water quality in the affected reaches of Myitnge River is generally favourable to aquatic life although it does not meet all drinking water quality standards.

Dissolved oxygen (DO) values ranged from 4.7 to 8.4 mg/l with the majority of samples having a DO level of 5-6 mg/l. The DO values were consistently higher during the monsoon season at peak river flow, and the highest DO values were recorded in the rapids (MYS 1-3 and MYS 1-4) and at MYS 1-8 near Me Poke. Generally, DO levels less than 4 mg/l can be detrimental to fish and other aquatic animals.

The only parameters that consistently exceeded national and international standards for potable water quality is nitrogen (NH_3-N) and turbidity, while some samples also had elevated levels of biological oxygen demand (BOD) and chemical oxygen demand (COD). The nitrogen level is not severely high but could be due to decomposition of animal wastes or chemical fertilizers (however, the recorded phosphorus level is insignificant).

BOD and especially COD are considered as effluent parameters showing if the river is polluted by human activities (e.g. industrial, agriculture or sewage). BOD levels ranged from 3.0 to 22.0 mg/l, while COD levels ranged from 6.2 to 55.9 mg/l. These values give evidence of some effluent inputs, probably from upstream cultivation and human settlements (including the only settlement at Myitnge Bridge), although not severe as compared to rivers with higher population densities. Indeed, the recorded values are within the limit values for treated wastewater (cf. World Bank / IFC EHS guidelines) and there is no evidence of faecal contamination (faecal coliforms and E. coli) in the water samples.

As expected, turbidity levels are higher in the high flow period (monsoon season) with values ranging from 69 to 115 NTU, compared to less than 50 NTU in the wet/hot season and less than about 20 NTU in the cold/dry season. Turbidity levels were however insignificant (2 NTU) immediately upstream (LYS1) and downstream of the Yeywa dam (LYS-2 and LYS-3), indicating that sediments are trapped in the reservoir.

It should be noted that additional water quality samples are planned to be collected from the Yeywa reservoir (downstream of the planned Middle Yeywa dam). These data will be reported in the final EIA report and could serve as an indication as to how the water quality characteristics of the Myitnge River will change after the filling of the reservoir.

Table 7-18: Water quality data for cold/dry season (February/March 2015) in Myitnge River.

Sample	Unit	MYS1-1	MYS1-2	MYS1-3	MYS1-4	MYS1-5	MYS1-6	MYS1-7	MYS1-8	MYS1-9
pH		7.95	7.99	7.76	7.77	7.93	8.0	8.3	7.78	7.91
BOD	mg/l	4.0	3.4	3.0	3.5	4.2	6.5	4.2	6.5	6.2
COD	mg/l	8.3	6.2	14.8	6.4	8.8	14.8	6.2	14.8	14.8
TSS	mg/l	0.04	0.04	0.08	0.08	0.32	0.64	0.72	0.68	0.32
Copper	mg/l	0.000	0.002	0	0.012	0	0	0.007	0	0.005
Iron	mg/l	0.03	0.02	0.01	0.01	0.02	0.03	0.03	0.01	0.03
Zinc	mg/l	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NH_3-N	mg/l	6.9	11.04	2.76	4.83	6.21	6.21	4.83	4.15	3.45
Phosphorus	mg/l	0.02	0.01	0.02	0.04	0.01	0.01	0.02	0.03	0.01
EC	µS/cm	472	416	422	420	417	410	410	417	418
Turbidity	NTU	17	14	20	19	20	20	10	21	20
DO	mg/l	5.2	5	5	5.2	4.7	4.7	4.7	5	5.2
Salinity	%	0.02	0.01	0.01	0.01	0	0	0	0.01	0.01
Tot. Coliform	N.	>16	>16	>16	>16	>16	>16	>16	>16	>16
Faecal Coliform	N.	0	0	0	0	0	0	0	0	0
E. coli	N.	0	0	0	0	0	0	0	0	0

Table 7-19: Water quality data for wet/hot season (May 2015) in Myitnge River.

Sample	Unit	MYS1-1	MYS1-2	MYS1-3	MYS1-4	MYS1-5	MYS1-6	MYS1-7	MYS1-8	MYS1-9
pH		7.39	7.46	7.35	7.46	7.49	7.49	7.47	7.41	7.38
BOD	mg/l	5.0	4.1	4.0	3.7	5.0	6.7	4.3	4.5	4.2
COD	mg/l	9.7	7.6	7.5	7.1	10.5	15.0	6.4	6.8	11.5
TSS	mg/l	0.28	0.52	0.60	0.52	0.35	0.48	0.80	0.64	0.04
Copper	mg/l	0.000	0.000	0.208	0.005	0.001	0.000	0.000	0.006	0.003
Iron	mg/l	0.15	0.10	0.05	0.04	0.05	0.06	0.10	0.40	0.10
Zinc	mg/l	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NH_3-N	mg/l	5.60	16.80	9.10	9.80	11.20	9.10	12.60	13.30	11.20
Phosphorus	mg/l	0.01	0.06	0.03	0.02	0.02	0.04	0.01	0.05	0.01
EC	µS/cm	400	420	426	425	443	410	410	434	421
Turbidity	NTU	45	47	50	47	37	42	45	37	27
DO	mg/l	5.2	5.3	5.2	5.3	5.1	5.2	5.2	5.3	5.3
Salinity	%	-	-	-	-	-	-	-	-	-
Tot. Coliform	N.	>16	>16	>16	>16	>16	>16	>16	>16	>16
Faecal Coliform	N.	0	0	0	0	0	0	0	0	0
E. coli	N.	0	0	0	0	0	0	0	0	0

Table 7-20: Water quality data for late monsoon season (September/October 2015) in Myitnge River.

Sample	Unit	MYS1-1	MYS1-2	MYS1-3	MYS1-4	MYS1-5	MYS1-6	MYS1-7	MYS1-8	MYS1-9	LYS-1	LYS-2	LYS-3
pH		7.31	7.51	7.34	7.26	7.26	7.20	7.44	7.25	7.28	8.06	7.64	7.94
BOD	mg/l	4.4	7.0	14.5	22.0	10.6	3.0	5.3	17.0	4.2	5.0	3.1	3.0
COD	mg/l	8.8	17.6	36.3	55.9	26.4	7.1	13.2	44.7	10.5	11.9	7.3	7.3
TSS	mg/l	0.48	1.12	0.20	0.40	0.52	0.44	0.60	0.96	0.68	0.52	0.44	0.64
Copper	mg/l	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Iron	mg/l	0.50	0.30	0.20	0.50	0.20	0.15	0.10	0.20	0.45	0.05	0.10	0.05
Zinc	mg/l	0.036	0.016	0.012	0.008	0.027	0.004	0.004	0.019	0.003	0.003	0.017	0.000
NH_3-N	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Phosphorus	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
EC	µS/c	-	-	-	-	-	-	-	-	-	-	-	-
Turbidity	NTU	69	95	115	113	105	91	96	114	112	2	2	2
DO	mg/l	5.7	5.7	7.5	7.5	6.5	5.6	7.5	8.4	6.9	5.6	5.6	5.8
Salinity	%	-	-	-	-	-	-	-	-	-	-	-	-
Tot. Coliform	N.	>16	>16	>16	>16	>16	>16	>16	>16	>16	>16	>16	>16
Faecal Coliform	N.	0	0	0	0	0	0	0	0	0	0	0	0
E. coli	N.	0	0	0	0	0	0	0	0	0	0	0	0

Table 7-21: Classification of river water (adopted by ASEAN).

Parameter	Class I: Potable water	Class II: Recreation	Class III: Commercial Fisheries	Class IV: Irrigation
pH	6-9	6-9	5-9	5-9
BOD (mg/l)	5	5	10	10
COD (mg/l)	30	30	100	100
Amm – N (mg/l)	0.3	0.3	1	3
TSS (mg/l)	50	50	150	300
DO (mg/l)	5	5	3-5	3
Faecal Coliform (counts/100) ml)	-	1000	-	-

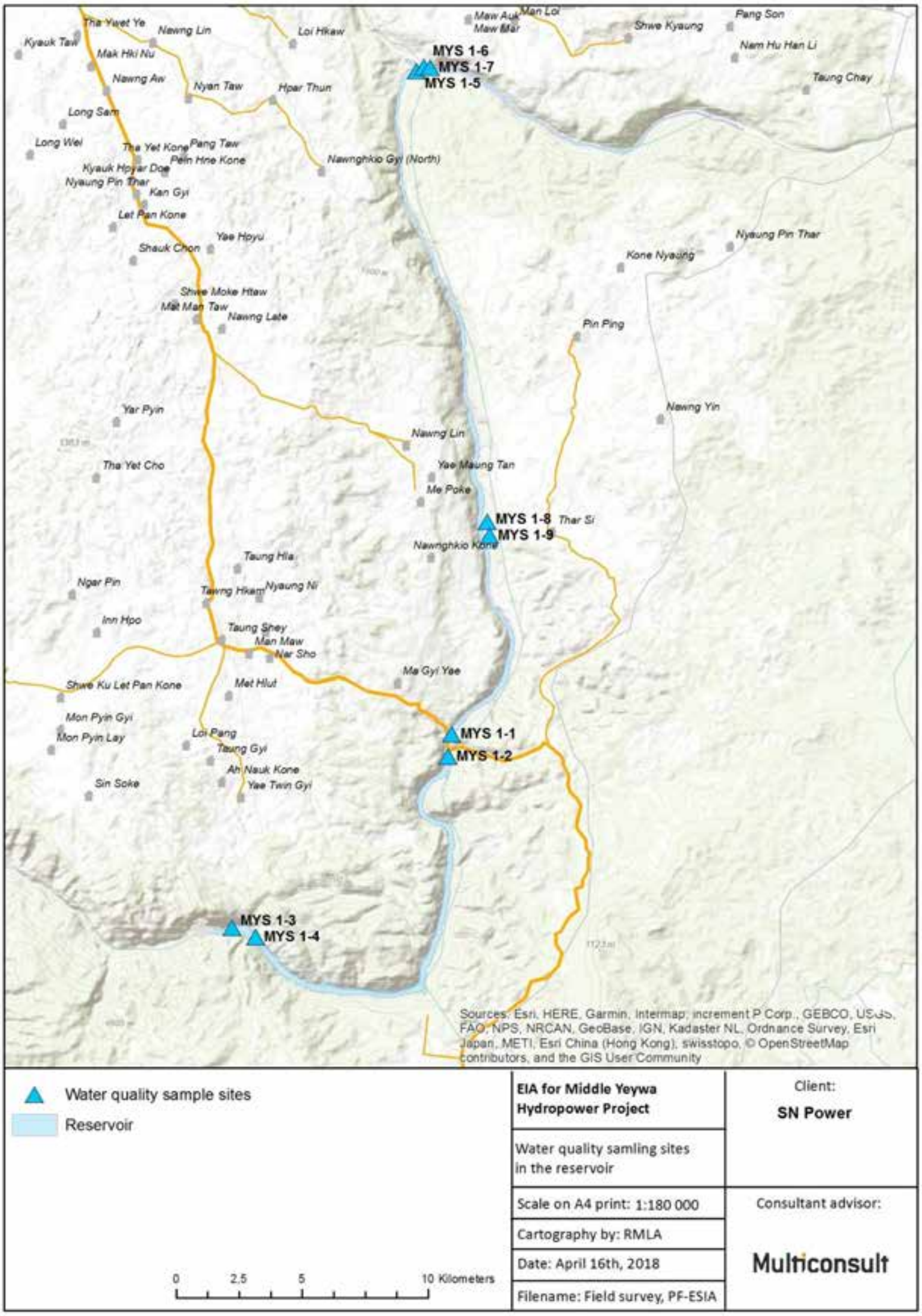

Figure 7-36: Sampling sites for water quality.

6.9 Biodiversity and Protected Areas

6.9.1 The Biodiversity Context

The Project is located within the Indo Burma Biodiversity Hotspot (Mittermeier *et al.*, 2004). This is one of the world's 35 biodiversity hotspots. The Indo Burma Biodiversity Hotspot originally covered an area of 2,373,000 km^2 (see ***Figure 7-37***). Biodiversity hotspots are the world's biologically richest and most threatened regions. The Indo Burma Biodiversity Hotspot covers a range of forest types with high diversity and limestone karst that supports distinctive vegetation formations with high levels of endemism particularly among plants, reptiles, and molluscs.

Less than five percent of the natural habitat in the Indo Burma hotspot remain, and the hotspot has more people than any other biodiversity hotspot globally. Hydropower development is acknowledged as one of the threats to biodiversity in the hotspot.

The Indo-Burma hotspot encompasses all or parts of seven Endemic Bird Areas defined by BirdLife International (Stattersfield *et al*., 1998, as updated by http://www.birdlife.org/datazone/), twelve of the Global 200 Ecoregions defined by WWF (Olson *et al*., 2000) and 28 Centres of Plant Diversity defined by the International Union for Conservation of Nature, IUCN (Davis *et al*., 1995).

Recognising the biodiversity importance of the larger region, the project developer has placed emphasis on analysing and understanding whether the project area is unique and undertaking field work to confirm desk review findings.

The Middle Yeywa project area is not located in any of these Endemic Bird Areas or centres of plant diversity. The project area is not located in any of the montane areas or the lowland evergreen forest areas that in geological and evolutionary time have been isolated and consequently developed high levels of localised endemism. The project is therefore not located in one of the areas within the larger biodiversity area that is of particularly high conservation value.

Figure 7-37: The boundaries of the Indo-Burma Biodiversity Hotspot defined by Mittermeier et al., (2004), which includes most of Myanmar except areas in the north of the country.

Overall, the biodiversity recorded in the Project's direct and indirect impact zones was not found to be unique. The ecosystems, habitats and species documented are relatively widespread. Sections 6.10 - 6.12 below provide further information, including on the ecosystems, habitats and species considered most important from a conservation perspective.

The terrestrial biodiversity has been and continues to be substantially negatively impacted by human disturbance, for instance logging of high value timber species, conversion of forest areas to agriculture, and hunting (see Figures 6-26 to 6-28). Some of the steep and less accessible areas towards the river have been less impacted by habitat conversion but hunting tends to be concentrated in these areas. The aquatic biodiversity is particularly impacted by hydropower development downstream and upstream of the Middle Yeywa Project.

Very likely, the project area will be subject to further pressures from human activities. The likely future scenario without the Project is therefore one with continued negative impacts on biodiversity, and this scenario provide the basis for comparison when considering likely project impacts.

Figure 7-38: Recent conversion of forest to agriculture on the left bank near Tar Si Village

Figure 7-39: Small-scale logging of selected hard wood species using chain saw in very steep slopes towards the Myitnge River near Nawnghkio Gyi Village. Wood is carried up the steep slopes.

Figure 7-40: Hunting for mammals and birds is practiced by local people using very simple technologies such as home-made guns using gun powder and small balls from bearings as ammunition. Hunting using dogs is also common.

6.9.2 Protected Areas

As can be seen in Figure 6-29, there are no confirmed protected areas in the Project's impact zones. The nearest protected area recorded in the World Database on Protected Areas is Pyin Oo Lwin Wildlife Sanctuary and is located approximately 35 km west of the dam site. This wildlife sanctuary appears to be a 'paper park' as the natural habitats have been largely converted to agricultural land and partly residential areas of Pyin Oo Lwin.

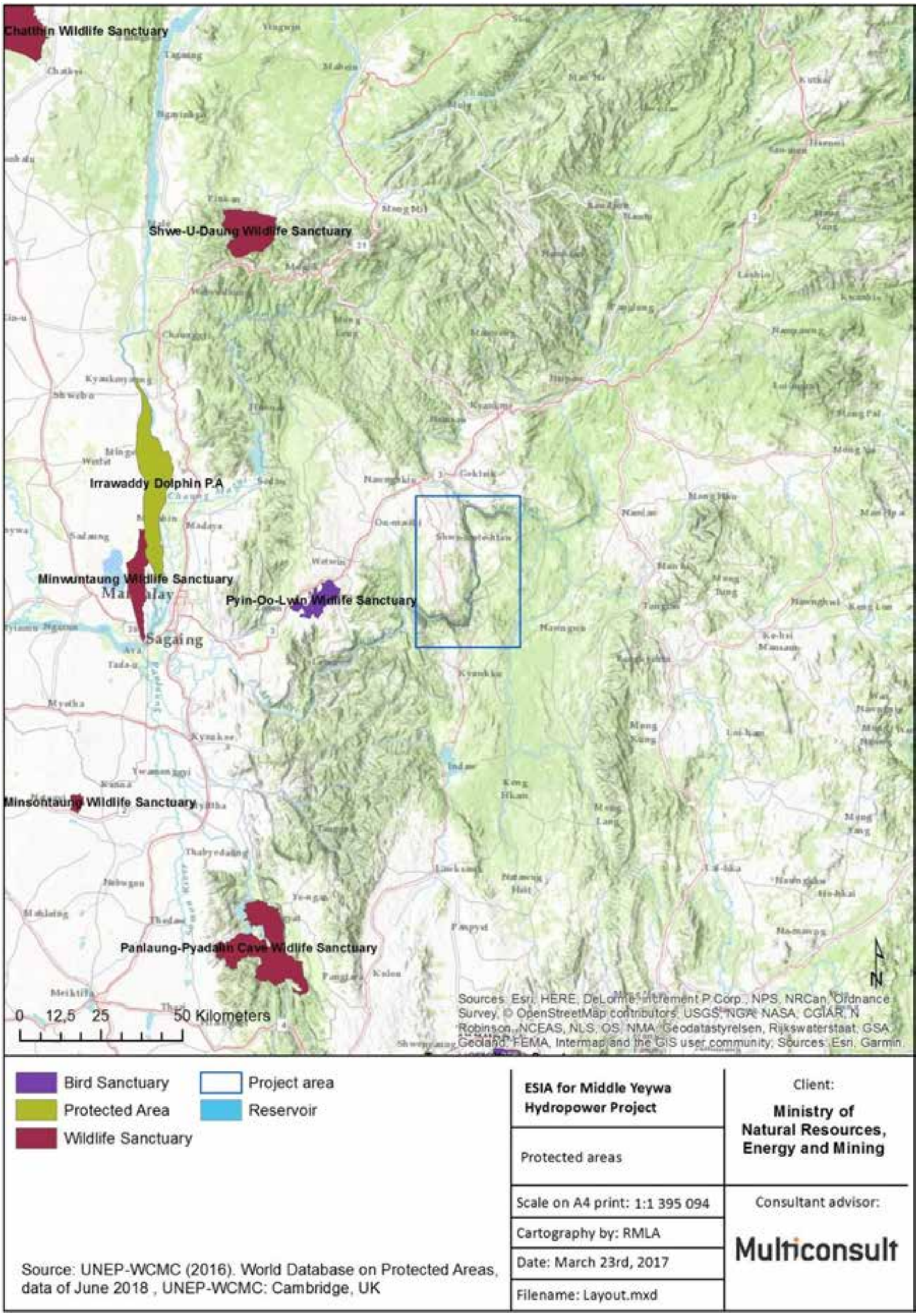

Figure 7-41: The Protected Areas closest to the project.

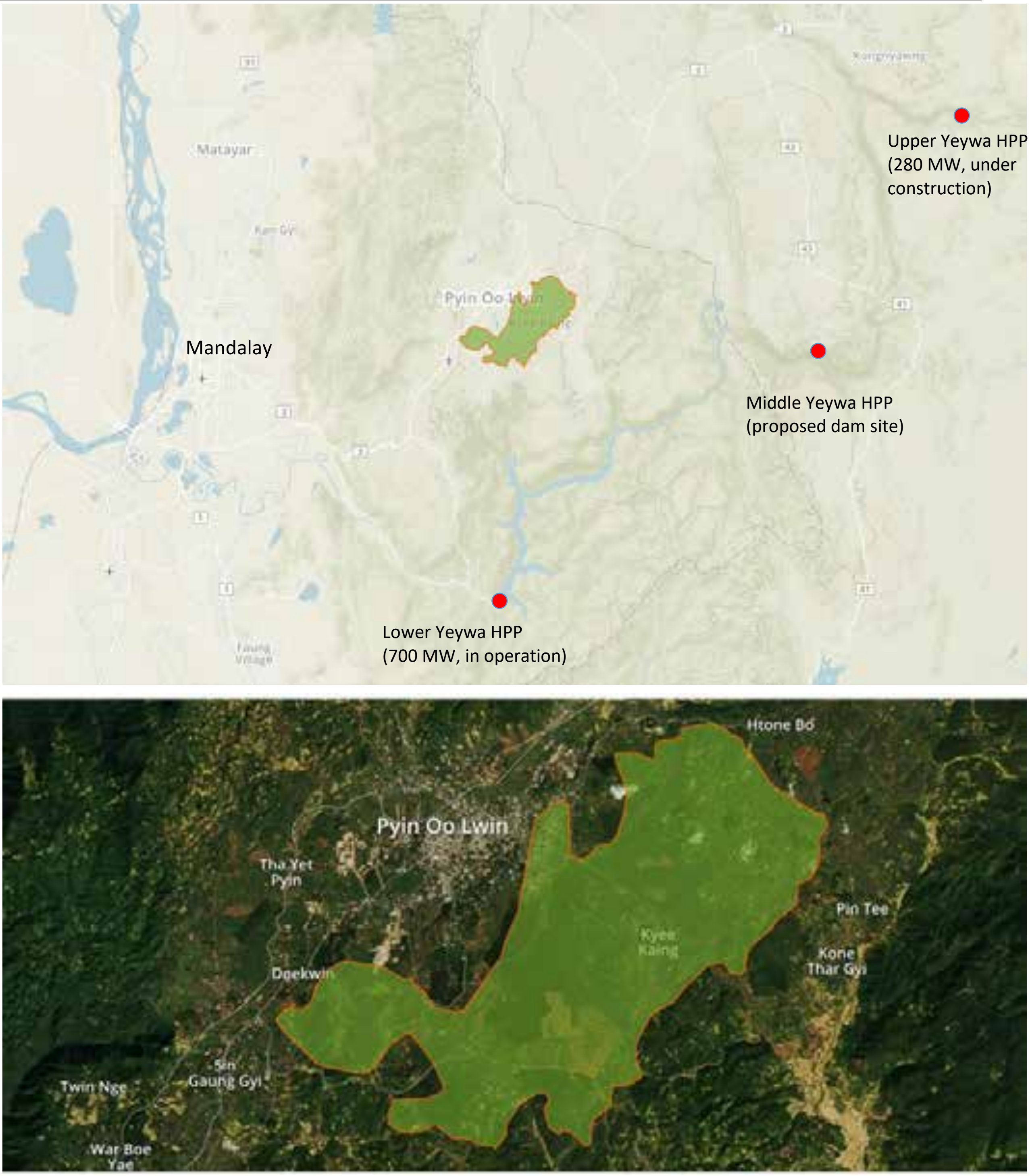

Figure 7-42: Upper map showing the location of the Pyin Oo Lwin Wildlife Sanctuary approximately 35 km west of the proposed Middle Yeywa dam site. Lower satellite image showing land conversion within the Pyin Oo Lwin Wildlife Sanctuary.

Source: www.protectedplanet.net

There is potentially a forest reserve in parts of the project area on the left bank upstream of the Nam-kam River to the upper end of the reservoir. The World Database on Protected Areas and publications on protected areas in Myanmar do not reflect any protected area along the river's left bank, but the potential existence or previous proposal for protection of an area on the left bank requires further clarifications from authorities in Myanmar. The area on the left bank proposed for the Naung Lon Forest Reserve is shown on the map in **Error! Reference source not found.**.

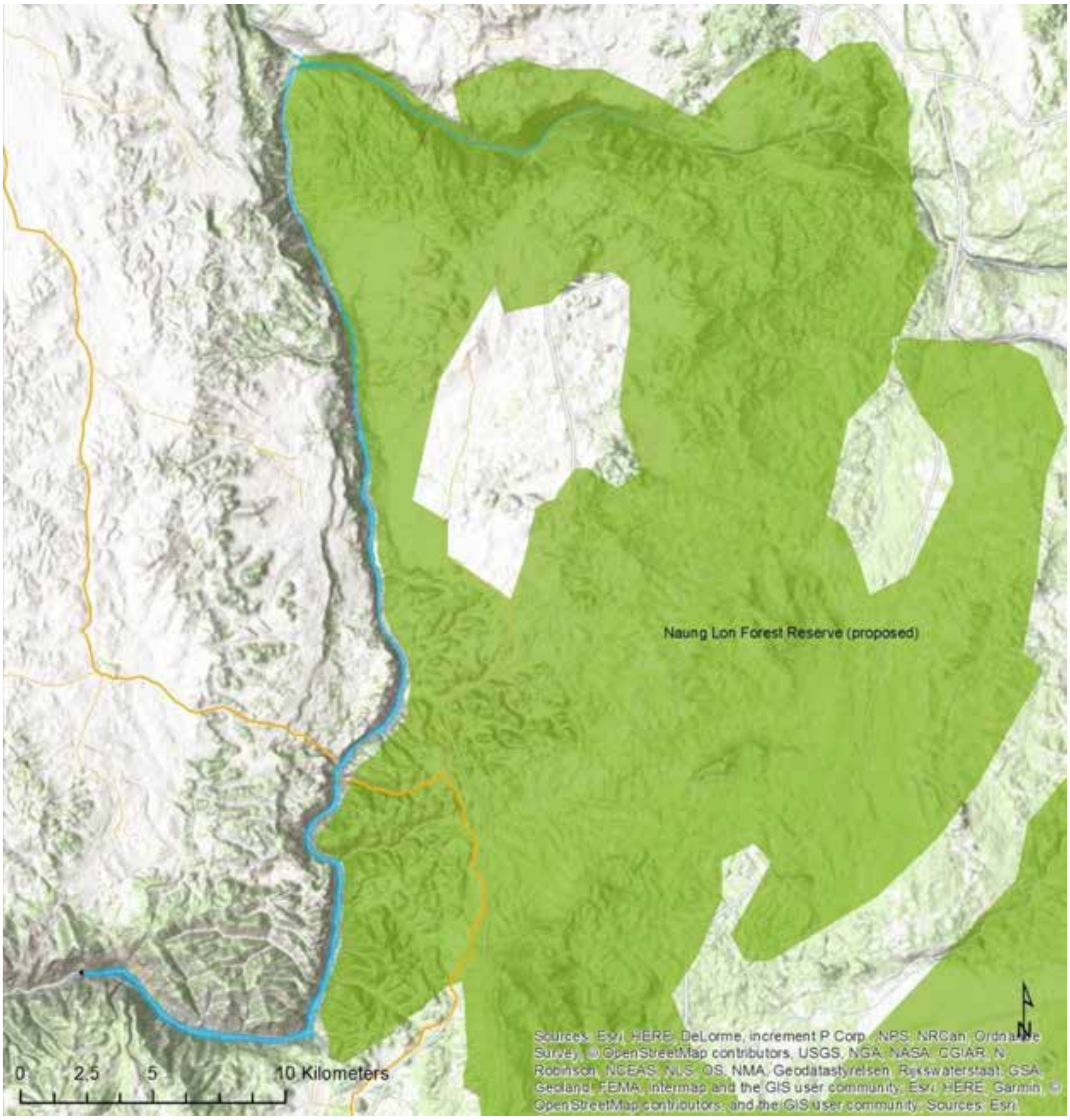

Figure 7-43: The unconfirmed forest reserve on the left bank.

The closest recognised area of particular biodiversity importance is the Mehon - Doke-hta Wady River key biodiversity area (KBA). This KBA is found between the Pyin Oo Lwin Wildlife Sanctuary and the dam site (see ***Figure 7-44***). The area does not have any legal status but is considered an International Bird Area by Birdlife International (IBA MM023), which was the basis for the KBA status. The delineation of this key biodiversity area is not unequivocal and is based on the presence of a bird species, the endangered Green Peafowl (*Pavo muticus*). This species was recorded within the project direct impact zone towards the dam site using wildlife camera traps, but the project direct impact zone or indirect impact zone are not considered key habitats for this species due the human pressures in the area.

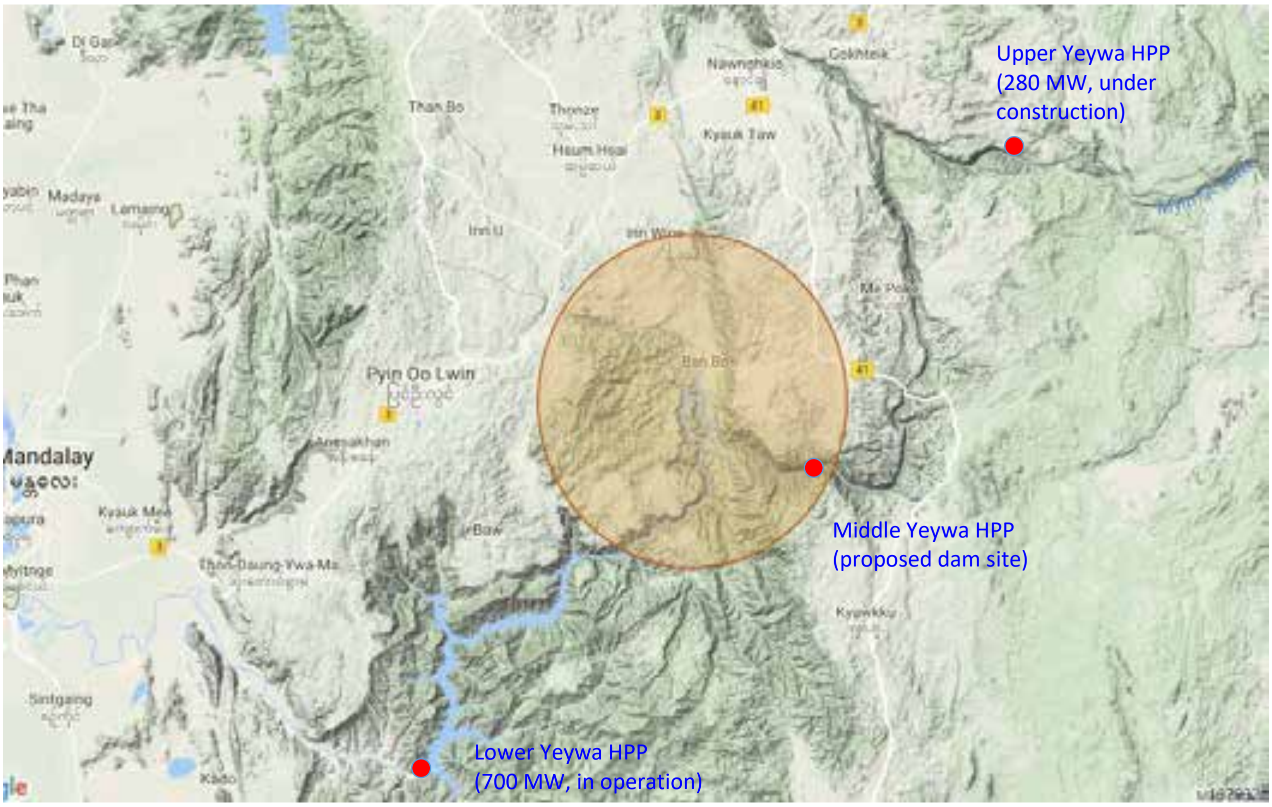

Figure 7-44: Map showing the location of the Mehon - Doke-hta Wady River key biodiversity area west of the Middle Yeywa project area.

Protected areas, key biodiversity areas and biodiversity hotspots are primarily defined based on terrestrial biodiversity rather than freshwater biodiversity. Available information about aquatic ecology in the project area is characterised by uncertainties, and further studies are therefore recommended to confirm the aquatic biodiversity values. Available information on aquatic ecology does not indicate unique biodiversity but this should be confirmed through further field surveys. The fact that Yeywa Hydropower Project was constructed several years back and that the Upper Yeywa Hydropower Project is under construction has important implications for aquatic biodiversity, including lateral connectivity between areas downstream and upstream of the Middle Yeywa Hydropower Project (see Section 8.2.12).

6.10 Vegetation

6.10.1 Materials and Methods

Vegetation data were collected over several sampling seasons, including:

- March-May 2015 (right bank, dry season)
- September-October 2015 (right bank, transition period after the rainy season)
- July-August 2016 (left bank, rainy season)
- December 2017 (both banks, dry season)

Plots of 20x20 m and 30x30 m were distributed along strategically placed transects. Plant species identification was carried out by using key to families of flowering plants and appropriate literature and confirmed by matching with herbarium specimens of Department of Botany, University of Yangon.

To get representative checklists of the plant species, collection and identification was also carried out by random transect lines along the roadsides and between one plot and another wherever possible.

The plant species were checked for their conservation status according to the IUCN Red List and threatened species were flagged, that is, species in the categories ‘near threatened’ (NT), ‘vulnerable’ (VU), ‘endangered’ (EN), and ‘critically endangered’ (CR).

Further details of the sampling methodology are provided in the respective field reports (see Appendices).

6.10.2 Vegetation Types

The vegetation in the project’s direct and indirect impact zones is predominantly deciduous Indaing (*Dipterocarp*) forest characterised by trees in the *Shorea* and *Dipterocarpus* genera, in particular *Shorea siamensis, S. obtusa* and *Dipterocarpus tuberculatus*. Other common species with a wide occurrence include *Sterculia foetida, Terminalia alata, Erythrina stricta, Schleichera oleosa, Syzygium grande, Dalbergia oliveri* and *Phyllanthus emblica.*

The Indaing forest may be further divided into several sub-types, but those are not clearly distinguishable at a landscape level expect for patches of bamboo especially on land that has previously been logged or disturbed. The bamboo species recorded in the Myitnge valley (and beyond) are *Dendrocalamus membranaceus, D. latiflorus, Gigantochloa albociliata* (syn. *Oxytenanthera albociliata), Bambusa tulda* and *Thyrsostachys oliveri.*

Figure 7-45: Bamboo forest.

Other sub-types include mixed deciduous forest dominated by the dipterocarp *Shorea siamensis* together with *Chukrasia velutina, Pterocarpus indicus, Eugenia operculata, Atalantia monopyhlla* and the teak tree *Tectona grandis.* Teak is sometimes also associated with bamboo, forming deciduous teak and bamboo forest characterised by the typical Indaing species (e.g. *Shorea siamensis, Shorea obtusa, Terminalia alata*, *Schleichera oleosa*, *Dalbergia oliveri*) together with *Tectona grandis* and one or several of the bamboo species mentioned above. Mixed evergreen forest also occurs within the wider Indaing forest with species such as *Polyalthia viridis, Mesua nervosa, Mangifera indica* and *Anthocephalus morindaefolius.*

Figure 7-46: Mixed deciduous forest.

The forest and shrubs growing along the Myitnge River do not form a true riparian or riverine vegetation type, as the dominant species are similar to those growing at higher elevation and there is no distinct riverine zone due to the steep topography. Thus, the Indaing forest generally extends all the way down to the edge of the river. The common trees found along the riverbanks include *Shorea siamensis*, *Shorea obtusa, Sterculia villosa, Terminalia alata, Schleichera oleosa, Tetrameles nudiflora, Xylia xylocarpa, Crateva magna, Acer oblongum*, *Bombax ceiba* and *Ficus* spp*.* However, one species that is largely restricted to the river flood zone (i.e. the zone between dry and wet season river water level) and is thus a true riparian species is the flood tolerant shrub *Homonoia riparia.* This species grows on the alluvial deposits along the entire length of the Myitnge River.

Figure 7-47: Riverbank vegetation.

Figure 7-48: **Homomia riparia.**

Aquatic plants are not widespread, probably due to the high water velocity, but some aquatic species were recorded in the slow flowing reaches of the river, including *Equisetum hyemale, Najas minor, Potamogeton crispus, Utricularia* sp. and *Echinodorus quadricostatus.* In addition, the green algae *Spirogyra* sp. can survive in small ponds between stones along the riverbanks, while some bryophytes and lichens were found growing on rocks and cliffs (e.g. *Racomitrium aciculare, Schistostega pennata, Grimmia trichophylla, Marchantia berteroana, Plagiochila obscura, Dichodontium pellucidum* and D. *hirsuta* ssp. *nepalensi*s). According to IFC *et al*. (2017), there are no threatened aquatic plant species recorded in the IBAT freshwater database for the Ayeyarwady river basin.

There are some small spray wetlands along tributaries, all of which appear to be seasonal spray zones. The most interesting of these are on the Nam-kam River which flows down a cascade of waterfalls before emptying into the main river on the left bank near Thar Si village. The spray zones at the foot of the falls were investigated for any threatened or endemic flora, but no such species were found other than some of the moisture dependent plants also recorded elsewhere along the Myitnge River (e.g. the liverwort *Dumortiera hirsuta* ssp. *nepalensi*s).

Overall, the Indaing forest and other vegetation sub-types in the Myitnge valley are common and widespread not only in the project's impact zone but also in other regions of Myanmar, including in other parts of Shan State, Mon State and Bagoyo Mountain Range.

6.10.3 Threatened Plant Species

A total of 462 species of flora (including some fungus species) were identified within the project's direct and indirect impact zones (see Appendices). Of these, five (5) species are classified as threatened according to the IUCN Red List, that is, species in the categories 'near threatened' (NT), 'vulnerable' (VU) and 'endangered' (EN) (but no 'critically endangered' (CR) species were recorded). It should be noted, however, that many of the recorded species have not yet been assessed for the IUCN Red List or are classified as 'data deficient' (DD). The globally threatened species are described below.

Dalbergia oliveri Gamble ex Prain is endangered (EN) according to the IUCN Red List version 2.3 (EN A1cd). The species occurs within a restricted distribution and is native to Myanmar, Thailand and Viet Nam. It was assessed in 1998 and listed as endangered due to overexploitation of its valuable red wood. The listing is in need of updating. In the Middle Yeywa project area, *D. oliveri* is a common species occurring both within the proposed inundation zone and at higher elevation.

Pterocarpus indicus Willd. is vulnerable (VU) according to the IUCN Red List version 2.3 (VU A1d). It is a widespread forest tree native to south-eastern Asia, northern Australasia, and the western Pacific Ocean islands. Many populations are seriously threatened and it has been confirmed as regionally extinct in Viet Nam. The observed decline is because of overexploitation (sometimes illegal exploitation) of timber, as well as from increasing general habitat loss. Cultivated sub-populations are widely distributed throughout the tropics. *P. indicus* is a relatively common tree species in the Myitnge valley (below and above the planned reservoir level).

Figure 7-49: **Dalbergia oliveri** ***(left) and*** **Pterocarpus indicus** ***(right).***

Cycas siamensis Miq. is vulnerable (VU) according to the IUCN Red List version 3.1 (VU A2cd). It is native to Myanmar, Thailand and Viet Nam, but also occurs in Cambodia and probably in Lao PDR. The species is widespread and locally extremely abundant, hence not under any immediate threat of extinction. However, the global population of *C. siamensis* is estimated to have declined by more than 30% over the past century, mainly due to forest clearing for agricultural purposes, forest fires, and over-collection for ornamental trade. In the project area, it is a rare species only found on the left bank of the river.

Dalbergia cultrata Graham ex Benth. is near threatened (NT) according to the IUCN Red List version 3.1. The species occurs within its native range of Cambodia, China (Yunnan), Lao PDR, Myanmar, Thailand and Viet Nam, as well as in India where it has been introduced. Thus, the distribution range extends over a wide area, but the species has been described as decreasing due to overexploitation of the timber (including illegal logging) and the severe reduction of forest areas in the countries where it occurs (i.e. conversion of forests to agricultural land and settlements). *D. cultrata* grows on both sides of the Myitnge River, mainly above the proposed impoundment zone.

Figure 7-50: **Cycas siamensis** ***(left) and*** **Dalbergia cultrata** ***(right).***

Curcuma alismatifolia Gagnep. is near threatened (NT) according to the IUCN Red List version 3.1. It is a herb species native to Cambodia, Lao PDR, Thailand, Viet Nam and presumably Myanmar (it was recorded on the left bank of the Myitnge River). While this is one of the fairly common species in the Indochinese floristic region, it is one of the commercially most exploited ginger species for cut flower industry in Thailand. It has been the target of commercial collectors for many years and this collection combined with the loss of habitat due to other threats has resulted in a population reduction in the last 60 years which comes close to 30%. Wild populations are exploited to gather new phenotypes for tissue culture propagation and introduction of new cultivars in the market. Over-collecting in the wild poses a threat to the wild populations of this species. *C. alismatifolia* is a rare species in the Myitnge valley.

Figure 7-51: Curcuma alismatifolia.

In addition to the IUCN Red List, the Forest Department has published a list of nationally protected plant species. Among the species recorded in the project's impact zone, three of them appear on this list, namely *Tectona grandis, Acacia catechu*, and *Dalbergia oliveri.* As explained above, both the teak tree (*T. grandis*) and *D. oliveri* are common species in the Myitnge River valley, while *A. catechu* was observed only on the left bank and with occasional occurrence. On a global scale, it has a wide distribution in East Asia including China, India and the Indian Ocean area.

6.10.4 Invasive Plant Species

Two of the recorded plant species are non-native to Myanmar and classified as invasive plants. These are *Mikania micrantha* Kunth. and *Mimosa pudica* L., both of which are widespread in the country as a whole and beyond. *Mikania micrantha* is native to the sub-tropical zones of North, Central, and South America and is a vigorously growing perennial creeper growing as a tropical weed, while *Mimosa pudica* is a pantropical weed native to South and Central America. In addition, the invasive grass *Neyraudia reynaudiana* (Kunth) Keng ex Hitchc. was also recorded, but this species is native to subtropical Asia (including Myanmar) and only known as a weed in southern Florida in the United States.

6.10.5 Baseline Threats

There is a clear distinction between the right and left bank of the Myitnge River. Human disturbance is significantly higher on the right bank of the river and especially on the plateau where the forest has been cleared for agriculture and settlements. In contrast, the population is much lower on the left bank where the forest is largely intact in many places. This pattern is, however, less pronounced on the steep slopes in the bottom of the valley where access is restricted by topography and there is less human interference on both sides of the river.

Apart from land clearing for agriculture, the Indaing forest in the Myitnge valley has been – and continues to be – affected by timber extraction. Most of the teak forest has already been cleared, at least on the right bank of the river, but other hardwood species are still being extracted for timber. In some places, the valuable trees have been taken by MTE (Myanma Timber Enterprise) and then later the local villagers have continued to extract and sell timber to merchants who come to the villages for buying logs. The illegal logging mainly occurs above the proposed inundation zone, due to topography and access, but the river is often used for transporting the logs by boat down the river to locations that can be accessed by timber lorries. The clear-cut areas are typically replaced by pure stands of bamboo forest.

The forest in the Myitnge valley is also heavily influenced by bush fires in the dry season. Local informants explained that the forest is burnt in order to keep it open for access by people and livestock as well as to replenish the soil nutrients for better pasture. This is a traditional and common practice throughout the project area, even on the steep slopes and valley bottom where there is virtually no grazing by cattle or buffalos but where burning of vegetation aids hunting for wildlife. According to the local people, the fires do little harm to the forest because they are localised and short lasting (typically a day or two before they die out) and the trees are adapted to the fire regime (e.g. teak is known to be fire resistant). Some tree species may also depend on fires for seed germination.

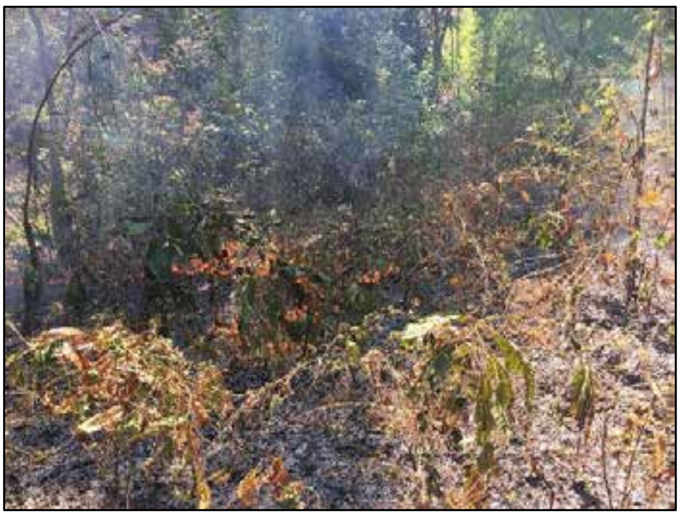

Figure 7-52: Bush fire.

Bush fires are also traditionally used when clearing land for shifting cultivation (slash and burn), especially on the plateau and upper valley slopes, although agricultural practices are currently changing from shifting cultivation into permanently cultivated relying on fertilizers and other inputs. This shift has already been completed in the right bank villages, where maize, sugarcane, paddy and other crops are grown over wide areas uphill from the river valley, and evidence of the same is also observed on the left bank. A striking example is Pin Ping village where large areas of forest have been cleared, initially for timber extraction and later for commercial maize cultivation.

6.11 Terrestrial Fauna

Fauna surveys were undertaken in the period 2015-2018 and identified more than 350 species across several groups. A number of these were not confirmed through visual observations but identified through interviews with local people, which introduces several uncertainties (e.g. interviewed persons not able to correctly identify species or providing information that reflects historical presence of species rather than current presence). The main findings are summarised below after a brief description of materials and methods. Further details can be found in the Appendices.

6.11.1 Materials and Methods

Comprehensive fauna surveys covered several groups of species, including:

- Mammals
- Amphibians and reptiles (herpetofauna)
- Birds
- Insects

Data were collected over several sampling sessions covering different seasons and considerable sampling effort, including:

- March-May 2015 (right bank, dry season): Covered mammals, amphibians, reptiles, birds, and insects.
- September-October 2015 (right bank, transition period after the rainy season):
- July-August 2016 (left bank, rainy season) Covered mammals, amphibians, reptiles, birds, and insects.
- December 2017 (both banks, dry season): Covered mammals, amphibians, reptiles, birds, and insects.
- December 2017 – April 2018 (both banks, dry season): Wildlife camera traps covering mammals and to a lesser extent birds.

A variety of methods were applied in collection data including:

- Transect walks for direct observations, that is, visual observations of species, sound recognition (e.g. bird calls) and traces of species (e.g. footprints, markings on trees). Voucher specimens were also taken for subsequent identification.
- Interviews with local people (e.g. hunters).
- Local market surveys to identify species caught and sold.
- Wildlife camera traps targeting mainly mammals but also resulting in observations of birds and hunters (see map in ***Figure 7-55***).

Species identified were checked for their conservation status according to the IUCN Red List and threatened species were flagged, that is, species in the categories 'near threatened' (NT), 'vulnerable' (VU), 'endangered' (EN), and 'critically endangered' (CR).

The previous studies in some instances used different scientific or common names compared to this ESIA. This report consistently uses the internationally accepted names as provided in the IUCN Red List (http://www.iucnredlist.org/) or alternatively Catalogue of Life (http://www.catalogueoflife.org/).

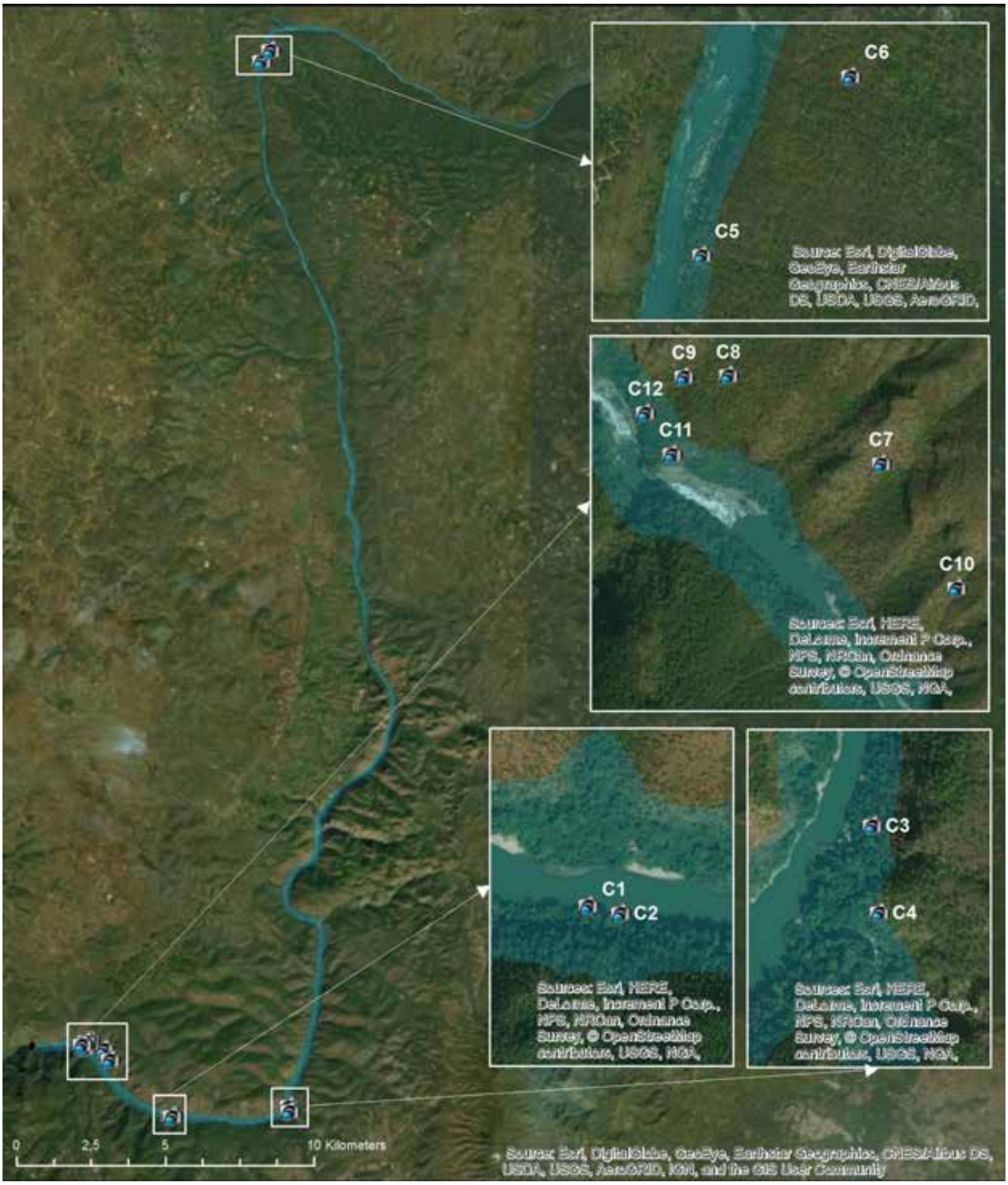

Figure 7-53: Map of camera survey sites

6.11.2 Main Habitat Types

The main habitat types for terrestrial fauna in the direct impact zone are the main river, small tributaries, riverine forest along the main river and tributaries, and dry deciduous forest (Indaing forest) above the riverine forest. Areas that will be used for camps and other associated infrastructure may also include cultivated areas, though the locations of such infrastructure have not yet been determined. There are some small spray wetlands along tributaries, most of which are seasonal spray wetlands. These small habitats are briefly described in Section 6.10.3 above). The direct impact zone is dominated by the main river and riverine forest and Indaing forest. The indirect impact zone is dominated by dry deciduous forest (Indaing forest) and agricultural areas.

The riverine forest and the spray wetlands have not been subject to disturbance that have changed the primary ecological functions and species composition. These habitats maintain viable populations of species found and are considered ‘natural habitats’ according to the IFC Performance Standard 6 on biodiversity. The dry deciduous forests have a larger degree of disturbance due to logging of high value timber species, fire, hunting and grazing. The ecological functionality of the habitat is largely maintained but the hunting and tree cutting have substantially impacted a number of species, in some cases also resulted in local extinction of some wildlife species.

Figure 7-54: Indaing forest above the dam site area showing strong seasonal variation. Upper photo from dry season in April 2017. Lower photo in December 2017 after the rainy season.

6.11.3 Mammals

More than 45 mammal species were identified, most of them in the indirect impact zone. For complete list of mammals identified, see Appendices. A considerable proportion of the species were only identified through interviews with local people and not confirmed by visual observations. It is difficult to ascertain whether all species reported by local people are within the project area at present. Some of the species reported by local people are certainly unlikely to maintain resident populations (e.g. Tiger, *Panthera tigris*) and may not be in the area at all even if they may have been observed there in the past due to the major habitat loss that has taken place. None of the mammal species identified were limited to the direct impact zone.

Mammal species' abundance, particularly for larger mammals, was greatly reduced by human disturbance and the negative trend continued with persistent forest conversion. Given the major conversion of forest to agriculture in recent years, a process still ongoing at high speed in parts of the left bank, several of the species identified are unlikely to maintain populations in the project area in the future and will become locally extinct unless current forest conversion is substantially reduced or stopped.

Among the identified species, several are categorised as threatened[5] on the IUCN Red List and these are included in Table 6-12 below. One species (1) identified in the surveys was categorised as critically endangered, the Chinese pangolin (*Manis pentadactyla*). This species was not observed and only reported through an interview survey. A total of six (6) mammals identified in the surveys were categorised as endangered on the IUCN Red List: Tiger (*Panthera tigris*), Dhole/Asiatic wild dog (*Cuon alpinus*), Banteng (*Bos javanicus*), Pharyre's langur (*Trochypithecus phayrei*), Cappet langur (*Trochypithecus pileatus*), and White handed gibbon (*Hylo bateslor*). Except *Cuon alpinus*, none of these were confirmed through direct observation during the surveys, which may indicate that the species are not in the area anymore or that these were incorrectly identified by local persons reporting their presence. Based on habitat characteristics and human pressures in the project area, it is

[5] The term 'threatened' in the context of the IUCN Red List includes the Red List categories 'near threatened', 'vulnerable', 'endangered', and 'critically endangered'.

considered unlikely that any of these species maintain resident populations in the direct impact zone or the indirect impact zone.

Twelve species (12) were categorised as vulnerable by IUCN. Several of these species were identified through camera traps (Leopard, *Panthera pardus*), skin found locally (Clouded leopard, *Pardofelis nebulosa*), or foot prints (Long-tailed macaque, *Macaca fascularis*, and Pig tailed macaque, *Macaca nemenstrina*). The other vulnerable species were identified through interviews. There were also three species (3) categorised as near threatened. None of these species are likely to maintain resident populations exclusively in the direct impact zone or indirect impact zone but some of the species recorded using camera traps. A selection of photos of some of the species recorded are included in Figures 6-40 and 6-41 below.

In addition to the IUCN Red List, the Forest Department has published a list of nationally protected species (notification no. 583/94). Among the mammal species recorded or reported in the Project's impact zone, several appear on this list such as Chinese Pangolin (*Manis pentadactyla*), Banteng (*Bos javenensis*), Tiger (*Panthera tigris*), Leopard (*Panthera pardus*), Clouded Leopard (*Pardofelis nebulosa*), White handed gibbon (*Hylo bateslor*), and Gaur (*Bos gaurus*).

Table 7-22: Mammal species identified in the project area through direct observations or interviews categorised as threatened on the IUCN Red List (categories 'near threatened', 'vulnerable', 'endangered', and 'critically endangered').

Scientific name	Common and local names	Habitat	Data source	Conservation status
Manis pentadactyla	Chinese Pangolin	Forest	Interview	Critically endangered (CR)
Bos javenensis	Banteng, Saing	Forest	Interview	Endangered (EN)
Cuon alpinus	Dhole/Asiatic wild dog	River side	Visual obs.	Endangered (EN)
Hylo bateslor	White handed gibbon, Myauk hlwe kyaw	Trees	Interview	Endangered (EN)
Panthera tigris	Tiger, Kyar	Forest	Interview	Endangered (EN)
Trochypithecus phayrei	Pharyre's langur, Myauk myat kwin pyar	Trees	Interview	Endangered (EN)
Trochypithecus pileatus	Cappet langur, Myauk nyo	Trees	Interview	Endangered (EN)
Arctictis binturong	Binturong	Forest	Interview	Vulnerable (VU)
Bos gaurus	Gaur, Pyaung	Forest	Interview	Vulnerable (VU)
Cervus unicolon	Sambar, Sat	Forest	Interview	Vulnerable (VU)
Helarctos malayanus	Sun bear	Forest	Interview	Vulnerable (VU)
Macaca fascularis	Long-tailed macaque, Myauk tangar	Trees	Foot print	Vulnerable (VU)
Macaca nemenstrina	Pig tailed macaque, Myauk putee	Trees	Foot print	Vulnerable (VU)
Macaca arctoides	Stump-tailed macaque			Vulnerable (VU)
Naemorhedus baileyi	Red goral, Taung sateni	Forest	Interview	Vulnerable (VU)
Nycticebus bengalensis	Bengal Slow Loris			Vulnerable (VU)
Ursus thibetanus	Asian black bear, Wat won	Forest	Interview	Vulnerable (VU)
Panthera pardus	Leopard, Kyar thit	Forest	Camera trap	Vulnerable (VU)
Pardofelis nebulosa	Clouded leopard	Forest	Skin	Vulnerable (VU)
Capricornis midneedwards	Chinese serow	Forest	Camera trap	Near threatened (NT)
Macaca assamensis	Assamese macaque, Arsam myuk	Trees	Visual obs.	Near threatened (NT)
Presbytis femoralis	Banded langur, Myauk mhee shae	Trees	Interview	Near threatened (NT)

Leopard (*Panthera pardus*)

Leopard Cat (*Prionailurus bengalensis*)

Large Indian Civet (*Viverra zibetha*)

Small Indian Civet (*Viverricula indica*)

Rhesus Macaque (*Macaca mulatta*)

Northern Treeshrew (*Tupaia belangeri*)

Figure 7-55: Selection of mammal species recorded during surveys December 2017 – April 2018.

Red Muntjac (*Muntiacus muntjak*)

Yellow-throated Marten (*Martes flavigula*)

Chinese Serow (*Capricornis milneedwardsi*)

Eurasian Wild Pig (*Sus scrofa*)

Figure 7-56: Selection of mammal species recorded during surveys December 2017 – April 2018.

6.11.4 Amphibians and Reptiles

The surveys only identified nine (9) amphibian species. All identified species are categorised as of least concern on the IUCN Red List, but the status for some of the species needed updating. Abundance of amphibians was also reduced by human disturbance as well as climatic factors (seasonal dry periods with limited available wetlands).

The surveys identified 40 species of reptiles. Four (4) threatened species were identified, all in interview surveys. These were the endangered Elongated Tortoise (*Indotestudo elongate*), the vulnerable Burmese Python (*Python bivittatus*), the vulnerable King cobra (*Ophiophagus hannah*), and the near-threatened Indian Black Turtle (*Melanochelys trijuga*). All four species were reported on both river banks. Eight (8) of the species were categorised at of least concerns while the remaining 28 species had not been evaluated as part of the IUCN Red List. As for other species groups, abundance of reptiles was reduced by human disturbance. Some species were affected directly as they were killed by people or due to collection of eggs, others were indirectly affected through habitat loss. A selection of photos of some reptile species recorded are included in Figure 6-42 and some amphibian species in Figure 6-43 below. In addition to the IUCN Red List, the Forest Department has published a list of nationally protected species (notification no. 583/94). No reptile species on this list was recorded or reported in the Project's impact zone. The list has no amphibians.

Table 7-23: **Reptile species identified in the project area through direct observations or interviews categorised as threatened on the IUCN Red List (categories 'near threatened', 'vulnerable', 'endangered', and 'critically endangered').**

Scientific name	Common and local names	Habitat	Data source	Conservation status
Indotestudo elongate	Elongated Tortoise/Yellow-headed tortoise, Taung late	Near river	Interview	Endangered (EN)
Python bivittatus[6]	Burmese Python, Saba ohn	Forest	Interview	Vulnerable (VU)
Ophiophagus hannah	King cobra, Taw-gyi-mwe-hauk			Vulnerable (VU)
Melanochelys trijuga	Indian Black Turtle, Lake chaepan	Near river	Interview	Near threatened (NT)[7]

Green Vine Snake (*Ahaetulla nasuta*)

Copperhead Rat Snake (*Coelognathus radiatus*)

Forest Garden Lizard (*Calotes emma*)

Common Garden Lizard (*Calotes versicolor*)

Figure 7-57: Selection of reptile species recorded during surveys.

[6] Named *Python molurus* in expert reports (ref. http://www.iucnredlist.org/details/193451/0).
[7] According to the IUCN Red List, the conservation status for the species requires updating.

Asian Grass Frog (*Fejervarya limnocharis*)

Rana sp.

Figure 7-58: Selection of amphibian species recorded during surveys.

6.11.5 Birds

The surveys identified a total of 118 bird species across the two river banks. All species were identified through visual observation or bird calls. A striking characteristic was that very few water birds were observed across the various sampling sessions. One (1) endangered species was recorded, the Green Peafowl (*Pavo muticus*), while six (6) near-threatened species were observed. The near-threatened species were Olive-backed Woodpecker (*Dinopium rafflesii*), Red-breasted Parakeet (*Psittacula alexandri*), Alexandrine Parakeet (*Psittacula eupatria)*, Grey-headed Parakeet (*Psittacula finschii*), Long-tailed Parakeet (*Psittacula longicauda*), and River Lapwing (*Vanellus duvaucelii*). A selection of photos of some bird species recorded are included in Figures 6-44 and 6-45 below. In addition to the IUCN Red List, the Forest Department has published a list of nationally protected species (notification no. 583/94). Among the bird species recorded or reported in the Project's impact zone, the Green Peafowl (*Pavo muticus*) is a protected species.

Table 7-24: **Bird species identified in the project area through direct observations as threatened on the IUCN Red List (categories 'near threatened', 'vulnerable', 'endangered', and 'critically endangered').**

Scientific name	Common and local names	Habitat	Data source	Conservation status
Pavo muticus	Green Peafowl			Endangered (EN)
Dinopium rafflesii	Olive-backed Woodpecker			Near threatened (NT)
Psittacula alexandri	Red-breasted Parakeet			Near threatened (NT)
Psittacula eupatria	Alexandrine Parakeet			Near threatened (NT)
Psittacula finschii	Grey-headed Parakeet			Near threatened (NT)
Psittacula longicauda	Long-tailed Parakeet			Near threatened (NT)
Vanellus duvaucelii	River Lapwing			Near threatened (NT)

Green Peafowl (*Pavo muticus*)

Red Jungle Fowl (*Gallus gallus*)


Puff-throated Babbler (*Pellorneum ruficeps*)


Large-billed Crow (*Corvus macrorhynchos*)


White-breasted Kingfisher (*Halcyon smyrnensis*)


Slender-billed Oriole (*Oriolus tenuirostris*)

Figure 7-59: Selection of bird species recorded during surveys.


Red-whiskered Bulbul (*Pycnonotus jocosus*)


Yellow-footed Green Pigeon (*Treron phoenicopterus)*


Spotted Dove (*Streptopelia chinensis*)


Collared Falconet (*Microhierax caerulescens*)

Figure 7-60: Selection of bird species recorded during surveys.

6.11.6 Insects

A range of insects and other invertebrate species were identified, including butterflies, beetles, dragonflies, grasshoppers, locusts, spiders, a species of scorpion and a species of praying mantis. A total of 138 species were recorded, of which 86 and 74 were identified on the left and right banks, respectively. These species are typically not yet considered as part of the IUCN Red List and therefore no clear overviews of conservation concern are available for these groups.

6.12 Aquatic Ecosystems

6.12.1 Materials and Methods

Aquatic surveys covered primarily fish and to a smaller extent other groups. The main sampling was undertaken:

- March-May 2015 (right bank, dry season)
- July-August 2016 (left bank, rainy season)
- December 2017 (right bank, dry season)[8]

A variety of methods were applied in collection data including:

[8] *Different types of fish traps were tested in different locations during placement of wildlife camera traps and drone overflights, but systematic sampling of aquatic life was not planned during the December site visit.*

- Voucher specimens were obtained from local fishermen along the river.
- Interviews with local people were undertaken.
- Local market surveys to identify species caught and sold.
- Limited sampling during testing of traps.

Species identified were checked for their conservation status according to the IUCN Red List and threatened species were flagged, that is, species in the categories 'near threatened' (NT), 'vulnerable' (VU), 'endangered' (EN), and 'critically endangered' (CR).

6.12.2 Main Habitats

The aquatic habitats in the direct impact zone that support fish, benthic macroinvertebrates and other aquatic life were categorised into six main habitats along the Myitnge River between the proposed dam site and the upper end of the reservoir:

A1. Falls and white-water rapids with very fast-flowing and turbulent waters. There was substantial mixing of air and water. This erosional habitat was characterised by boulders or bedrock as substrate except in some small sheltered areas with deposition of cobbles, pebbles, sand and some organic matter. River banks were generally steep and covered by primary forest, boulders and in some areas of the left bank near vertical cliffs. This habitat was only found 4-5 km upstream the dam site in a section about 800 m long, including two slower flowing pool areas, and therefore only covering approximately 1% of the affected river section. For most fish species, this section was likely to be a natural barrier to upstream fish migration.

A2. Fast-flowing and relatively shallow riffles. Rocks penetrated the water surface or rising close to the water surface resulting in turbulent water with mixing of air and water. This was also typically an erosional habitat with bedrock, boulders and cobbles as substrate. This habitat was usually found over rocky crests in the river bed and in very short sections. The river banks were typically covered by riverine forest. Overall, this habitat covered approximately 1-2% of the affected river section.

A3. Relatively fast-flowing deeper runs with water depth greater than rocks and consequently little or no turbulent water. The relatively fast flow erodes finer particles and the substrate was typically pebbles. The river banks were covered by riverine forest. This habitat was found in mosaic with slow-flowing deeper pools, and this mosaic was the overwhelmingly dominant types of habitat along the affected river section.

A4. Slow-flowing deeper pools often with deposition of sediments such as sand, silt and organic matter except in the outer edge of a bend in the river where there tends to be erosion. Some of the pools were deep (> 5 m). The river banks were covered with riverine forest. This habitat was found in mosaic with fast-flowing deeper runs, and this mosaic was the overwhelmingly dominant types of habitat along the affected river section.

A5. Stagnant or near-stagnant waters in seasonal small pools in a short area within the river section with falls and white-water rapids (A1). This habitat is available only in the low flow season along the sides of the river as water recedes.

A6. Tributaries to the Myitnge River. A limited number of tributaries, most of which are very steep and do not provide significant habitats for fish in the main river. An important exception is the Gotheik Stream on the right bank in the uppermost part of the reservoir that provide good quality aquatic habitats for fish and other aquatic organisms for a considerable distance away from the main river.

The distribution of the aquatic habitats is likely to be dynamic and change with varying river flow that also changes accompanying characteristics such as water speed, water depth, erosion, and deposition. This means that the habitat boundaries are not necessarily constant, they are to some extent dynamic.

None of these habitats were considered unique. It is worth mentioning that in the Strategic Environmental Assessment for Myanmar, the Project is located within an area with 'low' [9] geomorphology value and 'low'[10] aquatic ecology and fisheries value. In terms of river reach rarity, the affected river section was described as 'very common'.[11]

Figure 7-61: Part of the main falls and rapid section upstream of the proposed dam site. The largest fishing camp along the affected section is located near the first set of falls (red ellipse) where fish gathers and try to move upstream. Substrate dominated by large boulders.

[9] The value was assessed on a scale with the following five values: very low, low, medium, high, very high.
[10] The value was assessed on a scale with the following five values: very low, low, medium, good, very good.
[11] The rarity analysis applied the following four categories: very common, common, rare, very rare.

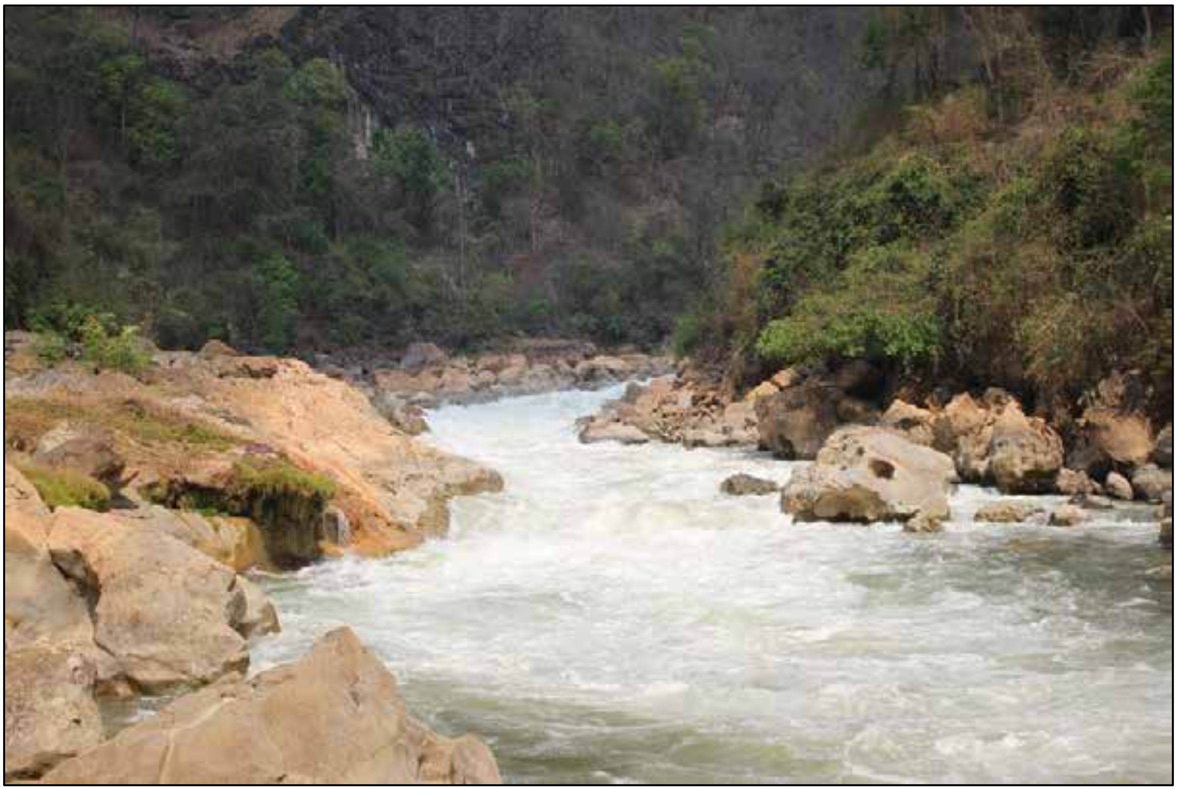

Figure 7-62: Part of the main falls and rapid section upstream of the proposed dam site (this section is visible as the uppermost rapids in Figure 6-46 above).

Figure 7-63: Looking downstream from the fishing camp towards the proposed dam site in the background (red arrow).

Figure 7-64: Slow-flowing deep pool area with fast-flowing and relatively shallow riffles in the background.

Figure 7-65: Typical river section that will be affected by the Middle Yeywa project – sections of pools (dominant aquatic habitat) interspersed by small riffle sections (red arrows) with bedrock or boulders penetrating the water surface.

Figure 7-66: Examples of riffle sections with boulders penetrating the water surface.

Figure 7-67: Example of long slow-flowing river section towards river bend where Gohteik Tributary joins Myitnge River (red arrow).

Figure 7-68: Gohteik Tributary just before joining the Myitnge River.

6.12.3 Fish Species

A total of 33 species of fish were identified, many through interviews with local respondents and approximately half of the species by voucher species caught by local fishermen. The fish fauna was dominated by cyprinids (family Cyprinidae) with 19 species. A total of eleven (11) families of fish were identified.

One fish species, which was identified by voucher specimen, was categorised as vulnerable (Gangetic loach, *Botia rostrata*). However, public records do not indicate that this species is found in Myanmar and hence this requires further clarifications. Five other fish species identified primarily through the interview survey were categorised as near-threatened (see ***Table 7-25***). The other fish species were largely categorised as of least concern except a limited number of species where data were either missing or the species were not evaluated in accordance with the IUCN Red List. A selection of photos of some fish species recorded are included in Figures 6-57 and 6-58 below.

Table 7-25: Fish species identified in the project area through direct observations as threatened on the IUCN Red List.

Scientific name	Common and local names	Habitat	Data source	Conservation status
Botia rostrata	Gangetic/Golden loach, Nga sin pyawt			Vulnerable (VU)
Anguilla bicolor	Shortfin eel, Nga myae			Near threatened (NT)
Osteobrama belangeri	Nga phal aung			Near threatened (NT)
Syncrossus berdmorei	Tiger botia, Nga sin pyawt kyar			Near threatened (NT)
Tor tor	Tor barb/Mahseer			Near threatened (NT)
Wallago attu	Butter fish/ Wallago, Nga but			Near threatened (NT)

Burmese Latia (*Crossocheilus burmanicus*)


Orange-fin Labeo (*Labeo kalbasu*)

Gangetic Loach (*Botia rostrata*)


Barbus Brevifilis (*Folifer brevifilis*)

Figure 7-69: Selection of fish species recorded during surveys.

Loach (*Botia* sp.)

Burmese Loach (*Lepidocephalichthys berdmorei*)

Loach (*Neonoemacheilus labeosus*)

Channa (*Channa aurantimaculata*)

Long-whiskers Catfish (*Mystus gulio*)

Mystus seengala

Spiny Eel (*Macrognathus* sp.)

Two different fish species climbing a vertical rock face in the main rapids area.

Figure 7-70: Selection of fish species recorded during surveys.

6.12.4 Other Species

Other species were also recorded during the surveys including freshwater crabs, freshwater shrimps and snails (see Figure 6-56 below). These were not identified to species level.

Freshwater snails

Freshwater Shrimp (*Cryphiops sp.*)

Figure 7-71: A species of freshwater snail and a species of freshwater shrimp caught in baited fish traps during trap testing in December 2017.

7 SOCIAL BASELINE CONDITIONS

7.1 Political and Administrative Context

The Republic of the Union of Myanmar is divided into seven states and seven regions as defined in the 2008 Constitution. In addition to the states and the regions, there are five self-administered zones, one self-administered division, and one union territory comprising the capital Nay Pyi Taw. The states/regions/zones represent the first administrative level in Myanmar. States and regions are constitutionally equivalent while the five self-administered zones/division have a constitutional status similar to that of a region or state.

The states /regions are sub-divided into districts as the second administrative level. Districts are further divided into townships (third level) which again is made up of village tracts and wards (fourth level). The village is the fifth and lowest administrative level in Myanmar.

The Middle Yeywa Project area is geographically fully located within the Shan State and the districts of Kyaukme (Northern Shan State) and Taunggyi (Southern Shan State). Within Kyaukme, the Project impinges on Nawnghkio and Kyaukme townships while in Taunggyi it touches the northern border area of Lawksawk Township.

Township administrations are headed by the senior official of the General Administration Department (GAD) of the Ministry of Home Affairs. The main tasks for the township government administration are birth registration, land registration, and most forms of tax collection. Districts are also headed by a senior official from the GAD.

7.2 The Shan State

7.2.1 History

The Shan State, within which the project area is located, forms the eastern portion of the present Union of Myanmar and consists of 52 townships. The state is bounded by the Kachin State on the north, the People's Republic of China on the northeast, Lao PDR and the Mekong River on the east, Thailand on the southeast, Kayah State on the south, and the Mandalay Division to the west. The Salween River (Nam Khone in Shan), separates the Shan Plateau into two parts, flowing from north to south and emptying into the Gulf of Martaban, a part of the Indian Ocean.

The name "Shan states" (plural) referred to a group of some 46 states each with more-or-less autonomous status, though some were more powerful than others. The majority were ethnic Shan, with some notable exceptions such as Kokang (a small Chinese group), Pwo Karen (Pa-O), Nagas, Wa, Kachin, and Palaung (Ta-ang). The Danu speaking area surrounding the Middle Yeywa Project, and extending further south, was never considered one of the states, though in part it was more recently granted status as an SAZ (Self-Administered Zone) in 2010. Other ethnic groups found within the Shan states are Lahu, Akha, Lisu, Wa and many varieties of Ta-ang.

Following independence and the establishment of the Union of Burma, all of these areas were grouped together under the singular designation of "Shan State."

7.2.2 Political Factions and Conflict

The Shan State has since independence seen armed conflict, mainly between the Union Government/national army and the ethnically based armed factions. The dominant armed faction that is now present and claims control over the part of the project area east of the Myitnge River (left bank) is the Restoration Council of Shan State (RCSS) with its armed wing, the Shan State Army - South (SSA-S). The SSA-S was formed in January 1996 while RCSS was formed in May 2000 as its political wing. RCSS is headquartered at 20 Loi Tai Leng in the Southern Shan State. The RCSS entered into an agreement with the Government in January 2012, which regulates the relationship between SSA-S and the Government when it comes to security issues and provides for cooperation between RCSS and the Government for regional development. The agreement also provided the basis for opening of liaison offices between the Government and the SSA-S in Taunggyi, Kholam, Kengtung, Mong Hsat and Tachileik and trading offices in Muse and Nanhkam[12].

Before the agreement with the Government, the SSA-S used to cross over to the right bank of the river but have since restricted their movements to the left bank. The project area has largely been peaceful since the agreement with the Government in 2012

7.2.3 Population

As noted above, the Shan State itself is quite diverse and comprises different ethnic groups such as the Shan, Pa-O, Palaung, Kachin, Intha, Danu, Kokang, Wa, Lahu, Taungyo, Myoungzee, Lishaw, and Yinnet. Of these, the Shan are the largest, numbering an estimated six million (although not all live in Shan State). Estimates of the total population of Pa-O and Danu vary (due to the lack of reliable censuses), but the Danu population is usually cited as 220,000 and the Pa-O population as 600,000. There are seven SAZs in Shan State, belonging to the Naga, Palaung, Kokang, Wa, Danu, and Pa-O. The Danu and Pa-O SAZs are located in southern Shan State. The Danu SAZ consists of two townships along the western edge of southern Shan State, with a total population of around 150,000, and the Pa-O SAZ consists of three non-contiguous townships with a total population of 400,000. Within both of these SAZs, the central government of Myanmar is present and performs all land management related functions.

7.2.4 Ethnic Groups of the Project Area

The Danu is by far the most numerous and dominant group in the Project area and in the socio-economic surveys that were conducted in 2015 and 2017 more than 90 of the sampled households were Danu (30% of all households sampled). The figure below shows the composition of the surveyed households in terms of ethnicity.

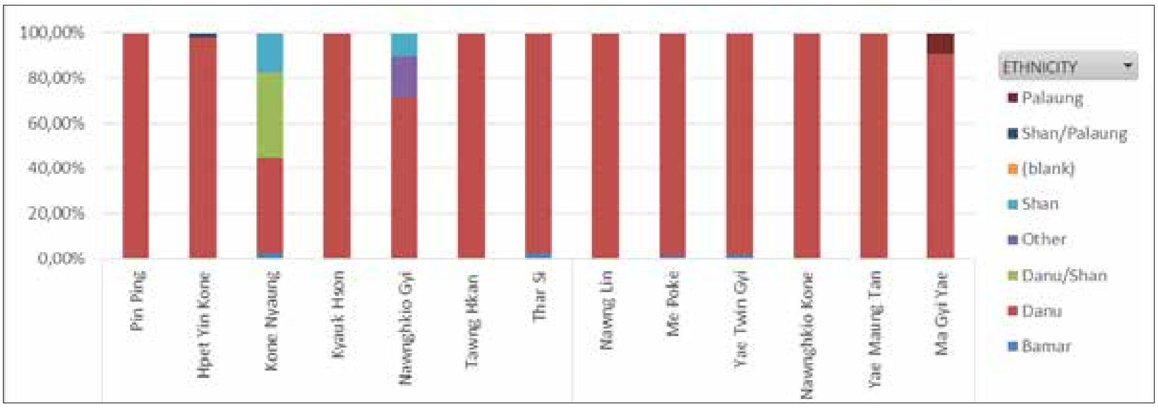

Figure 7-1: Ethnicity of the sampled households in the project area.

The second most numerous group in the project area, although far behind the Danu, are the Shan. They are present in some of the project area villages, most notably in the Kone Nyaung and Nawnghkio Gyi as indicated in the figure above. Intermarriage between the Danu and the Shan seems to be relatively common as indicated by the fact that 38% of the sampled households in Kone Nyaung were mixed Dany/Shan households.

Danu

Danu belongs to Burmish branch of Lolo-Burmese, part of the greater Tibeto-Burman stock. The Danu language is quite close to Burmese, and is one of numerous Burmese dialects than includes Intha, Taung'yo, Tavoy (Dawei), Beik and Rakhaing (Arakan). Most of these dialects can be understood by Myanmar speakers after a few weeks exposure indicating their separation from the mainstream is not

[12] https://en.wikipedia.org/wiki/Shan_State_Army_-_South

very old in linguistic terms. The Danu are said to have originated from a group of soldiers who were posted as a buffer between Pagan and the Shan States in the 18th century during the reign of King Alaungpaya, and whose territory stretches roughly from south to north between Taunggyi and Mandalay.

In the 1970s, the Japanese linguist Shiro Yabu travelled to the Danu speaking areas and made some observations on their geographical distribution and language. Yabu concluded that although northern and southern varieties of Danu differ slightly both are definitely Burmese and noted that the similarity of Danu, Taung'Yo and Intha dialects of Burmese. He estimated the total Danu population to be between 70,000 and 100,000.

The Danu often describe themselves as honest, hardworking and peaceful with great community spirit and solidarity within their villages, and this is evidenced by the fact that they construct their own roads collectively and help each member of the community with house building and other types of work

The Danu in the project area are keenly aware and proud of their ethnic identity and have their own flag that flies in all important locations in the village. They remain in touch with the Danu further south, the Pindaya Danu, and have adopted their dress and festivities, and have begun their own, Northern Danu, celebration, differing somewhat from the Pindaya.

The Danu are officially classed as an ethnic minority among the groups listed by the government, and they meet all of the criteria for qualifying as an indigenous group set forth in IFC's Performance Standard 7 on Indigenous Peoples:

- Self-identification as members of a distinct indigenous cultural group and recognition of this identity by others;
- Collective attachment to geographically distinct habitats or ancestral territories in the project area and to the natural resources in these habitats and territories;
- Customary cultural, economic, social, or political institutions that are separate from those of the mainstream society or culture;
- A distinct language or dialect, often different from the official language or languages of the country or region in which they reside.

However, with reference to the intent of the Performance Standard 7, the findings and evidence from socio-economic surveys, village meetings and consultations clearly indicates that the Danu are not marginalized or vulnerable:

- The Danu are the dominant ethnic group in the project area both numerically and, due to their close ethnic and linguistic affiliation with the Myanmar majority of the country, not a vulnerable minority;
- Their economic, social and legal status does not "limit their capacity to defend their rights to, and interest in, lands and natural and cultural resources";
- The Danu are well-off economically, have very large tracts of land averaging, by villager estimates, a minimum of 10 acres per household;
- Cultural pride is evident in a wide array of popular media, and annual ethnic festivals in which all villagers participate, and
- "Their ability to participate in and benefit from development," is not restricted in any form as far as can be concluded from the consultations and information collection conducted so far.

Based upon information gathering visits to a sample of seven widespread Danu villages in the project area, it is clear that the Danu have not had their lands and resources "transformed, encroached upon, or significantly degraded." Their languages, cultures, religions, spiritual beliefs and institutions are intact and not under threat, and in fact appear to be growing stronger. It is therefore highly unlikely that they will suffer "adverse impacts associated with project development" more than non-indigenous communities (there are in fact no non-indigenous communities in the project area regardless of how it may be ultimately defined). The Danu are not liable to lose their identity, culture, or natural resource-based livelihoods, nor are they likely to be exposed to impoverishment and disease at any time in the foreseeable future.

The Shan

Shan villages or villages with substantial Shan populations are found in Zone 4a (upper right bank) and also in Zone 4d (lower left bank) although they are few in relation to the Danu villages. The village of Nawnghkio Gyi in Zone 4 is for instance composed of roughly 50% Shan and 50% Danu households.

Linguistically the Shan belong to the Be-Tai sub-family of Kam-Tai family under the Kra-Dai ethnolinguistic stock. The Shan language spoken in the project area falls under the southwestern branch of Tai languages.

The Shan are an old and well-established ethnic group. Their current status as “minority” belies their historical position as a state nearly rivalling that of ancient Burma itself. What is now called the Shan State was formerly a group of principalities ruled by Saophas (or Sawbwas) since the 13th century. Today that includes a territory covering nearly one-third of Myanmar. Shan is a written language with an old literature both religious and secular.

With respect to IFC’s Performance Standard 7, the same reasoning applies to the Shan as to the Danu. They can be identified as an ethnic minority in the country as a whole as they see themselves as a distinct group, are attached to a geographically distinct area, have separate cultural and social institutions, and have a distinct language. However, they cannot be characterised as “marginalised or vulnerable” and their economic, social and legal status does not “limit their capacity to defend their rights to, and interest in, lands and natural and cultural resources”.

Palaung (Ta-ang)

The Palaung is the third notable ethnic group that is present in the wider project area. However, their villages are in general located further away from the reservoir and the dam site than the Danu villages or even the Shan villages. In the wider lower left bank area (below Zone 4d) there are six Palaung villages in Kyauk Ku village tract of Lawksawk township. There have been some involuntary relocations of this group from areas further north where armed resistance to the government has been taking place quite recently, but the villages in the project area do not appear to have been directly involved. The Palaung village that is located nearest to the dam site is Loi Hwang which lies around 10 km strait the south of the dam site.

Palaung, is an exonym applied to this group by the Burmese, and the general term preferred by the groups themselves is Ta’ang. This is a recently adopted political term, as there are said to be between 13 and 17 subgroups, whose languages are not all mutually intelligible. They prefer politically to be seen as speaking with a single common voice. In fact Ta-ang is also the name of a specific subgroup of Palaung. In the northern Shan State the Ta-ang (Palaung) have their own SAZ and an army. Internal Ta’ang diversity has also caused problems in the adoption a written language that can be understood by all dialects. The Palaung are thought to have predated the Shan in much of the area of the Shan State.

Ethnolinguistically, Palaung belongs to the Palaungic Branch of Austroasiatic, considered by some to be related to the Khasian Branch of Megdalaya in northeastern India. Palaungic includes several main groups, including Danau, Palaung, Riang, Angkuic, Lamet (Ramet, Xmet), and Waic (Plang, Lawa, Wa).

These groups are widely distributed around the Shan State, though their point of origin is thought to be in the north near the Chinese border. There are also Palaung languages spoken in Yuunan and Thailand. It is yet to be determined to which subgoup the Palaung in Lawksawk belong.

The Palaung are officially classified as an ethnic minority by the government, and although limited investigations have been undertaken in connection with the Middle Yeywa EIA studies, they are likely to meet all of the criteria for qualifying as an indigenous group set forth in IFC’s Performance Standard 7- Indigenous Peoples.

7.3 Socio-economic Conditions in the Project Area

7.3.1 Socio-economic Survey and Statistical Information

The socio-economic survey that forms the basis for the villages level information presented in the following sections has been carried out in two rounds. The first survey was carried out in May 2015 in six right bank villages (Zone 4a). The sample size was 33% of the households with the exception being the small village of My Gyi Yae which had a sample of 41% since there were only 27 households. The total sample size was 300 households of 902 in the six villages. The second round of the survey was carried out in June and October in 2017 and covered totally seven villages – six on the left bank (Zone 4c and 4d) and one the right bank (Zone 4b). In all 800 households were interviewed and the sample size was also here 33% of the total number of households in the village. The population in the survey villages along with number of households are listed in ***Table 7-1***. Village profiles and detailed information of each of the surveyed project area villages are found in Annex 4 along with the survey and interview forms that were used. The survey villages and their location in relation to the reservoir and dam site are shown on the map presented in ***Figure 7-2***.

All statistical information for the districts and townships in the project area has been extracted from the 2014 Census Report for the Shan State (Department of Population, 2015)[13].

Table 7-1: Population in project area villages covered by socio-economic survey.

Villages		Zone	Population	No of Households	Household size
Surveyed May 2015	Ma Gyi Yae	4a	173	37	4.7
	Me Poke	4a	1213	293	4.1
	Nawng Lin	4a	1387	300	4.6
	Nawnghkio Kone	4a	287	60	4.8
	Yae Maung Tan	4a	363	87	4.2
	Yae Twin Gyi	4d	1163	220	5.3
Surveyed in June and October 2017	Nawnghkio Gyi	4a	1344	290	4.6
	Kone Nyaung	4c	1360	273	5.0
	Pin Ping	4c	1754	367	4.8
	Thar Si	4c	1327	277	4.8
	Hpet Yin Kone	4d	870	180	4.8
	Kyauk Hson	4d	867	183	4.7
	Tawng Hkan	4d	387	97	4.0
Total Survey Village Population			**12 497**		

[13] *Department of Population, Ministry of Immigration and Population. 2015. The 2014 Myanmar Population and Housing Census, Shan State Report, Census Report Volume 3 – M, Nay Pyi Taw, Myanmar*

Figure 7-2: Location of socio-economic survey villages in the in the indirect impact zone.

7.3.2 Demographic Characteristics

According to the 2014 Census the population of Shan State has increased by 56 % since the last census in 1983. With its 5.8 million people the Stan State has the 4th largest population compared with the other states and regions in Myanmar. The population density of the Shan State in 2014 was 37 persons per square kilometre compared to the average for the whole country with 76 persons per square kilometre. This makes the Shan State one of the least densely populated states in Myanmar. Since the last census in 1983 the population density of Shan State has increased from 24 to 37 persons per square kilometre. The population in the districts and townships within which the project is located had according to the Census the following population numbers in 2014.

Table 7-2: Population and household characteristics in the wider Middle Yeywa project area

Administrative Unit/Level	Female	Male	Total	Number of HHs	HH Size	% Female Headed HHs	% Urban Population
Kyaukme District	393 962	376 103	770 065	163 679	4.4	24.5	15.5
Nawnghkio Township	74 081	75 761	149 842	32 224	4.3	18.8	12.6
Kyaukme Township	65 916	61 644	127 560	28 371	4.2	28.6	31.3
Taunggyi District	858 744	842 594	1 701 338	368 509	4.4	21.4	27.3
Lawksawk Township*	61 606	64 961	126 567	25 957	4.6	17.3	23.3

*In the 2014 Census Report spelled as Yatsauk

The population distribution across age classes for the Shan State is similar to that of the Union as a whole. The population data from the 2014 Census gives an "onion-shaped" age class pyramid with the age group of 10 - 14 as the largest. This indicates that the birth rate is declining. The figure below shows the age distribution pyramid for the Shan State.

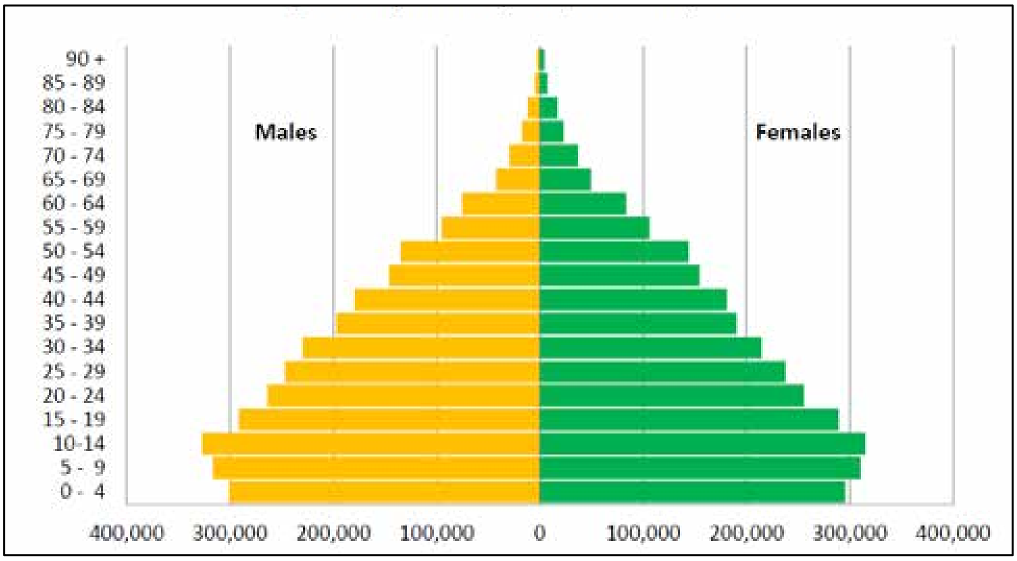

Figure 7-3: Population pyramid Shan State, 2014.
Source: Shan State Census Report (2014)

The dependency ratio measures the percentage of dependent people (not of working age) in a society against number of people of working age (economically active). It indicates the pressure on a productive population. The dependency ratios in the Shan State (56.9%) and in the project area are high because of the large segment of children below 14 years compared to the working age segment (15 – 64 years). In Europe, dependency ratios are typically 20 – 30% but are on the increase due to an ageing population. However, neighbouring Bangladesh and Thailand has similar dependency ratios with 51 and 40, respectively, for the year 2016 (https://data.worldbank.org/).

Table 7-3: Dependency ratios

Administrative Unit/Level	Dependency Ratio		
	Children	Elderly	Total
Shan State	50.2	6.7	56.9

Kyaukme District	47.2	7	54.2
Nawnghkio Township	43.0	6.3	49.3
Kyaukme Township	45.4	8.1	53.5
Taunggyi District	47.3	6.3	53.6
Lawksawk*	48.2	5.2	53.4

*In the 2014 Census Report spelled as Yawksawk

7.3.3 Road Access

Villages in the indirect impact zone primarily rely on unpaved roads of varying quality. Most villages on the right bank (Zone 4a) and several on the lower left bank (Zone 4d) have easy access to Road 41 via unpaved village roads. Two of the surveyed indirect impact zone villages are located on Road 41 itself, and both have notable higher income and education levels than the surrounding communities, most likely as a result of the good road and market access.

The villages located on the upper left bank (Zone 4c) have by far the most difficult access to Road 41 including the market centres and government services that are located along the route. Access from the main road to Thar Si village takes more than 1.5 hours on a very rough and steep road that crosses several large hills. In the dry season, it is accessible by four wheel drive cars, but for six to nine months a year it is only accessible by motorbike or local *trologyi* (large truck). Pin Ping and Kone Nyaung village lie beyond Thar Si, taking approximately an additional 30 minutes and one hour, respectively, to travel to by motorbike over relatively flat terrain but on unimproved and unpaved roads.

7.3.4 Literacy and School Attendance

Literacy in Myanmar is high relative to income levels and poverty incidence, with a rate of 89.5%. As shown in ***Table 7-4***, the Shan State is well below the national average, but the figures for two townships, Nawnghkio and Lawksawk, where the project is located, are both closer to the national numbers. These literacy numbers reflect the extensive primary school system across the country where almost all villages have at least a primary school with a small number of primary teachers. This ensures that most children are literate, but the rapid drop in education achievement after primary school shows the limitations of this system, where middle and high schools are much harder for rural communities to access.

Table 7-4: Literacy rates and school attendance in the Shan State and the wider project area.

Administrative Unit/Level	Literacy Rate of Population over 15 Years (%)			School Attendance (%) of Total Population between 5 and 29 Years		
	Female	Male	Total	Currently Attending	Previously Attending	Never Attended
Shan State	59.4	70.3	64.6	32	39	29
Kyaukme District	73.2	83.0	77.8	35	48	16
Nawnghkio Township	88.6	94.3	91.4	33	59	8
Kyaukme Township	74.3	84.3	78.9	38	50	12
Taunggyi District	79.3	91.7	85.2	38	54	8
Lawksawk*	81.4	91.2	86.2	40	52	8

*In the 2014 Census Report spelled as Yawksawk

The socio-economic survey results for the right and left bank villages (see ***Figure 7-4***) in the indirect impact zone show clear distinctions by area and gender for literacy. Male respondents' literacy is similar to the district and township levels across most areas, with slightly lower rates in the upper left bank (Zone 4C) reflecting access challenges. The high male literacy rates in the lower left and upper right bank area (Zones 4a and 4d) similarly reflect the better access these communities have to schools.

Female respondent's literacy rates, however, are well below their township averages: Yae Twin Gyi (YTG) in Zone 4b have literacy rates of 76% and 72% compared to 88.6% across Nawnghkio Township. On the lower left bank, the well-connected villages in indirect impact zone 4d actually beat Lawksaw's average of 81.4% with 91% of women being able to read and write but in the remote upper left just 47% of women are literate.

These numbers reflect that in particularly remote areas, where there is limited education infrastructure, women are likely to be left behind. It should be noted, though, that these numbers reflect respondents' literacy and so are reflective of an adult female population rather than the young women attending school at present. Indeed, a number of villages reported that active government schools had only appeared in their villages within the last 10 years. Prior to that, these communities relied on monastic education, an option frequently open only to young men and boys.

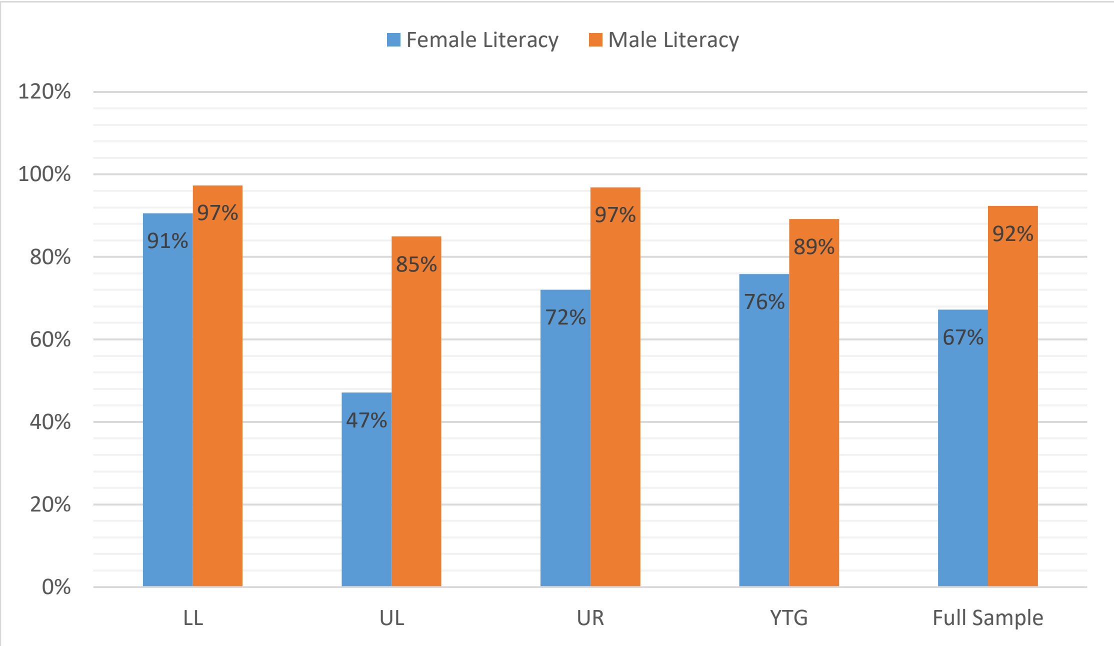

Figure 7-4: Literacy in right and left bank villages in the Middle Yeywa indirect impact zone.
(LL = lower left bank – Zone 4d; UL = upper left bank – Zone 4c; UR = upper right bank – Zone 4a; YTG = Yae Twin Gyi village – Zone 4b)

Figure 7-5 below shows the highest level of education attended by survey respondents. Educational outcomes show that for most residents in the project's impact zones, primary school is the highest level of education available. The high levels of monastic education in the three upper left villages of Thar Si, Pin Ping, and Kone Nyaung highlight the gender gap in literacy mentioned above.

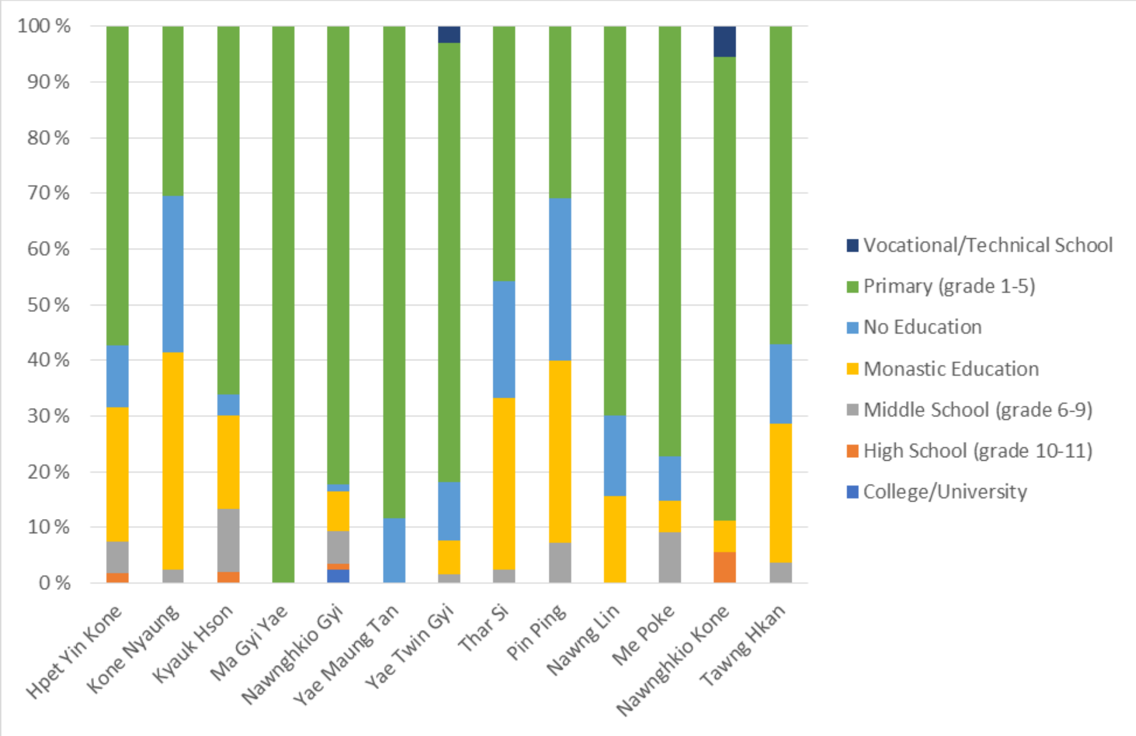

Figure 7-5: Education level in indirect impact zone villages.

7.3.5 Access to Education Services

Overview

Nationally, education services in Myanmar vary. There are a high number of primary schools across the country and access to basic education services is relatively good which in turn results in high literacy rates, as shown in Section 7.3.4. However, for rural communities, access to education beyond the primary level remains poor. As ***Table 7-5*** below shows, from almost universal access to village level primary schools, there is a rapid decline within impact zone villages of education access. None of the impact zone communities have their own high school and the survey found very few students in the villages that had completed their high school studies.

Table 7-5: Presence of educational institutions in indirect impact zone villages.

Village Name	Kindergarten	Monastic School	Primary School	Middle School*	High School
Hpet Yin Kone	Yes	No	Yes	No	No
Kone Nyaung	No	No	Yes	No	No
Kyauk Hson	No	No	Yes	Yes	No
Ma Gyi Yae	Yes	No	Yes	No	No
Nawnghkio Gyi	Yes	No	Yes	Yes	No
Yae Maung Tan	No	No	No	No	No
Yae Twin Gyi	No	No	Yes	Yes	No
Tawng Hkam	Yes	No	Yes	No	No
Thar Si	No	No	Yes	Yes	No
Pin Ping	Yes	No	Yes	Yes	No
Nawng Lin	No	No	Yes	Yes	No
Me Poke	No	No	Yes	Yes	No
Nawnghkio Kone	No	No	Yes	No	No

* There were more split responses within villages for this question, reflecting different villager perceptions of whether village schools that teach some, but not all, middle school grades are middle schools or not. For the analysis, we count all schools that teach middle school grades as middle schools.

Monastic Schools

Despite a significant number of adult respondents reporting they had received their education from Buddhist monastery schools, no villages reported having active monastic education systems at the time of the survey. This is likely due to two factors: firstly, as government schools have expanded their presence in ethnic minority areas over the past two decades (including in the project area), rural communities' reliance on monasteries for primary education has been reduced; and secondly, village monastic schools have over time become increasingly centralized at large monastery locations which have purpose-built education facilities. Village monasteries, particularly in ethnic areas, do continue to play an important role providing classes on Buddhism and ethnic minority languages and in some cases summer classes on other subjects. However, village monasteries rarely play the role of primary education provider at present.

Primary Schools

Outside of non-government controlled areas, village level primary schools have become almost ubiquitous across Myanmar in recent years. The villages within the impact zones are no different, and all but one village reported they had a primary school within the village limits. Most respondents in the one village without a primary school, Yae Maung Tan, reported that they had access to the school in nearby Me Poke, a 20-25-minute walk or 10-minute motorbike ride away. One village, Kone Nyaung, had previously built its own school and hired its own teachers independent of government systems, but last year it was formally amalgamated into the Ministry of Education system and has had its first government teachers assigned to it.

While access to primary schools is high, there are other limitations experienced by villages within the impact zone. As is the case across much of Myanmar, the teacher-student ratio is high and in almost all focus group discussions the need for more teachers was a key point that was raised by villagers. Many communities take it upon themselves to find and hire additional teachers through community initiative funds though the training and capacity of these auxiliary teachers can vary significantly. Such initiatives are particularly common in ethnic minority areas that have trouble retaining teachers, many of whom are of a different ethnicity and often leave after 2-3 years in these relatively remote areas of the country.

Middle School

Middle schools are much less common than primary schools across Myanmar and there is an additional definitional complexity. Instead of a strict classification of schools as primary or middle, as more teachers become available, primary schools in villages 'add' grades. These schools are often known as 'post-primary' schools, able to provide at least partial middle school education for local students. Of the thirteen surveyed villages, the majorities of respondents in seven villages reported that they had access to middle school, i.e. that their village schools were teaching at least some middle school grades.

High School and Beyond

None of the surveyed villages in the indirect impact zone have access to a high school within the village; all reported having to travel at least to the main village in the village tract in order to attend high school. For villages on the left bank (Zone 4d), a clear majority of respondents reported Kyauk Ku as the most accessible high school, with Nawnghkio and Lawksawk also mentioned. Responses from people on the right bank (Zone 4a) were more varied, with Taun Shae and Kan Gyi villages on the main road to Nawnghkio and 'no answer' being the most common responses. Individual households reported sending their children to Pyin Oo Lwin and Mandalay for high school.

For those students who complete high school, further education options are either distance university courses or travel to Mandalay, Pyin Oo Lwin, or even Yangon. There are no reported vocational or technical schools in the villages, and most respondents (55%) were not able to identify one they could access. For those who did identify the location of a vocational school, Mandalay (22%) was the most common response, followed by Taunggyi (12%).

7.3.6 Common Illnesses

Respondents were asked to list all incidents of illnesses that had occurred within the household by population group (men, women, children under 15 years, children over 15 years) over the year prior to the survey. The results, as shown in ***Figure 7-6***, illustrate that the major health challenges are fever and cold/flu. Malaria and tuberculosis are present, but with a low incidence in the impact zones communities, with 28 cases of the former and 19 of the latter reported across the thirteen villages.

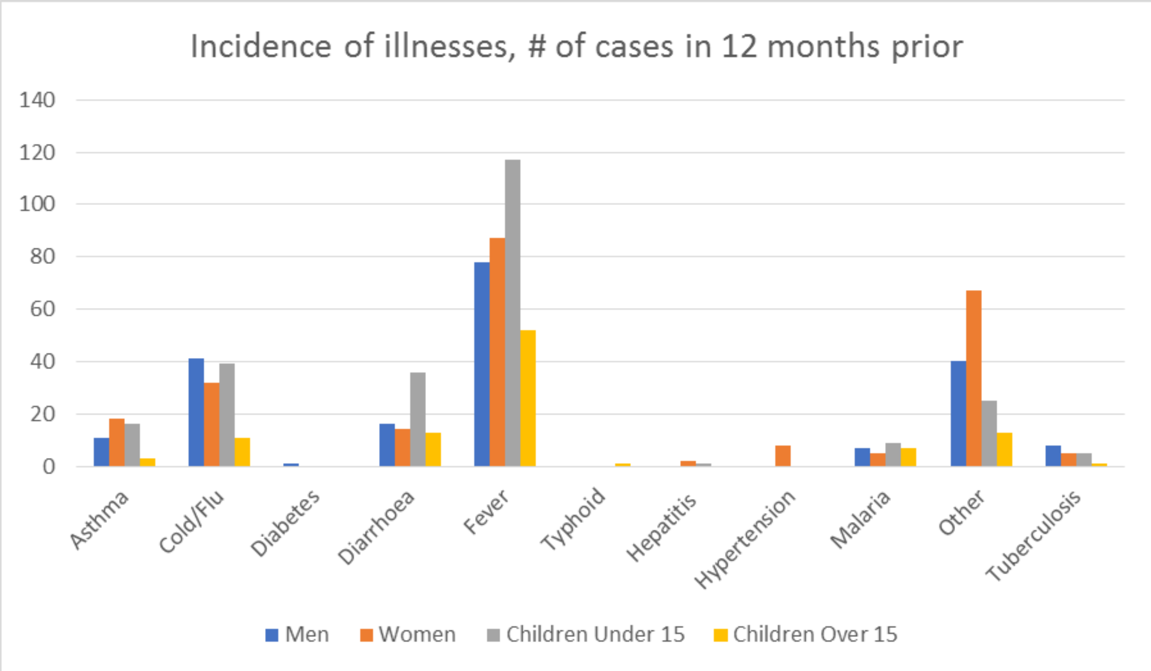

Figure 7-6: Incidence of illnesses in indirect impact zone villages.

7.3.7 Access to Health Services

The core component of Myanmar's healthcare provision in rural areas are the Rural Healthcare Centres (RHC), generally staffed with one to three midwives who are trained by the government and who receive a salary from the Department of Health (DOH). Their primary responsibilities are maternal and post-natal care for women in the villages, and they also provide both initial diagnostician and referral services and collect health data on behalf of the DOH. Their ability to treat is extremely limited and for any serious illness, patients are referred to the township hospitals or beyond.

RHCs are generally located in the largest village in a village tract, but there are also 'sub-centres' (RHSCs) which may exist in smaller villages around the tract and are generally staffed by one midwife and represent the most grassroots level of healthcare provided by government. Larger village tracts, and, occasionally, large villages within tracts may have a full 'station hospital' with assigned doctors (at least one, sometimes up to three), additional nursing staff, and a public health official. This latter individual is responsible for health education and for public health testing including for tuberculosis.

Table 7-6 shows the presence of RHCs and RHSCs across the impact zones. Less than half of the villages have a health centre within their community. As the table also shows, for many of those communities without a health centre, accessing health care requires a 30-minute motorbike drive.

Table 7-6: Location of nearest healthcare centre.

Village Name	Rural Health Care (Sub) Centre in Village?	If No, Location of Nearest RHC?
Hpet Yin Kone	No	Kyauk Ku Village, 30 min by motorbike
Kone Nyaung	No	Pin Ping Village, 30 min by motorbike
Kyauk Hson	Yes	
Ma Gyi Yae	No	Tae Shae Village, 15 min by motorbike
Nawnghkio Gyi	Yes	
Yae Maung Tan	No	Me Poke Village, 5 min by motorbike
Yae Twin Gyi	Yes	
Tawng Hkam	No	Kyauk Ku Village, 30 min by motorbike
Thar Si	No	Pin Ping Village, 45 min by motorbike
Pin Ping	Yes	
Nawng Lin	No	Me Poke, 30 min by motorbike
Me Poke	Yes	
Nawnghkio Kone	No	Me Poke, 15 min by motorbike

Despite RHCs and sub-centre midwives being primarily responsible for maternal and child health, they do act as the primary care provider for almost half of the survey respondents. ***Figure 7-7*** below shows the breakdown of responses for the question of what healthcare option a household will seek out first when someone falls ill. For 47%, the village health centre, i.e. a RHC or RHSC, will be the first choice while 24% reported other—an option that includes another village's RHC/RHSC. Notably, 15% reported they would first seek out a traditional healer, with a higher proportion of men selecting this option. This may be because the traditional healer is more accessible and cheaper but also because some people are more familiar with traditional healers and trust them more than the public health services.

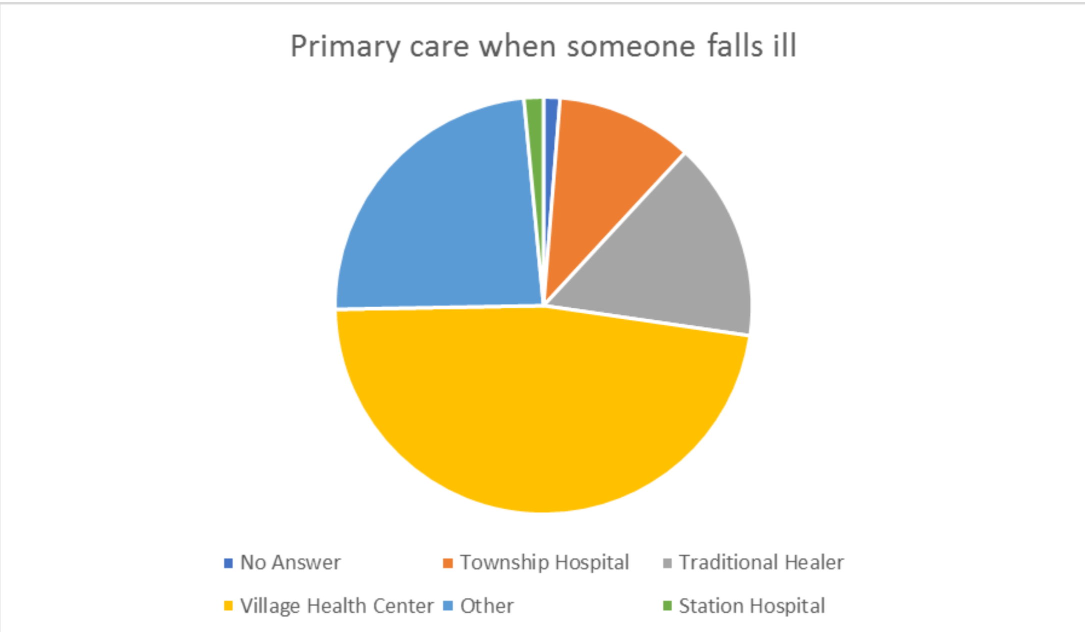

Figure 7-7: Preferred health care option in indirect impact zone villages.

7.3.8 Economy and Livelihoods

Regional Economy

The largest economic sector in Myanmar is agriculture contributing 38% of GDP and accounting for some 70% of labour employment.[14] The regional economy of northern Shan State is no different, and the majority of inhabitants across Nawnghkio and Lawksawk townships are farmers. Local towns provide services (especially agricultural inputs) and markets for farmers to sell their harvests. Shan State generally is known across Myanmar for its high quality produce thanks to its temperate climate and fertile soil. Markets in the region tend to rotate on a five-day basis, with villagers from surrounding communities traveling to the market.

Figure 7-8: Photo from market at Lawksawk, selling NTFPs and tea (Palaung ethnic group)

There is some natural resources extraction on a commercial scale in the northern Shan State, notably the Bawdwin mine which is one of the world’s longest running silver, zinc and lead mine. There are smelters located near Namtu town.

The road from Mandalay to Nawnghkio is one of the important trading corridors to China, and there is considerable heavy traffic of a variety of goods to border towns. . The town of Muse is the largest of these towns, located some five hours drive north of Nawnghkio.

7.3.9 Local Project Area Economy

Analytic Approach

Communities in the wider project area and in the indirect impact zone depend predominantly on agriculture for their primary and secondary incomes. Livestock raising is common, but almost entirely for household consumption or sale within the village. Very few households sell livestock at markets or have significant cash income from livestock raising. Instead, as in much of the rest of Myanmar’s more hilly and mountainous areas, upland farming and crop cultivation is the dominant livelihood.

This livelihood analysis focuses on the two geographically different areas in the indirect impact zone, the right bank and the left bank. The socio-economic survey for the right bank was carried out in 2015 with the exception of one village (Nawng Cho Kone) while the left bank survey was carried out in 2017.

[14] *http://www.fao.org/myanmar/fao-in-myanmar/myanmar/en/*

The difference in geographic features has been taken into account by dividing the villages into four indirect impact zones (see Figure 3-1). The upper right bank villages (Zone 4a), the upper left bank villages (Zone 4c), the lower right bank village of Yae Twin Gyi (Zone 4b), and the lower left bank villages (Zone 4d). Zone 4a only includes one village, Yae Twin Gyi, which is the village likely to experience the greatest impacts of the Middle Yeywa HPP due to its proximity to the dam site and the access road. The lower left villages are those located in Kyauk Ku village tract, on the left side of the lower section of the reservoir.

Land Use

On both sides of the Myitnge River, farmland consists of non-irrigated uplands fields. Many households rely on slash and burn techniques and have traditionally left the land fallow for 1-3 years between plantings. However, as population has grown in the villages and average plot sizes have decreased, the ability to leave the land fallow is decreasing. As a result, fertilizer use is increasing significantly and to date appears to have forestalled any drop in average yields caused by planting the same acres every year though farmers interviewed expressed concern that maintaining yield is requiring more and more fertilizer.

Land Access

Most households across the impact zones have access to their own land. This stands in contrast to the central regions of Myanmar where the land ownership is comparatively concentrated. In large part, this is a reflection of the low population density and the ability of households to clear forest land and create new upland agriculture plots, or *Taunggya* (specifically meaning shifting cultivation, but often used as a generic term for upland land).

Some villages have already expanded their fields to the edges of the traditional borders of the village. In these communities there is no possibility for expansion and plot sizes are being reduced in size as village population increases and land is passed down through inheritance.

Very few farmers reported having any formal rights to their farmland. The land registration process, which was initiated in 2015, has not yet reached many communities across Myanmar. In only two villages visited in 2017 did research respondents say their land had been surveyed by government representatives. Most farmers rely on historical or customary usage rights that are well understood within the village but have no formal protection under Myanmar law. There is no private ownership of agricultural land in Myanmar, as all land is in theory owned by the state.

Crop Selection

The most common crop grown by farmers is maize; 728 of 771 farmers who responded to the survey had grown maize in the previous agricultural season. However, the most profitable crop varies from one side of the river to the other, primarily a reflection of the presence of a large sugar mill located in Nawnghkio Township not far from Nawnghkio town. This sugar mill, which has been in operation for more than ten years, has had a large influence on agriculture in all right bank villages.

When the first phase of the baseline was undertaken in 2015, only a small number of the interviewed farmers were growing sugar cane and were able to take advantage of its profitability. Two years later, in the one right bank village included in the baseline's second phase, 82 out of 87 farmers reported to grow sugar cane, maize and upland paddy were supplementary, while sugar cane was cited by these villagers as easy to grow and a crop for which there was a reliable market. This one right bank village included in the 2017 survey indicates how villages on that side of the river have benefited from the attractive and reliable market for sugar cane; its households' average income was 20% higher than any other village, and nearly 60% higher when villages not located on the main road were excluded.

Notably, the factory does not buy sugar cane from the other side of the river (left bank) and so the agricultural context is quite different there. Communities reported that the reason for this was the poor road conditions leading across the river. As a result, the cash crops grown by left bank communities are different, primarily maize (which is shipped to China) as well as soybean (in a small number of villages).

In addition to these cash crops, communities grow a range of crops for home consumption, with any surplus being sold within the village rather than at a market. In most villages, upland rice is a staple, though a few villages with irrigated farmland grow paddy (wet rice). Peanuts, garlic and sesame were also mentioned by some respondents. Peanuts are notable as they are often processed into oil at the village level and used as the households' main cooking oil.

Livestock

Most households have a small number of livestock, almost exclusively poultry and pigs, for their own consumption. No households reported relying on livestock for primary or significant secondary income sources in any of the villages.

Market Access

Most farmers in the impact zones sell their harvests in the main town of Nawnghkio and the large village of Kyauk Ku (below Zone 4d). There is a rotating five-day market in Kyauk Ku village tract and a number of medium and large scale traders are based in Nawnghkio. Farmers finance transportation of the harvest to these markets, often joining to share the cost of hiring a large truck or *trologyi*. These costs can constitute a significant amount that reduce the profitability of maize cultivation in villages with poor road access.

Figure 7-9: Cultivated areas on the plateau above the Myitnge River Valley at Nawnghkio Gyi Village

7.3.10 Income Levels and Poverty

National Context

Despite five years of 6% or more annual economic growth, Myanmar remains one of the poorest countries in Southeast Asia. The World Bank calculates the country's GNI per capita as US$ 1,190, comparable to Cambodia (US$ 1,140) and well below Vietnam (US$ 2,060) or neighbouring Thailand (US$5,640).[15]

Poverty in Myanmar is relatively high. A recently released World Bank study that used household data from 2015 and set the poverty rate at 1,303 MMK (US$ 1.1)[16] per adult per day, found that in 2015, 32% of Myanmar's population lived in poverty. It also found that rural poverty was notably higher than

[15] *World Bank, GNI per capital 2016 in 2016 dollars, Atlas Method*
[16] *Using 2015 average exchange rate of MMK 1,182 to US$*

urban poverty (39% vs. 14.5%) and that the country's hilly and mountainous areas (which include the project site) had the second highest incidence of poverty (40%).

However, while poverty levels are high they have been declining: the same World Bank study estimated that poverty has declined from almost 55% in 2004/5 to 48% in 2009/10, to 39% in 2015.

Income Levels in the Project Area

Declared income levels within the project's impact zones are substantially above the World Bank's poverty assessment described above as well as above the global poverty line of US$2/day. Average income across the 13 villages was MMK 4,105,567 per year, or US$ 3,059, which corresponds to US$ 8.3 per day.[17] It is also important to note that declared income is likely to be an underestimate of the total household income[18]. Measurement of consumption and expenditure is often the preferred monitoring tool. However, the results for the project area indicator high rural income levels on average.

Breaking down the data between those villages surveyed in 2015 and those that were surveyed in 2017, there are clear indications that income levels have increased since 2015; average income was $8/day in 2015 versus $9.1/day in 2017, an increase of 12% over two years. This does not take into account that communities surveyed in 2017 were predominantly on the left bank which has reduced market access and less ability to grow the most profitable cash crop (sugar cane). The one right bank village surveyed in 2017 where sugar cane is grown extensively had average income of over US$16/day.

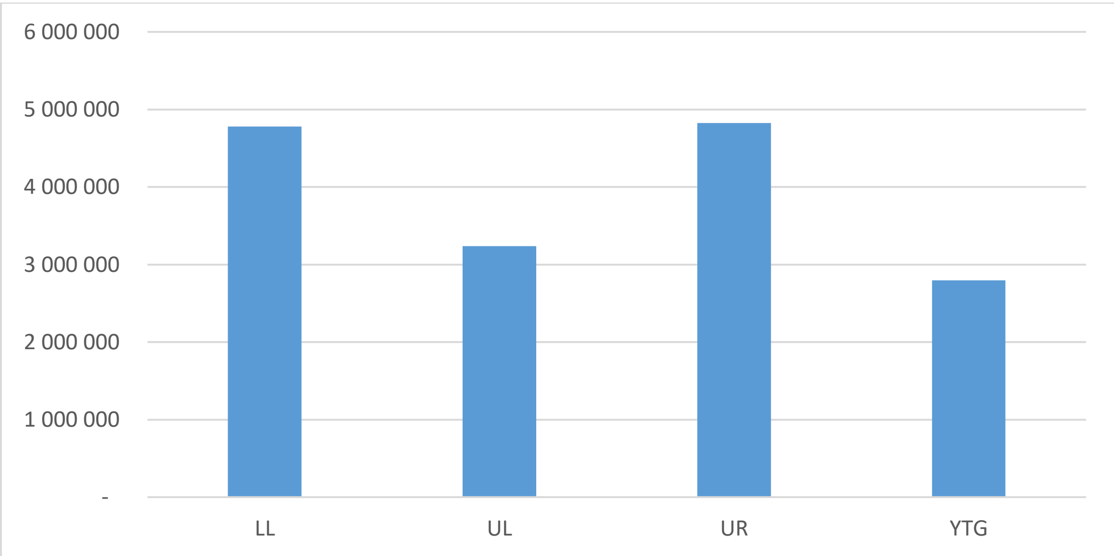

Figure 7-10: Income in right and left bank villages in the Middle Yeywa indirect impact zone.
(LL = lower left bank – Zone 4d; UL = upper left bank – Zone 4c; UR = upper right bank – Zone 4a; YTG = Yae Twin Gyi village – Zone 4b)

Non-farm Income

The figure below shows the average on-farm income compared to the average off-farm income which includes all other income sources such as income from forest products, casual labour and salaries. As can be read from the figure, the on-farm income share is the dominant source of income in all the surveyed villages. On the average across all surveyed villages, the on-farm income share represents around 80%.

[17] *Using 2017 average exchange rate of MMK 1,342 to US$*
[18] *Measure for Measure: Systematic Patterns of Deviation between Measures of Income and Consumption in Developing Countries. Evidence from a New Dataset. WYE City Group on Statistics on Rural Development and Agricultural Household Income. Economic Research Service, US Department of Agriculture, Washington DC*

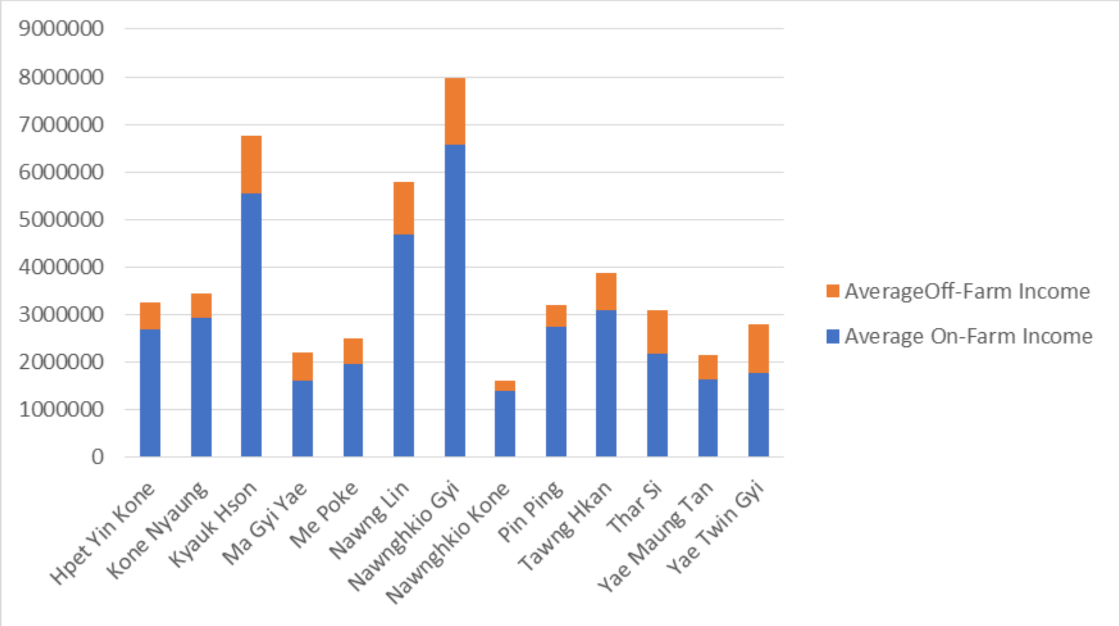

Figure 7-11: On-farm income in compared to off-farm in the Middle Yeywa indirect impact zone.

Income Levels of Vulnerable Groups

Within the context of the project site villages and Myanmar more generally, vulnerable groups are defined as women-headed households, landless households and households with disabled people. Some vulnerable groups within the villages were comparatively poorer than other households, but none of these groups, on average, fell below the US$2/day line. For example, of the 52 surveyed women who were identified as head of households, average income (at the 2017 exchange rate) was $7.58/day compared to US$9.1/day for male respondents identifying as head of households. Further income data on vulnerable groups is presented in the table below.

Table 7-7: Income levels among vulnerable groups.

Vulnerable Group	Average annual income (MMK)	Average annual income (US$)	Average daily income (US$)
All Households	4,105,567	3,059.29	8.38
Women-headed households	3,716,009	2,769.01	7.59
Landless Households	1,653,621	1,232.21	3.38
Households w/ Disabled Persons	4,166,816	3,104.93	8.51

These results suggest that in the project area landlessness is one of the most important factors with regard to the actual vulnerability of a household as it as it appears to have a stronger impact on the income level that the other vulnerability factors.

7.4 Natural Resource Use in the Impact Zones

Natural resources in and around the impact zones can be divided into two categories: forest resources and river resources. Communities within the impact zones are made up primarily of small farmers who plant a variety of upland crops on unirrigated farmland. As a result, few if any households within the 13 surveyed communities rely on either category of local natural resources for their primary income and only a handful derive any significant contribution from them.

7.4.1 Forest Resources

Forest resources include timber (for construction as well as firewood), foraged plants (for consumption and sale), and hunting (consumption and sale). Discussions with community leaders indicated that while many villagers participate in 'recreational' use of the forests, very few rely on them for any portion of their income. For example, many villagers reportedly hunting for recreation and to provide dietary diversity while others collected herbs and other plants from the forest, but very few reported selling any forest resources/products at the market.

Figure 7-12 shows the proportion of income derived from forest resources / products[19] across the thirteen villages.

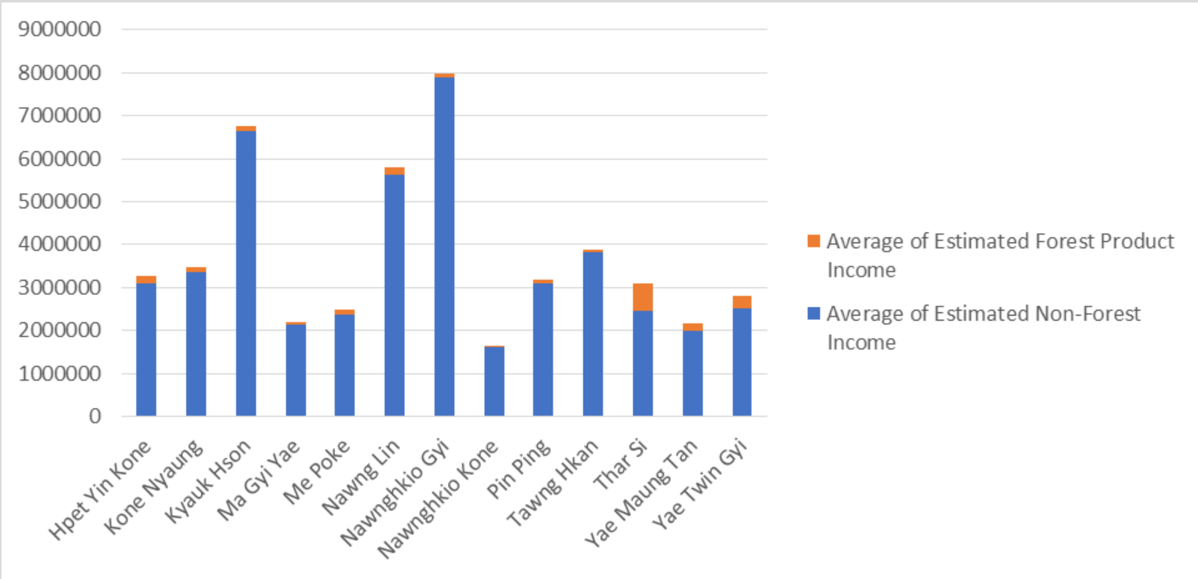

Figure 7-12: Average estimated non-forest income against estimated forest product income.

Thar Si village has a notably higher contribution to income from forest products, reflecting the large forests that surround the village that has not yet been converted into farmland due to the steep hills and rocky terrain in that area.

7.4.2 River Resources

River resources primarily involve fish and other food sources though in certain cases sand/gravel and water itself may be important natural resources used by nearby communities. In this case, none of the 13 villages within the indirect impact zones rely on the river as a primary or even secondary water source and the distances from the river to villages are too far for sand, gravel or stones to be useful. Some households reported recreational fishing, but this did not contribute in any significant way to household incomes.

[19] *Forest products income defined as income from the following sources: cutting firewood, other hardwoods cut, bamboo, wild animals, foraged fruit and vegetables, honey, foraged herbs, and flowers.*

Table 7-8 shows the average income from fishing per household. In no village did fishing account for more than 1% of average income.

Table 7-8: Income from fishing.

Village	Average HH Income from Fishing	Average Estimated Total Income	% of Income from Fishing
Pin Ping		3,191,605.45	0.00%
Hpet Yin Kone	3,148.15	3,258,760.93	0.10%
Kone Nyaung	1,463.41	3,458,945.24	0.00%
Kyauk Hson	927.27	6,770,728.91	0.00%
Nawnghkio Gyi	-	7,979,756.32	0.00%
Tawng Hkan	-	3,871,726.00	0.00%
Thar Si	1,903.61	3,078,926.51	0.06%
Ma Gyi Yae	5,454.55	2,207,136.36	0.25%
Me Poke	2,045.45	2,494,111.36	0.08%
Nawnghkio Kone	5,555.56	1,625,555.56	0.34%
Nawng Lin	1,240.56	5,792,230.87	0.02%
Yae Maung Tan	384.62	2,157,526.92	0.02%
Yae Twin Gyi	21,318.18	2,797,912.12	0.76%

Of the 800 households sampled, only 30 reported any fishing income, corresponding to 0.04% of the total number of sampled households. The average income from fishing for these households amounted to averaged MMK 78,922, corresponding to 2% of their reported income.

7.5 Archaeological Sites and Cultural Heritage

No archaeological or cultural heritage sites have been identified or reported in the direct impact zone of the Middle Yeywa HPP. However, villages in the indirect impact zone have temples and sometimes more local Buddhist shrines that are visited and maintained by the local population.

Figure 7-13: Example of large monastery on the right bank – Yae Twin Gyi

Figure 7-14: Local village guardian spirits (Nats) in Pin Ping

8 PROJECT IMPACTS

8.1 Introduction

This chapter presents the potential environmental and social impacts of the proposed Middle Yeywa HPP. The impact assessment has been based on the following information:

- Scoping of the social and environmental impacts carried out in 2015 with the preparation of the Pre-Feasibility Environmental and Social Impact Assessment Report;
- Consideration of present project layout and engineering plans in terms of geographical location and scale (presented in Chapter 2);
- Consideration and assessment of the Area of Influence of the Project;
- Stakeholder consultations related to the potential environmental impacts arising from the hydropower development plans (presented in Chapter 5);
- Baseline studies carried out in the Scoping and EIA phases (presented in Chapters 6 and 7);
- Consideration of the conservation, human and biodiversity value of the affected aquatic and terrestrial resources affected by the hydropower development.

8.2 Environmental Impacts

8.2.1 Topography and Landscape

Construction Phase

Visual impact: During construction, there will be substantial vegetation clearance, earthworks and movement of machinery in the direct impact zone. The Middle Yeywa HPP is a major construction project that will last for several years, and hence affect the appearance of the landscape to a large degree. However, the visual impacts will be concentrated mainly at the dam site, along the access road down the river valley and any other areas with construction activities including reservoir clearance. Towards the end of the construction phase, the reservoir will be filled and this will change the landscape significantly (see ‘Operation Phase’ below).

Mitigation measures:

- During earthworks, the good topsoil, where available, shall be removed first and be stockpiled separately for use in replanting and restoration;
- All disturbed surfaces shall be subject to landscaping, including revegetation using local topsoil and native plant species;
- Temporary construction facilities shall be decommissioned and the sites be restored to pre-construction state;
- Excess material (that cannot be incorporated into permanent works) shall either be disposed of in the Middle Yeywa reservoir area, or in spoil dump yards taking into consideration the natural terrain and be subject to revegetation, drainage and landscaping.

Operation Phase

Visual impact: In general, the aesthetic impact of infrastructure developments, including hydropower plants, is largely a subjective matter determined by individual preferences. The physical structures might be considered as architectural monuments and symbols of development, or as an intrusion in the natural landscape. The attitudes and perceptions will change with cultural background and over time.

The Middle Yeywa HPP will change the landscape from a natural and largely uninterrupted landscape with a dynamic river environment including rapids to a man-made landscape dominated by an artificial and more uniform lake. The dam and reservoir will become a significant landscape feature, which can be seen from far away, especially from the hills on both sides of the river valley. However, in contrast to seasonal storage reservoirs where the drawdown zone typically leaves a large eroded scar in the landscape during the dry season, the narrow zone (1.5 m) required for hydro-peaking in the Middle Yeywa power plant will hardly be noticeable on the steep slopes of the Myitnge valley.

Arguably, the new lake environment may also be considered to enhance the aesthetic qualities of the area and possibly attract visitors for recreation purposes. ***Figure 8-1*** and ***Figure 8-2*** show 3D-views of the Middle Yeywa reservoir.

Mitigation measures:

- Conduct pre-impoundment clearing of trees in the reservoir area in order to avoid dead trees standing in the water where feasible and accessible

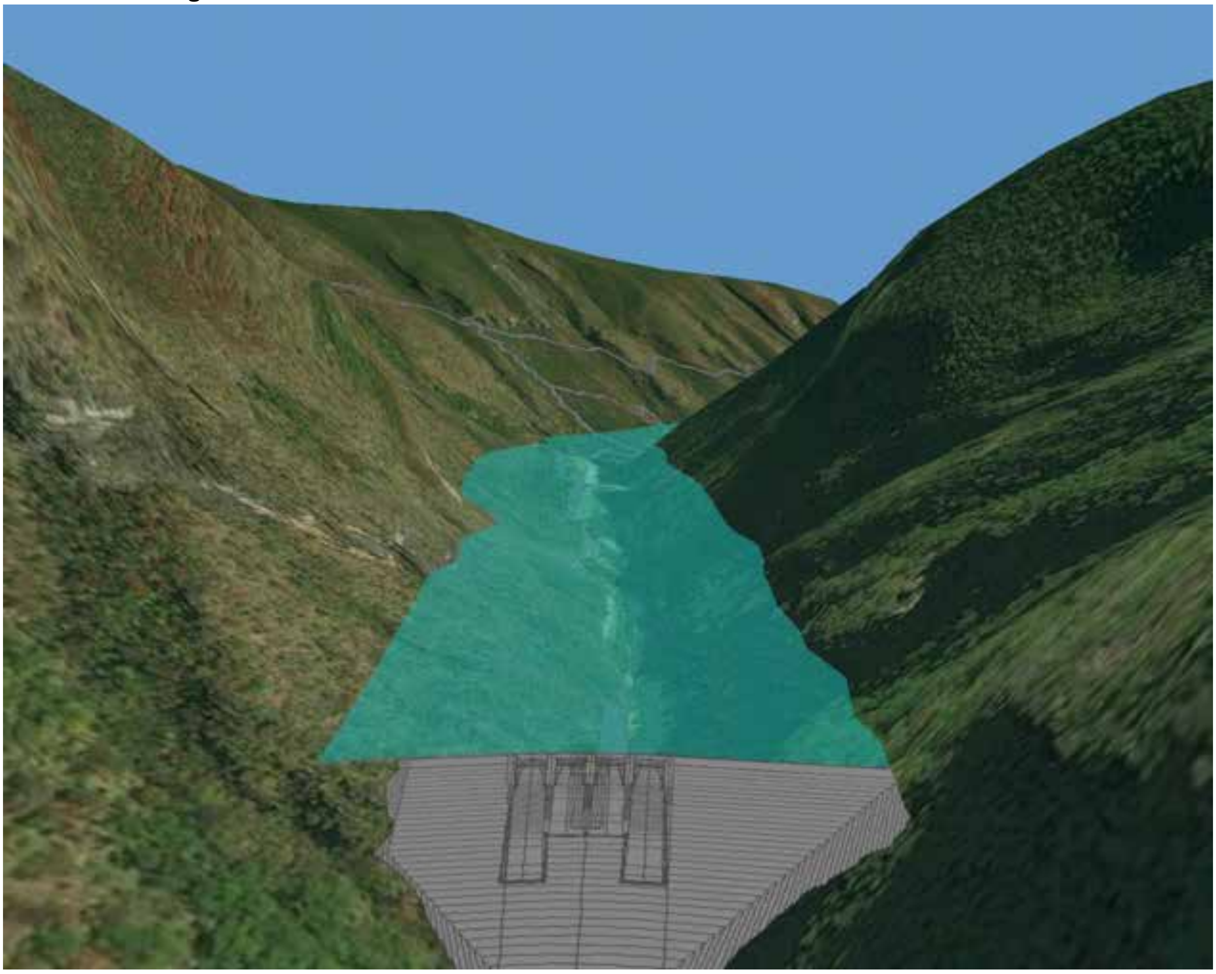

Figure 8-1: Illustration of the Middle Yeywa reservoir area after impoundment.

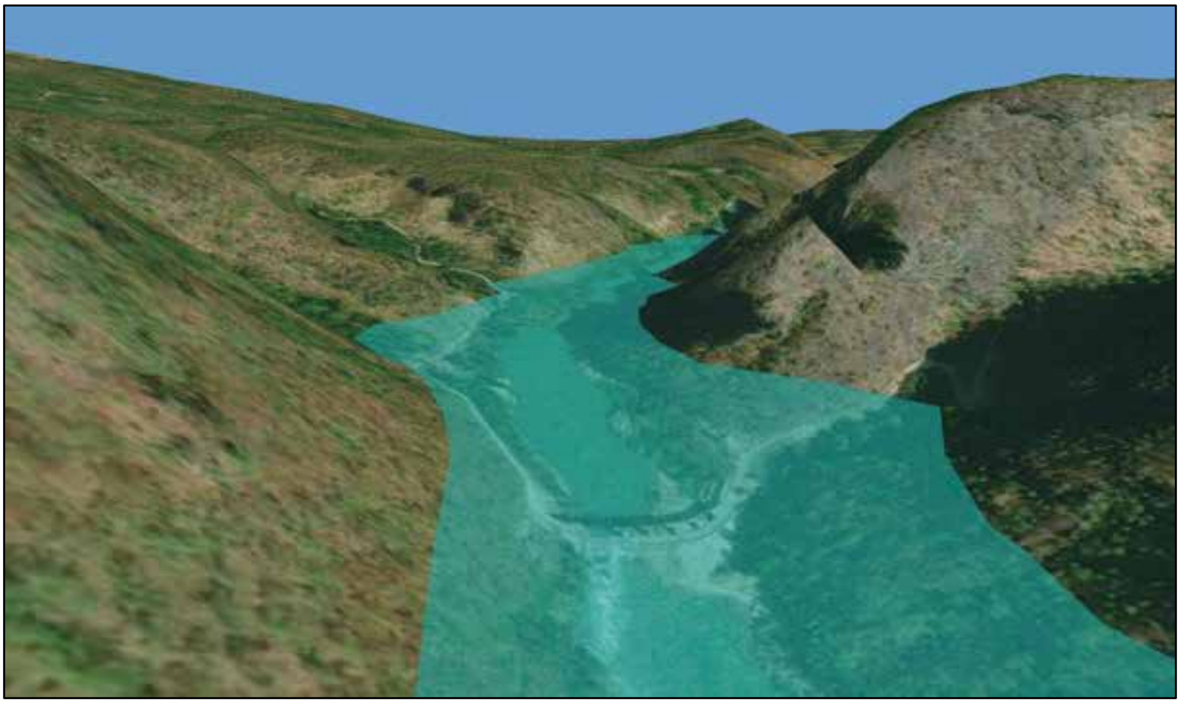

Figure 8-2: Illustration of the Middle Yeywa reservoir at the Myitnge bridge.

<u>Conclusion</u>

Phase	Magnitude – Topography and Landscape				
	Large Negative	*Medium Negative*	*Low/Insignificant*	*Medium Positive*	*Large Positive*
Construction		▲			
Operation		▲			

8.2.2 Geology and Soils

<u>Construction Phase</u>

Soil erosion: During construction, surface soil conditions will be impacted by activities, such as vegetation stripping, grading, soil removal, backfilling, compacting, excavation and disposal of surplus soil, etc. This applies especially to the road upgrade/construction works on the steep slopes of the Myitnge valley. Exposure of the ground and removal of vegetation cover will make the soil liable to erosion by wind and water runoff in particular.

Mitigation measures:

- Except where vegetation clearing is required for permanent works or excavation operations, all trees and vegetation shall be preserved;
- Erosion control practices including timely installation of drainage shall be implemented prior to any major soil disturbance and be maintained until permanent protection is established;
- All exposed surfaces (including roadsides) and spoil areas shall be covered with topsoil and replanted or re-seeded with native species;

Land contamination: Construction activities may result in the accidental pollution through the release of petroleum-based products, such as lubricants, hydraulic fluids and fuels during their storage, transfer or use in equipment. Other hazardous components include paint and other chemicals used in the building process. If such hazardous materials are not contained and handled properly, there is a risk that they can cause soil contamination as well as water pollution (see below).

Mitigation measures:

- Storage areas for fuel and hazardous materials shall be roofed and have a concrete floor with a bund for secondary containment and collection of spills;
- Diesel shall be stored in a standard skid tank with secondary containment proving 110% volume of the total capacity of the tank;
- Maintenance of machinery and trucks shall be done in workshop servicing and repair areas with impervious concrete platforms and oil traps;
- All storage areas and major construction sites shall have spill kits, sand, dust, and other appropriate absorbent materials;
- A proper waste management system including approved waste disposal procedures should be established.

Operational Phase

Soil erosion: After commissioning of the power plant, the proposed peaking operations will create a narrow drawdown zone in the reservoir (from 316.5 to 317.0 masl). Such daily or regular fluctuations in water levels are typically associated with a risk of shoreline erosion. When the reservoir is drawn down, local slips and failure of soils and material will occur with subsequent movement of soils/sediments into the reservoir due to a combination of groundwater in the soils, rain and wave action. However, the risk of large landslides during normal operation is considered relatively low due to the narrow drawdown zone (1.5 m) and limited depth of soils and loose material.

Major soil erosion and landslide risks will be significantly greater if/when the reservoir is drawn down to MOL or a lower level. This is expected to happen during sediment flushing operations, which will commence after tentatively 15 years of operation and will occur at least every 4 years thereafter (see Section 8.2.7). Even if such events may cause much erosion on the “riverbanks” below the reservoir FSL, the overall effect of sediment flushing is indeed to erode and remove the sediments from the reservoir in order to maintain the storage capacity and increase the lifetime of the hydropower plant.

In the downstream reaches (i.e. below the Middle Yeywa dam and upstream of the existing Yeywa reservoir), daily peaking operations and sediment trapping (creating water with little sediment and consequently a capacity to mobilise and transport more sediment) is likely to cause riverbank erosion. However, as explained in Section 8.2.7, the fact that the tailrace outlet is located a very short distance upstream of the existing Yeywa reservoir, combined with the predominantly bedrock and boulder characteristics of the riverbanks, suggests that the scale of downstream erosion will be relatively limited.

Outside the reservoir and the downstream reaches, soil erosion is expected to be temporary and short-term because exposed soils will be re-vegetated when the earthwork and construction activities have been completed. Limited erosion may nevertheless occur during heavy rains, especially along the access road.

Mitigation measures:

- Consider the need for adjusting the ramping rates and/or physical interventions along the reservoir perimeter and in the downstream (e.g. targeted tree planting, bank protection works) in order to prevent riverbank erosion and landslides/slips during peaking operations;
- Install drainage structures along access roads and areas disturbed by project activities including sufficient cross-drains and protection of drainage outlets and downstream areas until a natural drainage with sufficient capacity to handle water has been created; and ensure regular maintenance and cleaning of drainage structures.

Land contamination: During operation, soils can be impacted due to spillage of hazardous wastes and materials, including hydrocarbons. Failure or lack of spill prevention systems and inadequate handling of hazardous waste may cause soil contamination.

Mitigation measures:

- All permanent facilities where fuel and hazardous materials are used or stored shall be equipped with secondary containment, oil traps, spill kits and absorbent materials;
- A proper waste management system including approved waste disposal procedures should be established.

Conclusion

Phase	Magnitude – Geology and Soils				
	Large Negative	*Medium Negative*	*Low/Insignificant*	*Medium Positive*	*Large Positive*
Construction			▲		
Operation			▲		

8.2.3 Climate

Construction Phase

GHG emissions: During the construction phase, greenhouse gas (GHG) emissions will be generated from increased traffic, a range of motorised construction machinery and from diesel generators used to supply power for construction-related activities. In addition, pre-impoundment clearing of trees in the reservoir will cause emissions from deforestation. Assuming that the average CO_2 emissions from deforestation in Indaing forests are 581 tonnes per hectare (FAO data), the total emissions can be roughly estimated to 475,000 tonnes CO_2 from clearing all the forest in the reservoir (approx. 816 ha). This land use conversion represents a significant source of GHG emissions although the overall impact in terms of climate change is low.

Mitigation measures:

- Compensate the emissions from deforestation in the reservoir area by restoration of an equivalent area (816 ha) of comparable quality outside the reservoir area.

Operational Phase

Micro-climate changes: Large bodies of water influence the climate of their surroundings, especially the temperature and the humidity. The most notable effects are cooling in warm periods, warming in colder periods, and reduction of the daily temperature variations near the water body. In the case of Middle Yeywa reservoir, some minimal effects on temperature and humidity can be expected at local level.

Evaporation from the surface of the reservoir will replace the present evapotranspiration from the soil of the area to be covered by the reservoir. In certain months, evapotranspiration from the soil would exceed the evaporation from the reservoir as a result of heavy rainfall periods when the soil becomes saturated (see Section 8.2.6).

Mitigation measures:

- N/A

GHG emissions: The operation of the Middle Yeywa power plant is intended to supply renewable energy using a technology which is not generally considered to cause GHG emissions. Assuming that the power generation will replace fossil fuel based electricity generation, it will instead contribute to avoidance of GHG emissions from those other sources.

However, under certain conditions, hydroelectric projects can turn into a significant source of GHG emissions. This mostly applies to relatively shallow hydroelectric reservoirs in tropical areas with low energy production / flooded area ratio (i.e. power density).

According to the Intergovernmental Panel on Climate Change (IPCC 2006), there is usually a rapid surge of reservoir emissions immediately after flooding, after which emissions return to a relative stable level. Evidence suggests that CO_2 emissions for approximately the first ten years after flooding are the results of decay of some of the organic matter on the land prior to flooding.

Subsequent to flooding (and land clearing), CO_2 emissions, and CH_4 (methane) emissions if applicable, can occur via the following pathways:

- Diffusive emissions, due to molecular diffusion across the air-water interface;
- Bubble emissions, or gas emissions from the sediment through the water column via bubbles;
- Degassing emissions, or emissions resulting from a sudden change in hydrostatic pressure, as well as the increased air/water exchange surface after reservoir waters flow through a turbine and/or a spillway

The power density of the Middle Yeywa project is 64 (i.e. 700 MW / 11 km^2), which is significantly higher than the threshold of 10 W/m^2 above which the overall GHG emissions can be assumed to be zero (IPCC 2006). More recently, an even lower threshold (5 W/m^2) has been recommended based on more up-to-date evidence and research (including observations from the G-RES data set). Hence, even if there would be GHG emissions from the reservoir beyond the initial few years, they are considered to be negligible in comparison to the high power production that will replace emissions from fossil fuel based electricity generation (***Table 8-1***). The inundation areas do not contain wetland areas or other areas with substantial volumes of organic material that could be converted to greenhouse gases like the highly potent GHS methane following inundation.

For this reason (and because of insufficient data), detailed modelling of reservoir emissions has not been undertaken at this stage. There are also few mitigation measures available other than the planned removal of biomass from the inundation zone prior to filling of the reservoir.

Mitigation measures:

- Conduct pre-impoundment vegetation clearing in order to reduce emissions from decay of organic matter in the reservoir.

Table 8-1: Estimated CO_2 emissions produced by a steam-electric generator for different fuels.

Fuel	**kg CO_2 / kWh***	**tonnes CO_2 / 3,253 GWh**
Coal (Bituminous)	0.94	3,057,820
Coal (Sub-bituminous)	0.98	3,187,940
Coal (Lignite)	0.99	3,220,470
Natural gas	0.55	1,789,150
Distillate oil (No. 2)	0.76	2,472,280
Residual oil (No. 6)	0.82	2,667,460

* Source: EIA (US Energy Information Administration), March 30, 2015.

<u>Conclusion</u>

Phase	Magnitude – Climate
	Large Negative | *Medium Negative* | *Low/Insignificant* | *Medium Positive* | *Large Positive*
Construction	
Operation	

8.2.4 Air Quality

<u>Construction Phase</u>

Air pollution: The main impact to air quality during construction will be from increased dust levels arising from construction machinery, blasting, quarrying, excavations, earthworks, cement mixing and road construction. Emissions of small particles from diesel trucks as well as dust pollution have not been estimated, but the impacts from these emissions will be intermittent and short term. In addition to emissions of particles, there will be minor emissions of NOx and SO_2 from construction machinery, vehicles and from diesel power generators.

Mitigation measures:

- Water shall be sprayed on dirt roads to minimise dust dispersion when necessary, in particular in the vicinity of inhabited areas along transport corridors;
- Trucks transporting loose/friable materials shall be covered by tarpaulins to reduce wind entrainment of dust;
- Stockpiles of excavated soils located near residential areas shall be subject to water spraying.

Operation Phase

Air pollution: Air pollution during the operation phase is expected to be very limited. The main source of air pollution will be from vehicle emissions and dust from traffic on unpaved roads. In addition, there might be some dust caused by wind erosion from construction sites before they are properly re-vegetated.

Mitigation measures:

- N/A

Conclusion

Phase	Magnitude – Air Quality				
	Large Negative	*Medium Negative*	*Low/Insignificant*	*Medium Positive*	*Large Positive*
Construction		▲			
Operation			▲		

8.2.5 Noise and Vibration

Construction Phase

Construction noise: During construction, noise will be generated from vehicular movements, quarrying, sand and aggregate processing, concrete mixing, excavation machinery, blasting operations, etc. Noise levels in the construction area from machinery and vehicles will be quite high (typically from 80 to 95 dBA at a distance of 15 m). However, due to very few people living near the construction sites, the noise impacts will mainly be experienced by construction workers while community exposure will occur along the main access road due to increased traffic into the project area. Ground vibration caused by blasting will only occur at the main construction site (dam and powerhouse), a long distance from the nearest receptor.

Mitigation measures:

- Noisy installations shall be located in adequate distance to residential areas to meet noise limit values;
- Noisy activities shall be scheduled to daytime hours if possible;
- Noise control devices shall be installed in construction equipment if noise levels exceed the applicable guidelines.

Operational Phase

Operation noise: The only source of noise during the operation phase is the traffic to and from the power station and offices. The impact will be intermittent and short-term. The noise level from the operation of turbines and generators is expected to be insignificant (except occupation noise).

Mitigation measures:

- N/A

Conclusion

Phase	Magnitude – Noise and Vibration				
	Large Negative	*Medium Negative*	*Low/Insignificant*	*Medium Positive*	*Large Positive*
Construction		▲			
Operation			▲		

8.2.6 Hydrology

Construction Phase

River diversion: To allow for the construction of the Middle Yeywa dam, the Myitnge River will be temporarily diverted by means of upstream and downstream cofferdams and a diversion tunnel. However, this bypass arrangement will not affect the "natural" flow regime in the river (in terms of water volume) during the construction phase (until initial filling of the reservoir, see below). It should be noted that the river discharge, at the time of construction, is likely to be controlled or modified by the Upper Yeywa power plant which is currently under construction.

Mitigation measures:

- N/A

Reservoir filling: The filling of the Middle Yeywa reservoir will be done at the very end of the construction phase before commissioning. The filling schedule has not yet been defined, but it will allow for release of a continuous minimum flow during filling. This water can for instance be released through the lower level outlets during initial filling. The amount of water being released will depend on, inter alia, dam safety requirements (filling should be slow to ensure the integrity of the dam), the timing/season and duration of filling, and the downstream water demand (i.e. power generation at Yeywa HPP).

Given the short distance between the dam and the tail of the Yeywa reservoir, combined with the fact that this river reach will be severely affected once the power plant has been commissioned, the downstream water demand may be defined both by ecological requirements and by power generation needs in the downstream Yeywa power station.

The minimum flow to be adopted for the reservoir filling period will be negotiated and agreed once the project design has reached feasibility stage and further details are known about the joint operation of the power plants in the cascade.

Mitigation measures:

- Ensure continuous release of minimum flow during the initial filling of the Middle Yeywa reservoir not less than the minimum flow for the operation phase (to be defined).

Operational Phase

Reduced flow in the diversion reach: Since the powerhouse will essentially be located at the foot of the dam within a distance of less than 200 m from the dam axis to the turbine outlets, the project is proposed to be operated without release of environmental flow into the short diversion reach. This may cause a complete dewatering of the river below the dam (depending on local topography of the river bed and the backwater effect from the tailrace), except when there is spilling of water over the dam or the gates are open. The volume and frequency of spilling have not yet been modelled, but the limited storage capacity of the reservoir suggests that spilling will occur during much of the rainy season (when inflows are significantly higher than the maximum turbine flow) and in periods where the power station is not operating (e.g. due to power grid failures or faults in the power station). When the downstream Yeywa reservoir is full, the reservoir may reach the foot of the Middle Yeywa dam effectively creating a lake-like environment between the Middle Yeywa and Yeywa dams. The duration of such situation in an average year is not known at present.

Mitigation measures:

- N/A

Hydro-peaking effects: The Middle Yeywa power station will be operated as a peaking scheme. However, given the very limited live storage of Middle Yeywa, hydro-peaking will only be undertaken in parts of the year. The detailed operation regime of Middle Yeywa will be defined following the Power Purchase Agreement (PPA) negotiations between the Developer and the Government of Myanmar.

The operation of the plant will most likely vary from running continuously at full capacity (580 m^3/s) to running at full capacity only for a few hours. The power station will probably run at full or near full capacity in the rainy season/periods of high inflow to the reservoir, which is likely to be kept at FSL to avoid head loss. When the inflow to the reservoir is less than the turbine capacity, the power plant is likely to be operated in peaking mode. This means that water will be stored in the reservoir daily, and then the reservoir's live storage can be used to run the power plant at full or near full capacity for a shorter or longer period of the day depending on the water availability and power demand.

For periods of the year, hydro-peaking is likely to involve 7 to 10 hours of operation at full design discharge (580 m^3/s) combined with 14 to 17 hours of operation only to release a minimum flow or no operation (to refill the reservoir up to FSL). The maximum drawdown will be 0.5 m from FSL at 317 masl. to a minimum of 316.5 masl. (subject to verification during feasibility study and detailed design). This implies that the river downstream of the turbine outlets will be subject to only the minimum flow or zero flow in hours of refilling the reservoir (i.e. 14 to 17 hours per day in the example above). The distance of the downstream dewatered river section will depend on how far the Yeywa reservoir at any given time backs up in relation to the tailrace of Middle Yeywa.

Such extreme hydro-peaking involves very high ramping rates, i.e. rapid fluctuations in downstream river flows and water levels. However, in the case of Middle Yeywa, the turbine outlets empty the water into the river a short distance upstream of the existing Yeywa reservoir, in periods of the year probably directly into the Yeywa reservoir. The water level in these downstream reaches is largely controlled by the backwater effects of the Yeywa reservoir, at least during the rainy season and when the downstream reservoir is operated at FSL (185 masl.). This means that the length of the river section between the Middle Yeywa tailrace and the Yeywa reservoir will vary through the year, possibly from no river section at all (lake-like environment between the Middle Yeywa and Yeywa dams) to a river section of at least 1 km.

A likely important consideration for the Government of Myanmar is the joint operation of the cascade consisting of the Upper and Middle Yeywa HPPs that have relatively small live storage capacity and the downstream Yeywa HPP with a substantial live storage capacity. For instance, the Upper Yeywa and Middle Yeywa HPPs may either be running in the same daily mode or be allocated one of the two daily peaking periods (morning or evening) to each of the schemes. An example of daily fluctuations in reservoir level and turbine flow (equal to downstream river flow immediately below the turbine outlets in periods without spilling) is shown in ***Figure 8-3***.

Despite the short but varying distance between the tailrace of Middle Yeywa and the backwaters of the Yeywa reservoir, the extreme fluctuations in downstream flow (including several hours with very small or no flow) will have a significant local impact on riverbank and riverbed stability, aquatic life and potentially on the movement of terrestrial wildlife across the river (loss of existing barrier effect). This applies especially to the dry season when the Yeywa reservoir is drawn down to its lowest level, thus exposing the upstream river reach. For this reason, a less extreme peaking operation should be considered in order to maintain a continuous flow downstream of the turbine outlets. This can be achieved for instance by always running one turbine even in non-peak hours.

Mitigation measures:

- Always running at least one of the turbines in non-peak hours in order to maintain a continuous minimum flow between the tailrace and the downstream Yeywa reservoir.

- Carefully consider the ramping rates to reduce downstream safety risks and environmental impacts.

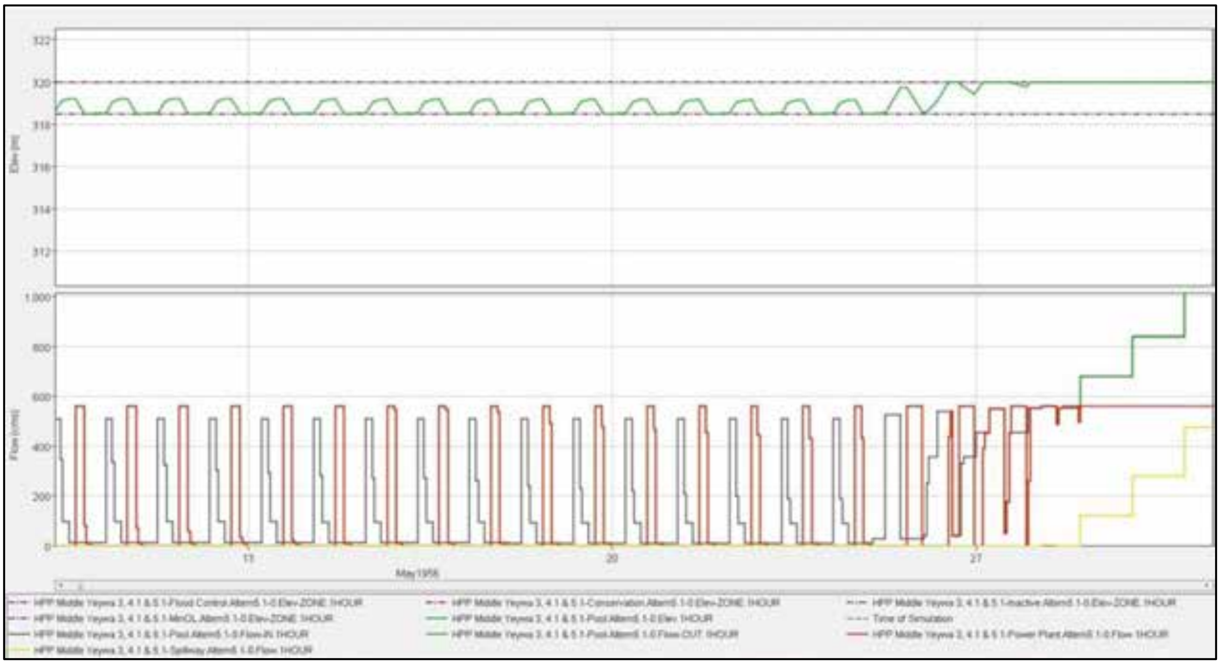

Figure 8-3: Example of daily fluctuations in reservoir level and turbine flow for peaking operations.
Source: Pöyry (2015)

Downstream flows during power station outages and after sediment flushing: The hydrological effects of planned or unplanned outages of the power station (including maintenance works) will resemble those of the no operation hours during unmitigated peaking operation, i.e. no turbine flow and no downstream flow. Such power generation stops may last for minutes, hours, days or even weeks, potentially having adverse impacts on the downstream environment (depending on the water levels in the downstream Yeywa reservoir and the time it takes for spilling to start at Middle Yeywa). However, instead of installing a bypass valve in the power station, water can be released from the reservoir by opening the spillway gates in order to compensate for the lack of turbine flow, assuming the gates are at a level that ensures flow. This will ensure that the no flow period during outages of the power station is minimised. Timely opening of the gates can ensure continuous water in the downstream section. The exception would be (i) if the outage occurs in an extreme low flow period and the reservoir level is below the Ogee crest, in which case it may take a longer period to fill the reservoir up to the level of the spillway gates, and (ii) during refilling of the reservoir after sediment flushing operations when the reservoir is drawn down to approx. 245 masl. (see Section 8.2.7). Alternatively, the use of the sediment flushing gates or alternative water release mechanisms can be considered.

Mitigation measures:

- Make provisions for immediate opening of the spillway gates or alternative mechanisms to release a minimum flow in case of power station outages;
- Make provisions for release of a minimum flow through the mid-level outlets or alternative mechanisms during the reservoir refilling period associated with sediment flushing operations until water is released through the turbines.

Evaporation from reservoir: Dam reservoirs transform the river and its riparian/terrestrial zone into a permanent water body. The moderate increase in water surface will cause higher evaporation, but the loss of water will be insignificant compared to the total river flow. According to Tractebel (2017), the net evaporation losses over the year will amount to approx. 250 mm per year (***Table 8-2***).

Mitigation measures:

- N/A

Table 8-2: Net evaporation losses for the Middle Yeywa reservoir in mm per year.

Period	Pan Evaporation (mm)	Reduction coefficient (-)	Lake Evaporation $E_{reservoir}$ (mm)	Precipitation (mm)	Actual Losses (mm)	Net Losses due to reservoir creation (mm)
Jan	78	0.8	62	8	5	57
Feb	97	0.8	78	2	1	76
Mar	138	0.8	110	14	9	102
Apr	174	0.8	139	33	20	119
May	152	0.8	122	135	84	38
June	115	0.8	92	191	118	-26
July	100	0.8	80	261	162	-82
Aug	98	0.8	78	360	223	-145
Sep	105	0.8	84	164	102	-18
Oct	107	0.8	86	121	75	11
Nov	97	0.8	78	27	17	61
Dec	81	0.8	65	10	6	59
Year	**1 342**		**1 074**	**1 326**	**822**	**251**

Source: Tractebel (2017)

Changes in groundwater tables: River impoundment and the altered flow regime will to some extent affect the groundwater tables along the riverbanks, including the shores of the Middle Yeywa reservoir. However, the Myitnge River has little influence on the overall hydrogeology on the Shan Plateau and no influence on water availability in the groundwater wells used by people. This is due to the fact that the reservoir shores will be located relatively deep down in the river valley quite far away from the settlements in terms of both vertical and horizontal distance from the plateau. Localised impacts on alluvial water tables will occur in the downstream reaches (due to hydro-peaking) and, for example, on the riverbanks along the Gotheik tributary in the upper end of the reservoir.

Mitigation measures:

- N/A

<u>Conclusion</u>

Phase	Magnitude – Hydrology				
	Large Negative	*Medium Negative*	*Low/Insignificant*	*Medium Positive*	*Large Positive*
Construction			▲		
Operation		▲			

8.2.7 Sediment Transport

<u>Construction Phase</u>

Sediment releases from construction works: During the construction phase, soil erosion from earthworks, including construction and removal of cofferdams, and runoff of crushed and ground rock material from drilling, blasting, stone crushing, etc. are expected to cause increased sediment load, and hence increased turbidity and other water quality impacts in the downstream reaches of the river and in the upper end of the existing Yeywa reservoir. A proportion of the particles mobilised will not be naturally eroded and rounded particles but rather sharp-edged or needle shaped particles that can have damaging effects on aquatic life (see Section 8.2.12). Sediment releases will also occur as a result of in-stream construction works at the new Myitnge Bridge (and demolition of the old bridge).

Mitigation measures:

- Erosion control practices including timely installation of drainage shall be implemented prior to any major soil disturbance on the riverbanks;
- Sedimentation controls shall be implemented in the form of silt trap fences, sedimentation ponds and drainage channels where appropriate;
- Coffer dams shall be constructed such as to minimise releases of sediments and pollutants to the downstream environment (e.g. avoiding rock material with high content of fine particles);
- All the water draining down from tunnelling operations, batching plants, crusher plants, etc. shall be led to sedimentation and neutralisation ponds and has to be treated until acceptable water quality is achieved before releasing it to the recipient water body;
- Close monitoring of water quality should be undertaken to track changes in water quality and inform decision-making on required changes to mitigation strategies.

Operational Phase

Sediment trapping and flushing: The Middle Yeywa dam will obstruct the flow of sediments from the upstream to the downstream. Coarse sediments (sand, gravel) and bedload will be deposited in the upstream reach of the reservoir before progressively filling up the lake towards the dam, while a fraction of the fine sediments (clay and silt) will remain suspended and enter the waterways/turbines or pass over the dam during spilling.

The sediment management plan for the Middle Yeywa reservoir has not yet been defined. This is mainly due to the lack of detailed data on sediment transport in the Myitnge River and especially the lack of a sediment management plan for the Upper Yeywa reservoir. It should also be noted that the extent of sedimentation in the existing Yeywa reservoir, commissioned in 2010, has not been documented.

However, Tractebel (2017) has conducted modelling of sediment transport and sediment deposition patterns in the Middle Yeywa reservoir based on available data. The results show that the reservoir will greatly profit from the sediment trap created by the Upper Yeywa reservoir where an estimated 51% of the sediments will be captured.

Figure 7-29 shows the bed level developments (longitudinal profiles) in the Middle Yeywa reservoir after 0, 5, 10, 15, 20, 25 and 30 years (without sediment flushing). It appears that the progress of the sediment delta within the first 30 years of operation is in acceptable limits and does not reach the Middle Yeywa dam (i.e. does not affect the power intakes). However, sediment deposition in the upper end of the reservoir will gradually affect the tailwater level at Upper Yeywa HPP (323 masl. at rated flow), causing a reduction in the available head by as much as 2.0 m after 15 years of operation (when the tailwater elevation is at 325 masl.).

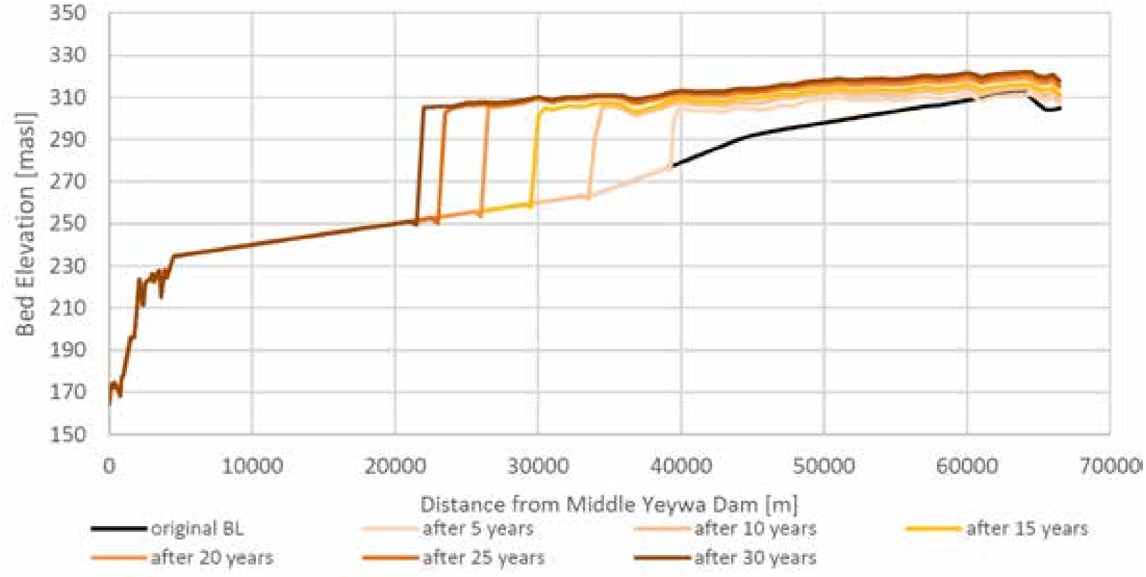

Figure 8-4: Bed level development in the Middle Yeywa reservoir over 30 years without flushing.
Source: Tractebel (2017)

As explained above, the Upper Yeywa will serve as a sediment trap for Middle Yeywa, meaning that the sediment inflow into Middle Yeywa is significantly reduced. However, as soon as the sediments, which accumulated over the years in Upper Yeywa, will be flushed, the sediment will flow in a very high concentration into the Middle Yeywa reservoir and settle there. According to Tractebel (2017), the total sediment inflow into the Middle Yeywa reservoir during normal operation of Upper Yeywa HPP will be approx. 9.1 Mm^3 per year, while sediment flushing will add another 10 Mm^3 per year (on average) from the year that flushing begins. This calls for a joint operation regime whereby sediment flushing is performed simultaneously at Upper Yeywa and Middle Yeywa.

Tractebel (2017) estimated that the first flushing at Upper Yeywa will occur in the 19th year of operation, when the dead storage of its reservoir (and 20% of its active storage) has been filled. Assuming that the Middle Yeywa HPP will be commissioned 4 years after Upper Yeywa HPP, the first flushing at Middle Yeywa will then occur in the 15th year of operation.

Without having access to the sediment management strategy for Upper Yeywa HPP, Tractebel (2017) assessed two different flushing scenarios; an annual flushing cycle and a 4 years flushing cycle. These two scenarios involve an 8 days and a 33 days flushing duration, respectively, while the flushing period would be in mid/late-August for the annual flushing alternative and the whole of August (until 3rd September) for the 4 year flushing alternative. This will allow the flushing to occur when the river has high sediment concentrations while also ensuring that sufficiently high flows will be available to refill the reservoir before the end of the rainy season.

The flushing operation for the two alternatives described above will be accomplished as follows:

Annual flushing cycle:

- Objective: flushing 10 Mm^3 of sediments out of the Middle Yeywa reservoir.
- The water level will be drawn down to approx. 245 masl. (i.e. 75 m below FSL) at a rate of 2.0 m per day by opening the mid-level outlets.
- With this operation, power production is interrupted for 64 days per year.

4 years flushing cycle:

- Objective: flushing 40 Mm^3 of sediments out of the Middle Yeywa reservoir.
- The water level will be drawn down to approx. 245 masl. (i.e. 75 m below FSL) at a rate of 2.0 m per day by opening the mid-level outlets.

- With this operation, power production is interrupted for 87 days every 4 years.

Figure 8-5 illustrates the water level development in Middle Yeywa as well as Upper Yeywa for the two flushing scenarios (but note that the water level will depend on the prevailing discharge).

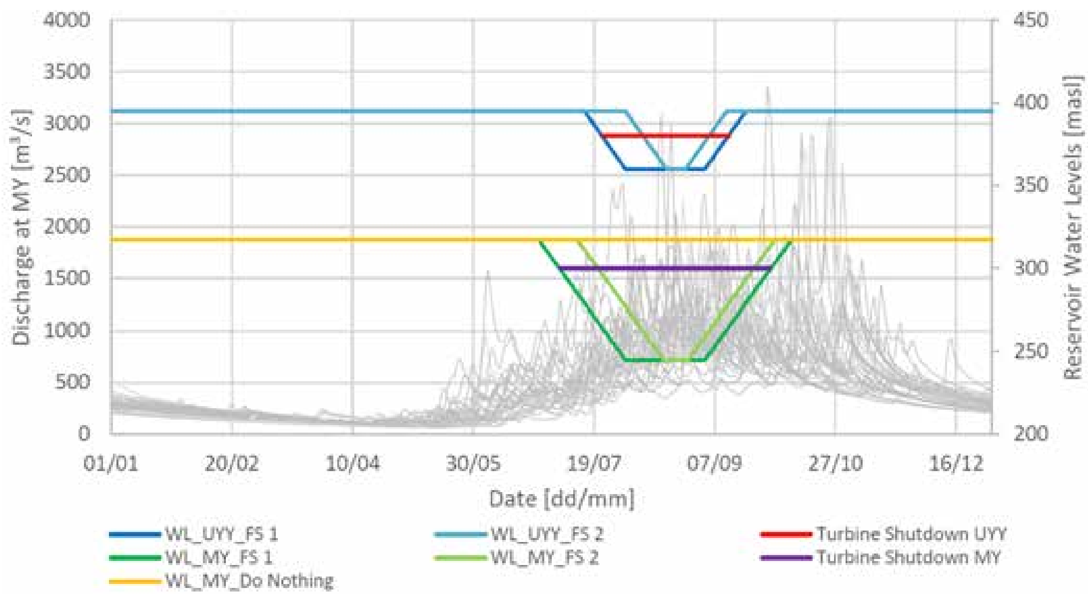

Figure 8-5: Water level at Middle Yeywa and Upper Yeywa for the two flushing scenarios.
Source: Tractebel (2017)
Note: UYY = Upper Yeywa; MY = Middle Yeywa; FS 1 = 4 years flushing cycle; FS 2 = annual flushing cycle

Figure 8-6 and ***Figure 8-7*** show the bed level developments (longitudinal profiles) in the Middle Yeywa reservoir after 0, 5, 10, 15, 20, 25 and 30 years for the two flushing scenarios (i.e. annual flushing and a 4 years flushing cycle). Both alternatives seem to perform satisfactory in remobilising sediments in the upper reach of the reservoir and keeping the lamella of active storage for the peaking operation free of sediments. However, whereas the annual flushing cycle achieves balanced and stable bed level elevations over the years, the 4 years flushing cycle results in prolonged sediment accumulation in the periods between the flushing events.

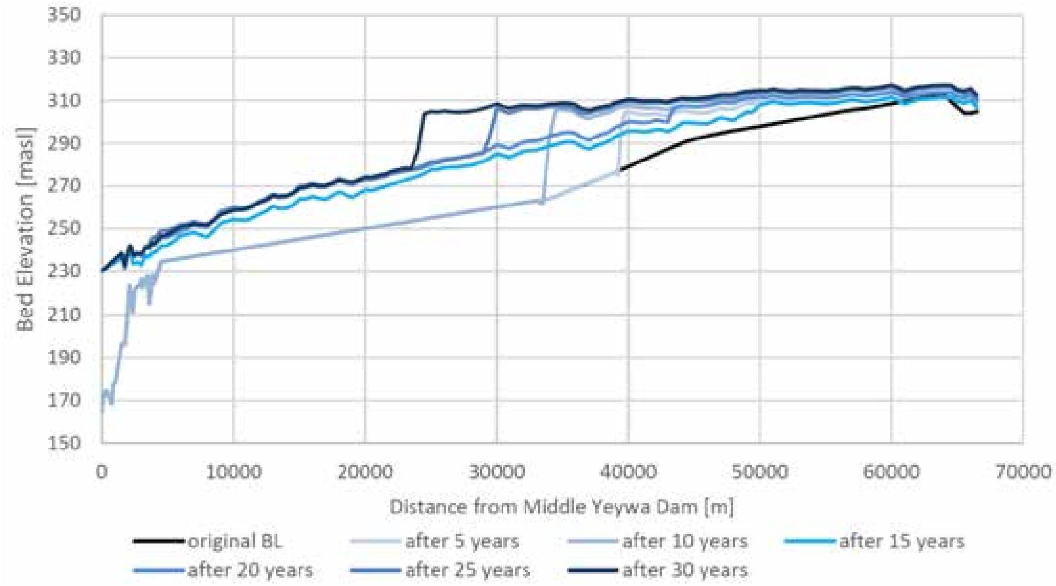

Figure 8-6: Bed level development in the Middle Yeywa reservoir over 30 years with a 4 years flushing cycle.
Source: Tractebel (2017)

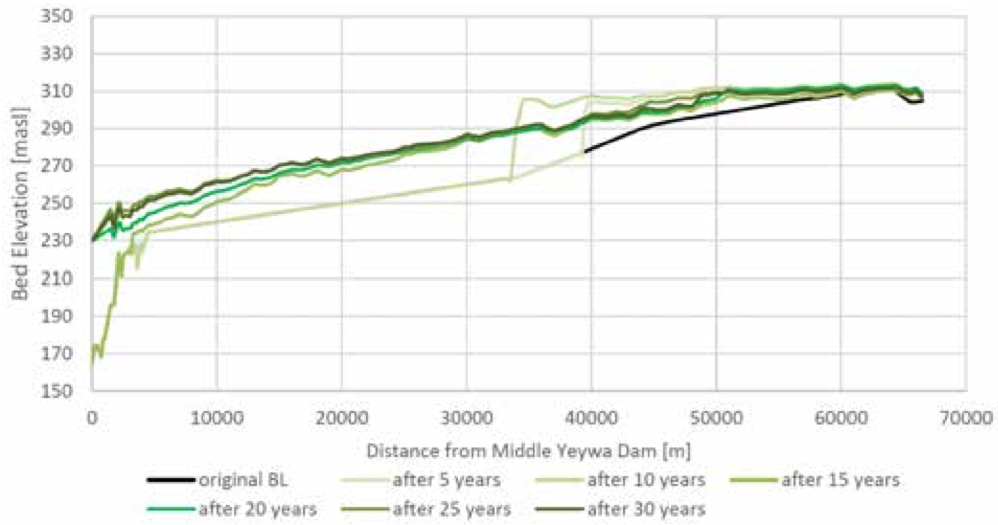

Figure 8-7: Bed level development in the Middle Yeywa reservoir over 30 years with an annual flushing cycle.
Source: Tractebel (2017)

In conclusion, the 4 years flushing cycle is clearly preferable in terms of minimising the number of days without power generation (caused by reservoir drawdown for flushing operation). The long-term average period of loss of power generation at Middle Yeywa HPP is about 3 times shorter when flushing is performed only every 4 years. On the other hand, the accumulation of sediments in the upper reaches of the reservoir is more distinct for this flushing scenario while the annual flushing cycle appears to be less critical with respect to a long-term increase of tailwater elevations at Upper Yeywa.

Tractebel (2017) recommends 4 years flushing cycle due to its economic advantage (increased power generation) while also calling for a flexible strategy that can be adjusted in response to observed sediment deposition in the upper end of the reservoir. If critical deposition of sediments is observed during the operation of Middle Yeywa, either local measures should be implemented to remove sediments from the tail end of the reservoir, or a limited reservoir drawdown can be carried out (in addition to the flushing itself) in order to remobilise the sediments deposited in the upper reach of the reservoir. Since the maximum top elevation of the sediment delta is calculated to be approx. 321.0 masl., a drawdown to MOL in Middle Yeywa – without a discontinuation of power generation – is expected to be sufficient. However, in the worst case, a higher flushing frequency would become necessary.

Mitigation measures:

- Update the sediment management strategy in response to detailed monitoring of sediment transport in the Myitnge River in the years up to commissioning and subsequently of observed sedimentation processes in the Middle Yeywa reservoir;
- If local measures are required in the upper end of the reservoir (e.g. excavations or dredging), then impose strict environmental conditions on the contractor to avoid chemical spills and excessive water turbidity.

Sediment transport in the downstream: The Middle Yeywa dam will significantly reduce the total sediment load in the downstream under normal operation. Combined with the trapping of sediments at Upper Yeywa, the turbine flow (and spills from the dam) will be starved of coarse sediments. This will have the consequence that sand and gravel deposits in the river below the dam will not be renewed from upstream (except during sediment flushing) and the sediment-depleted water below the dam and tailrace will erode and transport sediments downstream, causing channel and bank erosion in river sections with substrate that contains silt and sand. In periods with a high level of the Yeywa reservoir, silt is likely to be deposited shortly downstream the Middle Yeywa tailrace, while in periods of low level of the Yeywa reservoir these sediments are likely to be washed into the downstream reservoir. There is likely to be a net loss of sediments in the section between the Middle Yeywa dam and the Yeywa reservoir.

Riverbank erosion will also be caused by the daily variations in downstream water level (due to hydro-peaking, but depending on the backwater effect of the Yeywa reservoir). When the water level is high during operation, the riverbank will be saturated with water until it has achieved its equilibrium between the water pressure inside the bank and the external pressure exerted by the river water. When the power plant stops, the water level will drop. The external water pressure will disappear while the internal pressure will still be present. This will cause rapid outward directed water movements in the bank, loosening the soil structure in the riverbank surface. When the flow is increasing again, due to start-up of the power plant, the scouring forces of the current will erode part of this loose bank zone. In the long run, this will erode the lower part of the riverbank causing slides, tree-fall and increased sediment load in the river downstream. It should be noted that parts of the river bank consist of steep bedrock or boulders that will not be subject to these processes. Consequently, erosion does not represent a major environmental risk in the downstream reaches and the impacts will remain highly localised.

The fact that the tailrace outlet is located a very short distance upstream of the existing Yeywa reservoir, combined with the trapping of sediments behind the Upper Yeywa dam, suggests that the relative contribution of the Middle Yeywa dam in altering sediment transport in the Myitnge River is relatively less than it would be without those cumulative impacts.

The critical issue in terms of downstream sediment transport is rather associated with the sediment flushing events described above. Irrespective of the flushing frequency (e.g. annual or 4 years cycle), such release of sediments into the downstream environment will cause a short term pulse of high sediment load dominated by fine fractions (mostly silt and clay). These sediments will partly be deposited in the short downstream river reach but mostly be carried into the Yeywa reservoir where they will settle and contribute to sediment accumulation. Sediment accumulation in Yeywa reservoir takes place at present but will be in pulses determined by sediment flushing at Middle Yeywa (if constructed). Without Middle Yeywa, the sediment pulses will be governed mainly by the sediment flushing at Upper Yeywa and floods. Some fine sediments may also remain in suspension all the way down to the Yeywa power station, where they will be released through the turbines or the spillway. It should be noted, however, that the total volume of sediments entering the Yeywa reservoir and further downstream will be significantly less than at present without the upstream dams (Upper Yeywa and Middle Yeywa). The long-term sediment management strategy for the Yeywa HPP is not known, but it is likely that flushing may not be required due to the large size of the reservoir (2,600 Mm^3 compared to 400 Mm^3 for Middle Yeywa) combined with the reduced sediment inflow caused by the planned upstream dams.

Mitigation measures:

- N/A

<u>Conclusion</u>

Phase	Magnitude – Sediment Transport				
	Large Negative	*Medium Negative*	*Low/Insignificant*	*Medium Positive*	*Large Positive*
Construction			▲		
Operation		▲			

8.2.8 Water Quality

<u>Construction Phase</u>

Water pollution: During the construction phase, soil erosion from earthworks, including construction and removal of cofferdams, and runoff of crushed and ground rock material from drilling, blasting, stone crushing, etc. are expected to cause increased sediment load, and hence increased turbidity in the downstream reaches of the river and in the upper end of the existing Yeywa reservoir. As mentioned in Section 8.2.7, sediment releases will also occur as a result of in-stream construction works at the new Myitnge Bridge (and demolition of the old bridge).

In addition, accidental fuel and oil spills from construction machinery, and leaching of ammonia and other nitrogen compounds from the blasting and soil rock deposits, may cause pollution of the river unless effective mitigation measures are put in place. Another source of water pollution is represented by the batching plants and concrete works particularly by the effluent from concrete wash water which consists of wastewater with high pH and contaminants from the concrete additives.

The construction sites and workers' camp will generate sanitary effluents which are potential sources for microbiological and organic pollution of surface and ground water. The workers' camp will also produce domestic waste amounting to an estimated 0.5 kg/capita/day. Unless the waste and wastewater from domestic or construction origin (e.g. scrap metal, wood, plastic, cement bags, used tires and batteries, etc.) is adequately managed, it may result in pollution of both surface and ground water sources. Depending on the exact location of the workers' housing facilities, such pollution may either be localised or enter the Myitnge River.

The risk of tunnelling discharges requires special attention, as tunnelling works generate effluents that are typically high in suspended sediments and can have pH significantly different from receiving surface water bodies (IFC 2018). For example, tunnelling discharges can be strongly alkaline because of the use of standard cement or "shotcrete" in tunnel grouting activities, or strongly acidic because of the presence of acid generating rock, termed Acid Rock Drainage or ARD. The introduction of fine cement particles from cement grouting and shotcreting used to seal the walls of tunnels can result in extremely high pH in the tunnel effluent and receiving water body. The pH and suspended solids of tunnel wastewater discharges, as well as in the Myitnge River, should therefore be mitigated and closely monitored.

Mitigation measures:

- Erosion control practices including timely installation of drainage shall be implemented prior to any major soil disturbance. Activities on the riverbanks require particular measures;

- Sedimentation controls shall be implemented in the form of silt trap fences, sedimentation ponds and drainage channels where appropriate;
- Coffer dams shall be constructed such as to minimise releases of sediments and pollutants to the downstream environment (e.g. avoiding rock material with high content of fine particles whenever possible);
- All the water draining down from tunnelling operations, dam foundations, power house pit, batching plants, crusher plants, etc. shall be led to sedimentation and neutralisation ponds and has to be treated until acceptable water quality is achieved before releasing it to the recipient water body;
- Storage and handling of fuel and hazardous materials shall be kept away from the river;
- Storage areas for fuel and other hazardous materials as well as hazardous waste shall be roofed and have a concrete floor with a bund for secondary containment and collection of spills proving at least 110% volume of the total capacity of the stored materials/waste;
- All storage areas and major construction sites shall have spill kits, sand, dust, and other appropriate absorbent materials;
- Sanitary water treatment facilities shall be installed in the workers' camp;
- A proper waste management system including waste tracking systems and approved waste disposal procedures should be established and implemented;
- Close monitoring of water quality should be undertaken to track changes in water quality and inform decision-making on required changes to mitigation strategies.

Operation Phase

River impoundment: The Middle Yeywa dam will create a reservoir extending about 70 km upstream and with a surface area of approx. 11 km^2 and a total volume of 400 million m^3 (at FSL). The depth of the reservoir will be 135-140 m at the dam and reduce substantially above the rapids about 4 km upstream of the dam site and from there gradually reduce to zero toward the upstream end of the reservoir where a dynamic delta will evolve. The river will thus be converted into an artificial lake with fluctuating water levels in response to the operation of the power station (i.e. daily peaking and inter-annual drawdown for sediment flushing). This change from a free-flowing river into a lentic slow flowing water body will alter many physical, chemical and biological characteristics of the water within and downstream of the reservoir.

In general, the nature and extent of water quality changes depends on the retention (turnover) time of the reservoir – its storage capacity in relation to the amount of water flowing into it – and the pre-impoundment conditions, especially the amount of submerged biomass. The amount of organic material introduced by the main river and tributaries may also influence water quality. Water vegetation, particularly potential invasive species that establish a large biomass, may also influence the water quality.

Possibly the greatest risk is related to reservoir stratification, i.e. the creation of different layers in the water column due to differences in water density. This is usually thermal stratification related to varying densities of water with temperature but can also be related to differences in salinity. Stratification can result in an anoxic zone (water without oxygen) at the bottom layer of the reservoir due to microbial decomposition of flooded vegetation and other organic matter that may accumulate in the bottom layers of the reservoir. Stratification in Middle Yeywa is most likely to occur through density variation with temperature, and it is affected by physical characteristics such as reservoir depth, water retention time, water level fluctuations, atmospheric temperature and factors that can cause mixing of the water masses such as inflowing river and exposure to wind/waves.

In order to evaluate the risk of reservoir stratification and water quality deterioration, the following characteristics of the Middle Yeywa HPP should be taken into account:

- The reservoir has an average retention (turnover) time of 10 days

- The maximum depth of the reservoir is 135 m but the depth will be less than 80 m upstream of the rapids (about 2 km from the dam site) and significantly less towards the middle and tail end of the reservoir;
- The forest within the reservoir area will be cleared prior to commissioning, thus reducing the decomposable biomass;
- The amount of organic matter and nutrients entering the reservoir is not particularly high, will be further reduced due to the Upper Yeywa reservoir and is not expected to create eutrophic conditions.
- Continued conversion of forest areas to commercial agriculture with use of artificial fertilisers could result in increased runoff and increased contributions of organic matter and nutrients.
- Potential establishment of invasive alien plant species in the reservoir could also increase input of organic matter to the reservoir.

The risk of stratification can be evaluated based on limnologic theory (e.g. ***Figure 8-8***). According to the revised classification system for lakes based on mixing (Lewis 1983), the shallow upper part of the reservoir will probably have a "continuous warm polymictic" behaviour, which implies regular full mixing of all water up to 20 m depth or more. As the gradual accumulation of gravel and sand sediment fractions will occur first in the upper part of the reservoir, reducing the depth of free water, the mixing process will become complete and regular for all reservoir levels in the upstream section of the reservoir. Thus, the upper shallow part of the reservoir will be characterised by homogenous conditions for water temperature and water quality.

TABLE 1. Latitude adjustment per 100 m of elevation required to bring a lake to zero elevation for lake classification purposes.

Latitude (Degrees)	Latitude adjustment (Degrees per 100 m elev.)
0	0.27
10	0.31
20	0.34
30	0.39
40	0.46
50	0.54
60	0.68
70	0.89
80	1.3
90	2.4

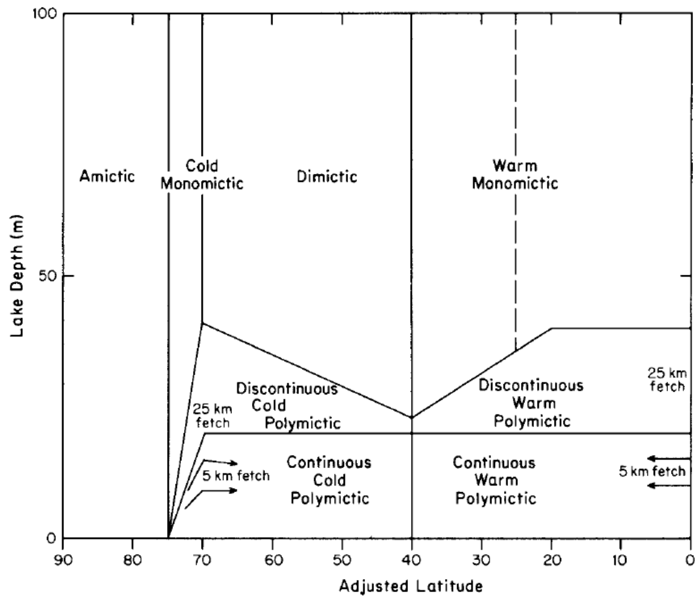

FIG. 2. Estimated distribution of the eight lake types of the revised mixing classification in relation to latitude (adjusted for elevation, see text) and water depth.

Figure 8-8: The revised classification system for lakes based on mixing.
Source: Lewis (1983)

In contrast, the deep part of the reservoir near the dam will be classified as "warm monomictic". This means there will normally be a full mixing of deep and shallow water layers once per year when the surface water temperature cools below the temperature of the bottom layers and full vertical circulation of water masses occur. There is a possibility that this mixing will not occur every year and not succeed in mixing all pockets of deep water (meromictic). Available information does not provide clarity on the frequency of full mixing or if full mixing is likely to occur at all in the deepest parts of the reservoir.

The deep part of the reservoir (hypolimnion) will be subject to a gradual accumulation of cooler denser water below the stratified layer (thermocline) which will persist for most if not all of the year. This temperature stratification typically prevents replenishment of oxygen in the deeper water mass. It is not possible with the current scarcity of data to predict the depth of the thermocline or to confirm whether anoxic conditions will occur in the bottom layers, but the possibility cannot be excluded even if the retention time of the reservoir is relatively short and pre-impoundment biomass clearing is implemented. Surveys in the downstream Yeywa reservoir could give indications of risks in the Middle Yeywa reservoir and give useful information on what appropriate mitigation and monitoring may consist of.

With an intake at elevation 282 masl. (i.e. 38 m below FSL), there is a risk that the power station will be drawing off water with a deficit of oxygen from the hypolimnion and in the worst case releasing anoxic water downstream with high content of hydrogen sulphide causing foul odours and poor water taste. Such problems have been recorded in many new tropical reservoirs, although mainly in reservoirs with a longer retention time. The risk is particularly high in the initial years after impoundment due to degradation of the newly flooded organic matter. Indeed, there is anecdotal evidence that such impacts occurred after the impoundment of the downstream Yeywa reservoir, probably caused by its much greater water volume and lack of biomass clearing in the reservoir.

The potential problem of releasing anoxic water downstream can be mitigated by installing multi-level withdrawal structures (power intakes) on the dam, or constructing aerating weirs in the tailrace. Before clear recommendations on the likely risks and appropriate mitigation (if needed) can be made, further data collection from the downstream Yeywa reservoir is recommended. Due to the fact that the turbine outflow will be released immediately upstream of the existing Yeywa reservoir – an already modified water body that can act as a water quality buffer zone, there may be less need for design modifications but this can only be assessed based on further information. If the Yeywa reservoir still suffers from anoxic (or hypoxic) conditions, then the release of water with a deficit in oxygen from the Middle Yeywa tailrace may contribute to even worse water quality conditions in the downstream Yeywa reservoir.

Mitigation measures:

- Conduct pre-impoundment vegetation clearing in order to reduce emissions from decay of organic matter in the reservoir.
- Monitoring of water quality in the reservoir to detect undesirable changes and implement appropriate responses as and when needed.
- Potential design modifications based on analysis of information from the Yeywa reservoir on risks of significant water quality changes at different water depths near the dam/intake.

Water pollution: During the operation phase, the risk of chemical water pollution will be reduced as compared to the construction phase. However, accidental fuel and oil spills could still occur with inadequate handling of hazardous materials and failure of spill prevention systems. Volumes of any spills are likely to be moderate or small compared with the water volume of the reservoir.

There is also a risk that water pollution will be caused by the disposal of excavated material (rock spoil) in the reservoir. It is assumed that the tunnels and power house cavern will be excavated by drilling and blasting, potentially causing ammonia and nitrogen contamination from the blasted rocks as well as increased suspended sediment content in the reservoir and downstream.

Mitigation measures:

- Storage and handling of fuel and hazardous materials shall be kept away from the river and bunded with capacity to contain at least 110% of maximum storage volume;

- All storage areas for fuel and hazardous materials shall have spill kits, sand, dust, and other appropriate absorbent materials;
- Test the rock material for heavy metals and consider alternative disposal methods and locations for the excavated materials before a decision is taken to dispose of the rock spoil in the reservoir, alternatively undertake washing of waste rock before disposal in the future dead storage reservoir area;
- Power house and switchyard should have oil and water collection systems leading to oil/water separator systems prior to the release of any water to the environment.

Conclusion

Phase	Magnitude – Water Quality				
	Large Negative	*Medium Negative*	*Low/Insignificant*	*Medium Positive*	*Large Positive*
Construction			▲		
Operation		▲			

8.2.9 *Protected Areas*

Construction Phase

Protected areas: No protected areas will be directly affected during the construction phase. The dam site, where construction activities will be undertaken on both river banks, is outside the potential forest protected areas referred to in Section 6.9.2.

Operational Phase

Protected areas: Using the World Database on Protected Areas and recent maps of protected areas in Myanmar found in various publications, there is no protected area that will be impacted by inundation or other project activities. However, a map was found that potentially indicated some form of forest protected area on the left bank between the upper tail end of the reservoir and the Nam-kam River approximately 12 km upstream of the dam site. A portion of the river valley will be inundated on the left bank upstream of the Nam-kam River. Should this have some form of protection status, there will be an impact in the form of direct loss of Indaing forest, including a narrow and partly patchy band of riverine forest, on the protected forest area.

Protection objective: In addition to confirming with forest authorities whether there currently is any protection status, it will be important to evaluate the extent to which inundation is in conflict with the objective of any such potential protection status and whether the Project impacts the values for which the protection status was established. Considering the logging undertaken and the large-scale conversion of forest habitat to agriculture in the forest area, the additional loss due to inundation affects a small proportion of the protected forest area. The long-term viability of the area is unlikely to change substantially. However, a formal acceptance from relevant authorities is strongly recommended.

Active management: There appears to be no active management of the forest area by the relevant authorities and the protection status, if it exists, exists only on paper and not on official protected area maps. Without a much more active management (demarcation of boundary, sensitisation of local people, management activities, monitoring, etc.), the forest area with a potential protection status is likely to continue to be converted to agriculture and the forest area management objectives will be compromised.

Mitigation measures (if a protection status is confirmed):

- Clearance of vegetation in the inundation area along the river on the left bank should not involve opening new roads into the left bank forest areas as these may facilitate even further logging and conversion to agriculture.

- Protection and active management of a forest area to compensate for the area inundated should be considered in consultation with relevant authorities and communities.

Conclusion

Phase	Magnitude – Protected Areas				
	Large Negative	*Medium Negative*	*Low/Insignificant*	*Medium Positive*	*Large Positive*
Construction			▲		
Operation			(▲)* ▲		

* Magnitude of impact if the area on the left bank has a protection status that is confirmed by relevant authorities.

8.2.10 Vegetation

Construction Phase

Vegetation clearing: The construction of the hydropower plant will involve vegetation clearance and reduction of woody biomass in most parts of the direct impact zone and especially along the access route to the dam site and within the footprints of all permanent and temporary facilities. Most of the trees that will be cut are common species of the Indaing forest vegetation type with a wide geographical distribution and that are not subject to major conservation risks. The exceptions are the five threatened plant species *(Dalbergia oliveri*, *D. cultrata, Pterocarpus indicus*, *Cycas siamensis*, and *Curcuma alismatifolia*), but even those species are common over a wider area far beyond the project's impact zone.

Mitigation measures:

- Except where vegetation clearing is required for permanent works or excavation operations, all trees and vegetation shall be preserved;
- All disturbed areas that are not required for permanent works shall be restored and replanted with native trees.

Reservoir impoundment: At the end of the construction phase, the vegetation growing within the reservoir area will be submerged and converted into a lake environment. A total of about 816 ha of Indaing forest below the FSL will be lost, including relatively intact forests on the left bank of the Myitnge River. In addition, the seasonal spray zone at the lower Namkam waterfalls will be submerged and lost. Without pre-impoundment clearing, this will result in rapid decomposition of the soft biomass (herbaceous plants, tree leaves, etc.), while large trees will remain for a long time as dead biomass. Among the trees and other plants that will be lost are those of the five threatened plant species mentioned above.

- Conduct pre-impoundment vegetation clearing within the reservoir area;
- Compensate the loss of trees by afforestation/reforestation of an equivalent area outside of the direct impact zone.

Tree cutting by workers and in-migrants: Vegetation clearing may also occur as a result of illegal tree felling by project workers, camp followers and other in-migrants. Road construction and upgrade will improve access to previously undisturbed areas, creating a risk that outsiders will enter to extract illegal timber. The population influx will contribute to increasing the pressure on natural resources and forests.

Mitigation measures:

- Access to project sites shall be controlled to prevent unauthorised access;
- Workers shall be prohibited from cutting trees and collecting firewood;

- Forestry extension officers shall be capacitated to provide monitoring, control and surveillance.

Operation Phase

Establishment of invasive species: One of the effects of disturbance of vegetation and soils (during construction) is the subsequent upsurge of invasive plants (during operation). These have a high potential to suppress the native flora and change the structure and composition of the vegetation as they spread. Exotic and invasive plants may also be introduced to the project area for ornamental reasons.

At least two invasive plant species already exist in the project's impact zone (*Mikania micrantha* and *Mimosa pudica*), both of which have a high potential for spreading further into land disturbed by construction activities. However, as they are already established across a wider area in the project's impact zone, the project will probably not contribute significantly to further increasing their occurrence. Standard protocols for invasive species control should nonetheless be observed.

Mitigation measures:

- Removal of invasive plant species during routine vegetation maintenance;
- Restore disturbed areas immediately after the construction and maintenance works;
- Avoid importation of exotic trees and soil from other places (e.g. for restoration or as ornamentals).

Conclusion

Phase	Magnitude – Vegetation				
	Large Negative	*Medium Negative*	*Low/Insignificant*	*Medium Positive*	*Large Positive*
Construction		▲			
Operation			▲		

8.2.11 Terrestrial Fauna

Construction Phase

Loss of habitat: Clearing of areas for construction will result in direct loss of habitat for terrestrial fauna. The exact areas required for construction are not yet fully known. Habitat will be lost due to dam construction, camp areas, access roads, borrow pits, contractors' yards and a range of infrastructure required for project construction. A new bridge across the Myitnge River, and a section of new road to link with the existing road, will also be constructed to replace the current bridge that will be inundated. Workers and associated in-migration are likely to lead to illegal tree cutting for timber or energy, which will result in additional habitat loss for a number of species. Should the construction activities result in spreading of invasive alien species (flora or fauna), this may gradually result in loss of habitat as such species spread into new areas. The Indaing forest habitat will be the clearly most affected terrestrial habitat type as this is the habitat dominating the impact zone. This type of habitat is widely spread and common in the region and hence of limited conservation concern. No species of conservation concern are expected to lose significant parts of their habitats.

Disturbance: The construction phase (5-6 years) will be associated with noise, vibration, movement by vehicles and people, dust, light and other forms of disturbance. The sensitivity to such disturbance varies from species to species, but most species will be negatively affected and largely move away from the immediate surroundings of construction areas. Species that are more tolerant to human disturbance, typically opportunistic generalist species, tend to be of limited conservation interest. Species of conservation concern tend to be more sensitive to disturbance and are likely to stay away at least temporarily from a considerably larger area than the footprint required for construction-related activities. The latter includes species such as the Green peafowl, the leopard and other mammals of conservation concern. Fauna populations will be reduced as a result of the construction phase due to habitat loss and to some extent also due to disturbance. For several species, this will be a temporary impact during construction, after which species can return to areas when construction-related disturbance is reduced or removed.

Hunting: The presence of many hundred workers for an extended period, and probably an even larger number of camp followers that seek economic opportunities in relation to the construction phase, also represent a threat to mammal species in particular and partly species of birds. Illegal hunting is likely to increase beyond current levels and more modern and effective means of hunting may be introduced. Species like Muntjac and Red Jungle Fowl may be sought after as sources of food and populations are likely to be reduced at least temporarily during the construction phase.

Pollution: Pollution risks in the form of hazardous materials will be experienced in virtually all construction sites. However, any spills of hazardous materials or hazardous waste are expected to be relatively localised. The construction phase impact area will largely be devoid of any larger species of terrestrial fauna and such species are therefore much more prone to other forms of pollution and disturbance (e.g. noise and light pollution).

Reservoir: The area to be inundated will be cleared for as much woody vegetation as possible. Forest-dependent species will lose parts of their habitat. Subsequent filling of the reservoir towards the end of the construction phase will result in loss of all terrestrial fauna in the inundation area, irrespective of whether species are forest-dependent or not. The riverine forest, which is part of the Indaing forest, will be disproportionately affected by the inundation but no species that rely on this narrow and patchy band of forest along the river were identified. A limited number of bird species prefer nesting in areas of cliffs and boulders along the river, and there may be locations with bat roosting places in the inundation area. There are similar habitats available above the future reservoir level, but these species may experience a population reduction in the project area if availability of nesting places is a limiting factor for their population size, which is unlikely to be the case.

Habitats: Some highly localised habitats that will be inundated were identified. There are small areas of seasonally inundated sand banks scattered along the river. There may be insect species requiring such sand banks to complete their life cycle. Information from local people indicated presence of turtle species along the river though the degree to which this reflected presence in the past rather than at present was not clear. Any species relying on the sand banks will lose their habitats along the river. This habitat may partly be replaced by the delta quickly developing at the upstream end of the reservoir and where large volumes of sand and silt will settle. At the Namkan River, a spray zone will be partly inundated by the reservoir. No unique species were found in this unusual habitat and there are similar spray zones available above the inundation area along the Namkan River.

Mitigation measures:

- Land take during construction should be minimised, required areas demarcated and contractors going beyond the demarcated areas sanctioned.
- Workers' induction and contracts should raise awareness of illegal hunting and workers found violating the requirements should be sanctioned.
- Awareness raising and sensitisation of local communities to minimise illegal hunting and tree cutting should be undertaken.
- Community activities to minimise the impacts of peaking demand of local goods should be undertaken (see Section 8.3 on social impacts).
- Unauthorised access and activities should be controlled and monitored.
- As construction progresses, areas that are not needed any longer should be restored on an ongoing basis.
- Artificial lighting should be minimised to prevent light pollution.
- Hazardous materials and waste should be stored in bunded areas with capacity to contain at least 110% of the maximum storage capacity.
- Invasive alien species should be monitored and removed routinely.

- Waste should be closely tracked and disposed of by licensed waste handlers.
- Following further clarity on the locations of associated infrastructure, a plan to avoid and minimise impacts on wildlife species of conservation concern should be developed as an integral part of the EMP.

Operational Phase

Loss of habitat: Some of the construction phase land take will be permanent while areas required temporarily will be restored. The main land take and loss of habitat for the operation phase will be due to the inundation area (11 km^2) that will be established towards the end of the construction phase. Restored areas are likely to gradually be recolonised by Indaing forest vegetation and subsequently gradually recolonised by fauna in these areas.

New habitat: The reservoir will represent a new habitat available to some species. The baseline surveys showed very limited presence of waterfowl and other wildlife using water bodies as their habitat. The available information indicates that the new habitat will not become important for water fowl or other wildlife species beyond being a permanent source of drinking water.

Disturbance: Levels of disturbance will be gradually but greatly reduced following commissioning of the Project and decommissioning of construction activities. Operation phase disturbance will still be experienced due to the daily activities and traffic associated with project operation but at much lower levels compared to the construction phase. Particularly sensitive species are still likely to avoid habitats nearby areas with disturbance such as the dam and power house area.

Hunting: Illegal hunting is likely to be reduced following commissioning. In the event that construction results in a larger local human population in the longer-term, the hunting pressures are unlikely to return to pre-project levels and hence permanently higher levels of hunting may be experienced unless specific efforts are made to minimise illegal hunting.

Hydro peaking: As per current plans, the Project is likely to be operated in hydro-peaking mode (see Section 8.2.6 above). Terrestrial fauna is not expected to be significantly affected by hydro-peaking as there are very few species that rely on the affected river section between the dam site and the upstream end of the existing Yeywa reservoir. Assuming that a minimum flow is released in off-peak hours, the barrier effect from Myitnge River will be maintained. If there is no minimum flow released from the dam or tailrace, there will be a loss of a natural barrier that will allow previously separated populations of some species to mix and individuals to migrate over longer distances. However, the available information does not indicate any significant environmental impacts of creating such wildlife corridor across the Myitnge River downstream of the Middle Yeywa dam.

Mitigation measures:

- Workers' induction and contracts should raise awareness of illegal hunting and workers found violating the requirements should be sanctioned.
- Awareness raising and sensitisation of local communities to minimise illegal hunting and tree cutting should be undertaken.
- Unauthorised access and activities should be controlled and monitored.
- Hazardous materials and waste should be stored in bunded areas with capacity to contain at least 110% of the maximum storage capacity.
- Waste should be closely tracked and disposed of by licensed waste handlers.
- Invasive alien species should be monitored and removed routinely.
- A continuous minimum flow should be released downstream the dam site. Following further clarity on the locations of associated infrastructure, a plan to avoid and minimise impacts on wildlife species of conservation concern should be developed as an integral part of the EMP.

Conclusion

Phase	Magnitude – Terrestrial Fauna				
	Large Negative	*Medium Negative*	*Low/Insignificant*	*Medium Positive*	*Large Positive*
Construction		▲			
Operation		▲			

8.2.12 Aquatic Ecosystems

Construction Phase

Loss of habitat: Loss of habitat will mainly be experienced in the dam site area in the first stages of construction. The dam foundation and areas required for coffer dams will be negatively impacted to a large extent. The impacts will be felt across all species groups in these areas. Replacement of the bridge across Myitnge River will involve construction activities in and close to the River and associated loss of aquatic habitats in highly localised and small areas.

Disturbance: Disturbance in the form of various types of pollution from activities within the river as well as in the wider construction area will be an important negative impact in areas downstream of the dam site all the way to the existing Yeywa reservoir and probably in the uppermost parts of this reservoir as well during activities like coffer dam construction and coffer dam removal (see Sections 8.2.7 and 8.2.8 above).

Fishing: The presence of a large work force and opportunity seekers may result in a slight increase in fishing efforts. However, the current fishing practices in the river are based on simple technologies and the large river is challenging to fish effectively. No substantial negative impacts are expected unless new methods are introduced by the work force or camp followers.

Migration barrier: From the time of construction of coffer dams, the construction works will be a barrier to upstream fish migration even in the rainy season. This will limit access to upstream river reaches for any fish downstream the dam, including fish from the downstream Yeywa reservoir. The bypass tunnel that will be constructed is unlikely to be passable for fish and will hence not ensure upstream migration. Further considerations on fish migration are included in the section on cumulative impacts (see Section 8.5.7 below).

Reservoir: Towards the end of the construction phase, the reservoir filling will take place. During filling, the river flow downstream the dam will be substantially reduced, and available aquatic habitat will be reduced with short-term negative impacts on aquatic life in this area. Impacts on aquatic habitats in Yeywa reservoir due to filling of Middle Yeywa reservoir are expected to be marginal and short-term due to the large storage capacity of the existing Yeywa reservoir. Upstream of the dam, the aquatic habitats will change from a mosaic of slow and fast flowing river sections (lotic ecosystem) to a less dynamic and more stable lake-like habitat (lentic or lacustrine ecosystem). Species composition across groups will change from species competitive during riverine conditions to species that are more competitive during lake-like conditions. Impacts associated with this major change in habitat characteristics are discussed below.

Mitigation measures:

- Mitigation measures reflected in Sections 8.2.6-8.2.8 above concerning hydrological changes and water quality changes including sediment transport.

Operational Phase

Loss of habitat: Reservoir filling and project commissioning represent the start of project operation with a major transformation of riverine habitats to lake habitats. Species adapted to lotic conditions (flowing water) will largely lose their habitats except in a limited number of tributaries along the reservoir that will provide some riverine habitat, but considerably less than prior to inundation. These tributaries are often seasonal and only short riverine sections are available to fish due to the steep or very steep terrain that creates barriers to upstream fish movement. Flying insects and birds and aquatic animals able to move on land will be able to move upstream of sections that are barriers to fish in such tributaries. The most important tributary is the Gotheik Stream that is perennial and most likely provide riverine habitats for several kilometres upstream for all aquatic groups in river systems. This tributary is on the right bank in the upper part of the reservoir and would benefit from management interventions to prevent destruction of the likely most important refuge for riverine species in the new reservoir system. The short and varying length of river between the Middle Yeywa tailrace and the Yeywa reservoir as well as the short and less varying length of river between the Upper Yeywa tailrace and the Middle Yeywa reservoir will provide a modified riverine habitat. These areas will represent small refuges for riverine species.

Habitat modification: The Developer is considering placement of substantial volumes of rocks in the river for a 1 km distance downstream of the tailrace in order to meet a potential requirement from the Government of Myanmar for a 'free flowing' river section between the Yeywa reservoir and the Middle Yeywa dam. The rationale appears to be a desire to have a minimum of aeration of the turbine discharge before it enters the Yeywa reservoir (in the event of poor water quality in the Middle Yeywa reservoir). Such rock filling will have a short-term impact on water quality during establishment (e.g. increased turbidity) and will alter the river substrate and habitat characteristics for the operation phase. Some of the existing river bed is likely to be rock (bedrock and boulders) and hence rock filling will represent only a moderate change in such areas in the medium to long-term. Other areas are low-energy habitats with sand and silt substrate, and rock filling will greatly modify these habitats. The feasibility of rock filling this river section should be carefully reviewed both in terms of water quality impacts on the downstream Yeywa reservoir (during construction and operation) as well as in terms of habitat impacts for aquatic organisms that are likely to be negatively affected. If such a rock fill is to be implemented following documentation that it serves the desired function in terms of water quality, the rock fill should be designed to create a riverbed with dynamic and heterogeneous habitats for aquatic life.

New habitats: The considerable new lentic environment (relatively still water) will dominate the reservoir. The natural dynamics of the aquatic habitats upstream of the dam will change radically as water depth, water speed and geomorphological processes associated with a flowing river, including concurrent erosion and sedimentation processes that create a dynamic and heterogenous system, will be substantially altered. Over time, a delta will evolve in upstream part of the reservoir with active sedimentation and erosion processes, but this delta system is unlikely to provide a suitable habitat to many species due to the near continuous deposition of sediments and very unstable substrate.

Regulation zone: The riparian zone of the future reservoir will be longer than the current riparian zone along the river. However, the likely daily fluctuation in reservoir level (due to hydro-peaking) combined with wave action are likely to erode the zone between full supply level and the lowest regulated water level. The shallow areas around the reservoir are therefore not likely to be highly productive in terms of vegetation and macro-invertebrates, dependent upon the final size the drawdown zone (currently 0.5 m). The areas below the lowest regulated water level are likely to ensure some productivity in the littoral zone assuming that turbidity of the reservoir water is limited and light can penetrate to areas stable enough to support aquatic vegetation and macro-invertebrates.

Species composition: The typical river species will be largely outcompeted in the reservoir assuming the reservoir will be colonised by species well adapted to a lentic or lacustrine system. Phytoplankton and zooplankton are unable to swim against the current and hence move passively with flow or currents and do not establish large populations in a river system due to the continuous washing out of individuals. In the very slow-flowing reservoir environment, both phytoplankton and zooplankton communities are likely to expand considerably and also provide the basis for an increased biomass of other species that feed on plankton. The fish community will change in species composition towards species favouring lake-like aquatic environments. Given limited information about fish species composition in the river as well as in the downstream Yeywa reservoir, it is difficult to predict the future composition of the fish community, including the extent to which the reservoir can provide a basis for a fishery. Further records on fish and other species from the Yeywa reservoir and the Myitnge River would allow for a more refined analysis of likely changes.

Fishing: Fishing is currently practiced by a limited number of people along the Myitnge and with a strong seasonal variation in the level of fishing activities. Fishing techniques are relatively simple and the deep and at times fast-flowing river makes fishing challenging. Unless new fishing equipment is taken into use in the reservoir, there is likely to be limited scope for fishing for the people currently relying on fishing. Current fishing practices in the river are not likely to significantly impact on aquatic life in the reservoir. Introduction of new fishing techniques could affect the fish communities as well as increase yields from fishing. Surveys of fish communities and fishing activities in the downstream Yeywa reservoir would inform a more detailed analysis of impacts and the scope for future fishing in the reservoir.

Diverted section: There is likely to be a short section between the dam and the tailrace (200 m) where water will be diverted completely (depending on topography of the river bed and backwater effect from the tailrace) except for the periods where there is spilling of water over the dam or the gates are open. While this may effectively remove aquatic life from the short, affected river section, the length of the diverted river section (less than 200 m) is so small that impacts are considered insignificant. Also, when the downstream Yeywa reservoir is full, the reservoir may reach the foot of the Middle Yeywa dam effectively creating a lake-like environment. This also means there are no strong arguments for a release of a continuous minimum flow from the dam itself and a release by running at least one turbine continuously would serve the same ecological purpose assuming there is a functional back-up in the event turbines are not running (e.g. water release through a gate at the dam or a bypass valve in the waterway to the turbines).

Peaking: The Project is likely to be run for hydro-peaking (see Section 8.2.6 above). This will introduce major daily flow variation between the tailrace and the downstream Yeywa reservoir for most of the year. This flow variation will have substantial negative impacts on aquatic life in the short but varying length of affected river section. Complete drying out of the river should be prevented by releasing a continuous minimum flow as well as identifying ramping rates that are acceptable in terms of environmental and safety concerns (avoiding excessive risks of stranding of fish and avoiding risks to people close to the river). As discussed in Section 8.2.6 above, the operation regime has not yet been defined but is likely to be a complex picture of varying water release regimes depending on the inflow to the reservoir and the power demand from the grid. This implies that impacts caused by the flow reduction and peaking operation may be a continuum of impacts ranging from natural or near-natural flow conditions in periods with high inflow to the reservoir, to a highly modified flow regime with major daily fluctuations during periods with low inflow to the reservoir. Thus, the operational regimes may create an unstable and stochastic environment, which may challenge local adaptations among fauna and flora in unpredictable ways.

Migration barrier: The proposed dam will represent a barrier to upstream fish migration. The tall height of the dam means that construction of a fish passage is not considered feasible due to the complications of constructing a fish passage across such a large height as well as due to the uncertainties whether such a tall fish passage will work at all. Long-distance fish migration was blocked with the construction of the Yeywa dam downstream and has recently been further blocked by the ongoing construction of the Upper Yeywa dam. An upstream fish passage is not recommended as it is unlikely to serve any significant ecological purpose given the dams upstream and downstream the Middle Yeywa Project. Further considerations on fish migration are included in the section on cumulative impacts (see Section 8.5.7 below).

Mitigation measures:

- Mitigation measures reflected in Sections 8.2.6-8.2.8 above.
- If the riverbed downstream the tailrace is to be modified to ensure a 'free flowing' section, it should be designed as a varied river section with habitats that serve ecological purposes.
- Based on currently limited available information, introduction of fish species to the future reservoir is not recommended. Should such introduction be considered, a separate impact assessment should be undertaken. Further surveys in the downstream Yeywa reservoir should inform the feasibility of introducing any species and other potential measures to support fishing activities and management of the future reservoir.

Conclusion

Phase	Magnitude – Aquatic Ecosystems*				
	Large Negative	*Medium Negative*	*Low/Insignificant*	*Medium Positive*	*Large Positive*
Construction		▲			
Operation		▲			

* It should be noted that limitations in collection of primary data on aquatic ecosystems introduce significant uncertainty associated with assessment of magnitude of impacts.

8.3 Social Impacts

8.3.1 Approach

In the following, identified social impacts associated with construction and operation of the Middle Yeywa HPP are presented. The assessment is based on the present technical plans and layout of the project as presented in Chapter2 and the social baseline presented in Chapter 7. The impacts on the human environment have been evaluated and categorised according to the general methodology presented in Chapter 3 involving the steps of 1) Assigning a value to the social and environmental component being considered; 2) Assessment of the scale or magnitude of the impact; and, 3) Combination of value and magnitude to arrive at an overall impact on the considered components. For human environment components, it should be noted that the value is by default considered as high, thus making magnitude the decisive factor when it comes to the overall impact. The receptors of social impacts are villages, local communities, households and individual persons.

8.3.2 Local Project Area Economy

The Middle Yeywa HPP is likely to generate possibilities for employment for the local population, both directly and indirectly. At this stage of planning, the number of skilled and unskilled workers is yet to be estimated but based on experience from construction of similar hydropower project in the region it is likely that some 600 to 700 workers will be needed at the peak of construction activities. Up 40-50% of these may be unskilled workers while the rest will be semi-skilled and skilled workers.

Towards the end the construction phase the number of workers will decrease while the share of skilled workers is likely to increase as the electromechanical works gains momentum requiring specialised workers that will be provided by the electromechanical contractor.

In the operation phase, a considerable number of workers for operation and maintenance works, the majority probably skilled, will be needed. Again, no estimates for the number of people needed for operation and maintenance are available but for a project of this size the number of permanently employed staff and workers can be predicted to be somewhere between 50 and 100.

In addition to those directly employed in construction activities, a number of local businesses will benefit from the increase in demand for goods and services that the Project will generate. The number of people employed by the local businesses delivering goods and services such as different types of hardware and food supplies for the workers' canteens is likely to increase as existing businesses have to expand or new businesses are started to meet demand.

In terms of increases in indirect employment, much will depend on the ability of local businesses to seize the opportunity and expand their capacities. The chances that this will happen can be enhanced by timely dissemination of information of what kind of services the Project will be needing so that the local business community can position and prepare themselves to capture contracts and seize on the project related opportunities that will present themselves.

With regard to direct employment, the local population is predominantly employed in the agricultural sector and this may present a constraint on the possibility to employ local people. However, given that employment on the Project is likely to be more attractive for the local workforce due to the fact that the pay is likely to be higher and the employment more steady compared to what can be offered in the agricultural sector, it should be possible to recruit a substantial amount of local workers. The peak labour demands within the agricultural sector, for instance during sugar cane harvesting, is likely to be filled by migrant agricultural workers from outside the project area.

Conclusion

The magnitude of the impact on local economy is assessed as **medium to large positive** for the local population and local businesses in the construction phase and **low to medium positive** in the operation phase.

Phase	Magnitude - Local Project Area Economy -								
	Large Negative		*Medium Negative*		*Low/Insignificant*		*Medium Positive*		*Large Positive*
Construction								▲	
Operation						▲			

8.3.3 *Physical Displacement and Resettlement*

At the present stage of planning and project development, the size and accurate location of the project lands has not yet been determined in detail. Establishing an accurate estimate of the number households and project affected people that will be physically displaced by the Project has therefore not been possible. Road No. 41 from Nawnghkio to Taung Shey and further on from the junction on a local unpaved village road down to Yae Twin Gyi is likely to be chosen as the main project access road. Road No. 41 and the local village road passes through a number of villages and a possible improvement and widening of the main access route may lead to some physical displacement of in terms of commercial and residential buildings located close to the road. Some of these buildings may be located within the present road right of way.

From Yae Twin Gyi and down the escarpment to the dam site, an access road will have to be built but it is unlikely that this will lead to any physical displacement as the road will be routed away from and outside of the village. The same applies to the camp and workshop areas which will probably be located within the village territory of Yae Twin Gyi but should be sited away from existing commercial or residential buildings in the village.

With regard to the reservoir, it will be confined within the steep river valley where there are no settlements except for temporary fishing and illegal logging camps. The exact number of shelters in these temporary camps is yet to be confirmed but is not considered significant.

Mitigation measures:

- Minimisation of physical displacement through adaptive planning of roads and location of project components;
- Careful identification of all affected project affected persons (PAPs) and households that will lose residential land and buildings;

- Full compensation at replacement cost for all affected buildings and residential land;
- Option to choose between full monetary compensation and project assisted relocation for project affected persons and households.
- Resettlement of PAPs within their local community if possible

Conclusion

Although the impact of physical displacement and resettlement will be perceived as a large and even traumatic experience for the affected individual households, the magnitude and overall impact will be less on a community level. The magnitude of the impacts in terms of physical displacement and resettlement is therefore assessed as **low to medium negative** during the construction phase and **insignificant** during the operation phase due to the anticipated low number of impacted houses or structures.

Phase	Magnitude of Impacts – Physical Displacement and Resettlement
	Large Negative *Medium Negative* *Low/Insignificant* *Medium Positive* *Large Positive*
Construction	▲ (between Medium Negative and Low/Insignificant)
Operation	▲ (Low/Insignificant)

8.3.4 Economic Displacement and Loss of Livelihoods

As noted above, the size and locations of project lands are yet to be determined in detail. The impact in terms of loss of commercial and productive agricultural land will therefore have to be confirmed at a later stage of the project development and planning process. However, loss of agricultural land that will reduce the available productive resources providing livelihoods to people is expected to be limited in area. This is due to the fact that there seems to be relatively suitable unoccupied and uncultivated land around Yae Twin Gyi where camps and workshops can be located, while the entire reservoir area is uncultivated. Some land may be lost due to the construction of the access roads that will lead from Yae Twin Gyi down the escarpment and to the dam site, but there are good possibilities for routing most of it outside of the productive and permanently cultivated agricultural land surrounding Yae Twin Gyi.

Mitigation measures:

- Minimisation of economic displacement through adaptive planning of roads and location of project components;
- Careful identification of all affected project affected persons (PAPs) and households that will lose commercial land and buildings;
- Full compensation at replacement cost for all affected commercial buildings and land.

Conclusion

The magnitude of the impact in terms of economic displacement and loss of livelihoods is assessed as **low to medium negative** during the construction phase and **insignificant** during the operation phase.

Phase	Magnitude – Economic Displacement and Loss of Livelihoods
	Large Negative *Medium Negative* *Low/Insignificant* *Medium Positive* *Large Positive*
Construction	▲ (between Medium Negative and Low/Insignificant)
Operation	▲ (Low/Insignificant)

8.3.5 Population Influx and Impacts on the Social Fabric

Construction Phase

During construction, there will be a temporary increase in population in the area surrounding the main construction site, including the dam and powerhouse, due to in-migration of workers, job seekers, camp followers, traders, service providers, etc. The exact number of workers to be employed is not known at the current stage, but it may reach 600-700 people at the peak of the construction activities. The villages likely to experience the impacts of population influx are those located closest to the main construction site including Loi Pang, Taung Gyi, Ah Nauk Kone and Yae Twin Gyi. As Yae Twin is located at the end of the existing public road, from where the new access road is likely to be built, this village is likely to experience the most pronounced impacts.

While many of the unskilled and semi-skilled workers will be recruited from the local/neighbouring communities, others will come from outside and be resident in the project area for the duration of the construction period.

Population influx, even though temporary, may put additional pressure on the local infrastructure, services and utilities, especially on community health and sanitation. An increase in population is usually also associated with strains on social cohesion and fabric, norms and local cultural practices. This could potentially result into an increased risk of exposure to HIV/AIDS and other STDs as well as tensions between the resident population and the in-migrants.

Mitigation measures:

- Establish transparent recruitment procedures to avoid camp followers in the form of job-seekers;
- Establish a recruitment policy that gives priority to local residents for less specialised work, conduct skills development training locally in the project area to maximize recruitment potential and provide contractors with lists of qualified local people with appropriate skills;
- Recruitment procedures to be shared with the local authorities for further dissemination;
- Opportunities for sub-suppliers and sub-contractors should be awarded to local firms which in turn employ local labour;
- Consider bussing services to nearby villages to reduce the size of camps and facilitate access to construction areas;
- Establish a workers' housing camp and a site clinic to reduce pressure on local infrastructure, services and utilities;
- Conduct public health campaigns addressing issues of behavioural change, water and sanitation, malaria and HIV/AIDS;
- Provide training and awareness to workers on health risks and prevention, and establish a code of conduct on worker-community relations.

Operation Phase

Out-migration: After the construction phase, the population is likely to be reduced significantly. However, there may be residual impacts of the population influx if the social fabric and local norms have been changed permanently during the construction phase. The out-migration will be partly counteracted by improved infrastructure, services and utilities created during the construction phase, resulting in increased population in or around villages near the construction sites

Conclusion

The magnitude of the impact caused by the anticipated population influx are assessed as **medium negative** for the construction phase and **low negative/insignificant** during the operation phase.

Phase	Magnitude – Population Influx and Social Fabric				
	Large Negative	*Medium Negative*	*Low/Insignificant*	*Medium Positive*	*Large Positive*
Construction		▲			
Operation			▲		

8.3.6 Community Safety and Security

Construction Phase

A number of safety issues are likely to occur as a result of the Middle Yeywa HPP construction. These include:

Dust and noise: People living along the access roads will experience higher emissions of dust and noise during the construction phase due to increased traffic, including an increase in trucks and heavy vehicles. This is likely to have a negative on the ambient quality air as well as increasing noise pollution levels along the road. This may have health implications for the roadside population.

Traffic accidents: The construction-related traffic along with the general increase in road traffic associated with the increase in population and economic activities, most notably in the villages closest to the main construction site, are unlikely to lead to congestion problems. However, increased traffic of heavy haulage trucks, busses and smaller vehicles, including motorbikes, is likely to result in an increase in road incidents and serious accidents and injuries, including fatalities, along the main access route which passes through a number of villages between Nawnghkio and Yee Twin Gyi. The risk for traffic incidents and accidents is exacerbated by the fact that people in the villages typically reside immediately adjacent to roadside and in addition probably are unaccustomed to the level of heavy traffic that the project activities will generate. The assumed unawareness of the dangers of traffic may increase the likelihood accidents occurring, for instance in connection with crossing of roads by local people, especially children.

New project related installations and equipment: In connection with establishment of new infrastructure, safety issues often arise due to the novelty of these installations and equipment in the local environment. Community members may for instance sustain injuries when interacting with unsecured equipment, falling into unsecured trenches or climbing fences and new power transmission towers.

Management of waste: If hazardous waste and materials generated in connection with project activities, or activities related to the increased economic activities in the project area, are not appropriately and safely managed, they may be released into the environment and lead to serious contamination and pollution of water sources used by the local population. A number of activities may potentially generate pollution, for instance, accidental oil and fuel spills along the access route and at workshops and fuel depos, as well as the washing of trucks and vehicles in local streams.

Dam safety: The risk of dam failure will be extremely low, but the downstream impacts in case of an unlikely dam breach could be dramatic due to the water storage in the reservoir. It should be point out, though, that there are no people living immediately downstream of the Middle Yeywa dam, but there may be people living in close vicinity to the existing Yeywa reservoir and further downstream. The dam safety aspects, including emergency preparedness and response planning (e.g. flood warning system), will be addressed in the ongoing feasibility study.

Mitigation measures:

- Preparation of an On-site Traffic and Access Management Plan, including speed bumps, safe crossing points and other measures in populated areas;
- Speed limits for different sections of the road network;
- Specification of parking sites for the construction vehicle fleet;
- Preparation of specific plans for hauling heavy loads and hazardous materials;
- Signalling and warning measures;
- Awareness raising to alert the local population of the dangers of increased traffic loads with an especial focus on schools;
- Fencing and control measures to avoid unauthorised access to construction sites and equipment and new installations;
- Refuelling of heavy equipment and machinery by a service vehicle, with appropriate safeguards and protection measures;

- Storage of fuel and hazardous material in special designates proper facilities away from the streams and water sources;
- Collection and treatment of storm water runoff from workshops in hydrocarbon separation pits/tanks.

Operation Phase

For the operation phase, it is likely that an operator's village with good facilities for waste handling and management will be established in the vicinity of the hydropower plant. The operator's village will contribute to the future population increase in the area and also contribute incrementally to the future traffic loads on the local roads. However, compared to the construction phase, these impacts will be limited considering also the general trend of traffic load increases as the economy improves in the area.

Conclusion

The magnitude of the impact on community safety and security is assessed as **medium-negative** during the construction phase, while it is considered **low negative/insignificant** during the operation phase.

Phase	Magnitude – Community Safety and Security				
	Large Negative	*Medium Negative*	*Low/Insignificant*	*Medium Positive*	*Large Positive*
Construction		▲			
Operation			▲		

8.3.7 Forest Resource Use

Construction Phase

During the construction phase, some forest resources may be lost due to building of the access road down the escarpment to the main construction site comprising the dam and powerhouse areas. This is unlikely to affect the forest resource use of the nearby villages, including Yae Twin Gyi, due to the fact that the area is too steep and inaccessible to allow for any logging and extraction of timber by villagers who probably acquire timber for building and construction purposes from other area higher up on the slope.

To the degree that there is any hunting taking place in the area affected by the access road, it cannot be ruled out that wildlife will be scared away from the area by the construction activities. However, it is fair to assume that if any hunting is done in this area it is insignificant in terms of income and diet for the local population which has agriculture as their all-important source of income. The same reasoning applies for collection of non-timber-forest-products (NTFPs) which according to village interviews and the socio-economic survey results is an insignificant income source.

Operation Phase

The villages surrounding the Middle Yeywa reservoir rely predominantly on agriculture as their main source of livelihood. According to the results from the socio-economic survey, income from forest based resources on the average accounts for only 4% of the reported income (see also Figure 7-9). Forest resources include timber for construction and firewood and foraged plants and hunted animals for consumption and sale. The village of Thar Si is the village where forest resources provide the highest share of reported total income with 20%. This relatively high share contributes to lifting the average of forest-derived income for the whole group of survey villages. Of the total forest product incomes reported by the surveyed households, timber is the dominant source.

Interviews conducted in connection with the socio-economic survey indicate that the villagers extract forest resources, and especially the timber resources, from the upper and less steep slopes of the Myitnge River valley and not from the steep lower part that will be submerged by the reservoir. As such, it is not likely that the loss of the timber resources in the submergence zone will have any significant effect on the use of the forest resources by the villagers in the area around the reservoir. However, it needs to be noted that illegal logging with extraction of the most valuable commercial timber and tree species is taking place along part of the lower river valley. A few local villagers may be engaged in this activity which normally is organised by outsiders so in this respect submergence of the lower river valley may have an impact for a few individuals.

Another forest resource use is hunting of wild animals which is still fairly common, especially on the left bank which have the most intact forest areas. There is a possibility that this activity and source of wild meat will be affected by the hydropower development as there is reason to believe that the hunting to a large degree is taking place in the steep and forested lower part of the river valley. This assumption is supported by the fact that hunters were actually caught on camera by the camera traps that were deployed at strategic locations in the submergence zone. It needs to be noted though that hunting is more an exciting leisure activity and a dietary supplement for the villagers, than an important source of income.

As collection of NTFPs is not commonly practised by villages and consequently has little economic significance, submergence of the lower part of the Myitnge River valley is unlikely to have negative effect on income levels of the project area village populations.

Mitigation measures:

- Training on forest resource management through the Community Forest Programme
- Establishment of community forest lots.

Conclusion

The magnitude of the impact on forest resource use by the local population is assessed as **low negative** during both the construction and the operation phase.

Phase	Magnitude – Forest Resource Use				
	Large Negative	*Medium Negative*	*Low/Insignificant*	*Medium Positive*	*Large Positive*
Construction			▲		
Operation			▲		

8.3.8 River Resource Use

As noted in Section 7.4.2, the income from fishing appears to be insignificant, constituting less than one percent of the total average income of the surveyed households. However, for some households in the villages surrounding the future Middle Yeywa reservoir, fishing appears to be a source of dietary supplement and for some also a source of income. This is shown by the results of the interviews that were carried out in April 2017 (see Chapter 5, Table 5-3). According to the information provided in the village meetings, there are people that fish for household consumption, most commonly in the fish migration period of March-April. The number of people that practise fishing seems to be limited to less than 20 in most villages. The village where fishing has the largest significance as a source of income for the local population is Yae Twin Gyi which is the village that lies closest to the dam site. Here it was informed that 10-20 people go for fishing, staying for up to 5 days in a fishing camp, located on the riverbank at the rapids close to where the dam has been planned. The catches per fishing trip was said to be 20-30 kg which is brought to local markets for sale or consumed in the village.

Although the impacts on the income levels for the local population caused by the planned hydropower development is likely to be minor at the macro level, it needs to be kept in mind that for some households, perhaps most notably in Yae Twin Gyi, the potential loss of this source of income and dietary supplement can be significant. To what extent it will be possible to establish reservoir fisheries that can replace the income source from the river fisheries remains to be seen. If this is possible, reservoir fisheries may potentially become a source of income for more people than what the situation is today.

Mitigation measures:

- Consider provision of fishing gear and equipment villagers interested to utilize fish resources in the reservoir
- Consider organisation and training of village fisheries groups that can manage the potential fish resources in the reservoir.

Conclusion

The magnitude of the impact on river resource use is assessed **as medium to low negative** both during the construction and the operation phase.

Phase	Magnitude – River Resource Use								
	Large Negative		Medium Negative		Low/Insignificant		Medium Positive		Large Positive
Construction				▲					
Operation				▲					

8.3.9 Archaeological Sites and Cultural Heritage

As stated in Section 7.5, no archaeological or cultural heritage sites have been recorded in the direct impact zone of the Middle Yeywa HPP. However, it cannot be ruled out that there are intangible sites of spiritual or religious nature that will be directly affected by construction activities and by river impoundment. However, discovery of such site is highly unlikely as the Danu are not originally from this area and thus have limited spiritual connection to the land.

Although no physical and intangible cultural heritage sites have been identified so far it will be important to be prepared to handle chance finds during construction in a proper manner. Possible mitigation measures in this connection is listed below.

Mitigation measures:

- Provide contractor training and awareness programme;
- Establish a chance finds procedure and conduct salvage excavation when required.

Conclusion

On the basis of present knowledge, the impact on archaeological sites and cultural heritage is assessed as **insignificant** in both the construction and operation phase.

Phase	Magnitude – Archaeological Sites and Cultural Heritage								
	Large Negative		Medium Negative		Low/Insignificant		Medium Positive		Large Positive
Construction				▲					
Operation					▲				

8.4 Overall Impact Assessment

Table 8-3 summarises the potential impacts of the Middle Yeywa HPP without and with the possible mitigation/enhancement measures. The residual impact that remains with mitigation measures in place is given in the last column ("overall impact with mitigation").

Table 8-3: Summary of impact assessment without and with mitigation/enhancement measures.

Theme	Value/ Vulnerability	Impact Magnitude	Overall Impact	
			Without Mitigation	With Mitigation
CONSTRUCTION PHASE				
Physical Environment				
Topography and landscape	**Medium**	**Low - medium negative**	**–/– –**	**–**
Geology and soils	**N/A**	**Medium negative**	**– –**	**–**
Climate	**High**	**Low negative**	**–**	**0/–**
Air Quality	**High**	**Low - medium negative**		**–**
Noise and vibration	**High**	**Low - medium negative**	**–/– –**	**–**
Hydrology	**N/A**	**Low negative**	**–/– –**	**–**
Sediment transport	**High**	**Low - medium negative**	**–/– –**	**–**
Water quality	**Medium-high**	**Low - medium negative**	**–/– –**	**–**
Biological Environment				
Protected areas	**Low**	**Insignificant**	**0**	**0**
Vegetation	**Medium**	**Low - medium negative**	**–**	**0/–**
Terrestrial fauna	**Medium**	**Medium negative**	**– –**	**–**
Aquatic ecosystems	**Medium**	**Medium negative**	**– –**	**–**
Human Environment				
Local project area economy	**High**	**Low - medium positive**	**++**	**++/+++**
Physical displacement and resettlement	**High**	**Low - medium negative**	**–/– –**	**0**
Economic displacement and loss of livelihoods	**High**	**Low - medium negative**	**–/– –**	**0**
Population Influx and social fabric	**High**	**Medium negative**	**– –**	**–**
Community safety and security	**High**	**Medium negative**	**– –**	**–**
Forest resource use	**High**	**Insignificant - low negative**	**–**	**–/0**
River resource use	**High**	**Low - medium negative**	**–/– –**	**–**
Archaeological sites and cultural heritage	**High**	**Insignificant**	**0**	**0**
OPERATION PHASE				
Physical Environment				
Topography and landscape	**Medium**	**Low - medium negative**	**– –**	**–**
Geology and soils	**N/A**	**Low-medium negative**	**– –**	**–**
Climate	**High**	**Low - medium positive**	**+**	**+ +**
Air Quality	**High**	**Insignificant**	**0**	**0**

Theme	Value/ Vulnerability	Impact Magnitude	Overall Impact	
			Without Mitigation	With Mitigation
Noise and vibration	**High**	**Insignificant**	**0**	**0**
Hydrology	**N/A**	**Low - medium negative**	**–/– –**	**–/– –**
Sediment transport	**High**	**Low - medium negative**	**–**	**0/–**
Water quality	**Medium-high**	**Medium negative**	**– –**	**–/– –**
Biological Environment				
Protected areas*	**Low**	**Insignificant or low negative**	**0 or –**	**0 or –**
Vegetation	**Medium**	**Low negative**	**–**	**0/ –**
Terrestrial fauna	**Medium**	**Medium negative**	**– –**	**– –/–**
Aquatic ecosystems	**Medium**	**Medium negative**	**– –**	**– –/–**
Human Environment				
Local project area economy	**High**	**Low - medium positive**	**+**	**++**
Physical displacement and resettlement	**High**	**Insignificant**	**0**	**0**
Economic displacement and loss of livelihoods	**High**	**Insignificant**	**0**	**0**
Population influx and social fabric	**High**	**Low negative**	**–**	**–**
Community safety and security	**High**	**Insignificant**	**0**	**0**
Forest resource use	**High**	**Low negative**	**0**	**+**
River resource use	**High**	**Medium - Low negative**	**–**	**0**
Archaeological sites and cultural heritage	**High**	**Insignificant**	**0**	**0**

* Assessment depends on confirmation whether parts of the left bank have a forest protection status or not.

8.5 Cumulative Impacts

8.5.1 Introduction

Cumulative impacts are those that result from the successive, incremental, and/or combined effects of an action, project, or activity when added to other existing, planned, and/or reasonably anticipated future ones. The magnitude of the cumulative impacts can be equal to the sum of the individual effects (additive effect), or can be an increased effect (synergistic effect) or a decreased effect (antagonistic effect) (IFC 2013).

The assessment of cumulative impacts includes two main components:

- The anticipated future condition arising from the cumulative impacts
- The contribution of the development under evaluation to the cumulative impacts

In order to assess the cumulative impacts, the geographical and temporal scope has to be expanded as compared to the definition of the Middle Yeywa project's area of influence or impact zones. In particular, any developments in the upstream catchment must be considered even if the proposed project has no impact beyond the tail end of the reservoir.

The other existing and planned developments that have been selected for analysis (see below) include those identified by stakeholders to be of critical concern and that have a high relative importance. The cumulative impacts may translate into a wide range of changes in the physical, biological and human environments, but only the most significant issues are dealt with here. Indeed, a full cumulative impact assessment for the concerned river catchments requires a wider scope and would involve more detailed sector studies and wider stakeholder engagement.

8.5.2 Other Planned or Existing Projects

The Middle Yeywa project will be implemented in an environment that is already modified by the downstream Yeywa Hydropower Project and that will undergo further changes due to the Upper Yeywa project currently under construction.

The 790 MW *Yeywa HPP*, commissioned in 2010, is located downstream of the proposed Middle Yeywa HPP. The reservoir has a FSL at 185 masl., a surface area of 59 km^2 and a total volume of 2,600 million m^3, of which 1,600 million m^3 is for active storage. Thus, the Yeywa reservoir is capable of attenuating the daily flow fluctuations from Middle Yeywa HPP without a significant change in the reservoir water level.

The daily operation data series at Yeywa are illustrated in ***Figure 8-9***. Spill flows occur from July after the reservoir has reached its full capacity (FSL is 185 masl.) and last as long as the water level exceeds the FSL. When the inflows exceed the total outflow (via turbines+spillway), the water level increases.

Based on the available hydrological records, the mean annual volume of the flow through turbines of the Yeywa HPP is 10,290 Mm^3 while the spill flow is 5,200 Mm^3 and the inflow is 15,450 Mm^3. On average, the outflows are larger than the inflows between January and May with 280 m^3/s and 185 m^3/s, respectively, due to the seasonal emptying of the Yeywa reservoir. In contrast, the outflows are lower than the inflows between July and September with 704 m^3/s and 954 m^3/s, respectively, due to the seasonal filling of the reservoir.

The 280 MW *Upper Yeywa HPP*, currently under construction, is located about 130 km upstream of the existing Yeywa HPP and immediately upstream of the tail end of the proposed Middle Yeywa reservoir. The power plant will be operated as a daily peaking scheme with FSL at 395 masl and MOL at 385 masl, providing an active storage of about 18.6 Mm^3 (total storage 55 Mm^3). The tailwater level is 323 masl. The dam will be 87 m high and be equipped with a gated spillway and bottom outlets at elevation 334 masl. The construction of Upper Yeywa HPP is ongoing but has suffered major delays and the commissioning date is currently unknown.

It should be noted that a fourth hydropower plant is currently also being planned on the Myitnge River downstream of the existing Yeywa HPP. The project is known as *Deedoke HPP*. It will consist of a 27 m high dam with a run-of-river 77 MW power plant that will take advantage of the river regulation of the Yeywa reservoir. According to the latest information, the proposed Deedoke HPP is scheduled for completion by 2020-21.

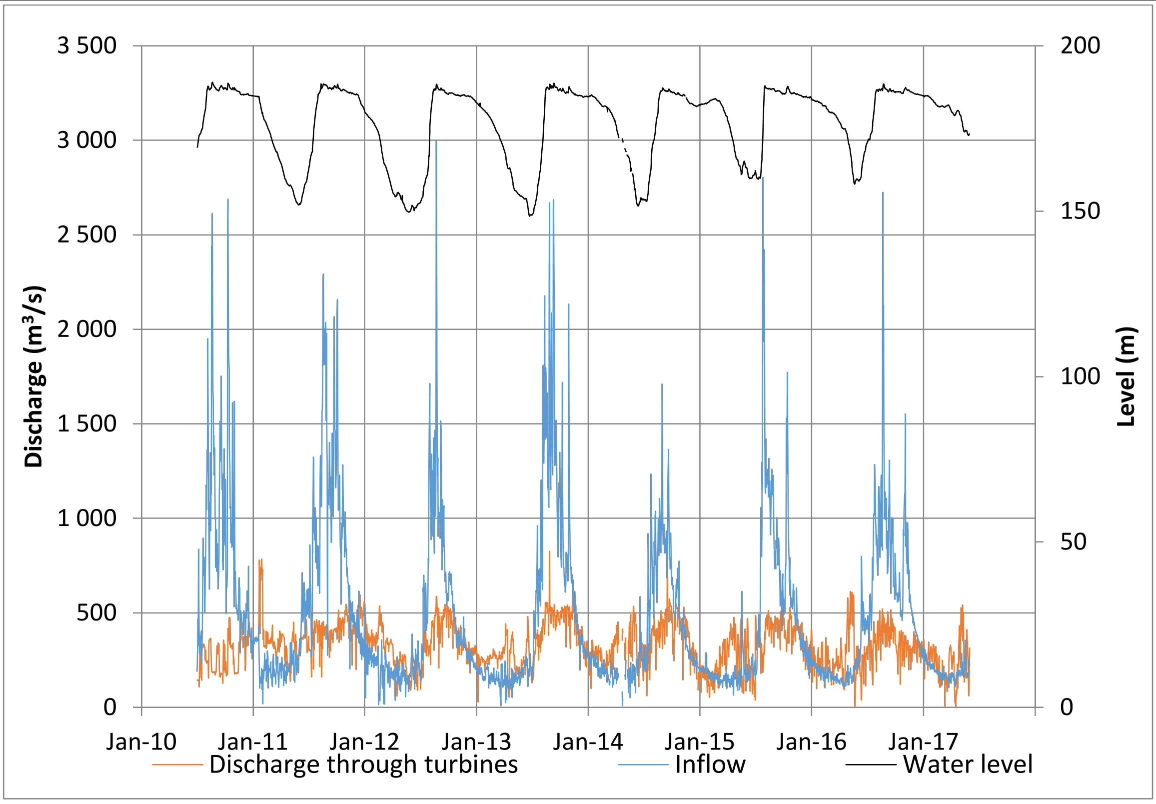

Figure 8-9: Daily operation data series at Yeywa HPP.
Source: Tractebel (2017)

8.5.3 Climate Change

There is little doubt that a changing climate may have significant impacts on the availability of water resources, and hence, on hydropower planning, operation and safety. As explained in Section 6.3.2, the predicted change in rainfall regime in the Myitnge River basin varies with different climate change projections, though an increase in precipitation is more likely than a decrease in precipitation whatever the time horizon.

Tractebel (2017) assessed how the climate change scenarios will affect the inflow at Middle Yeywa. The results are shown in ***Table 8-4*** and ***Table 8-5*** for RCP4.5 (low emissions scenario) and RCP8.5 (worst case scenario), respectively.[20] The main observations are as follows:

- In the near term time horizon, the possible change in runoff does not depend much on the RCP. The 25th, 50th and 75th percentiles of the mean annual runoff are -13%, 2%, 3% for the RCP4.5 and -14%, 4% and 3% for the RCP8.5, respectively.
- In the midterm time horizon, the discrepancies between both RCPs are just slightly more pronounced. The 25th, 50th and 75th percentiles of the mean annual runoff are 0%, 0%, 16% for the RCP4.5 and -3%, -2% and 14% for the RCP8.5, respectively.
- In long term horizon, the discrepancies between both RCPs are pronounced. The 25th, 50th and 75th percentiles of the mean annual runoff are -1%,-3%, 9% for the RCP4.5 and -9%, 6% and 12% for the RCP8.5, respectively.
- Whatever the time horizon and the RCP, the distribution is scattered around 0%. The latter means that the runoff change is uncertain as some climate scenario experiments project a decrease in runoff while some others climate scenario experiments project an increase in runoff.

[20] *RCP = Representative Concentration Pathway*

In conclusion, the change in the mean annual runoff of the Myitnge River is likely to be in the range of -14% to 3% in near term time horizon, -3% to 16% in mid-term and -9% to 12% in long term.

Table 8-4: RCP4.5 – change in runoff.

	2016-2035			2046-2065			2081-2100		
	25%	50%	75%	25%	50%	75%	25%	50%	75%
RCP4.5 Change in runoff (%)									
Dec	-10%	-3%	0%	-4%	-3%	4%	-5%	-7%	4%
Jan	-11%	-4%	-1%	-5%	-5%	2%	-7%	-8%	0%
Feb	-11%	-5%	-2%	-6%	-6%	0%	-8%	-10%	-1%
Mar	-11%	-6%	-2%	-7%	-7%	-2%	-9%	-11%	-2%
Apr	-12%	-5%	-2%	-6%	-7%	0%	-8%	-11%	-2%
May	-15%	0%	1%	-3%	-4%	12%	-5%	-8%	3%
June	-17%	3%	3%	1%	0%	21%	-1%	-4%	9%
July	-17%	5%	5%	3%	2%	25%	2%	-1%	11%
Aug	-15%	6%	5%	4%	3%	25%	3%	1%	12%
Sep	-13%	5%	4%	4%	3%	22%	3%	1%	10%
Oct	-12%	-1%	4%	-2%	0%	12%	-3%	-4%	11%
Nov	-10%	-3%	2%	-4%	-2%	8%	-5%	-6%	8%
Year	**-13%**	**2%**	**3%**	**0%**	**0%**	**16%**	**-1%**	**-3%**	**9%**

Source: Tractebel (2017)

Table 8-5: RCP8.5 – change in runoff.

	2016-2035			2046-2065			2081-2100		
	25%	50%	75%	25%	50%	75%	25%	50%	75%
RCP8.5 Change in runoff (%)									
Dec	-13%	1%	0%	-7%	-5%	3%	-12%	-5%	-1%
Jan	-12%	0%	-1%	-9%	-7%	0%	-14%	-8%	-6%
Feb	-11%	-1%	-2%	-10%	-8%	-2%	-16%	-11%	-9%
Mar	-7%	-1%	-2%	-11%	-9%	-3%	-17%	-12%	-11%
Apr	-5%	-1%	-2%	-11%	-10%	-2%	-18%	-11%	-11%
May	-7%	2%	1%	-9%	-8%	7%	-16%	-3%	0%
June	-14%	5%	4%	-5%	-5%	17%	-12%	7%	13%
July	-18%	6%	5%	-1%	-2%	21%	-8%	13%	20%
Aug	-17%	6%	5%	0%	-1%	21%	-5%	15%	22%
Sep	-15%	5%	4%	1%	0%	19%	-4%	13%	19%
Oct	-13%	4%	4%	-5%	-1%	13%	-9%	4%	12%
Nov	-13%	3%	2%	-6%	-3%	8%	-11%	-1%	5%
Year	**-14%**	**4%**	**3%**	**-3%**	**-2%**	**14%**	**-9%**	**6%**	**12%**

Source: Tractebel (2017)

8.5.4 Physical Environment

The Myitnge River hydropower cascade will cause a dramatic change in hydrological conditions, sediment transport and water quality characteristics. The cumulative impacts on the physical environment have been described as part of the project-specific impacts, especially for hydrology (Section 8.2.6), sediment transport (Section 8.2.7) and water quality (Section 8.2.8). The three hydropower reservoirs will essentially convert the Myitnge River from a free-flowing river with a seasonal flow regime into a fragmented system with standing or slow-flowing water bodies controlled by dams acting as sediment traps and releasing daily fluctuating flows in periods when inflow is lower than turbine capacity. During the months of high flow (periods of the year when there is spilling over the dams or releases through gates), the projects will not affect the flow levels.

At the time of commissioning of the Middle Yeywa HPP, many of these changes will already have occurred as a result of the Upper Yeywa HPP and the existing Yeywa HPP. Indeed, the river discharge, sediment transport and water quality downstream of the Yeywa HPP is already determined by the Yeywa dam and will continue to be so due to the large size of its reservoir and its location as the lowermost hydropower plant in the Myitnge River. In this respect, the incremental impact of the Middle Yeywa HPP is significantly less than it would have been without the two other hydropower dams.

There is currently no information available on how the three hydropower plants will be operated in order to maximise production and meet the daily demands for electricity while also managing sediments to increase the lifetime of the reservoirs. It is expected that Upper Yeywa and Middle Yeywa will be subject to joint/coordinated operation, but this needs to be explored further and be defined in the operating licenses and the Power Purchase Agreement.

8.5.5 Vegetation and Forests

The loss of forest in the Middle Yeywa reservoir will be additional to the loss already caused by the downstream Yeywa HPP and the Upper Yeywa HPP under construction. The cascade of hydropower dams will thus convert a long section of the Myitnge River valley (>200 km) from a forest-dominated ecosystem into a largely aquatic dominated ecosystem surrounded by forest areas.

According to DHPI (2014), none of the threatened plant species recorded in the present EIA report occurs in the impact zone of the Upper Yeywa HPP. However, there is a risk that these species were not reported in the field surveys and that at least some of them also grow upstream of the Middle Yeywa reservoir. Similarly, it is likely that some trees belonging to the threatened species have already been submerged by the large Yeywa reservoir downstream.

Despite such cumulative impacts (“additive effects”), the overall reduction in population size for the threatened species, as well as for other plant species, is not considered to be significant at a national or global scale. Even locally, these plant species will continue to grow and reproduce in the river valley uphill from the three hydropower reservoirs, as they are not confined only to the lower elevation of the river valley.

The major issue in the long term is whether the hydropower developments in the Myitnge River valley will increase pressure on the forests (due to in-migration, conversion of forests to agriculture or other land uses, etc.) or whether the government and other stakeholders will be capable of managing and enforcing more stringent control over the natural forest areas. Indeed, there is a risk that illegal timber extraction will increase, at least during the construction period of Middle Yeywa HPP, although this is largely a project-induced impact and not so much a cumulative impact (as the two other power plants will already be in operation at that time, with less population influx).

8.5.6 Terrestrial Fauna

Loss of habitat, various forms of disturbance and hunting are likely to increase pressures on a range of fauna species in the project area. The species found in the Middle Yeywa impact zone are generally spread throughout a much larger areas, including in the Lower and Upper Yeywa project areas. The baseline surveys did not document species that rely only on the habitats impacted by the Middle Yeywa Project. These species are generally found in large areas within Myanmar and beyond in the region. However, the combination of loss of relatively unaffected areas in the steep river valleys between Yeywa and Upper Yeywa (including the impact zone of the Middle Yeywa) and substantial conversion of forest on the surrounding plateaux will result in a cumulative fragmentation of habitats and habitat loss that are likely to reduce populations of many forest-dependent species. Species requiring large habitats and species sensitive to human disturbance are most vulnerable. These include the some of the cats, some of the primates and some of the bird species of conservation concern. Maintaining a minimum of habitats in the wider landscape and maintaining corridors between these habitats are likely to be important to prevent local extinction of such species. Even if none of the species are likely to be severely impacted by the Middle Yeywa HPP in isolation, the gradual fragmentation and cumulative loss of habitat are resulting in reduced populations of species of conservation concern. There appears to be no landscape-wide planning for the management of sufficiently large and connected habitats for species of conservation concern. In the face of climate change, the connectivity between habitats may become vital for the robustness of the species populations within a mosaic of habitats. The Middle Yeywa HPP can play a role in facilitating sustainable management of areas around the reservoir that play a positive role in maintaining important habitats in a larger landscape and thereby mitigate cumulative impacts from multiple developments. It is recommended that the plans to compensate for forest loss (reservoir clearing) are strategically targeted to also play a useful role in mitigating landscape-wide cumulative impacts by ensuring good quality habitats that support connectivity in the wider landscape.

8.5.7 Aquatic Ecosystems

The aquatic ecosystems are probably the ecosystems most affected by cumulative impacts even if the contribution from the Middle Yeywa HPP will be relatively small considering the existence of the Yeywa dam and reservoir and the ongoing construction of the Upper Yeywa dam. The Myitnge River probably had comprehensive two-way connectivity with the greater Ayeryawady River system prior to the construction of the Yeywa HPP though it should be noted that the potential presence of natural barriers to upstream fish migration remains unknown to the Consultant. At present, upstream migration of species such as fish and shrimps has been blocked by the downstream Yeywa dam. Further dam development upstream of the existing Yeywa will not alter the connectivity with the larger Ayeryawady River system significantly. However, if there is local migration of some fish species within the Myitnge River, or between the Yeywa reservoir and upstream areas, such migration patterns will be impacted first by the Upper Yeywa HPP and then the Middle Yeywa HPP. The limited available information on aquatic ecology and fish migration patterns does not allow for any refined analysis of this issue.

There are likely to be a range of aquatic species that complete their life cycle within the Myitnge River and hence do not rely on connectivity with the greater Ayeyarwady river system. Those species are adapted to riverine conditions and will, because of the cumulative impacts from Yeywa, Middle Yeywa and Upper Yeywa HPPs, see the majority of riverine habitats lost between the Yeywa and Upper Yeywa HPPs. This may result in local extinctions and it is recommended that these risks are further studied prior to constructing the Middle Yeywa HPP. Some riverine species may survive in the limited river sections between the reservoirs, in the limited number of tributaries flowing into the reservoirs as well as in the reservoirs themselves unless the species are outcompeted or heavily predated upon by species better adapted to a lake environment.

Along the Myitnge River, there is a large number of small sand banks. These sand banks may be an important habitat for various insect species and possibly turtle species of conservation concern. The cumulative loss of river sections with sand banks may also result in local extinction of such species. Some sand banks will be created at the upstream ends of the Middle Yeywa reservoir and these may substitute for lost sand banks but probably only to small extent due to the limited size compared to the large number of sand banks along the inundated river section. Further consideration should be made of species of conservation concerns.

8.5.8 Local Project Area Economy

The Upper Yeywa HPP is the only major infrastructure project that may possibly add to the social impacts created by the Middle Yeywa HPP. Although construction of the Upper Yeywa HPP has already started, delays in the construction schedule could result in the possibility that the construction phases of the two projects could overlap. If this happens, this may add to the increased economic activities and employment opportunities that are likely to result from the Middle Yeywa HPP. This may lead to increased demands for local goods and services as well as for locally recruited labourers. A result from this economic boost may be an incremental increase in local prices on goods and services that would not have happened if the two projects did not overlap. However, it is still too early to know whether this will actually happen but the possibility cannot be ruled out at this stage.

8.5.9 Population Influx and Social Fabric

In the wider project area, an overlap of the construction phases of the two hydropower projects could also trigger a larger in-migration into the area in the form of camp followers and people seeking to benefit from the increases in demands for all kinds of services.

8.5.10 Community Safety and Security

Along with the more general increase in road traffic on National Highway No. 3 that runs through Nawnghkio, an increase in construction related heavy traffic though the township may occur in the case of a concurrent construction of the Upper and Middle Yeywa hydropower projects. This may in turn lead to an incremental increase in the number of traffic incidents, including fatal accidents along National Highway No. 3. During operation, road traffic will decrease in terms of heavy construction traffic.

9 ANALYSIS OF ALTERNATIVES

9.1 Introduction

This chapter describes and examines the alternatives to the proposed Middle Yeywa HPP in line with the requirements of IFC Performance Standard 1 (Assessment and Management of Environmental and Social Risks and Impacts) which states that "*For greenfield developments or large expansions with specifically identified physical elements, aspects and facilities that are likely to generate potential environmental or social impacts, the client will conduct a comprehensive ESIA, including an examination of alternatives, where appropriate.*"

While only one project alternative was examined in detail in Chapter 8, different technical alternatives have been considered in the pre-feasibility and feasibility study stage.

Generally, a comparison of alternatives can help to determine the best method of achieving project objectives while minimising environmental and social impacts. Alternatives should be evaluated and compared on the basis of their potential environmental and social impacts, costs and feasibility.

9.2 Project Need and Alternative Sources of Energy

According to ADB (2015), the total primary energy supply for Myanmar was about 18 million tons of oil equivalent energy (MTOE) in 2012–2013 (ADB, 2015). More than half (54% or 9.7 MTOE) of Myanmar's energy supply was from biomass, followed by 17% (3 MTOE) from hydro, 15% (2.8 MTOE) from oil, and 12% from gas. Coal accounted for only a small share (3%).

Myanmar has over the last years seen a growth of the Gross Domestic (GDP) by 6 to 8%. For 2018, a growth of 8% has been forecasted by ADB (2017). Strong economic growth is also expected for all sectors of the economy for the years to come with a most likely growth scenario of around 7% (ADB 2014). To fuel this economic growth, total energy demands will be increasing rapidly. According to the Myanmar Energy Master Plan (ADB 2015), the electricity demand within Myanmar is estimated to increase to 25.8 TWh in 2021 and 57.7 TWh in 2030. The hydropower share of the total electricity supply is expected to decline from around 70% in 2012 to 57% in 2030 while electricity from coal fired plants is expected to increase from around 2% to 30% over the same period. The planned strong expansion of rural electrification is one of the main drivers behind the high electricity demand growth.

Table 9-1: Forecasted electricity demand in Myanmar.

	2012	2015	2018	2021	2024	2027	2030
INPUT (mtoe)	1.97	2.22	2.21	2.52	4.22	5.45	7.54
OUTPUT Electricity (GWh)	10,364	14,398	19,446	25,763	33,904	44,238	57,654
Electricity output shares (%)							
Hydro	69.7%	65.0%	56.5%	74.1%	64.0%	65.7%	57.1%
Solar PV	0.0%	0.0%	0.0%	0.0%	0.0%	2.0%	5.2%
Wind	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Natural gas	28.1%	33.4%	38.9%	22.4%	12.7%	8.3%	8.2%
Oil	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Coal	2.2%	1.6%	4.6%	3.4%	23.3%	24.0%	29.5%

Source: Myanmar Energy Master Plan

If built, the Middle Yeywa HPP will contribute to meeting the future demands for electricity supply presented in Table 9-1. The "No Development Alternative" will imply that other electric energy sources and projects may have to be developed in order to realise the ambitious plans for rural electrification and providing electricity for businesses and future industrial projects. Coal appears to be the most likely alternative electric energy source, as other sources, such as solar power, are only expected to provide 5% of the supply in 2030. Considering that the Middle Yeywa HPP in the long run will be a better alternative than coal from a CO_2 emissions and climate change perspective, it can be seen as the preferable alternative for addressing future electricity demands.

9.3 Assessment of Hydroelectric Alternatives

According to the Baseline Assessment Report prepared in connection with the Strategic Environmental Assessment of the Hydropower Sector in Myanmar (MOEE and MONREC 2016), there are 29 existing hydropower plants already in operation ranging from 10 to 790 MW with a total installed effect of 3298 MW. Six other hydropower projects are currently under construction, including the 280 MW Upper Yeywa, the 51 MW Keng Tawng, the 111 MW Thahtay, the 42 MW Buywa, the 30 MW Baluchaung and the 1050 MW Shewli 3 hydropower plants.

In addition to the projects under construction, 69 other hydropower and multipurpose projects are in various stages of planning, including those that have yet only been identified as potential hydropower development projects. Among these 69 identified hydropower development projects, there are a number of projects that match and exceed the size of Middle Yeywa HPP with most of them located in the Ayeyarwady River Basin. The largest of these is the controversial and now suspended 6000 MW Myitsone HPP located on the upper Ayeyarwady mainstream followed by 3400 MW Chipwi HPP located in the Nmae Hka sub-basin. However, these projects are located relatively far north in Myanmar, far from Yangon and Mandalay where the largest increases in the electric power demand is expected. In the Myitnge Sub-basin, where Middle Yeywa is located, there are no other planned hydropower projects of a similar size in terms of installed capacity (MW) and annual energy generation (GWh/yr). The table below shows the planned hydropower projects in the Myitnge sub-basin.

Table 9-2: Key data for hydropower projects planned in the Myitnge sub-basin.

River	Project	Installed Capacity (MW)	Generation (GWh/yr)	Dam Height (m)	Total Storage (hm^3)	Reservoir Area (km^2)	Reservoir Length (km)	Retention Period (days)	Type (#)	Export (%)
Myitnge	Middle Yeywa	700	3,253	160	454	11	70	NP	NP	0%
	Deedoke	77	338	27	NP	NP	19	NP	NP	0%
Nam Tu/Myitnge	Nam Tu	100	410	114	NP	NP	4	NP	NP	0%
Tributaries to Myitnge	Nam Hsim	30	NP	NP	NP	NP	NP	NP	NP	0%
	Nam Lang	210	NP	NP	NP	NP	NP	NP	? NP	0%
Sum		**1,117**	**4,001**		**>454**	**>11**	**>93**	**NP**		

Source: MOEE and MONREC (2016)
NP: not provided

In the smaller Ma Gyi Chaung sub-basin located to the west of Myitnge Sub-basin, the Ministry of Agriculture, Livestock and Irrigation is planning to build a multipurpose dam upstream of the existing 25 MW hydropower project. The project will include a 64 MW hydropower plant with a 24 km^2 reservoir.

The only project that is planned in the Paung Laung sub-basin, which is located south of the Myitnge sub-basin, is the 100 MW Middle Paung Laung HPP. It is scheduled for completion in 2021.

In terms of other hydropower development projects that will have the capacity to provide electricity to fulfil ambitious rural electrification targets and meet future demands in large population centres such as Mandalay, it appears that Middle Yeywa HPP represents one of the best choices given its size and favourable and central location in relation to future load centres.

9.4 Comparison of Design Alternatives

The pre-feasibility study considered a number of alternatives for hydropower development on the around 70 km long section of the Myitnge River between the existing Yeywa HPP and the planned Upper Yeywa HPP (Pöyry 2015). Different layouts for a development in one or two stages were considered. The alternatives were evaluated on the basis of topographical, hydrological and geological conditions as well as site access. The different design parameters of the considered alternatives are presented in the table below. For location of the different alternatives, see Figure 2-6 in Chapter 2.

Table 9-3: Features and design parameters of considered alternatives.

Alternative	FSL (masl.)	MOL (masl.)	TWL (masl.)	Discharge (m^3/s)	MW	Dam
1	320	305	276	540	200	55 m high RCC dam with a vertical upstream face and a downstream slope between 0.80:1 and 0.85:1
2	320	300	256	550	300	75 m high RCC dam with a vertical upstream face and a downstream slope between of 0.85:1
3	256	236	185	560	400	85 m high RCC dam with an upstream slope of 0.1:1 and a downstream slope of 0.85:1
4.1	276	256	185	560	500	105 m high RCC dam with an upstream slope of 0.1:1 and a downstream slope of 0.85:1
4.2	276	260	185	560	500	50 m high RCC dam with vertical upstream face and a downstream slope between 0.80:1 and 0.85:1
5.1	320	300	185	560	690	150 m high RCC dam with an upstream slope of 0.1:1 and a downstream slope of 0.85:1
5.2	320	300	185	560	690	95 m high RCC dam with an upstream slope of 0.1:1 and a downstream slope of 0.85:1

Source: Pöyry (2015)

The location of Alternatives 1, 2, 3, 4.1 and 4.2 were chosen to allow for a development of the river in two stages with construction of the different dams as far upstream or as far downstream as possible while achieving an installed effect of 400 MW or more. The following combination of alternatives were considered:

- Alternative 1 (circa 200 MW), followed later by Alternative 4 (circa 500 MW).
- Alternative 2 (circa 300 MW), followed later by Alternative 3 (circa 400 MW).
- Alternative 3 (circa 400 MW), followed later by Alternative 2 (circa 300 MW).
- Alternative 4 (circa 500 MW), followed later by Alternative 1 (circa 200 MW).

Cost estimations show that a two stage development is likely to be significantly more expensive than a one stage development as shown in the table below.

Table 9-4: Comparison of cost between a one and a two stage development of Middle Yeywa HPP.

Alternatives	**Alt.1+4.1**	**Alt. 1+4.2**	**Alt. 2+3**	**Alt. 5.1**	**Alt. 5.2**
Installed capacity (MW)	660	650	660	690	690
Total costs (Million USD)	970.8	1,008.4	1,055.6	720.6	724.3
Cost per kW installed (USD/kW)	1,471	1,523	1,407	1,075	1,114

As mentioned in Chapter 2 (Section 2.9.1), the project developer has decided at this stage of project planning to go further with Alternative 5.1 for full feasibility study due to cost considerations and the fact that this alternative allows for exploitation of the entire available head while maximising the installed capacity.

From an environmental and social perspective, Alternative 5.1 is acceptable compared to a two-stage development in terms of concentrating the construction works to a single dam site and to a single period. Assuming that the entire head between the existing Yeywa HPP and the Upper Yeywa HPP will eventually be developed, the proposed Alternative 5.1 is acceptable. However, if the alternative was to develop only parts of the available head, then such an approach would reduce the overall environmental and social impacts. On the other hand, the pristine nature of the Myitnge River would in any case be undermined by the existing Yeywa HPP and the dams further upstream even if parts of the river reach was left untouched. This also applies to the “no project alternative” as it cannot prevent that the Myitnge River becomes heavily modified due to the cumulative impacts of the Yeywa HPP (acting as the main barrier to river connectivity) and the Upper Yeywa HPP (controlling the flow of water and sediments into the Middle Yeywa reaches).

10 OVERVIEW OF THE SOCIAL AND ENVIRONMENTAL MANAGEMENT PLAN

10.1 Introduction

This Chapter presents an overview of the Environmental and Management Plan (EMP) along with the Social Management Plan (SMP) presented in detail in the two following chapters. The organisational set-up and staffing that will be necessary for implementing the management plans is also presented in this chapter.

The EMP and the SMP aim to fulfil the requirements of the Performance Standards of the International Finance Corporation (IFC) as well as the Environmental Health and Safety (EHS) Guidelines of the World Bank Group and the Good Practice Note on EHS Approaches for Hydropower Projects. At a national level the EMP and the SMP aim to comply with the requirements for Environmental Management Plans as set out in the Environmental Impact Assessment Procedure (Notification 616/2015) issued by the Ministry of Natural Resources and Environmental Conservation (Chapter VII)

The EMP and the SMP are based on the information available at this stage of project planning and it needs to be noted that the further planning process, especially when it comes to the design and location of associated infrastructure, may change the project impacts and accompanying mitigation strategies. This will require revision and updating of the EMP and SMP, most notably with respect to the construction phase activities

10.1.1 Overall Goals and Objectives

The overall goal of the EMP is to identify and describe effective mitigation measures for environmental and social impacts likely to be caused by the Middle Yeywa Hydropower Project. More specifically the main objectives of the EMP is to:

- Formulate actions and measures that will avoid and mitigate the negative impacts on the physical and biological environments that have been identified;
- Identify measures to enhance the value of environmental resources where feasible;
- Provide a structure for monitoring of the negative impacts as well as evaluation of the effectiveness of the implemented mitigation measures.

The overall goal of the SMP is to safeguard the interests of stakeholders and to prescribe mitigation measures that minimises social impact of the Project as far as possible. One important objective to achieve this is to carry out a comprehensive consultation process that provides all stakeholders with an opportunity to express their views and concerns so that potential social impacts can be identified and addressed.

10.1.2 Overall Coordination and Roles and Responsibilities

In relation to the requirements from international funders and national environmental authorities, SN Power will have the overall responsibility for implementing and coordinating all social and environmental mitigation activities and programmes. With regard to construction related impacts, the contactor carries the main responsibility to implement effective measures as described in the EMP and SMP for the Project. SN Power will through its project organisation and in cooperation with local and local environmental authorities monitor the environmental and social performance of the contactor and make sure that contactors maintain compliance with environmental standards.

Local government institutions and NGOs are likely to play a role in the implementation mitigation programmes but further project consultations and meetings will be necessary to identify eligible implementation partners more closely.

SN Power's own environmental and social performance with regard to implementation of the EMP/SMP and compliance with international and national standards will be monitored by the Ministry of Energy and Electricity as well as the Ministry of Natural Resources and Environmental Conservation. In addition, the lenders will nominate a Lenders Technical Advisor that will monitor the environmental and social performance of SN Power throughout the construction phase and in the first part of the operation phase.

10.2 Overview of the EMP Programmes and Activities

10.2.1 Construction Management Plan

The Construction Management Plan addresses a number of environmental issues in connection with construction activities and describes best practises for managing these issues. Measures are described for spoil disposal, sediment management, waste water treatment and dust and noise control.

For controlling dust and noise emission the Construction Management Plan the most important measures are frequent watering of dirt roads, limiting blasting operations to daytime and fitting construction machinery with noise control devises.

10.2.2 Water Quality Monitoring Plan

The most important construction phase water quality issues include discharge of hazardous chemicals, discharge of domestic wastewater and sewage from work sites and camps, and sediment loads from construction activities. The Water Quality Monitoring plan prescribes monitoring of a number of parameters for water quality, including important parameters such as turbidity, nitrogen and phosphate concentration, chemical and biological oxygen demand and total suspended solids. Compliance levels will be determined with reference to ASEAN classification and the World Bank Group effluent water standards.

The plan recommends continuing with the same quality monitoring stations as in the EIA study while the recommended monitoring frequency is bi-monthly during construction.

10.2.3 Aquatic Ecology and Fisheries Management Programme

The overall goal of the Aquatic Ecology and Management Programme is to avoid and minimise impacts on the aquatic ecosystems through project design modifications, mitigation, enhancement measures, and monitoring. Important activities include:

- Develop and implement measures that reduce impacts on the aquatic ecosystems, and the people who rely on its ecosystem services, to acceptable levels;
- Monitor and document changes in aquatic ecosystem dynamics, species composition and abundance, and ecosystems services provided, in particular the opportunities for fishing;
- Use monitoring results to inform decision-making on adjustments to project operation, mitigation and enhancement measures and future monitoring;
- Assess the feasibility of supporting sustainable fishing activities in the reservoir. If considered feasible, develop and implement a fisheries management plan.

The programme activities will focus on the proposed reservoir area, the river section between the Middle Yeywa dam and the downstream Yeywa reservoir as well as the Gohteik tributary on the right bank in the upper section of the Middle Yeywa reservoir.

10.2.4 Reservoir Clearance and Filling Plan

The objectives of the biomass clearance are to:

- Reduce the amount of biomass, thereby reducing the risk of poor water quality and greenhouse gas (GHG) emissions from decay of organic matter in the reservoir;
- Reduce the amount of wood debris floating on the reservoir and/or getting into the trash racks;
- Reduce the number of dead trees standing in the water which would become an aesthetic nuisance and an obstacles for possible boat transport and fishing in the reservoir;
- Salvaging valuable timber resources, which would otherwise be submerged and lost.

Selective logging will be carried out to harvest accessible standing timber with a commercial value. The logging and transport of timber will be completed in advance of the full clearing operations. It is assumed that the value will exceed the cost of the salvage logging operation.

Following the harvesting of commercial timber, one or more contractors shall be appointed by SN Power to carry out biomass clearance of selected areas within the reservoir.

During initial and final reservoir filling, it will be necessary to clear the water of logs and organic debris by using booms placed above the intake and spillway structures.

10.2.5 Biodiversity and Conservation Protection Plan

The overall goal is to avoid and minimise impacts on biodiversity through project design modifications, mitigation and enhancement measures, and monitoring.

Specific activities under the Biodiversity and Conservation Protection Plan will include protection of important habitats and catchment areas, conservation of selected species and biodiversity monitoring.

Priority will be given to areas with important habitats that to a limited extent have been have changed by land conversion and other human activities. The areas that are most interesting in this regard are the steep river valley areas towards the reservoir and the plateau on the left bank, including the proposed Naung Lon Reserve Forest.

10.2.6 Community Forest Programme

The overall goal of the Community Forest Program is to compensate for the loss of forest in the Middle Yeywa reservoir by restoring priority forests outside of the project's direct impact zone.

The Community Forest Program will focus on areas that already have been identified as interesting in a conservation perspective. One potential area is located in the catchment of the existing Yeywa reservoir, a short distance downstream of the proposed Middle Yeywa dam site. This area has been prioritised by the Forest Department and consists of the Pyin Oo Lwin Wildlife Sanctuary, a highly degraded habitat that is not properly protected, and the Mehon (Doke-hta Wady River) Key Biodiversity Area (KBA), which is home to the Endangered Green Peafowl (Pavo muticus). In addition, the Naung Lon Reserve Forest on the left bank of Myitnge River will be considered for community forest activities.

A number of interventions will be proposed and may include:

- Sustainable management of existing forests where villagers are allowed to extract firewood, posts and poles in accordance with established by-laws;
- Assisted regeneration of trees involving nurseries to raise seedlings;
- Agro-forestry practices on land that already has been converted to agriculture.

10.3 Overview of SMP Programmes and Activities

10.3.1 Stakeholder Engagement Plan

The overall goal of the Stakeholder Engagement Plan is to establish a platform and structure for an effective and continuous dialogue with all stakeholder groups. The consultative process in the villages will in the pre-construction and the construction phase will be focused on the planning of the community development initiatives (CDI), including access road improvement and grid connection.

For local businesses that are interested to utilize the increased market opportunities created by the Middle Yeywa HPP, public meetings will be arranged to inform them about the project planning process and in particular what kind of services and goods that will be required by the Project.

10.3.2 Compensation for Lost Land, Production and Fixed Assets

All affected assets, including building infrastructure and residential and agricultural land, will be surveyed and fully compensated. It is expected that the project components that to the largest degree will trigger compensation payments are the access roads from Nawnghkio to Yae Twin Gyi and further down to the dam site. Analysis by Google Earth has identified a total of 137 structures that may have to be relocated because of the widening of the access road. The analysis also indicate that losses of agricultural land largely can be avoided as the access road from Yae Twin Gyi to the dam site can be routed along an existing track across the agricultural fields on the plateau. However, some agricultural land may still have to be taken for the road construction while camps and project facilities may add to the loss of agricultural land. Preliminarily the he loss of agricultural land has been estimated at around 3.0 ha.

10.3.3 Social Management for Construction Areas

It is assumed that in-migrants and people who are seeking some kind of business opportunity in connection with the Project will seek accommodation in villages in the project area rather than settling in unmanaged camps close to the workers' camps.

Depending on the actual influx of people, there may be a need to improve water supply and sanitary conditions in the villages that receive in-migrants as well as organising an effective waste collection and disposal system. In addition, there will be other issues such as monitoring of births, mortality and illness.

10.3.4 Community Development Initiatives (CDI)

Community Development Initiatives, including upgrading existing village access roads and rural electrification, will be prosed by the Project. The main project access road from Nawnghkio to the project construction site via Yae Twin Gyi will be upgraded to a width of 5.5 m. In addition, access roads sections for the following right bank impact zone villages will be upgraded and improved:

- NR 41 to the village of Nawnghkio Gyi via several other village sites;
- NR 41 to Nawng Lin, Yae Maung Tan, Meh Poke and Nawnghkio Kone.

On the upper left bank the Project will consider improving and upgrading the access road from NR 41 to the village of Pin Ping via Thar Si.

In the lower left bank impact zone area, the section from Kyauk Ku on Road NR 41 to the village of Hpet Yin Kone via Tawng Hkan will be proposed for upgrading and improvement. Other villages along the road will also be able to benefit from this upgraded section.

The rural electrification program that will be part of the Community Development Initiatives will largely be focused on the same villages as those that will benefit from the upgraded village access roads. The villages that are proposed to be included in the rural electrification programme include:

- *Right Bank:* Ma Gyi Yae, Nawnghkio Gyi and villages along improved access roads, including Hpar Thun, Nyang Taw and Nawng Lin (1), Nawng Lin (2), Yae Maung Tan, Meh Poke, Nawnghkio Kone and Yae Twi Gyi;
- *Upper Left Bank:* Thar Si and Pin Ping;
- *Lower Left Bank:* Tawng Hkan and Hpet Yin Kone.

10.3.5 Workforce Recruitment and Employment

The goal of the workforce recruitment strategy is to ensure that the local population benefit from the employment opportunities created by the Middle Yeywa HPP. In order to ensure that are local workers are hired by the contractor the main measures to be implemented will include:

- A requirement in the tender documents and in the construction contact that the contractor should give preference to local labour over labour from outside the region, and also commit to a target of recruiting at least 30% of the total workforce locally;
- Compilation of lists of skilled and semi-skilled village and local able-bodied workers for presentation to the contractor.

The Project will also link up with the Human Resource Unit of the Department of Border Affairs and Development of National Races in Taunggyi to further explore possibilities of arranging skills training for trades such as carpentry, brick laying and rebar work. English skills training courses will also be considered.

10.3.6 Occupational Health and Safety

The overall goal of the occupational health and safety (OHS) measures is to safeguard the health of the workers and to prevent accidents leading to injuries. The contactors will have the responsibility for training all workers in work safety routines and provide them with the necessary personal protection equipment (PPE). The contractors will be required to prepare Occupational Health and Safety (OHS) plans for approval by the Developer, and to provide initial and refresher OHS training for all workers. The contractors will also be required to put in place emergency preparedness and response measures, including first-aid stations, fire-fighting equipment and evacuation plans in case of emergencies and serious accidents.

10.4 Implementation Team -Organisational Set-up and Staffing

10.4.1 Organisation and Objectives

In the project organisation of the Developer an Environmental and Social Unit (ESU) will be created to carry out the following activities and functions:

- To implement preventative measure to protect the environment as a result of the Middle Yeywa HPP;
- To recruit and employ skilled and experienced personnel to be responsible for organizing and overseeing all mitigation and benefit sharing programs;
- Be a channel for providing and controlling funds for the implementation of mitigation and benefit sharing programs;
- Carrying out environmental monitoring and supervision during the construction phase in cooperation with the contractor;

The ESU will be headed by an expatriate Environmental and Social Manager who will report directly to the Project Manager. A national Deputy Environmental and Social Manager will assist the

Environmental and Social Manager in the day-to-day implementation of the social and environmental programmes for the Middle Yeywa HEPP. The Deputy Environmental and Social Manager will have a special responsibility for following up and managing the national staff of the ESU. A separate Administration Team headed by a Senior Administrator that will ensure the smooth running and operation of the ESU.

The ESU will include five separate teams that will take responsibility for implementing the different mitigation activities and programmes described in in the EMP and SMP. Each of the teams will have a Team leader who will be assisted by 3- 4 specialists. The organisational set-up and composition of the SEU is illustrated in the figure below.

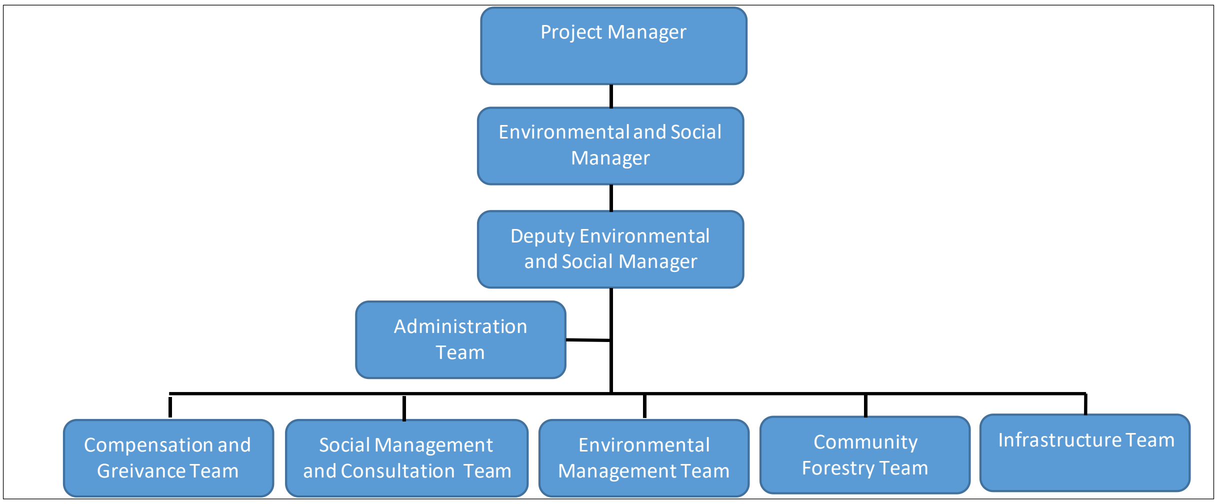

Figure 10-1: Set-up of the Social and Environmental Unit

10.4.2 Personnel Budget

The ESU will have to be established well ahead of the start-up of construction activities although recruitment of some professional staff may continue into the construction phase. It is assumed that the infrastructure team can be phased out after three years while the Community Forestry team can be recruited and formed one year later than the other teams. The table below presents the ESU budget for the operation phase. The total personnel budget amounts to 2 859 600 USD.

Table 10-1: ESU budget for the construction phase

	Personnel Category	Pre-constr.	Construction phase						Total
		Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	
1	**Environmental and Social Manager**	**120 000**	**120 000**	**120 000**	**120 000**	**120 000**	**120 000**	**120 000**	**840 000**
2	**Deputy Environmental and social Manager**	**60 000**	**60 000**	**60 000**	**60 000**	**60 000**	**60 000**	**60 000**	**420 000**
3	**Administation Team**	**30 000**	**30 000**	**30 000**	**30 000**	**30 000**	**30 000**	**30 000**	**210 000**
3.1	*Senior Administrator*	*12 000*	*12 000*	*12 000*	*12 000*	*12 000*	*12 000*	*12 000*	*84 000*
3.2	*Admin. assistants /secretaries (x3)*	*18 000*	*18 000*	*18 000*	*18 000*	*18 000*	*18 000*	*18 000*	*126 000*
4	**Compensation and Grievance Team**	**45 600**	**45 600**	**45 600**	**45 600**	**45 600**	**45 600**	**45 600**	**319 200**
4.1	*Teamleader*	*12 000*	*12 000*	*12 000*	*12 000*	*12 000*	*12 000*	*12 000*	*84 000*
4.2	*Specialists*	*33 600*	*33 600*	*33 600*	*33 600*	*33 600*	*33 600*	*33 600*	*235 200*
5	**Social Management and Consultation Team**	**45 600**	**45 600**	**45 600**	**45 600**	**45 600**	**45 600**	**45 600**	**319 200**
5.1	*Teamleader*	*12 000*	*12 000*	*12 000*	*12 000*	*12 000*	*12 000*	*12 000*	*84 000*
5.2	*Specialists*	*33 600*	*33 600*	*33 600*	*33 600*	*33 600*	*33 600*	*33 600*	*235 200*
7	**Environmental Management Team**	**45 600**	**45 600**	**45 600**	**45 600**	**45 600**	**45 600**	**45 600**	**319 200**
6.1	*Teamleader*	*12 000*	*12 000*	*12 000*	*12 000*	*12 000*	*12 000*	*12 000*	*84 000*
6.2	*Specialists (x4)*	*33 600*	*33 600*	*33 600*	*33 600*	*33 600*	*33 600*	*33 600*	*235 200*
8	**Community Forestry Team**	-	**45 600**	**45 600**	**45 600**	**45 600**	**45 600**	**45 600**	**273 600**
8.1	*Teamleader*	-	*12 000*	*12 000*	*12 000*	*12 000*	*12 000*	*12 000*	*72 000*
8.2	*Specialists (x4)*		*33 600*	*33 600*	*33 600*	*33 600*	*33 600*	*33 600*	*201 600*
9	**Infrastructure Team**	**52 800**	**52 800**	**52 800**	**-**	**-**	**-**	**-**	**158 400**
9.1	*Teamleader (building / civil engineer)*	*14 400*	*14 400*	*14 400*	-	-	-	-	*43 200*
9.2	*Engineers / technicians (x4)*	*38 400*	*38 400*	*38 400*	-	-	-	-	*115 200*
	Total ESU Personnel	**399 600**	**445 200**	**445 200**	**392 400**	**392 400**	**392 400**	**392 400**	**2 859 600**

In the operation phase it is assumed that the Deputy Environmental and Social Manager will replace the expat Social and Environmental Manager while a social management specialist is retained to deal with upcoming issues. The Environmental Management Team along with the Community Forestry Team will continue to work with water quality management and follow-up and monitoring of biodiversity conservation and community forestry activities that are schedules to continue into the operation phase. It is expected that the staffing on the teams can be slightly reduced. The table below shows the budget for the operation phase.

Table 10-2: ESU budget for the operation phase

	Personnel Category	Operation phase					Total
		Year 1	Year 2	Year 3	Year 4	Year 5	operation
1	**Environmental and Social Manager**	**60 000**	**60 000**	**60 000**	**60 000**	**60 000**	**300 000**
2	**Administation Team**	**24 000**	**24 000**	**24 000**	**24 000**	**24 000**	**120 000**
2.1	*Senior Administrator*	*12 000*	*12 000*	*12 000*	*12 000*	*12 000*	60 000
2.1	*Admin. assistants /secretaries (x2)*	*12 000*	*12 000*	*12 000*	*12 000*	*12 000*	60 000
3	**Social Management Officer / Specialist**	**12 000**	**12 000**	**12 000**	**12 000**	**12 000**	**60 000**
4	**Environmental Management Team**	**37 000**	**37 200**	**37 200**	**37 200**	**37 200**	**185 800**
4.1	*Teamleader*	*12 000*	*12 000*	*12 000*	*12 000*	*12 000*	60 000
4.2	*Specialists (x3)*	*25 000*	*25 200*	*25 200*	*25 200*	*25 200*	125 800
5	**Community Forestry Team**	**37 000**	**37 200**	**37 200**	**37 200**	**37 200**	**185 800**
51	*Teamleader*	*12 000*	*12 000*	*12 000*	*12 000*	*12 000*	60 000
5.2	*Specialists (x3)*	*25 000*	*25 200*	*25 200*	*25 200*	*25 200*	125 800
	Total ESU Personnel	**170 000**	**170 400**	**170 400**	**170 400**	**170 400**	**851 600**

10.4.3 Government of Myanmar Budget for Monitoring and Capacity Building

The Government of Myanmar (GOM) will be following up the Project through regular visits and meetings at site to monitor the progress of the construction activities and to discuss any upcoming issues. The visits will include annual high-level delegation visits from key ministries and departments at Union and State level.

The Project will also be committed to build capacities of key government staff at Union and State level through training workshops. The subject matters for the training workshops will be determined through further discussions with GOL.

Costs for per-diems, hotels, transport and meeting allowances have been stipulated as shown in the table below. The tentative GOL budget amounts to 298 100 USD

Item	Pre-constr.	Construction phase						Total
	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	
Transportation costs for Meetings and site visits (Union, State and township officials)	6 500	6 500	6 500	6 500	6 500	6 500	6 500	45 500
Per diem for all GOM staff site visits and meetings at site	10 200	10 200	10 200	10 200	10 200	10 200	10 200	71 400
Overnight costs for Union and State official visits (reduced after camp accommodation completed)	9 600	9 600	4 800	4 800	4 800	4 800	4 800	43 200
Training and Workshops at Union Level (rental of facilities)	6 000	6 000	6 000	6 000	6 000	6 000	6 000	42 000
Training and Workshops at State Level	6 000	6 000	6 000	6 000	6 000	6 000	6 000	42 000
High-level delegation visits (ca. 15 people for one overnight visit) - food and fuel costs	12 000	12 000	6 000	6 000	6 000	6 000	6 000	54 000
Total GOL budget	**50 300**	**50 300**	**39 500**	**39 500**	**39 500**	**39 500**	**39 500**	**298 100**

10.4.4 EMP and SMP Budget Summary

The total costs for implementing the EMP and SMP, including personnel and GOM costs will amount to 13 261 450 USD as shown in the table below.

No	Item	Pre-constr	Construction Phase						Total
		Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	
1	Pesonnel Costs - ESU	399 600	445 200	445 200	392 400	392 400	392 400	392 400	2 859 600
2	Government of Myanmanr Costs	50 300	50 300	39 500	39 500	39 500	39 500	39 500	298 100
3	Environmental Management Plan Costs	130 000	100 000	100 000	110 000	265 000	265 000	185 000	1 155 000
4	Social Management Plan and Community Initiatives	492 000	1 853 000	2 418 750	1 987 500	1 002 500	1 002 500	182 500	8 938 750
	Total EMP/SMP Costs	**1 071 900**	**2 448 500**	**3 003 450**	**2 529 400**	**1 699 400**	**1 699 400**	**799 400**	**13 251 450**

11 ENVIRONMENTAL MANAGEMENT PLAN

11.1 Introduction

11.1.1 Overall Goals and Objectives

The overall goal of this Environmental Management Plan (EMP) is to prescribe a programme implementation of effective environmental mitigation measures, including:

- Formulating actions and measures that will avoid and mitigate the negative impacts on the physical and biological environments that have been identified and described during the EIA studies (see chapter 7 of this report);
- Identify measures to enhance the value of environmental resources where feasible;
- Provide a structure for monitoring of the negative impacts as well as evaluation of the effectiveness of the implemented mitigation measures;
- Provide a structure for monitoring to uncover unexpected negative impacts so that mitigation strategies can be modified to address such potential impacts;
- Identify roles and responsibilities for the implementation of the EMP.

The EMP is based on the information available at the present stage of project planning. In the detailed project planning phase, introduction of new elements and changes in the project layout or proposed operation may necessitate a revision of this EMP accordingly through more detailed action plans.

11.1.2 Roles and Responsibilities

SN Power as the Developer will have the overall responsibility for making sure that the EMP is implemented in an appropriate manner. However, mitigation activities may be carried out fully or partly by other organisations/institutions such as the contractors, local government agencies and non-governmental organisations (NGO), in agreement with SN Power.

11.1.3 Staffing and Organizational Aspects

As presented in Chapter 10, the Developer will establish an Environmental and Social Unit (ESU) with an Environmental Management Team that will be implementing some selected mitigation measures and in addition have a monitoring function vis-à-vis the contactors and any other implementing partners, acting in agreement with the Developer. The Environmental Management Team will be staffed by a Team Leader and 3 to 4 environmental officers with different specialisations.

11.2 Construction Environmental Management Plan

11.2.1 Roles and Responsibilities

With regard to implementation of construction related mitigation measures, the main contractor will be responsible for avoiding or minimising environmental impacts. The contractor will develop and implement detailed management and monitoring plans for specific construction activities (hazardous materials management, hazardous and non-hazardous waste management, pollution spill contingencies, erosion control, emergency preparedness and response, spoil management, blasting management, river diversion management, etc.) to be approved by the Developer.

11.2.2 Staffing and Organisational Aspects

The contractors will be required to hire environmental officers/specialists in environmental engineering for the controlling, monitoring and reporting on the implementation of mitigation activities under the contractor's responsibility. The contractors' environmental officers will work in close collaboration with the Environmental Management Team of the ESU.

11.2.3 Obligations in the Tender Documents

Contactors that intend to bid for the Middle Yeywa HPP construction contracts will be required to respond to the environmental obligations as specified in the tender documents, including those set-out in the EIA Report (EMP and SMP) and any subsequent additional requirements defined by lenders or authorities in Myanmar. In particular, bidders will have to provide details on how they will operationalise and in practical terms, safeguard the environment at the construction sites and to avoid or minimise all negative environmental impacts that are associated with construction of the hydropower plant including associated infrastructure.

In particular, the prospective contractors will be required to describe how they will:

- Provide the Developer with adequate information for ESU disclosure and public consultation activities with the local population relating to environmental (or social) matters pertaining to the Works;
- Implement and comply with the environmental (and social) requirements specified in the EIA;
- Ensure that the subcontractors implement and comply with the specified environmental requirements;
- Carry out the supervision and monitoring of construction activities, including the activities that are undertaken by sub-contractors;
- Assist the Developer in establishing an effective mechanism for storing and communicating environmental information;
- Report all grievances to the ESU in order to record all complaints from affected groups of persons and local communities and the measures to be taken by the contractor to address and/or mitigate the complaints;
- Provide training to their own and the subcontractor’s employees and personnel on the environmental requirements of the EMP.

11.2.4 Specific Activities

Spoil Disposal

The objectives for spoil disposal and management during construction of the Middle Yeywa HPP are to maximise re-use of spoil and to minimise potential adverse impacts of spoil disposal on air and water quality.

The excavation will result in the generation of large amounts of spoil (material from tunnelling and excavation). It is expected that some of the spoil can be used for construction purposes but this will be limited. Depending on the content of the spoil it may in some cases also be used as coarse aggregate for concrete.

Environmental issues associated with spoil disposal include:

- Loss of land to allow placement of stockpiles;
- Erosion and sediment transport from stockpiles;
- Wind erosion of fine particles from stockpiles affecting air quality in their surroundings;
- Impacts on visual amenity making the landscape less aesthetically attractive;
- Impacts on water quality resulting from low pH in the surface runoff and drainage from the spoil stockpiles and deposits.

The day-to-day management of spoil disposal will primarily be the responsibility of the contractor, but spoil disposal (or storage) site selection and potential reuse of spoil will be the responsibility of the Developer. The following measures are recommended to minimise the impact of spoil disposal:

- Maximise re-use of spoil in construction activities;

- Clearly mark spoil disposal areas on maps at the construction sites and keep them displayed throughout the construction period;
- Remove top soil from spoil disposal areas and stockpile to be used in later revegetation and rehabilitation work;
- Locate spoil disposal areas away from flood zones;
- Appropriately contour and compact spoil disposal piles to prevent erosion and sediment transport; and
- Install appropriate drainage around spoil disposal areas to ensure that run-off is captured to allow monitoring and treatment, if necessary, prior to release to the environment.

In addition to the above, measures mentioned in sections of the EMP with regard to sediment management, air quality and site erosion and sediment control (see below) will be implemented at spoil disposal areas.

There is a possibility that the rock spoil will be disposed of behind the dam in the future reservoir area. In that case, the rock material from the excavations (drill and blast) shall be tested for heavy metals and ammonia/nitrogen contamination before such decision is taken. Washing of the waste rock prior to disposal shall be considered, if deemed necessary based on test results.

Sediment Management

All the water draining down from tunnelling operations and quarry sites needs to be lead to sedimentation and neutralisation ponds with sufficient retention time and has to be treated before releasing it to the recipient water body. Similarly, all the waters from the batching plants, the concrete mixer washing facilities and the crusher plants needs to be collected and treated before releasing to the environment.

Sedimentation controls shall be implemented in the form of silt trap fences, sedimentation ponds and drainage channels where appropriate. These shall be built prior to the start of the activity and shall be maintained until the completion of that activity. All structures including silt fences, bunds and sediment basins need regular maintenance to remove silt.

Desilting of sedimentation ponds or silt trap shall be initiated when 75% of the total storage is filled through sediment build-up. The silt trap shall have the design capacity accordingly to the requirement. Ineffective drainage during wet weather shall be promptly corrected. Any discharge from the silt trap to the existing drainage system and rivers shall be less than 50 mg/l of TSS.

For in-stream works, isolation techniques such as berming or diversion shall be used during construction to limit the exposure of disturbed sediments to moving water. The duration and timing of in-stream activities shall be restricted to periods that are not critical to biological cycles of valued flora and fauna (e.g., migration, spawning, etc.). During in-stream construction periods, water turbidity immediately downstream shall be monitored.

Coffer dams shall be constructed such as to minimise releases of sediments and pollutants to the downstream environment (e.g. avoiding low flow periods and rock material with high content of fine particles).

Quarry Management

The objective of the managing the quarrying operations is to minimize adverse effects in terms of noise, sediment runoff and air quality. Management plans for quarry sites for aggregate and borrow pits for sand will have to be prepared prior to operation, including assessment of mitigation measures and procedures for closure of the quarries. Specification for the use of quarries and borrow areas will be incorporated into the construction contracts.

The management plans for the quarry sites will:

- Describe the measures taken to minimize the quarry and borrow areas and the efforts needed to reduce the visual impacts.
- Specify the measures needed to re-establish vegetation and re-establish natural water courses and drainage pattern at the sites.

The contractor will be responsible for the management of the quarries and borrow areas in accordance with the provisions of the management plans.

Chemical Waste and Spillage

The contractor shall develop a detailed Chemical Waste and Spillage Management Plan for collection, transport and handling/storage of construction waste. The plan will also include implementation and monitoring of the use of waste. Materials and chemicals that will be used during the construction such as explosives, fuel and oils, paints, sol-vents, acids and concrete additives will be included in the plan.

Some of the requirements in the plan will be:

- Strict conditions on handling and storage of fuel, explosives and other chemicals should be imposed on the contractors and suppliers to prevent accidental pollution and injury;
- The contractor shall keep a detail log of all chemical materials and waste materials to be audited regularly by ESU and HSE inspection teams;
- Storage areas for fuel and other hazardous materials as well as hazardous waste shall be roofed and have a concrete floor with a bund for secondary containment and collection of spills proving at least 110% volume of the total capacity of the stored materials/waste;
- All storage areas and major construction sites shall have spill kits, sand, dust, and other appropriate absorbent materials;
- Facilities have to be constructed for collection of waste oil products. The locations for machinery and vehicles repair, maintenance and washing should be equipped with concrete floors and provided with oil skimmers and collection facilities. The oil collected in this manner should be disposed of or re-used safely;
- The diesel shall be stored in a standard skid tank with concrete bunker, which provided 110% volume of the total capacity of the tank. The skid tank shall be located at least 100 meter away from any watercourse;
- The contractor shall establish a standard procedure for loading the diesel into the skid tank to prevent any oil spillage and soil contamination from occurring. The site supervisor or engineer shall regularly monitor and check the skid tank to ensure that the diesel is handled in accordance with the specification and no spillage occurrence;
- Spent oil or used oil generated from the workshop maintenance yard shall be categorized as hazardous waste. This type of hazardous waste is to be stored in containers, with proper bunds, which are able to prevent spillage or leakage into the environment;
- The containers of the scheduled wastes shall be clearly labelled in accordance for identification and warning purposes;
- The contractor shall engage a licensed contractor to collect, transport and dispose of all the waste oil and other hazardous waste generated at the project site;
- The oily waste should not be allowed to be used for uncontrolled burning or heating or the workers camps, or to be spread on roads or dumpsites for dust control.

Emergency Plan for Hazardous Materials Handling and Disposal of Hazardous Wastes and Materials

The main contractors will prepare an Emergency Plan for hazardous materials used or stored on site. The Emergency Plan will cover:

- Procedures for immediate actions specified for all relevant hazardous materials used in the construction processes;
- Complete list of equipment available for use in emergency situations;
- Procedures for neighbours and downstream warning in cases of accidental release of hazardous substances;
- Procedures for immediate warning and notification in case of discharges and standards for reporting irregular events.

Camp and Site Waste Management

The contractor must develop a detailed Household Waste Management Plan for collection, transport and handling/storage of household waste to minimise the pollution associated with handling and disposal of domestic waste at the construction sites and camps in order to avoid water pollution, spreading of diseases by vectors.

Some of the requirements in the plan will be:

- Waste collection containers should be placed at regular intervals at the project site and in workers camps. These containers should be marked with clear labels for ‘organic’, ‘paper’ and ‘other waste’ for sorting waste collection;
- Garbage shall regularly be collected and disposed at designated sites;
- Waste disposal sites shall be located above the 20 year flood levels and at least 2 km from the nearest village;
- The disposal sites should be protected from contaminating groundwater by an impermeable membrane or clay. Leachate shall be collected and properly treated before released into water courses.

Once a week the disposal sites shall be compacted and covered with soil. At closure the site shall be covered with at least 1.5 m of topsoil.

Waste Water Management

The contractor will develop a Wastewater Management Plan with the objective of properly managing liquid waste from construction activities.

Wastewater from the camps and offices must be collected and properly disposed of. The sanitary water and the grey water (used household water) should be kept separate. The grey water should be infiltrated in the ground at sites with soils of suitable filtering capacity and minimum 500 m away from water courses and water supply springs in the area.

The sanitary water should be treated by Compact Treatment Units or by septic tanks before infiltration. Such units shall be installed at each short term work site employing 5 workers or more. At least one chemical portable toilet shall be installed for each 20 workers. The contractors shall maintain the toilets in a clean and sanitary manner.

All wastewater shall be treated in such a way that the discharged effluent meets the requirements specified in the table below.

Table 11-1: Sanitary Sewage Discharge Standards.

Indicative Values for treated Sanitary Sewage Discharges		
Pollutants	**Unit**	**Guideline Value**
pH	pH	6-9
BOD	mg/l	30
COD	mg/l	125

Indicative Values for treated Sanitary Sewage Discharges		
Pollutants	**Unit**	**Guideline Value**
Total nitrogen	mg/l	10
Total phosphorus	mg/l	2
Oil and grease	mg/l	10
Total suspended solids	mg/l	50
Total coliform bacteria	MPN/100 ml	400

Source: World Bank Group EHS Guidelines (2007)

Emission, Dust and Noise Control

The objective for the management of air quality, noise and vibration during the construction phase of Middle Yeywa HPP is to prevent nuisance and health and safety effects on the workers and on nearby communities and to limit as far as possible the adverse impacts on the natural environment due to poor air quality and potential noise impacts associated with the construction activities.

Poor air quality caused by dust and exhaust fume emissions from construction traffic and operation of heavy machinery as well as elevated noise levels from the construction activities will inevitably cause disturbance to local communities and reduce the quality of life of inhabitants of these communities. The closest sensitive receptors for potential air quality and noise impacts include villages along the access roads and the village of Yae Twin Gyi which is the village nearest to the dam construction site.

The main construction activities that are likely to generate dust and noise emissions include:

- Vegetation stripping and subsequent wind erosion from exposed areas;
- Use of excavators, loaders and bulldozers;
- Compacting, concreting;
- Quarrying, drilling and blasting;
- Concrete mixing and batching plant;
- Dumping spoil and waste;
- Vehicle movement on construction access roads;
- General domestic noise from the project campsites.

An Emissions, Dust and Noise Control Plan will be prepared by the contractor and shall be based on international standards for ambient concentrations of particulate matter. The plan will identify all relevant places for dust control and monitoring. This include roads, quarry sites, crushing and concrete batching sites, earthworks, waste burning sites, etc.

Air quality: For the local communities along the access roads dust generated by construction related traffic is likely to be the main air quality issue but emissions of exhaust gasses containing noxious and toxic substances, such as carbon monoxide (CO) and hydrocarbons from incomplete combustion, nitrogen oxides (NOx) and particulate matter (mostly soot) will add to the air quality problems. Dust can potentially result in health impacts by exacerbating existing respiratory conditions, such as asthma or respiratory infections. Dust emissions on access roads can also create a safety risk by decreasing visibility. Dust deposition may also lead to decreased crop yields and productivity. Air quality impacts will be most pronounced in the dry season and affect villages or people living within a 500 m of the unpaved access roads and tracks.

The following activities should be implemented to limit and reduce the air quality impacts associated with construction related traffic and construction activities:

- Seal roads or water dirt roads using water carts to minimise the generation of dust;

- The frequency of water spraying shall be fixed 2 to 3 times per day for normal weather conditions. The water spraying frequency shall be increased to about 4 to 6 times a day during dry and windy seasons;
- Obsolete roads to be ripped and re-vegetated unless to be made available for community use;
- Impose and enforce speed limits through villages and speed bumps to reduce traffic in populated areas, especially in the vicinity of schools;
- Keep land clearing and topsoil removal to a minimum and rehabilitate cleared land, as soon as practicable;
- Where possible, do not undertake activities such as loading and dumping of topsoil and spoil during high winds;
- Conduct topsoil stripping at times when soil moisture can be expected to be optimal to minimize dust formation while minimising erosion risks, such as after moderate rains or after sprinkling of water;
- Regularly maintain vehicles with tires kept at the recommended pressure;
- Access tracks used for topsoil stripping and spoil transport equipment to be watered in the dry season during their loading and unloading cycle;
- Long term topsoil stockpiles (not used for over 6 months) to be re-vegetated;
- Contour and revegetate spoil disposal areas to minimize erosion of exposed surface areas;
- Use of dust aprons during drilling;
- Drills to be equipped with dust extraction cyclones, or water injection systems;
- Water injection or dust suppression sprays to be used when high levels of dust are being generated;
- During the construction phase, it is recommended that dust monitoring be undertaken at sensitive receptors (villages) to assess the effectiveness of management and mitigation measures.

Recommended measures to minimise harmful vehicle emissions include:

- Regular maintenance of vehicles (in accordance with the vehicle manufacturer’s instructions);
- Regular review of tyre air pressure;
- Vehicles will be prohibited from idling in residential areas and engines must be turned off when the vehicle is parked near residences, offices or eating areas;
- Use of low-lead / unleaded fuels;
- Provide proper driving instructions and increasing the awareness of engine maintenance to drivers and operators;
- Management of traffic through residential areas to prevent vehicles from making sudden stops and starts.

Ambient air quality monitoring of the particulate matter in the air shall be carried at villages where construction traffic is passing through and at constructions sites and stone crushing plants where workers will be are exposed to dust emissions and high dust levels in the air. It is recommended that at least As Particulate Matter (PM10) levels are monitored as this particle size is easily inhaled and lodged in the lungs.

The air quality at construction sites shall comply with the guidelines for particulate matter issued by the WHO. If the air quality monitoring shows that the particulate matter values recurrently exceeds the guidelines then additional measures shall be taken by the contactor to bring the PM10 values down. The WHO guidelines are shown in the table below.

Table 11-2: WHO Standard for Particulate Matter.

WHO Ambient Air Quality Guidelines		
	Averaging Period	**Guideline Value in µg/m^3**
Particulate Matter (PM_{10})	1-year 24-hour	20 50
Particulate Matter ($PM_{2.5}$)	1-year 24-hour	10 25

Source: World Bank Group EHS Guidelines (2007)

Noise: From a noise perspective, the construction of the Middle Yeywa dam and power house will be located at the lower parts of the narrow Myitnge River valley and therefore some noise attenuation from the steep forested hillsides is likely. The only sensitive noise receptors are the villages located along the access roads. Recommended measures for avoiding and minimizing generation of noise in connection with the construction activities include:

- Combine noisy operations to occur during the same time period, if possible;
- Construction activities in populated areas (along the roads) shall be limited to day time and evening hours (06:00 to 22:00);
- Noise control devices such as silencers and mufflers to be fitted to exhausts, radiators, compressors and fans;
- Speed limits to be enforced through villages and the application of speed bumps;
- Locate noise sources to less sensitive areas to take advantage of distance and shielding (if possible);
- Monitor noise at sensitive receptor areas (villages, built up area) to assess the effectiveness of management and mitigation measures;
- Identify and enforce a blast exclusion zone (approximately 400 m diameter around the blast area);
- Blasting to be conducted during the daytime;
- Implement access controls along construction roads, prior to blasting to ensure that no unauthorised vehicles or pedestrians are present in the exclusion zone.

The plan for noise and vibration control and monitoring will be based on international standards as shown in the table below.

Table 11-3: WHO Noise Level Guidelines.

Noise Level Guidelines		
	One Hour L_{eq} (dBA)	
Receptor	**Daytime 07:00–22:00**	**Night time 22:00-07:00**
Residential; institutional; educational	55	45
Industrial; commercial	70	70

Source: IFC EHS Guidelines (2007)

Noise and vibration level monitoring shall be carried out at the rock quarrying site and diversion tunnel areas due to the activities involving rock blasting. Monitoring shall also be carried at villages with heavy construction traffic.

Noise level measurement shall be carried out quarterly. However, if the noise levels exceed the permissible limits recommended by WHO or when there are complaints from the public, then the monitoring frequency shall be increased. This may occur along the access roads where noise level measurements shall be done on a weekly basis.

Traffic and Access Management

An On-site Traffic and Access Management Plan will be prepared by the contractor with the objective of avoiding traffic accidents and reducing the risk for construction traffic incidences.

The plan will include:

- Speed limits for different sections of the road network;
- Speed bumps in populated areas;
- Specification of parking sites for the construction vehicle fleet;
- Specific plans for hauling heavy loads and hazardous materials;
- Control measures to avoid unauthorised access to construction sites;
- Signalling and warning measures.

As a minimum, the plan must comply with the following requirements:

The Contractor and Sub-contractors shall make sure that their vehicles will not be operated unless:

- Vehicle is fit for purpose, inspected and confirmed to be in safe working order;
- System for annual inspection and control of all vehicles is in place;
- Number of passengers does not exceed manufacturer's specification for the vehicle;
- Loads are secure and do not exceed manufacturer's design specification or legal limits for the vehicle;
- Seat belts are installed and worn by all occupants.

The Contractor and Sub-contractors shall make sure that drivers are not authorised to operate the vehicle unless:

- They are trained, certified and medically fit to operate the class of vehicle;
- They are not under the influence of alcohol or drugs, and are not suffering from fatigue;
- They do not use hand-held cell phones and radios while driving.

The contractor shall take every possible precaution to prevent its operations from damaging public roads in the vicinity of the project area. Moreover, the contractor shall implement a maintenance program for access roads carried out before rainy season (cleaning gutters, improvement of the road if necessary, etc.).

The Developer will in cooperation with the local road authorities be responsible for adequate signage, warnings and controls, including speed limits. The contractor will be responsible for e ensuring that all vehicles, equipment and materials that are required to pass through urban areas and villages are operated and loads transported safely without endangering these communities. Special caution has to be taken in front of schools where children suddenly cross the street. In the villages, animals and pedestrians have the right of way.

All loads are to be secured and all loads with fugitive dust producing materials (e.g. excavated soil and sand) are covered with tarpaulins.

The contractor shall ensure that drivers have reasonably timed delivery schedules so as to allow them to operate within government mandated speed limits.

The contractor shall develop specific procedures for moving special loads, such as hazardous material, or heavy loads. Maximum load restrictions shall be developed and enforced.

The contractor when entering into any sub-contract for the execution of any part of the construction works or the supply or transport of heavy loads, materials or spoil shall incorporate in any such subcontract provisions requiring the sub-contractor or supplier to comply with the traffic and transportation safety requirements.

Reinstatement of Camp and Construction Sites (Landscaping and Restoration)

The contractor will prepare a Landscaping and Erosion Protection Plan encompassing the construction areas, camps, access road, etc. The objective will be to reshape the landscape and the vegetation for erosion control and for the visual amenity and landscape aesthetics. Remediation under this plan shall be implemented as soon as possible after the different construction activities have ended so that bare soil will not be exposed during the wet season.

The plan will be based on the following:

- All land where the natural vegetation has been destroyed or damaged shall be restored as far as possible to its initial status with original drainage patterns restored;
- Spoil heaps shall be profiled to allow for future use and erosion protection;
- Excavated topsoil shall be stockpiled and used for landscaping and construction site reinstatement;
- Only indigenous and preferably local plant species shall be used for replanting and erosion control.

11.2.5 Budget and Schedule

Recruitment of requisite staff and specialists for landscaping and erosion control will be part of the costs for the contractor and the sub-contractors and the implementation arrangements to be approved by the Developer. The costs for implementation of the Construction Environmental Management and Monitoring Plan will be integrated in the overall construction costs. A separate budget has therefore not been indicated as implementation of the mitigation measures and the monitoring activities will be part of the environmental requirements specified in the tender documents which the prospective contractors will have to take into consideration in their pricing of their bids for the construction contract.

The scheduling of the implementation of mitigation activities will be determined by the progress of the construction activities.

11.3 Water Quality Monitoring Plan

11.3.1 Overall Goals and Objectives

The purpose of the water quality monitoring program will be to document the water quality changes resulting from the Middle Yeywa project, including those resulting from the construction phase activities and those that are a consequence of the establishment of the reservoir and the operation of the power plant. This will be closely integrated with the aquatic ecology and fisheries management plan.

The construction phase water quality issues include:

- Risk of discharge of hazardous chemicals;
- Discharge of domestic wastewater and sewage from work sites and camps;
- Sediment loads from construction activities;
- Water quality changes caused by decomposition of organic materials during filling of the reservoir.

The operational phase water quality issues include:

- Downstream changes in sediment transport and associated water quality characteristics.

- Risks of eutrophication and oxygen depletion in parts of the reservoir and release of oxygen deficient water downstream in the event that strong reservoir stratification in the water column develops combined with extensive decomposition of organic matter;
- Downstream changes in water temperature;

The mitigation measures related to the issues above are dealt with in other sub-EMPs including the Construction Environmental Management Plan and the Reservoir Clearance and Filling Plan. The main objective of the water quality monitoring is to provide checks on the performance of those mitigation measures, to uncover potential unexpected developments and to identify corrective measures if needed.

11.3.2 Roles and Responsibilities

SN Power will be overall responsible for the water quality monitoring and will enter into an agreement with an accredited water quality laboratory in Myanmar for analysis and interpretation of water quality samples throughout the construction and operation phases of the Project.

The results of the water quality monitoring and, if relevant, reports on accidental pollution events, will be summarised in bi-monthly reports and made available to relevant GoM agencies. In the unlikely event of dramatic developments and pollution incidents (oil spills, development of massive oxygen depletion, etc.), the regulatory agencies will be notified without delay by SN Power.

11.3.3 Staffing and Organisational Aspects

The water monitoring sampling and assessment will be carried out by the Environment Management Team, with support from specialised entities, which will be staffed with at least one officer with competence and experience within the field of water quality sampling and assessment. Additional staff should be trained in sampling, storage and transportation techniques of water samples as needed. The Environmental Management Team together with contracted specialised entities will be adequately equipped with all means necessary to carry out the monitoring programmes. This includes:

- Sampling equipment;
- Field measurements and field testing kits;
- Storage and transportation material;
- PC for data storage and processing;
- Transport (car, boat, etc).

11.3.4 Specific Activities

Methodology and Quality Control

Any water quality monitoring system has to be specifically responsive to types of parameters to be measured and desired outcomes of the testing. Water quality monitoring will provide reliable data that can be used to inform decision-making concerning mitigation strategies.

The water quality monitoring objectives for this EMP would be:

- Detecting trends;
- Monitoring critical conditions (annual maximum or minimum values of certain water quality constituents);
- Monitoring any violation of standards.

The objectives will determine sampling sites, frequency, duration of monitoring and the need for specific up-front recipient studies.

Quality assurance is vital to all monitoring systems. A system of quality control has to include (i) technical manuals describing in detail the procedures of water sampling, sample transport and storage, analytical methods, "metadata" requirements, and (ii) an inter-calibration procedure for laboratories involved in the monitoring activities. Monitoring protocols and programs should be established as soon as possible in order to improve the water quality baseline, for better to assess the changes caused by the power plant.

Water Quality Monitoring Stations

Construction phase:

- As much as possible the same stations as for the EIA study (see map in Figure 6-24 above) but complemented with high risk sites in light of contractors facilities and work plans.

Operation phase:

- Upstream of the tail end of the Middle Yeywa reservoir (surface water);
- Gotheik Tributary
- Myitnge bridge (surface water + 3 depths);
- Middle Yeywa dam (surface water + 5 depths);
- Downstream of tailrace outlet (surface water);
- In addition: collaborate with operator of Yeywa dam and Upper Yeywa to collect water samples from the respective reservoirs (surface + 3 depths).

Water Quality Parameters – Frequency and Compliance Levels

The water quality parameters recommended for inclusion in the monitoring system are indicated in Table 11-4: List of proposed monitoring parameters (methods may be revised later). The parameters include standard pollution indicators as well as parameters relevant to the oxygen and the eutrophication situation in the reservoir and a few other parameters not relevant for the project's impacts but of interest for contributing to a more comprehensive picture of the water quality situation in the basin as a whole. The construction phase parameters and the operation phase parameters will be slightly different in order to reflect the unique risks for the specific phases. The list of parameters may be revised in light of water quality test results to ensure that the most important issues are well covered.

Table 11-4: List of proposed monitoring parameters (methods may be revised later).

Parameter	Symbol	Unit	Method	Measured
Temperature air	T_{air}	ºC	SM 2550 B	On site
Temperature water	T_{water}	ºC	SM 2550 B	On site
pH	pH		SM 4500 –H B	On site
Turbidity		FTU	ISO 7027	In laboratory
Dissolved Oxygen	DO	mg/l	SM 4500-O G (Probe)	On site
Saturation Oxygen	Sat O_2	%	YSI Probe	On site
Nitrite + Nitrate Concentration	$NO_2 + NO_3$	mg/l	SM 4500-NO3 E	In laboratory
Total Nitrogen Concentration	Tot – N	mg/l	SM 4500-Norg(Macro-Kjeldahl)	In laboratory
Orthophosphate Concentration	PO_4 – P	mg/l	SM 4500 – P E	In laboratory
Total Phosphorus Concentration	Tot – P	mg/l	SM 4500 – P B+E	In laboratory
Chemical Oxygen Demand	COD	mg/l	Permanganate method	In laboratory
Biological Oxygen Demand	BOD	mg/l	Permanganate method	In laboratory
Faecal Coliform		no/ml	SM 9222 B (Membrane filter)	Within 24 hours
Alkalinity (as CaCO3)	Alk	mg/l	SM 2320 B	In laboratory

Parameter	Symbol	Unit	Method	Measured
Calcium Concentration	Ca	mg/l	SM 3500 – Ca-B	In laboratory
Magnesium Concentration	Mg	mg/l	SM 3500 – Mg-B	In laboratory
Sodium Concentration	Na	mg/l	SM 3111 B	In laboratory
Potassium Concentration	K	mg/l	SM 3111 B	In laboratory
Chloride Concentration	Cl	mg/l	SM 4500 – Cl C	In laboratory
Electric Conductivity	EC	Ms/m	SM 2519	On site
Total Suspended Solids	TSS	mg/l	SM 2540 D	In laboratory
Chlorophyll	Ch-a	Ms/m	Acetone extraction/ spectrophotometer	In laboratory
Algae	Algae	No./ml	Microscope counting	In laboratory

Compliance levels will be determined with reference to ASEAN classification (***Table 11-5***) and the World Bank Group effluent water standards (***Table 11-1***).

Table 11-5: Classification of river water (adopted by ASEAN).

Parameter	Class I: Potable Water	Class II: Recreation	Class III: Commercial Fisheries	Class IV: Irrigation
pH	6-9	6-9	5-9	5-9
BOD (mg/l)	5	5	10	10
COD (mg/l)	30	30	100	100
Amm – N (mg/l)	0.3	0.3	1	3
TSS (mg/l)	50	50	150	300
DO (mg/l)	5	5	3-5	3
Faecal Coliform (counts/100) ml)	-	1000	-	-

Monitoring frequency:

- Bi-monthly during construction;
- Semi-annually during early operation.

In addition, more frequent and targeted monitoring will be carried out in conjunction with high risk activities during the construction phase.

Possible Mitigation Interventions

In the case of accidental or planned pollution events during construction or operation, including releases of large quantities of anoxic water from the reservoir or sediment flushing, such incidents have to be registered and reported, and timely notification given to any affected water users in the downstream.

11.3.5 Budget and Schedule

The cost for the water quality program has been estimated at 10 000 USD per year in the construction phase and the first two years of operation, and 5000 USD per year in the subsequent early operation phase. With an estimated construction time of 6 years the total cost of water quality monitoring will be 60 000 USD for the construction phase.

11.4 Aquatic Ecology and Fisheries Management Program

11.4.1 Introduction

During the construction phase, the aquatic ecosystem of the Myitnge River will be impacted in localised construction areas and immediately downstream. The aquatic ecosystem will effectively be transformed over a 70 km section after filling of the reservoir and moving into the operation phase. In addition, the short but varying length of river section between the Middle Yeywa dam site and the downstream Yeywa reservoir will experience significant impacts due to peaking and later also intermittent sediment flushing from the Middle Yeywa reservoir. The Developer is considering placement of substantial volumes of rocks in the river for a 1 km distance downstream of the tailrace in order to meet a potential requirement from the Government of Myanmar for a ‘free flowing’ river section between the Yeywa reservoir and the Middle Yeywa dam. This can potentially cause further negative impacts unless the works are purposely designed to serve ecological functions.

Importantly, the riverine ecosystem has already been profoundly impacted by the downstream Yeywa Hydropower Project, its dam and its large reservoir. The Upper Yeywa Hydropower Project is currently under construction immediately upstream of the proposed Middle Yeywa Project and is also having significant impacts on the river system prior to the potential construction of the Middle Yeywa Hydropower Project.

This Aquatic Ecology and Fisheries Management Programme outlines the goal and objectives, summarise the main adaptations in project design to avoid and minimise impacts as well as the proposed mitigation and monitoring measures. Division of roles and responsibilities is described along with staffing and organisational aspects. The main activities and indicative budgets are summarised.

The limited available information on the affected aquatic ecosystems means that the programme should be updated following further clarifications on project design and further aquatic ecology data collection. Ideally, further data collection should include the existing Yeywa reservoir that can give valuable indications about the likely future developments in the Middle Yeywa reservoir.

11.4.2 Overall Goal and Objectives

The overall goal is to avoid and minimise impacts on the aquatic ecosystems through project design modifications, mitigation and enhancement measures, and monitoring.

The objectives of the Programme are:

- Develop and implement measures that reduce impacts on the aquatic ecosystems, and the people who rely on its ecosystem services, to acceptable levels;
- Monitor and document changes in aquatic ecosystem dynamics, species composition and abundance, and ecosystems services provided, in particular the opportunities for fishing;
- Use monitoring results to inform decision-making on adjustments to project operation, mitigation and enhancement measures and future monitoring;
- Assess the feasibility of supporting sustainable fishing activities in the reservoir. If considered feasible, develop and implement a fisheries management plan.

The programme will focus on the proposed reservoir area, the river section between the Middle Yeywa dam and the downstream Yeywa reservoir as well as the Gotheik tributary on the right bank in the upper section of the Middle Yeywa reservoir. For the purpose of detailing this programme, surveys are also recommended in the existing Yeywa reservoir. It should also be noted that future analysis of cumulative impacts along the Myitnge River may provide information for the Myanmar Government in terms of wise operation of the cascade including Upper, Middle and Lower Yeywa Hydropower Projects. Regimes for cascade operation may necessitate a revision of this programme.

The Aquatic Ecology and Fisheries Management Programme will be closely coordinated with the Reservoir Clearance and Filling Plan, the Construction EMP, the Water Quality Monitoring Plan and the

Compensation/Livelihood Restoration Plan for project affected persons (PAPs) having their fishing activities impacted by the Project.

11.4.3 Roles and Responsibilities

SN Power, through the ESU, will be overall responsible for the implementation of the Aquatic Ecology and Fisheries Management Programme. Specialised tasks are likely to be outsourced to national and/or international experts with the SN Power remaining ultimately responsible, including to provide updates and reports to stakeholders. The detailed roles and responsibilities will be developed as part of establishing the ESU for the Project.

11.4.4 Staffing and Organisational Aspects

The team implementing this programme will likely be an integrated team working on the Water Quality Monitoring Programme, which will have critically important linkages to the Aquatic Ecology and Fisheries Management Programme. Specialists involved, most of whom are likely to be short-term consultants, will likely include a fish biologist, a macro-invertebrates expert, a micro-invertebrates expert and an aquatic vegetation expert, in addition to experts from the water quality team. In the unlikely event of an invasion by aquatic weeds in the new reservoir, an additional expert on aquatic weeds management may have to be involved. Laboratory services will be sourced from within Myanmar. Technicians and various other national support staff will also be needed.

11.4.5 Specific Activities

Further Pre-construction Data Collection

The EIA team recommends further data collection on aquatic ecology and fisheries in the Myitnge River and the Gotheik tributary as part of further project development. In addition, it is recommended to undertake data collection in the downstream Yeywa reservoir to provide important information about the likely transformation of aquatic biodiversity and water quality in the future Middle Yeywa reservoir as well as input to assess the feasibility of developing fisheries in the future reservoir. The recommended surveys include:

- Additional sampling of aquatic biodiversity using a diversity of field equipment and methods to establish a robust baseline for Myitnge River and Gotheik tributary.
- Water quality sampling to strengthen the baseline for Myitnge River and Gotheik tributary.
- Sampling of aquatic species composition and abundance in the Yeywa Reservoir.
- Water quality sampling to establish key water quality parameters in the Yeywa Reservoir including the degree of stratification of the water column in areas with considerable water depth.
- Surveys of the riverbed between the Middle Yeywa tailrace and the Yeywa reservoir to review the feasibility of designing and implementing a river rock fill as a riverine habitat in this section.

Methodology and Quality Control

A number of shortcomings in the previous aquatic surveys illustrate the need for careful planning and quality assurance of future aquatic surveys. The EIA team therefore recommends further surveys.

Aquatic vegetation has been documented qualitatively in the supplementary EIA studies in 2017 but systematic surveys of aquatic vegetation were not undertaken. Potential future baseline surveys should include the river section between the proposed Middle Yeywa dam site and the Yeywa reservoir, including establishment of a limited number of monitoring plots than can be re-surveyed during the construction and operation phases.

Micro-invertebrates (phytoplankton and zooplankton) and macro-invertebrates should be sampled in the Myitnge River and the downstream Yeywa reservoir to establish a baseline for the project's direct impact zone and provide indications or likely invertebrate communities in the future reservoir. Standardised sampling methods for micro-invertebrates and macro-invertebrates in river and lake environments should be applied, including fine mesh nets as well as specialised traps to collect samples at specific depths.

Fish species sampling in Myitnge River, Gotheik tributary and Yeywa reservoir should be based on several methods, including gill nets in standing and slow-flowing waters, seine and different sizes of baited minnow traps that can be used under a range of conditions. Fishing gear available to local fishermen will also be used opportunistically. Electrofishing equipment is unlikely to be available.

A boat or raft will be required to sample some sections of the Myitnge River and the Yeywa reservoir where access from land is unfeasible.

Potential fishing opportunities in the Middle Yeywa reservoir will be considered by analysing likely changes in the fish community, potential fishing gear likely to be available to local people, and potential market opportunities for the fish. This can only meaningfully be analysed following information collection and analysis from the downstream Yeywa reservoir. Deliberate introduction of new species to the Middle Yeywa reservoir is discouraged as a precautionary measure and should, if considered, be subject to a detailed EIA.

Identification of Monitoring Points

Specific aquatic ecology monitoring points will be established for the Myitnge River, the Gotheik tributary and the Yeywa reservoir and these will be aligned with monitoring points for water quality. The location of the points will be selected to ensure a sound coverage given available resources and will be identified to cover representative areas of the project's direct impact zone while considering efficiency in access to sampling sites in an at times very challenging terrain. Relevant sampling sites include (see also Figure 6-24 for baseline sampling sites):

- The Myitnge River: i) close to the Gotheik tributary, ii) close to the Myitnge bridge, iii) between the cascade and the Middle Yeywa dam site (deepest part of reservoir), iv) between the dam site and the Yeywa reservoir, and v) between the Upper Yeywa dam and the Middle Yeywa reservoir;
- The Gotheik tributary above the future full supply level of Middle Yeywa reservoir;
- The downstream Yeywa reservoir close to the Yeywa dam in areas with close to maximum reservoir depth.

Indicators for Aquatic Species and Fish Monitoring

Further surveys will identify the most appropriate indicators for monitoring aquatic species and potential fisheries. The indicators will be established in conjunction with indicators under the Water Quality Monitoring Programme and the Compensation/Livelihood Restoration Plan. Based on available information it seems likely that micro-invertebrates, macro-invertebrates and selected fish species should be monitored, including fish species of particular interest for fisheries. Indicators could include:

- Phytoplankton
- Zooplankton
- Benthic macro-invertebrates (insects living on the river/reservoir bottom)
- Fish species such as the Gangetic Loach (*Botia rostrata*), the Tor Barb (*Tor tor*) and the Butter Fish (*Wallago attu*). Species living both along the river/reservoir bottom and in the main water body of the reservoir should be covered, including fish species of particular interest for local fishermen.

Possible Project Design Modifications, Mitigation and Enhancement Measures

Project design has sought to avoid and minimise negative impacts through design modifications and mitigation and enhancement measures, including measures listed for the construction environmental management plan. In addition, the following measures are recommended:

- Release of a continuous minimum flow during reservoir filling (including filling after sediment flushing) as well as during any periods when there is no release through the turbines (e.g. during power station outage or grid failure);
- Release on a continuous minimum flow during the project operation through the turbines to ensure water for the river section between the dam sites and the Yeywa Reservoir;
- Carefully consider the ramping rates to reduce downstream environmental and social impacts;
- If the riverbed downstream the tailrace is to be modified to ensure a 'free flowing' section, it should be deliberately designed as a varied river section that ensures a dynamic and heterogenous set of habitats that are also able to withstand both peaking and large floods. As a supplementary or as an alternative measure, river habitats may be designed between the Middle Yeywa reservoir and the Upper Yeywa dam;
- Sensitise local communities to avoid catching any threatened species, avoid use of harmful or unsustainable fishing methods (e.g. poison, dynamite), and promote sustainable fishing practices.

11.4.6 Budget and Schedule

The recommended surveys prior to construction can be done in parallel with further project development and has been estimated at approximately USD 40,000.

Monitoring during the construction phase is estimated at an average annual cost of USD 10,000 except the final year prior to commissioning when the reservoir will be filled, and expanded surveys are recommended bringing the annual budget to USD 15,000.

Costs for potential support to establishing fisheries activities in the future reservoir have not yet been estimated due to the uncertainties of the potential for such fisheries and the scope of related work. The budget is assumed to be 50,000 for the first three years, highly dependent upon the scope of the work to be undertaken. Budgeting for these activities will be coordinated with the Compensation/Livelihood Restoration Plan as fisheries can play a role in restoring livelihoods for a limited number of affected people.

During the operation phase, monitoring will be most intense during the first few years as the new lake ecosystem undergo considerable ecological transformation and the same is likely to be the case for the river section between the Middle Yeywa dam and the downstream Yeywa reservoir. The average annual budget for aquatic ecology monitoring is expected to be approximately USD 20,000 for the first three years, after which it is likely to be reduced.

11.5 Reservoir Clearance and Filling Plan

11.5.1 Overall Goals and Objectives

The Middle Yeywa reservoir will cover a surface area of about 11 km^2 submerging mainly forestland on steep valley slopes. Experience from other dam projects in tropical countries show that it is important to remove or reduce the amount of biomass in the reservoir before inundation. Indeed, pre-impoundment biomass clearing has become international best practice in hydropower although it can involve significant costs and technical challenges.

There is no doubt that clearing of trees in some places along the Myitnge River will be extremely difficult, if not impossible, due to the steep topography and associated safety hazards. However, until such cases have been confirmed by those responsible for the reservoir clearance, SN Power shall aim at removing as much woody biomass as is feasibly possible below the FSL.

The objectives of the biomass clearing include:

- Reducing the amount of biomass, thereby reducing the risk of poor water quality and greenhouse gas (GHG) emissions from decay of organic matter in the reservoir;
- Reducing the amount of wood debris floating on the reservoir and/or getting into the trash racks;
- Reducing the number of dead trees standing in the water which would become an aesthetic nuisance and an obstacle for possible boat transport and fishing in the reservoir;
- Salvaging valuable timber resources which would otherwise be submerged and lost.

11.5.2 Roles and Responsibilities

SNP Power will be responsible for the implementation of the Reservoir Clearance and Filling Plan through the following:

- Provision of management and planning control through its Environmental and Social Unit (ESU);
- Engaging one or more contractors with appropriate technical and management expertise to clear the reservoir;
- Arranging timber salvage to be executed by a qualified contractor or State Enterprise
- Provide training, if an appropriately qualified contractor is not available, in operational methods, health and safety and environmental awareness.

11.5.3 Staffing and Organisational Aspects

Detailed planning will decide the division of tasks between the ESU staff, managerial and technical specialists engaged for the planning and supervision and sub-contracted companies or teams.

The public information campaigns related to the reservoir clearance and filling will be carried out by ESU staff, including the consultation team with its community liaison officers, as part of their regular duties.

Similarly, SN Powers environmental, health and safety inspectors will be responsible for providing oversight and compliance monitoring of the logging contractors.

The entire operation will be headed by the Environmental and Social Manager, who will be responsible for all contractual matters related to the sub-contracted companies.

11.5.4 Specific Activities

Demarcation

It is important that the pre-impoundment vegetation clearing is confined to below the FSL, such that existing vegetation along the shores of the reservoir is protected. For this reason, the perimeter of the clearance area shall be marked in the field to indicate the inundation limit. This task will be carried out either by the contractor assigned to clear the reservoir, or by a separate contractor at an earlier stage. The marking methods should be determined by the contractor after a detailed investigation of the topographic conditions and as part of a bidding process.

Harvesting of Commercial Timber

Following the reservoir demarcation, a contractor or State Enterprise will be requested to harvest all merchantable standing timber (selective logging). The logging and transport of timber should be completed in advance of the full clearing operations.

Logs are probably best transported on the river downstream instead of pulling them up the steep valley slopes. The logs can be collected at various pool areas with access in the upstream part of the Myitnge River (sites currently used for illegal timber harvesting) or transported down to the Yeywa reservoir from where it can be transported out of the project area by timber trucks.

The value of the salvaged timber cannot be estimated at this time. It is however assumed that the value will be such that the logging can be carried out without need of any subsidies from SN Power.

Clearance of Selected Area and Controlled Burning

Following the harvesting of commercial timber, one or more contractors shall be appointed by SN Power to remove the remaining biomass within the demarcated reservoir area. The work will benefit from the opening up of the forest caused by the timber extraction. On the other hand, cutting of trees may in some places be impossible due to the steep topography and associated safety hazards.

The contractor(s) will be expected to employ local people to carry out the clearing and burning, provided that they are given personal protective equipment (PPE) and safety training. Local people should also be allowed to make use of the wood.

The reservoir area will be divided into operational blocks, each with a dedicated team of professionals and local villagers responsible for clearing and burning. The teams will cut all non-commercial trees (not removed by the contractor) and stockpile the wood for collection by villagers. The clearing should start from the riverbanks towards the reservoir perimeter so that animals can escape into the right direction.

Thereafter, each block will be “back-burnt” in a controlled manner. It should be noted that burning is a widespread management practice in the project area, both for shifting cultivation (on the plateau) and to keep the forest open for access by people (e.g. for hunting) and livestock as well as to replenish the soil nutrients for better pasture (in the valley). The controlled burning will be done in the last dry season before filling the reservoir. This will minimise the establishment of secondary growth vegetation in cleared areas prior to impoundment.

Residue Collection and Removal

The logging and clearing teams should try to minimise the amount of wood and large branches that might be flushed downstream by the river or left floating in the future reservoir. However, it is inevitable that some wood will be remaining even after burning. Large softwood logs that comprise “soft biomass “ that are not completely consumed by fire will float as the water level rises, while any durable hardwood material remaining will not float with very minor decomposition occurring.

During initial and final reservoir filling, a team will be organised to clear the water of logs and organic debris using booms placed above the intake and spillway structures. A heavy duty boat will be available to haul the material into collection ramps.

Erosion Control Measures and Spill Prevention

The contractors shall be instructed and required to minimise soil erosion and avoid any spillage of fuel or other oil products in accordance with the requirements specified in the Construction Environmental Management and Monitoring Plan (see above).

Safety Measures during Filling

The reservoir filling procedure will be defined once the detailed design has been completed and in compliance with strict dam safety requirements. SN Power will, as part of its ongoing stakeholder engagement, carry out public information campaigns in the neighbouring villages prior to impoundment. People will be warned about the safety risks and will be instructed to stay away from the river and the Myitnge valley during the filling period. SN Power will also deploy a large team of safety inspectors to enforce control over the reservoir area at this critical time.

11.5.5 Budget and Schedule

The reservoir clearing shall commence at least two years before impoundment, and the controlled burning shall be done in the last dry season. Detailed planning is required in order to estimate the total time period needed for the reservoir clearance.

The cost of vegetation clearing cannot be estimated in detail at this early stage, but experience in Lao PDR and western Africa indicates that the unit rate would be about 500 to 1000 USD/ha (Salignat *et al.*, undated). For preliminary planning, three potential clearing areas have been identified with a total area of 420 ha (4.2 km^2) (***Figure 11-1***). Highest priority is the area behind the dam in the deepest portion of the inundation zone (area no. 1), but the two other areas also have thick vegetation cover combined with relatively easy access which would make the clearing operations technically feasible.

Thus, for the purpose of preliminary budgeting, we have assumed that the commercial timber will be extracted at no cost while the clearance and burning will be restricted to the three areas shown in ***Figure 11-1*** at a unit cost of 1000 USD/ha. The total cost of vegetation clearing is then estimated at USD 420,000.

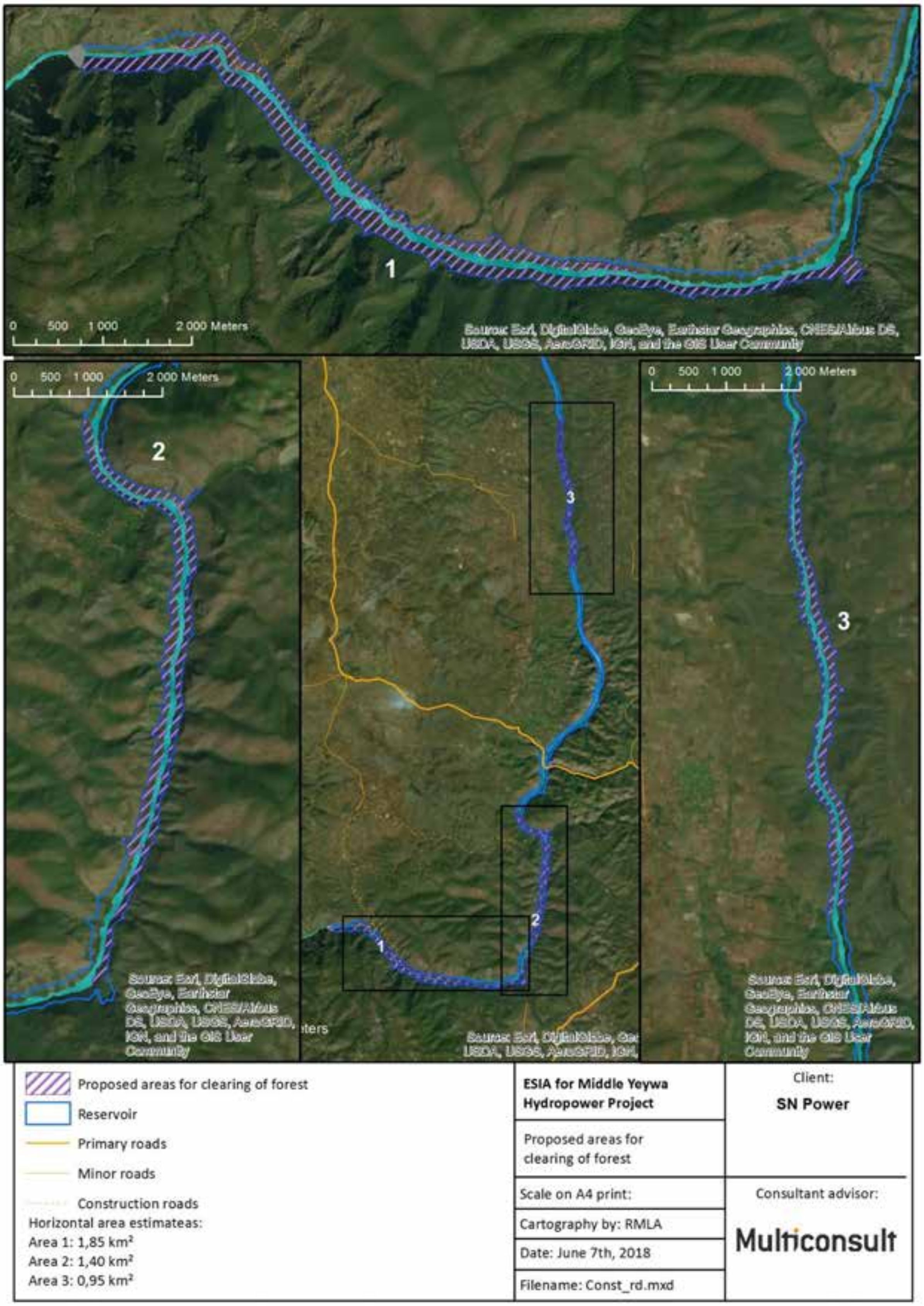

Figure 11-1: Proposed areas for pre-impoundment biomass clearing.

11.6 Biodiversity and Conservation Protection Plan

11.6.1 Introduction

The biodiversity values in the project's direct and indirect impact zones are moderate. An unconfirmed reserve forest has been identified on the left bank while the nearest protected area recorded in the World Database on Protected Areas is Pyin Oo Lwin Wildlife Sanctuary located approximately 35 km west of the dam site. The nearest key biodiversity area (KBA) is called Mehon - Doke-hta Wady River and is located between the dam site and the Pyin Oo Lwin Wildlife Sanctuary. This KBA is an International Bird Area (IBA MM023) and does not have a legal status in Myanmar. The delineation of this KBA appears indicative and is based on the presence of one bird species, the endangered Green Peafowl (*Pavo muticus*). There are also a limited number of other threatened species recorded, most of which are forest-dependent species. The project area is under severe land pressure with rapid conversion of natural habitats to agricultural areas except the steep river valley towards the Myitnge River. Without additional measures for conservation or sustainable use of the project area, most of the significant biodiversity values are likely to disappear in the next 2-3 decades.

11.6.2 Overall Goal and Objectives

The overall goal is to avoid and minimise impacts on biodiversity through project design modifications, mitigation and enhancement measures, and monitoring.

The objectives of this plan are as follows:

- Develop and implement measures that reduce impacts on the biodiversity, and the people who rely on ecosystem services, to acceptable levels, including avoiding a net loss of key biodiversity values;
- Monitor and document changes in biodiversity and terrestrial ecosystem dynamics, species composition and abundance, and ecosystems services provided;
- Reduce the pre-project level of illegal logging and illegal hunting;
- Reduce and eventually stop degradation of forest habitats;
- Restore important habitats degraded prior to the project and habitats affected by the construction phase;
- Minimise soil erosion in the immediate reservoir catchment and subsequent sedimentation of the reservoir;
- Use monitoring results to inform decision-making on adjustments to project operation, mitigation and enhancement measures and future monitoring.

The programme will focus on the reservoir area and its surroundings as well as areas impacted directly or indirectly by associated project infrastructure. During further project development, areas beyond the project area will also be considered where biodiversity protection measures for threatened species, or particularly important habitats, can be implemented more cost-efficiently in the wider landscape rather than in the project area.

Analysis of cumulative impacts may indicate that some areas of conservation interest may at present not be viable in the longer-term and hence guide biodiversity management measures towards areas in the wider landscape that are not affected negatively by the project or likely future cumulative impacts arising from other developments.

It should be noted that this Biodiversity and Conservation Protection Plan focuses on terrestrial biodiversity while the Aquatic Ecology and Fisheries Management Programme focuses on aquatic biodiversity. The plan will be closely coordinated with the Reservoir Clearance and Filling Plan, the Construction EMP, and the Community Forest Programme. Furthermore, where areas outside the project's impact zones are covered, the plan should be aligned with other management plans developed or implemented by government or non-government stakeholders, for instance forest management plans or protected area management plans.

11.6.3 Roles and Responsibilities

SN Power, through the ESU, will be overall responsible for the implementation of the Biodiversity and Conservation Protection Plan. Specialised tasks are likely to be outsourced to national and/or international experts or organisations with SN Power remaining ultimately responsible, including to provide updates and reports to stakeholders. The detailed roles and responsibilities will be developed as part of establishing the Environmental and Social Unit (ESU). Authorities at local, regional and national levels will be consulted as will national and international NGOs working on biodiversity and forest conservation.

11.6.4 Staffing and Organisational Aspects

Most of the team involved in this programme will likely be short-term consultants, including a mammal expert, a bird expert, an amphibian and reptile expert, and possibly an insect expert. A protected area specialist may also be required. Laboratory services will be sourced from within Myanmar. Technicians and various other national support staff will also be needed.

11.6.5 Specific Activities

Protection of Important Habitats and Catchment Areas

In consultation with forest authorities, local authorities and communities, SN Power should consider establishment of one or more forest protected areas around the reservoir on both river banks. Priority should be on areas with important habitats that still have limited degrees of land conversion and other pressures from the local communities as well as potential hotspots for erosion and sedimentation. This will likely cover most of the steep river valley towards the reservoir currently not used for any form of cultivation but subject to selective logging of high-value timber species, hunting, burning and in some grazing areas. In addition, the plateau on the left bank, including the proposed Naung Lon Reserve Forest which could be extended to the dam site, will be considered and discussed with forest authorities. According to the Forest Department in Taunggyi the procedure for establishing a forest reserve area is as follows.

- Preparation of a proposal to the Union Government with a 60 day period to the public for claims on land use;
- An MOU is issued for preparation of a detailed management plan for the forest reserve;
- MoNREC reviews the management plan and submits it to State officials for comments before final approval
- Claims for compensation are negotiated and settled.

The forest reserve will then be protected against logging and other uses of the forest, except by local villages for non-commercial purposes. Any harvesting of timber by villagers needs approval by the forestry department.

The Forestry Department will assign a minimum of two staff to supervise the area. Patrolling is done in three ways:

- Patrolling the area and then dealing with illegal issues as they are discovered;
- Acting on information to investigate an issue;
- Surprise road checks

Assessing the feasibility and extent of protection of the immediate reservoir catchment areas should build on existing EIA documentation and further include:

- Further mapping of forest extent, consultations with local communities on legal and illegal resources use as well as formal and informal rights in these forest areas, and consultations with local authorities on village boundaries;
- Dialogue with forest and energy authorities on the most appropriate legal provisions for protecting such forest catchment areas and the relevant guidance for implementing such provisions;
- Dialogue with forest authorities and protected area authorities on their priorities for protected areas in the project area, if any;
- Assessment, in consultation with relevant authorities, of alternative areas for protection and associated form of protection, including requirements for community involvement in management of the protected area or buffer zones;
- Development of a simple management plan for the protected catchment area in consultation with stakeholders at local, regional and national levels. While it is anticipated that natural regeneration of high-value timber species is the most feasible approach, active restoration efforts should be considered as part of developing the management plan. Active restoration works are particularly relevant in areas affected by construction activities including potential access roads for reservoir clearing;
- Participatory demarcation of boundaries for the protected area;
- Establish monitoring plan for a limited number of key indicators (e.g. presence and abundance of species of particular conservation concern, forest cover, erosion), including baselines;
- Establish a functional management unit in cooperation with relevant authorities and local communities.

No physical displacement is anticipated for the purpose of establishing the catchment forest protected area. Where feasible, community forest management will be integrated in the catchment forest protection; however, active forest management measures by communities (e.g. agro-forestry) is unlikely to be feasible for sensitive species.

Conservation Activities for Protection of Selected Species

The project's impact zones partly overlap with the Mehon - Doke-hta Wady River Key Biodiversity Area (KBA) that has been delineated based on the anticipated habitat of the endangered Green Peafowl (*Pavo muticus*). The KBA has no formal protection status in Myanmar. Expected project impacts on this species and its habitat are limited, yet the project will seek to avoid any net loss of habitat for the species and the KBA. In addition to potentially establishing a protected catchment forest around the reservoir, the Project will consider supporting improved management of important habitats for the Green Peafowl with priority on areas within the KBA that are part of, or connected to, habitats for this species of significant size. The figure below shows the KBA but potential focal areas for support for improved habitat management within the KBA have not been identified yet.

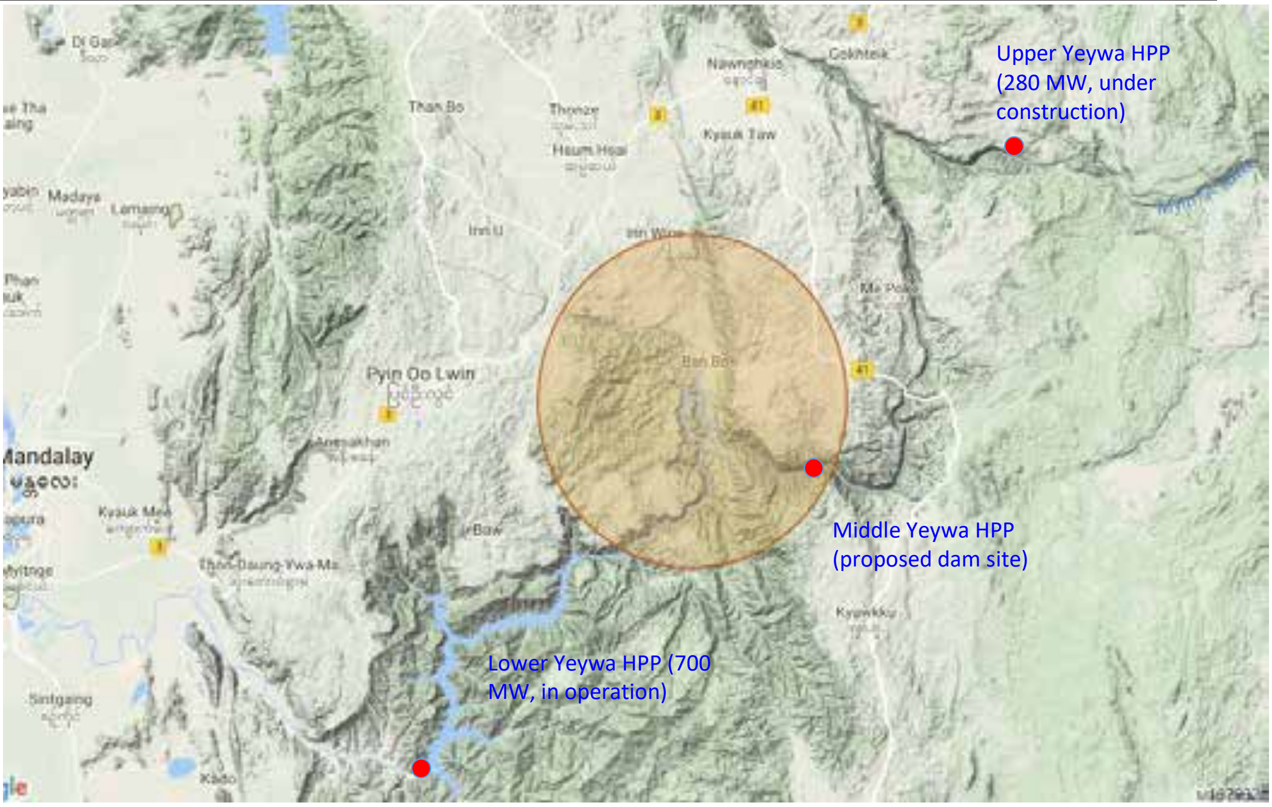

Figure 11-2: Map showing the location of the Mehon - Doke-hta Wady River key biodiversity area west of the Middle Yeywa project area.

Maintaining Connectivity

The biodiversity impacts of Middle Yeywa Hydropower Project seen in isolation are moderate. However, at landscape level the cumulative impacts from establishing three large hydropower projects (Lower, Middle and Upper Yeywa Projects), combined with large-scale conversion of forest to agriculture and settlement areas, will undoubtedly result in substantial loss of habitat and increased fragmentation of remaining habitats.

Establishing a catchment forest protected area around the Middle Yeywa reservoir will contribute to maintaining connectivity, particularly for forest-dependent species or species moving between habitats via such forest areas that provide corridors in a landscape largely converted to agriculture and settlements, particularly on the right bank. Activities to avoid a net loss of habitat for the endangered Green Peafowl and the KBA may also contribute to maintaining connectivity in a wider landscape. Identifying areas for catchment forests or Green Peafowl habitat will seek to optimise the contribution to connectivity in the larger landscape and avoid creating isolated habitat patches through project-related habitat conservation efforts.

Monitoring Program

The biodiversity monitoring will cover presence and abundance of selected species, quantity and quality of important habitats as well as levels of illegal activities in important biodiversity areas. This will also provide input to assessing actual impacts on ecosystem services and potential measures required to mitigate negative impacts on these services.

The baseline surveys identified several species of conservation interest, most of which are forest-dependent species. Project impacts during construction and operation will be monitored to document the level of impacts experienced, to evaluate the effectiveness of mitigation and enhancement measures, and to inform decision-making in terms of changes to construction practices, operation regime, mitigation strategies, enhancement measures and future monitoring. The monitoring will cover habitat quality and quantity for key habitats and key species and will bring together three main components to a coordinated biodiversity monitoring programme:

- Monitoring integrated in the management plan for the catchment forest protected area;
- Monitoring as part of habitat support for the Green Peafowl or the KBA to avoid a net loss;
- Monitoring focussing on the construction and operation phases in other areas.

Levels of illegal activities (logging and hunting) will be monitored primarily in the catchment forest protected area. Monitoring during the construction phase will focus on the catchment forest areas near the construction sites while the operation phase monitoring will be less intensive but cover the wider catchment forest areas and supported Green Peafowl habitats and KBA.

11.6.6 Budget and Schedule

Further work prior to construction start will include developing a fully-fledged Biodiversity Management Plan including initial work to map potential habitats that can be supported to avoid a net loss of Green Peafowl habitat and KBA. Preliminarily, the work is budgeted at USD 50,000.

Monitoring during the construction phase will focus on the areas close to the construction sites including monitoring of illegal activities and filling gaps in baseline information. An average annual cost of USD 20,000 is estimated except the final year prior to commissioning when the reservoir is likely to be filled and additional surveys are recommended during the filling period, which bring the annual budget figure that year to USD 40,000.

Costs for potential support to Green Peafowl habitats and the KBA have not yet been estimated due to the uncertainties of whether support outside the catchment forest areas is likely to be required and feasible. The budget is assumed to be approximately 50,000 for the first three years, highly dependent upon the scope of the work to be undertaken and the arrangement with government or non-government implementation partners.

During the operation phase, monitoring will be most intense during the first few years as the reservoir will be a new habitat, important catchment forest activities will be undertaken and there will potentially be start-up of activities to support Green Peafowl habitats and KBA in a location of the wider region (outside the project area). The average annual budget for biodiversity monitoring is expected to be approximately USD 25,000 for the first five years, after which it is likely to reduce.

An indicative budget for the Naung Lon Reserve Forest on the left bank, should this reserve be confirmed, is USD 10,000 for stakeholder engagement and awareness raising, USD 5,000 for boundary demarcation, USD 25,000 for development of a management plan with zonation for multiple use, and annual costs of USD 10,000 for the first three year of establishing an active management regime.

11.7 Community Forest Program

11.7.1 Overall Goals and Objectives

Background

Myanmar suffers significant annual deforestation due to over-exploitation, illegal logging, shifting cultivation, governance and institutional issues, and expansion of urban and agricultural lands (IUCN 2018). The Middle Yeywa HPP will contribute to forest loss on a local scale, especially related to the pre-impoundment clearing of the reservoir.

An opportunity to compensate for the project-induced deforestation is through forest landscape restoration, which has gained momentum in Myanmar in recent years. In 2016, the government launched a 10-year National Reforestation and Rehabilitation Program in Myanmar (NRRPM) aimed at not only restoring degraded and deforested landscapes, but also improving economic and environmental conditions of local communities.

In 2017, the Forest Department, supported by IUCN and The Nature Conservancy, conducted a multi-criteria spatial analysis which identified opportunities for restoration. Forest loss areas in the country (from 1990) and Key Biodiversity Areas (KBA) were analysed. Based on the results, watershed protection near medium population density areas was identified as a priority. The analysis also identified over 713,000 hectares of degraded land as a priority for restoration action (***Figure 11-3***).

One of the selected areas is located in the catchment of the existing Yeywa reservoir, a short distance downstream of the proposed Middle Yeywa dam site. This priority area consists of the Pyin Oo Lwin Wildlife Sanctuary, a highly degraded habitat that is not properly protected, and the Mehon (Doke-hta Wady River) Key Biodiversity Area (KBA), which is home to the Endangered Green Peafowl (*Pavo muticus*).

Forest landscape restoration in Myanmar is implemented mainly through community forestry programmes. The Community Forestry Instruction (CFI) was issued in 1995, and initiated the promotion of community forestry across the country with the support from international donor projects (e.g. UNDP / JICA / DFID) as well as through the Forest Department, and in some cases self-organisation by communities. The CFI law states that community forestry certificates can be issued to a Forest User Group (FUG) for 30 years lease. To qualify for such certificate, a FUG must commit itself to manage the forest sustainably and systematically according to the forest management plan that they develop. As of 2011, there are 572 FUGs with certificates, managing more than 100,000 acres of forest in Myanmar. Many of these certificates have been issued in Shan State under UNDP project support.

According to Shan State forestry officials, there is also a reserve forest on the left bank of Myitnge River extending all the way from the Upper Yeywa HPP down to the Nam-kam tributary in the lower reaches of the proposed Middle Yeywa reservoir. This reserve forest is known as the Naung Lon Reserve Forest but no programmes are presently implemented due to security reasons. However, with improved government control over the area, this reserve forest can be selected for community forestry interventions.

The Shan State Forest Department has already conducted training activities in the Middle Yeywa project area, including the left bank. The approach is in line with MoNREC's new regulation called the 9-steps which involves management by villagers within 5 km of the designated community forest areas. The scope of education and forestry training programmes is currently restricted by funds.

Objectives

The Community Forest Program will consist of both natural and assisted regeneration of tree species as well as protection of existing forests and promotion of agro-forestry practices. The objectives are as follows:

- Compensating for the loss of forest in the Middle Yeywa reservoir by restoring priority forests outside of the project's direct impact zone;
- Contributing to watershed management and biodiversity conservation whilst also improving the communities' access to ecosystem services through sustainable community-led forest management.

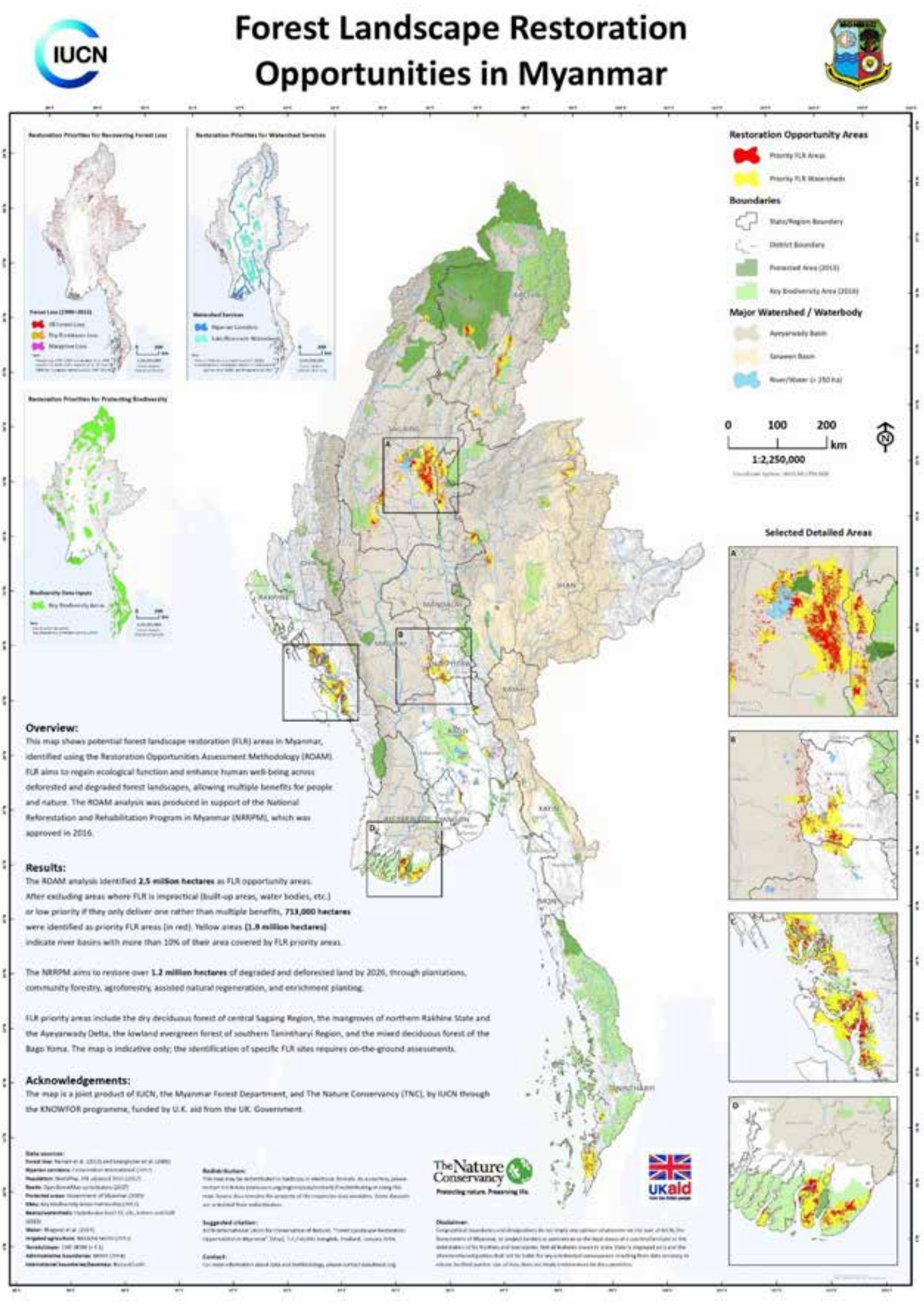

Figure 11-3: Forest landscape restoration opportunities in Myanmar.

Source: IUCN (2018)

11.7.2 Staffing and Organisational Aspects

The Community Forest Program should rely on the services of the Forest Department in Shan State (and possibly Mandalay Region) while also exploring the opportunities for creating partnerships with NGOs and seeking co-funding from international donors in the forestry sector. At this early stage, it is premature to define the organisational set-up and staffing requirements for the community forestry interventions. However, it is envisaged that the project's Environmental and Social Unit will have a Community Forestry Team staffed with at least two forestry advisors who will work together with government staff (and possibly NGO personnel).

11.7.3 Roles and Responsibilities

SN Power will be responsible for the implementation of the Community Forest Program through the following:

- Provision of management and planning control through its Environmental and Social Unit;
- Technical backstopping services by its own personnel (forestry advisors);
- Ensuring support from the Forest Department, possibly including secondment of government staff to the project's Environmental and Social Unit;
- Partnership arrangements with NGOs working in the communities with forest restoration and management.

The roles and responsibilities of third-party institutions will be agreed during the detailed design of the Community Forest Program.

11.7.4 Specific Activities

Identification of Potential Restoration/Reforestation Areas

Based on the identification of priority areas for restoration of forest landscapes in the Pyin Oo Lwin Wildlife Sanctuary and the Mehon (Doke-hta Wady River) Key Biodiversity Area (KBA), as well as the need to strengthen law enforcement in the Naung Lon Reserve Forest, SN Power through its Environmental and Social Unit shall facilitate the Forest Department and other relevant government offices to select exact locations for restoration/reforestation activities within these wider areas. The total size of the land should be equivalent to that lost due to dam impoundment (approx. 8.2 km^2). Detailed maps (GIS and hard copy) will be produced for each of the selected forest restoration/reforestation sites.

Local Communities Participation and Communication Plan

The communities within or near the selected restoration/reforestation areas will be consulted in order to determine the type of interventions suitable at each site. Experience from other programmes shows that failure is often caused by the villagers not gaining a clean and detailed understanding of the community forestry concepts during the early stage. It is therefore important to conduct a thorough and meaningful consultation process to ensure full participation and commitment by the local communities. The communities will be encouraged to establish Forest User Groups (FUGs) in line with government policies and regulations.

It is envisaged that a range of interventions will be proposed including outright protection to conserve important forest habitats and catchment areas and to promote natural regeneration of valuable tree species; sustainable management of existing forests where villagers are allowed to extract firewood, posts and poles in accordance with established by-laws; assisted regeneration of trees involving nurseries to raise seedlings; and agro-forestry practices on land that has already been converted to agriculture. The trees selected for protection or reforestation may include timber species (e.g. *Tectona grandis, Gmelina arborea*) as well as trees under conservation threat (e.g. *Dalbergia oliveri, D. cultrata, Pterocarpus indicus, Cycas siamensis*).

Nurseries and Reforestation Implementation Programme

The growing of seed stock for reforestation often requires a long period of time. Seeds from suitable species need to be collected from the surrounding forested areas, prepared for planting, and then grown to a suitable maturity for transplanting. This can take up to two years for some species. Therefore, in the long term forest regeneration plan, the development of nurseries and the growing of saplings should be addressed in the very first phase of implementation.

One option is to establish a central nursery in conjunction with a forestry research centre being planned by the Shan State Forest Department downstream of the Middle Yeywa dam. Regeneration trials could begin there as a pilot phase before the full scale regeneration operation when seedlings are distributed to the various FUGs. There is also the option of establishing smaller nurseries in villages to provide employment.

Monitoring and Protection Measures

SNP will be responsible for continued monitoring of all community forest activities, including survival rates of seedlings until reaching maturity as well as compliance with protection by-laws and overall progress of forest cover from year to year.

11.7.5 Budget and Schedule

The Community Forest Program will require a dedicated team within SN Powers Environmental and Social Unit. This Community Forestry Team will consist of SN Power personnel as well as staff seconded from the Forest Departments in Shan State and possibly Mandalay Region.

For the purpose of preliminary costing, we have assumed that the average of cost of tree planting is around USD 2,000 per hectare all inclusive (based on experience from other projects). More investigations and negotiations with the government will be necessary to determine the total area that shall be covered by the Community Forest Programme. The tentative budget for the construction phase has been stipulated to USD 240 000 while the budget for the first 5 years of the operation phase has been stipulated to USD 120 000.

11.8 Operation Phase Environmental Management Framework

11.8.1 Overall Goals and Objectives

The overall goal of the Operation Phase Environmental Framework is to provide a programme for safeguarding the biodiversity in the project area on the long term and throughout the concession period for the Middle Yeywa HPP. One additional objective is to monitor the long term impacts of the hydropower development as well as the effectiveness and outcomes of the different mitigation programmes so that adjustments can be made if necessary.

11.8.2 Roles and Responsibilities

SN Power will have the responsibility for maintaining the mitigation programmes into the operation phase. When the programmes are well established the responsibility will be gradually handed over to implementing partners such as NGOs and the relevant government agencies.

11.8.3 Staffing and Organisational Aspects

In order to manage the different mitigation activities and programmes early in the operation phase SN Power will retain the Environmental and Social Unit with sufficient staffing to ensure an effective implementation of all activities. These staffing requirement will to some degree depend on the detailed planning for the mitigation programmes and to what degree implementing partners can be found. It is expected that the staffing of the ESU can be gradually reduced as the mitigation activities are either phased out or handed over to implanting partners. However, SN Power will be required to maintain an environmental and social staffing in an organisational form and at a level that ensures implementation and monitoring of long term mitigation and enhancement activities.

11.8.4 Specific Activities

Operation Phase Environmental Management Plan

An Operation Phase Environmental Management Plan should be developed by the Middle Yeywa HPP well ahead of the start of the operation phase. The plan and should build on the different mitigation programmes initiated in the construction phase and should tentatively cover the following environmental issues:

- Waste Management and pollution control (routines for handling accidental oil spills, household waste and waste generated by the operation of the hydropower plant);
- Water quality monitoring;
- Fisheries management and aquatic ecology monitoring
- Conservation protection activities;
- Community forest management.

Emergency Response Plan

SN Power will be required to develop an Emergency Response Plan for dam rupture and unexpected floods with detailed manuals specifying schedules and responsibilities for taking managerial actions and mobilise technical mitigation measures as well as specific instruction for rapid communication with downstream settlements and village and local authorities.

Close cooperation with village and local authorities is needed for preparing realistic emergency procedures. With the plan in place it will be necessary to arrange training and drills in the emergency procedures for managerial and operational staff at regular intervals.

11.8.5 Budget and Schedule

The budget for the first five years of the operation phase has been estimated at totally USD 320 000 with the Biodiversity and Conservation Protection Plan and the Community Forest Programme being the largest budget items with USD 125 000 and USD 120 000 respectively. The annual budgets for each of the operation phase programmes are shown below.

Table 11-6: Estimated budget for the operation phase environmental management framework.

Item		Operation Phase					Total
		Year 1	Year 2	Year 3	Year 4	Year 5	
1	Water Qyality Plan	5 000	5 000	5 000	5 000	5 000	25 000
2	Aquatic Ecology and Fisheries Programme	20 000	20 000	10 000			50 000
3	Biodiversity and Conservation Protection Plan	25 000	25 000	25 000	25 000	25 000	125 000
4	Community Forest Programme	30 000	30 000	20 000	20 000	20 000	120 000
Operation Phase Environmental Management Fr.		**80 000**	**80 000**	**60 000**	**50 000**	**50 000**	**320 000**

11.1 Summary of EMP Budget

Table 11-7 below summarises the budget for the Environmental Management Plan for the operation phase for the Middle Yeywa HPP. The Reservoir Clearance and Filling Plan is largest cost item with USD 420 000. The total SMP budget amounts to USD 1 155 000.

Table 11-7: Summary of the EMP budget

Item		Pre-constr.	Construction Phase						Total
		Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	
1	Water Qyality Plan	-	10 000	10 000	10 000	10 000	10 000	10 000	60 000
2	Aquatic Ecology and Fisheries Programme	40 000	10 000	10 000	10 000	10 000	10 000	15 000	105 000
3	Reservoir Clearance and Filling Plan					175 000	175 000	70 000	420 000
4	Biodiversity and Conservation Protection Plan	90 000	60 000	50 000	50 000	20 000	20 000	40 000	330 000
5	Community Forest Programme		20 000	30 000	40 000	50 000	50 000	50 000	240 000
Total Environmental Management Plan Activities		**130 000**	**100 000**	**100 000**	**110 000**	**265 000**	**265 000**	**185 000**	**1 155 000**

12 SOCIAL MANAGEMENT PLAN

12.1 Introduction

12.1.1 Overall Goal and Objectives

The overall goal for the Social Management Plan (SMP) is to mitigate project impacts and to enhance benefits for the stakeholders in the Middle Yeywa Hydropower Project. A first step in achieving this overall goal is to make sure that social mitigation is built into the project design so that negative social impacts are avoided or minimised as far as possible. To this end, a comprehensive consultation process is necessary, giving all stakeholders an opportunity to contribute with their knowledge of local conditions and to express their views and concerns. For the potential negative social impacts that are unavoidable, this plan aims to identify and formulate activities and programmes that reduce the impacts to acceptable levels.

12.1.2 Roles and Responsibilities

As the Developer, SN Power will have the overall responsibility for implementing the SMP. Parts of the SMP will be implemented by the Environmental and Social Unit (ESU) while some activities and programmes may be outsourced to organisations that have the necessary capacity and expertise to implement them. These organisations, to be engaged by SN Power, may comprise both NGOs and government agencies. Through further detailed planning and project development, potential implanting partners will be identified.

12.1.3 Staffing and Organisational Aspects

As set out in the overview of staffing in Chapter 10, the ESU will have a number of specialised teams that will be charged with implementing and monitoring the mitigation programmes. There are two teams in the ESU that first and foremost will have the responsibility for implementing and monitoring the SMP, i.e. the Compensation and Grievance Team and the Social Management and Consultation Team. Each of these teams will be headed by a team leader and be staffed with 3 to 4 specialists with the necessary qualifications. In the event that implementation of the SMP programmes are outsourced, these teams will also function as the main interface between the implementing partners and the Project.

12.2 Stakeholder Engagement Plan

12.2.1 Overall Goals and Objectives

The overall goal of the Stakeholder Engagement Plan is to establish a platform and structure for an effective and continuous dialogue with all stakeholder groups. This will provide greater transparency and enhance project sustainability by creating acceptance and local ownership of the Project. Other important objectives include:

- Ensuring that the views and perceptions of people who may be affected by the Project are taken into account;
- Minimisation of project impacts through stakeholder inputs into design and implementation;
- Keeping potentially affected people and communities informed about project planning and the implementation process;
- Enable potentially affected people to understand their rights so that they may become aware of their entitlements and submit claim through the Project's grievance mechanism, if necessary.

12.2.2 Roles and Responsibilities

The Environmental and Social Unit Manager (ESU Manager) and the Social Management and Consultation Team will be directly responsible for the detailed planning and implementation of the Stakeholder Engagement Plan. As needed, technical expertise will attend consultation meetings and assist with the presentation of technical plans. It may also be necessary for the Project Manager to participate in the consultation process if more high level and policy issues are presented and discussed.

12.2.3 Stakeholder Consultation Methodology

The stakeholder consultation methodology will comprise of different tools and approaches and will be adapted to the characteristics and composition of each stakeholder group. In the following, the prospective methodologies that may be applied for the different stakeholder groups are briefly described.

Villagers and Village Leadership

The consultative process in the villages has already commenced in the pre-feasibility and feasibility phases, and this will continue to be carried out in a systematic manner by using different approaches and techniques, including qualitative methods of investigation and evaluation. The focus in the pre-construction and the construction phase will be more on the planning of the community development initiatives (CDI), including access road improvement and grid connection, that SN Power will be funding.

The consultation approaches in the next phases are likely to include:

- Moderated village meeting where as many as possible of the village population attend (care will be taken to choose a timing that assures a good attendance);
- Semi-structured interviews with key persons in the village, including the village leadership;
- Focus group discussions with vulnerable groups that will require special attention to help them express their concerns and identify any constraint with respect to benefitting from project supported interventions.

The semi-structured (conversational) interviews will continue to be conducted in a flexible manner by the use of a questionnaire with a limited number of pre-set questions. This technique aims to keep the focus on selected topics while at the same time allowing enough flexibility so that participants can introduce and discuss any topic they see as important.

Focus group meetings will also continue to be conducted in a semi-structured way with small groups of four to twelve participants plus the moderator. Focus group discussions aim to ensure that attitudes, feelings and preferences of people within a specific group are taken into consideration and will be applied as needed with respect to vulnerable groups and others that are perceived to require special attention.

Gender analysis will also be applied as a cross-cutting theme in the village consultations and will focus on understanding the differences in gender roles with respect to project interventions and support programs. Both gender-segregated semi-structured interviews and focus group discussions will be used to ensure women's voices can be heard during the village consultations.

Local Businesses and Contractors

For local businesses that are interested to utilize the increased market opportunities created by the Middle Yeywa HPP, public meetings will be arranged to inform them about the project planning process and in particular what kind of services and goods that will be required by the Project. The meetings will be held well ahead of the start-up of construction activities to allow local businesses enough time to prepare and plan for delivering services and goods to the Project. These meetings will be held at different strategic venues to allow the business community in a wide circle around the project area an opportunity to attend the information meetings.

District and Township Governments

Some preliminary meetings have been held with local government as part of EIA planning. In the future, information and consultation meetings will be held with the general administrative departments of the two districts and three townships whose territories the Project directly touches on. The meetings will be held according to the formal protocol that the government requires. It is expected that these meetings also will be attended by representatives of government line agencies such as the health and agriculture offices at district and township level. At the meetings, Project representatives will inform about the currents state of the project planning and invite feedback that can be incorporated and taken into consideration in the further planning process. The meetings will also present an opportunity to explore possibilities for cooperation between the Project and local government institutions with regard to implementation and monitoring of Environmental Management Plan/Social Development Plan activities.

State Government

The information and consultation meetings that will continue to be arranged with the Shan State Government in Taunggyi will build on the meetings and discussions already held with the Chief Minister and ministers for the different line ministries, including the Ministry of Electricity and Energy and the Ministry of Construction (see Section 5.4.3). Important topics for discussion will be possibilities for integrated planning and joint implementation of Environmental Management Plan/Social Development Plan programmes, including possible support for village electrification and improvement of road infrastructure (see Section 12.7 below).

12.2.4 Budget and Schedule

It is anticipated that the next phase of the consultation process will start at least one year ahead of the construction activities and continue throughout the whole construction phase. For the operation phase, it is expected that the power company's public relations and Corporate Social Responsibility (CSR) staff will continue consultations as needed. The budget for the operation phase consultations will therefore be part of the annual budgets for the public relations and CSR activities.

For the pre-construction consultations, it is estimated that the consultation activities will require a budget of totally 10,000 USD (not including salaries and allowances of ESU staff) for materials and organizational costs. It is assumed that the construction phase will last for six years and that an annual budget of 5,000 USD will be needed for the first three years, while the annual budget for the next 3 years will be around 2,500 USD. The total consultation budget for the pre-construction and the construction phase will thus amount to 32,500 USD.

12.3 Compensation for Lost Land, Production and Fixed Assets

12.3.1 Overall Goals and Objectives

The objectives for the compensation programme is to survey, record and fully compensate for all affected residential, agricultural and forest land areas as well infrastructure that are affected by the Middle Yeywa HPP. The compensation will be based on full market prices and on the principles of replacement values for all affected assets. In addition to the compensation at replacement value for assets, a disturbance allowances will also be paid as a compensation for the disruption caused by relocation of building infrastructure for project-affected persons/households and for general disturbance due to noise and traffic. The overall goal for the compensation programme is thus to keep all affected persons/households free from harm in an economical sense.

12.3.2 Roles and Responsibilities

SN Power will have the direct responsibility for ensuring that all affected persons/households, businesses and organisations are properly identified are compensated according to their entitlements as described in the Projects compensation policy. Throughout the whole compensation process, the relevant government offices will be consulted to make sure that due process is followed with respect to the legal requirements for land acquisition and compensation for fixed assets and crops.

12.3.3 Staffing and Organisational Aspects

The asset surveys for affected land and buildings will be carried out by the Compensation and Grievance Team of the ESU. The team leader will be in charge of the survey and valuation of assets, supported by a team of 3 to 4 survey and valuation specialists. The Compensation and Grievance Team will work in close collaboration with village authorities and coordinate with local government authorities as needed. In addition, the Social Management and Consultation Team will assist the Compensation and Grievance Team in their work as needed, and especially in connection with negotiations and complaints about compensation awards raised through the projects grievance mechanism.

12.3.4 Specific Activities

Development of a Compensation Policy with Rates and Prices

The Compensation and Grievance Team will initially carry out a survey of the current market rates for land, agricultural commodities and house construction materials. A review of the official government compensation rates will also be carried out to assess whether they reflect market prices. A detailed Project Compensation Rate Policy with prises for different types of land, crops and building infrastructure will subsequently be prepared. Care will be taken to make sure that the rates for all items covered by the policy are equal to or above current market rates to make sure that the rates reflect the actual replacement costs. The policy will be shared and discussed with the local government authorities will to get their approval before it is put into effect.

Land Areas and Fixed Assets Surveys

As soon as detailed technical project planning has progressed to a stage where impacts in terms of loss of land, crops and building infrastructure can be identified with a high degree of certainty, land and fixed asset surveys will be carried out in all project affected areas. The Compensation and Grievance Team will cooperate with the technical planners and surveyors to make sure that all affected assets are correctly identified. All asset surveys will be done in the presence of the land and property owners while the village authorities will be asked to act as witnesses. Identified assets will be recorded on an inventory form and countersigned by all parties present. A copy of the same record will be given to the property owner for future reference.

It is expected that the project components that to the largest degree will trigger compensation payments are the access roads from Nawnghkio to Yae Twin Gyi and further down to the dam site. In addition, land for camp and workshops areas within the Yae Twin Gyi village territory may impact on agricultural land which subsequently will need to be compensated. The types of land and assets that are most likely to be impacted include:

- Residential land ;
- Commercial land;
- Residential buildings/ houses;

- Commercial buildings;
- Agricultural land;
- Forest land

To allow for transport of wide and heavy loads on the access roads, improvement and widening of the road from Nawnghkio to the village of Yae Twin Gyi will be necessary. The impact in term of loss of residential land and need for relocation of building structures caused by the access road improvement, will depend on the final routing of the access road. There may be opportunities for avoiding and minimising loss of land and displacement of structures by using alternative routings around the most narrow and densely populated road sections.

Relocation of Buildings At this stage of project planning it is only possible to give a rough estimate of the costs associated with compensation for loss of residential land, building structures. This estimation has been done using Google Earth satellite pictures to count building structures that appear to be lying within a 20 m (10 m on both sides of the centreline) wide road corridor along the access roads (see ***Figure 12-1***). The result of this analysis indicate that 137 structures may have to be relocated if a 20 m is applied as the minimum required width of the access road corridors. To arrive at an estimate for compensation of buildings, including residential/commercial land, a stipulated value of 3 000 USD per building was used. This stipulated cost is assumed to cover compensation for land, building structures, disturbance allowances as well as compensation for other fixed assets such as trees. By using this approach the actual compensation needs for building structures and properties will probably be overestimated as it does not take into consideration the possibilities to divert from the existing roads. Using the above figures the total budget for compensation caused by widening of the access road will be 411 000 USD.

Loss of Forest Land Regarding forest land, which is owned by the Government, the 1995 Community Forestry Instructions (CFI) gives legal backing to rural communities for sustainable management and exploitation of forests. If access roads and camp areas impacts on community forest land that is managed and exploited by the villagers, compensation for the loss of forest resources may have to be paid. However, an analysis done by Google Earth indicate that the assumed access road alignment from Yae Twin Gyi down to the dam site is unlikely to affect any forested area near the village (see ***Figure 12-2***). Some forest will inevitably be affected by the damsite access road but these forested areas are concentrated at the lover part of the valley and will probably be limited to around 10 ha. It is assumed that no compensation will have to be paid for the government owned forestland.

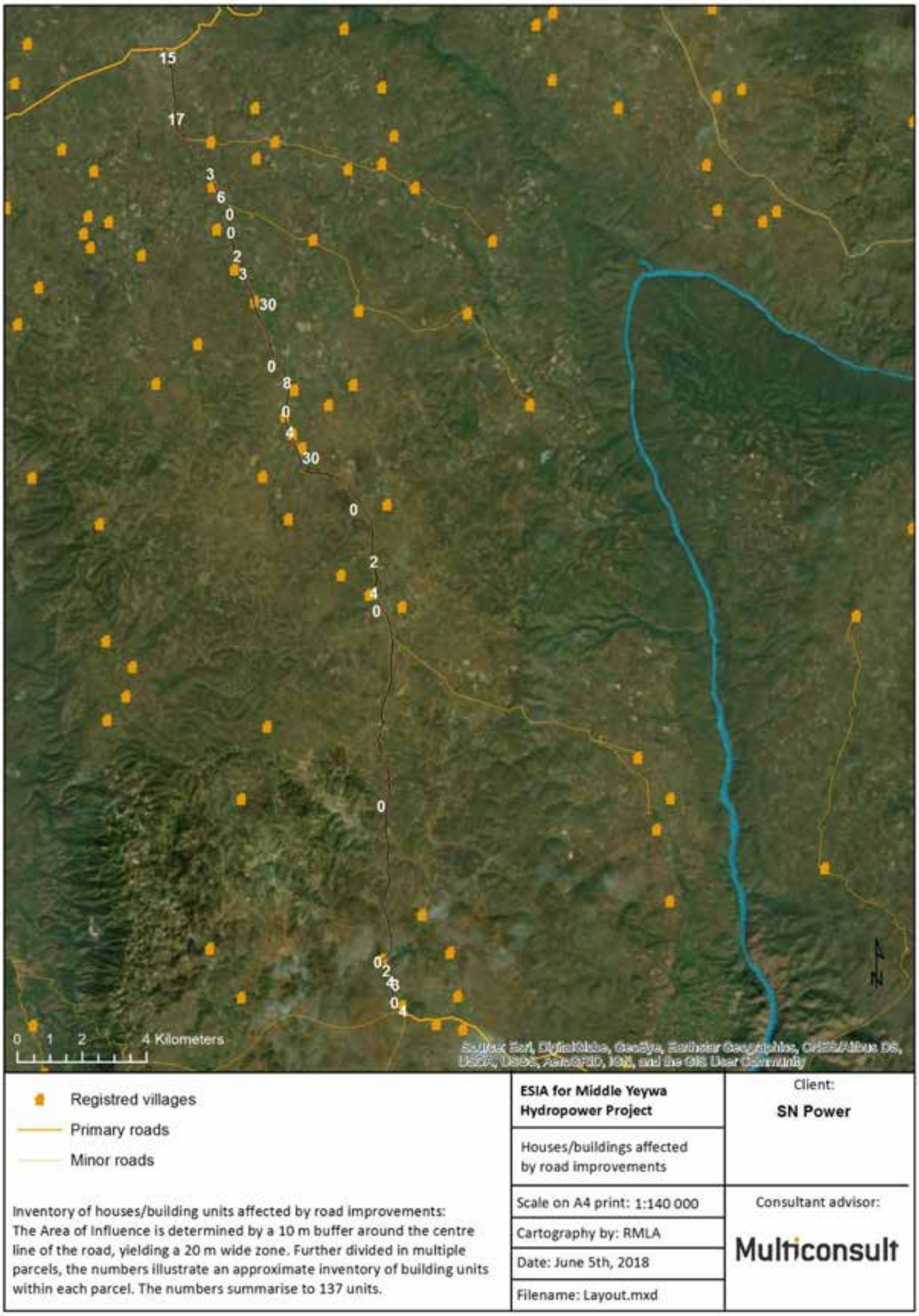

Figure 12-1: Building Structures within a 20 m wide road corridor along access roads from Nawnghkio to Yae Twin Gyi.

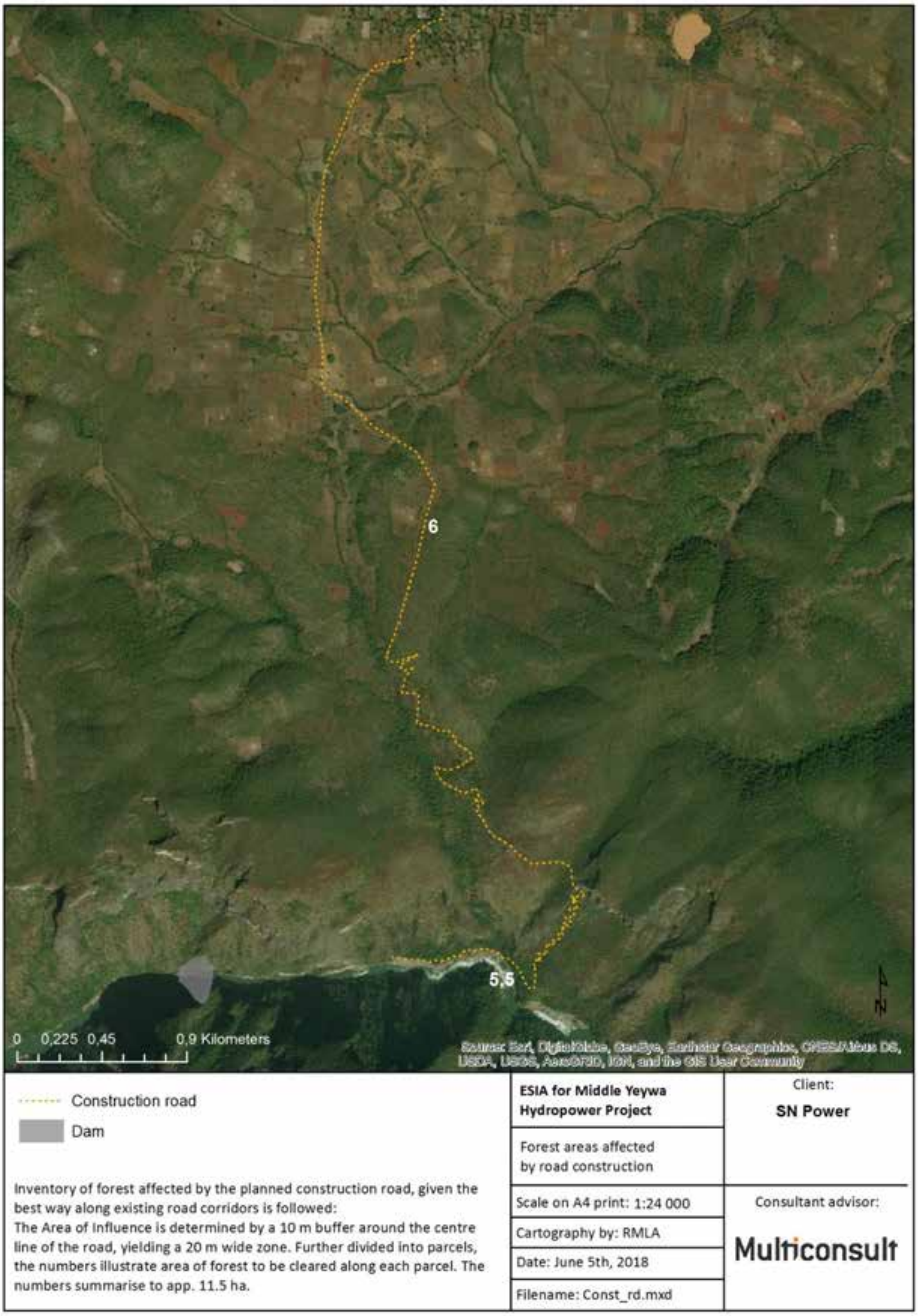

Figure 12-2: Assumed alignment of access road from Yae Twin Gyi to dam site

Agricultural Land The access road from Yae Twin Gyi to the dam site will most likely first follow the existing track across the agricultural fields on the plateau and Google Earth analysis indicate that the track is largely wide enough to accommodate a 20 m wide road corridor (see ***Figure 12-2***). However, the some agricultural land may have to be taken for the road construction. Assuming that the access road corridor will affect a total distance of 500 m of cultivated fields the total loss of agricultural land will be 1.0 ha. Regarding land requirements for camps and other project facilities there should be ample possibilities for locating these on marginal and non-agricultural land and on the plateau around Yae Twin Gyi. However, some loss of agricultural land due to camp and project facilities cannot be ruled out and it is assumed that this could amount to another 1.0 to 2.0 ha of agricultural land. For good measure, it is stipulated that the loss of agricultural land will be 3.0 ha in total. The compensation cost for one ha of paddy land in connection with other projects in Kyaukme District (Gote Twin bridge) has been around 26 000 for developed paddy land and around 17 500 USD for upland agricultural fields. A compensation amount of 20 000 USD per ha has been assumed for agricultural land in the Yae Twin Gyi area and the total compensation for agricultural land is therefore estimated to be 60 000 USD.

Compensation Payment Modalities

On the basis of signed inventory forms and approved compensation rates, valuation forms showing the awarded compensation for the individual property owner/household will be prepared. If accepted and countersigned by the property owner, the compensation can be transferred. To make the compensation payment process transparent and safe, the compensation will only be transferred to the property owner's bank account. The Project will open bank accounts for those property owners that do not already have a bank account.

Compensation Options - Replacement in Kind or Cash Payment

The non-vulnerable project affected persons/households will be offered the choice between replacement of lost assets in kind or cash compensation payments. In the case of in-kind replacement, the Project will take the full responsibility to procure all construction materials and to engage builders to constructs replacement commercial or residential buildings.

12.3.5 Grievance Mechanism

In line with IFC's requirements and to ensure that the basic rights and interests of the project affected persons/households are protected, that concerns are adequately addressed and entitlements delivered, a grievance procedure will be set-up. All affected persons/households will be informed about the existence of a defined process for expressing dissatisfaction and to seek redress. Information regarding the existence of this procedure will be made public during the consultations as well as during the asset survey and compensation process.

Grievances and disputes related to resettlement and compensation may arise for different reasons including:

- Mistakes related to the identification of affected property;
- Disagreements related to the ownership of property;
- Disagreements regarding land and asset valuation;
- Disagreements regarding other compensation allowances.

Proposed Grievance Procedure / Structure

The most important element of the grievance resolution is conflict avoidance. The consultative and participatory approach that will be employed for the compensation process is intended to minimise the occurrence of disagreements and conflicts regarding entitlements. In instances where disagreements do occur, it will be important that they are resolved quickly before positions harden and disagreements escalate.

If a project affected person/household or person is not satisfied with the awarded compensation or if, for any reason, the compensation is not provided in accordance with the Project's entitlement policy, the affected person/household shall have the right to lodge a complaint/grievance.

Village Grievance Committee

The Village Grievance Committee (VGC) will function as the lowest grievance level. When affected households/persons are dissatisfied with their awarded compensation, they will first address their grievance to the VGC. The VGC will try to resolve the issue and bring the complaint to the ESU and the Grievance and the Compensation Team for reconsideration of the survey result and the valuation of the land or asset. If it is found that the compensation has been awarded on faulty survey data or an erroneous valuation computation, a new compensation award will be offered by the Project.

If the VGC cannot resolve the grievance or if the claimant is not satisfied with the offer of settlement from the Project, the VGC or the claimant can refer the grievance to the next grievance level.

Township Grievance Committee

As the second grievance level, it is suggested that a Township Grievance Committee (TGC) be established. The TGC will be composed of a representative from SN Power management, a representative from the General Administration Department and the Township Planning Office.

The TGC will consider grievances that are referred to it and try to reach an agreement with the affected households/persons by offering additional compensation or support if the grievances are found to be justified.

The TGC will be required to respond to any claim or grievance within one month and the ruling of the TGC will be binding on SN Power. The TGC cannot, however, award compensation that goes beyond established precedents.

Both the VGC and the TGC will maintain written records of the grievances they address and their decisions.

Referral to the Courts

If the claimants do not accept the decision of the Township Grievance Committee, they can, as a last resort, refer their grievance to the courts, as is their right under the Land Acquisition Act through an application to the Collector.

The grievance procedure is illustrated in **Error! Reference source not found.*****Figure 12-3*** overleaf.

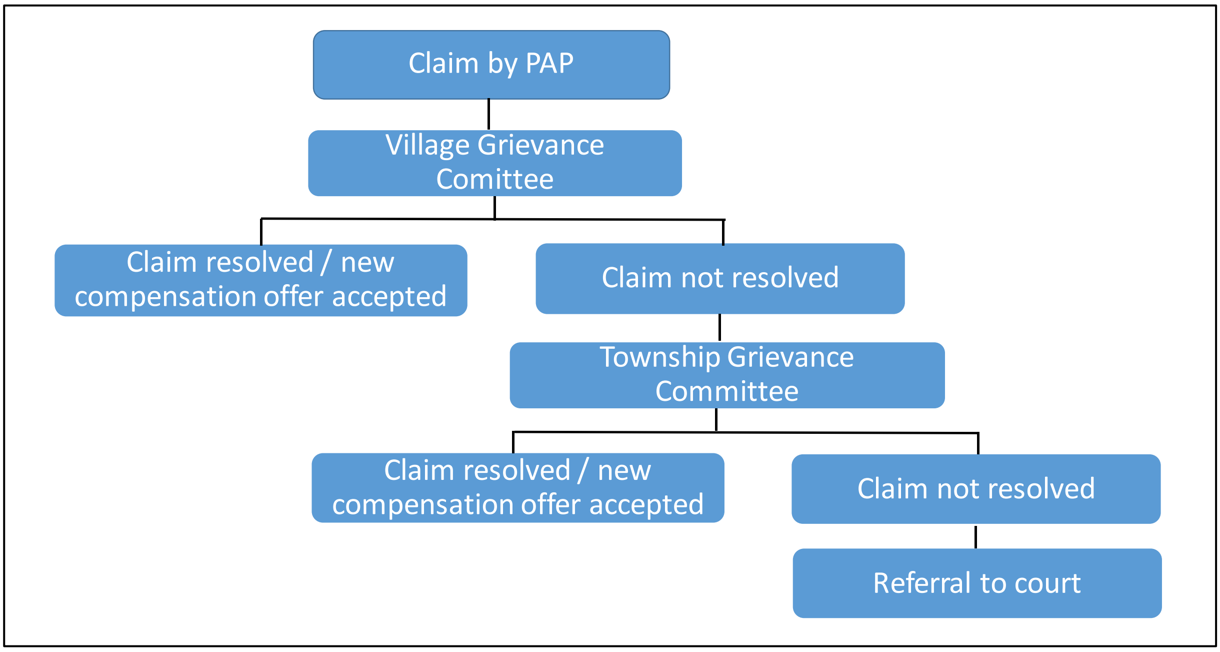

Figure 12-3: Proposed Grievance Mechanism for the Middle Yeywa Hydropower Project

12.3.6 Budget and Schedule

The compensation payments for fixed assets will have to be completed before building structures residential land and other fixed assets are affected by construction activities. It is therefore assumed that all compensation costs are paid in the pre-construction phase and in the two first years of the construction phase. The costs for building structures and properties plus agricultural land add up to 142 000 USD for the pre-construction year, 147 000 for the first year of the construction phase and 137,000 for the second year. The total compensation costs thus amount to 426 000 USD.

12.4 Social Management for Construction Areas

12.4.1 Overall Goals and Objectives

The construction of the Middle Yeywa HPP will involve the employment of approximately 700 workers at the peak of the construction phase. The establishment of camps for workers and contactors is expected to attract a certain number of in-migrants that will impact on and interact with villages located near the project camps. Given experience with other in the region the number of in-migrants will probably not exceed the number of workers and could be less than this. However, a Social Management Plan will be required to limit and mitigate the impacts of the population influx especially with regard to health issues and preventing traffic accidents

The Social Management Plan aims to comply with the requirements of IFC's Performance Standards, most notably Performance Standard 2 – Labour and Working Conditions and Performance Standard 4 – Community Health, Safety and Security.

The objectives of the Social Management Plan for the construction areas of Middle Yeywa HPP are to:

- Minimize and limit negative impacts associated with the influx of camp followers and people seeking to benefit from the market and business possibilities of all kinds created by the Project activities;
- Address the concerns of the residents in or close to impacted areas with regard to security and health concerns;

- Make sure that in-migrants and host village populations have access to basic sanitation facilities and safe drinking water to safeguard their health condition and prevent disease outbreaks;
- Prevent and reduce incidents of Sexually Transmitted Diseases.

12.4.2 Roles and Responsibilities

SN Power will have the overall responsibility for implementing the activities aimed at preventing and reducing potential negative social impacts in the construction areas. However, it is expected that the local authorities will be an important partner in the implementation and monitoring of planned activities and that some of the implementation responsibilities can be delegated to township and village level authorities.

12.4.3 Staffing and Organisational Aspects

The Social Management and Consultation Team of the Environmental and Social Unit (ESU) consisting will be responsible for detailed planning and implementation of the social mitigation and management activities. The team will cooperate closely with Nawnghkio Township government authorities and village authorities when it comes to planning and implementation of specific activities.

12.4.4 Specific Activities

Management of Camp Followers

It is assumed that in-migrants and people who are seeking some kind of business opportunity in connection with the Project will seek accommodation in villages in the project area rather than settling in unmanaged camps close to the workers' camps. The villages that receive the camp followers may have limited capacity to absorb the in-migrants and therefore some kind of preparedness for managing the potential population influx has to be put in place. The Environmental and Social Unit through its Social Management and Consultation Team will therefore prepare a plan for management of in-migrants that will address the following main issues:

- Improvement of water supply and sanitation infrastructure in receiving villages;
- Health status and services for the in-migrants and local population ;
- Security and population management issues.

Depending on the actual influx of people there may be a need to improve water supply and sanitary conditions in the villages that receive in-migrants. In addition, there will be a need to organise an effective waste collection and disposal system.

In addition to safe water supply, sanitation and waste collection and disposal, there are a number of other outstanding health issues. Cooperation with local health authorities will be established to carry out monitoring of the general health situation among the in.migrants. This may include monitoring of births, mortality, causes of mortality and illness. Regarding monitoring of Sexually Transmitted Infections engaging an NGO to assist in carrying out this task will be considered if the responsible government agencies at township/district or state level does not have the sufficient capacity.

For internal security reasons and potential negative impacts on nearby communities (crime or negative social influences), a proper management of the in-migrants will be necessary. This will have to be done in close collaboration with the local authorities and village authorities. Possible population management issues will include:

- Proper registration of new individuals and families settling in the vicinity of the workers camps and local communities;
- Development of a system for the registration and tracking of temporary residents;
- Monitoring of informal entertainment venues and “truck stops”.

Traffic Safety Measures

As a result of project activities and the upgrading and construction of access roads in the project area, more accidents and incidents are likely if proper measures are not introduced. Project related traffic can be expected to increase considerably along the new main access from Nawnghkio to Yae Twin Gyi village which is the village located closest to the dam and powerhouse site. Measures to reduce traffic related accidents may include the following:

- Adherence to standard safety procedures and regulations regarding noise and dust pollution, such as regulating working hours for heavy machinery, signposting and watering of roads in inhabited areas;
- Construction of speed bumps at strategic locations on the roads;
- Development of traffic regulations and monitoring for implementation in project construction areas;
- Implementation of a road safety programme for schools along the upgraded or new access roads.

Sexually Transmitted Disease Control Measures

According to the Global AIDS Response Progress Report for Myanmar (Ministry of Health, 2015), the HIV infection rate for female commercial sex workers was estimated to be around 6% in 2014. Given the fact that the Project will be employing a considerable number of workers and also attract in-migrants, there is a risk that the Project may lead to an increase in the number of commercial sex activities in the wider project area, for instance in connection with informal “truck stops” along local roads. Local authorities can be expected to control these kind of activities efficiently but there will be a need for support from the Project in terms of funds for HIV/AIDS prevention campaigning. The ESU will therefore engage an NGO that has the necessary experience and capacity to develop and implement an Information, Education and Communication (IEC) campaign for workers, commercial sex workers and surrounding communities, ensuring that both women and men have access to the information. This will be done in close cooperation with the local health authorities

Conflict Resolution Measures (Villages vs. Workers/Camp Followers)

With the establishment of project camps, conflicts between villagers and construction workers or camp followers may arise due to improper behaviour and disputes about money and payments. The best mitigation measure regarding these potential conflicts is conflict avoidance, hence channels for consultation and conflict prevention must be put in place. In the cases that conflicts do occur, all efforts should be made to resolve them quickly before they escalate and become intractable. For this reason, different approaches may be required according to the seriousness of the conflicts, including:

- Conflict avoidance through participatory planning and decision making;
- Simple disagreements resolution through informal negotiation, discussion and mediation;
- Solution of established conflict situations by use of the Project’s Grievance Mechanism;
- Intractable conflicts may be referred to the local court system.

12.4.5 Budget and Schedule

In-migrants

For the management of in-migrants and construction of water supply and sanitary facilities in receiving villages, a lump sum of 30,000 USD to be expended early in the construction phase has been stipulated. For health checks and other health related activities in the six year construction phase, a total sum of 5,000 USD per year is assumed. The total budget for in-migrants amounts to 55,000 USD.

Traffic Safety

Traffic safety campaigning and implementation of traffic safety measures will start before the construction and continue through the first three years of the construction phase. A lump sum of 10,000 USD is assumed for the pre-construction phase while 5,000 USD is stipulated for the first three years of the construction phase. This amounts to a total traffic safety budget of 25,000 USD.

Sexually Transmitted Diseases (STD)

The IEC activities for the local population will start in the pre-construction phase and continue with the inclusion of workers and camp followers into the construction phase. Although it is anticipated that most of the IEC activities will be implemented during the early construction phase it will need to be followed up by monitoring as long as there are construction workers and in-migrants in the area. A lump sum of 5,000 USD has been assumed for the pre-construction period while 10,000 USD annually is stipulated for the first three years of the construction phase. For the last three years, an annual budget of 5,000 USD is assumed. The total budget for the STD control measures will thus amount to 50,000 USD.

Total Social Management Budget

Regarding the costs for resolving conflicts between workers, in-migrants and the local population, it is assumed that they will be covered by the consultation budget. The three other components under the Social Management for Construction Areas programme will totally amount to 130,000 USD.

12.5 Community Development Initiatives (CDI)

12.5.1 Overall Goals and Objectives

Establishing good relations with impacted communities and local government is necessary for the long-term operations of the Project. Benefit-sharing in the form of supporting local development and through sustainable initiatives should lead to cooperation and stable conditions during construction and operation, as well as benefits to communities in the project affected area.

As part of the preparation for this document, consultations were held with all local communities directly affected by the project or in the vicinity of the project and with local and regional governments. Views and concerns were solicited from these stakeholders and options were investigated in terms of feasibility and practical arrangements within the scope of the project. The following areas were repeatedly mentioned by many stakeholders:

1. Rural road construction or upgrading existing tracks;
2. Rural electrification;
3. Water supply.

After these initial consultations were held, meetings were conducted between the Developer and various government agencies in order to acquire information about ongoing government infrastructure projects and regional and local plans. It was important to identify synergies between potential project assistance and existing government plans so that any contribution the Project made would be compliant with and complement government priorities and initiatives.

Part of the discussions with local and regional organizations also related to obtaining an understanding of routines, procurement and procedures, as well as capacity of various agencies that would be involved in joint implementation arrangements.

12.5.2 *Roles and Responsibilities*

The implementation of the CDI will require a close cooperation between the Project and the government. It is proposed that a committee be formed that consists of relevant government implementation agencies and representatives from the Developer in order to coordinate detailed planning and design, procurement and supervision of contractors.

Using existing government procedures and routines will guide the implementation process, and the Developer will have the role of technical advisor and supervision/quality control of the work.

12.5.3 *Staffing and Organisational Aspects*

In terms of staffing, the Developer will have one engineer to oversee the planning, procurement and quality control of the activities. In addition, there will be 2-3 field supervisors to jointly supervise the work in accordance to specifications and health and safety standards.

On the government's side, existing staff in relevant agencies and support organizations will provide expertise in detailed planning, drawing up tender specifications, contract selection and supervision/quality control. Monitoring of compliance with contracts and health and safety should be carried out jointly. Regular reports on progress shall be submitted to the committee.

It is assumed that the government contribution to the planning and supervision in terms of manpower resources will be provided without cost to the Project and that the project staff work closely with them. The costs of materials and other expenses necessary for construction will form part of the project budget.

12.5.4 *Specific Actions*

Rural Roads

Compared to many areas in rural Myanmar, the project area has a relatively good rural road system. However, conditions of rural roads (unsealed) differ greatly within the project area. Roads on the right bank (Zone 4a) and lower left bank (Zone 4c) are in considerably better condition than those on the upper left bank (Zone 4b) due to terrain. The former areas are relatively flat and some of the roads are elevated with drainage whereas the hilly terrain on the left bank can severely limit access in the rainy season.

In terms of the level of upgrade, an assessment of construction cost versus maintenance costs has been undertaken with government authorities. The following choices were presented:

- Upgrade to gravel road (12 feet wide and 1 foot in depth) is approximately 100,000 USD per mile
- Upgrade to sealed asphalt road (12 feet wide and 1 foot in depth) is approximately 125,000 USD per mile;
- Upgrade to concrete road (12 feet wide and 1 foot in depth) is approximately 170,000 USD per mile.

The gravel road is the cheapest type but will require more maintenance. Thus the sealed asphalt road is the preferred option as the cost is 20% higher but the maintenance is considerably less. The option of concrete roads is considered too high for rural roads that are not heavily trafficked.

Main Project Access Road – Right Bank (Zone 1c)

The main road traversing the project area, National Road (NR) 41, joining the State Capital, Taunggyi, to Nawnghkio via Lawksawk is presently being upgraded by the government and due to be completed by 2020. This will result in a sealed, two-lane road (3.6m in width). The project will need to upgrade a section of this road from Nawnghkio to the project construction site to a width of 5.5m and capable of handling 60-tonne loads.

The costs for this road upgrade are covered in the technical contractor documents. However, there may be compensation payments despite the fact that the Right-of-Way is defined and ample enough for the expansion of the road (see 12.3.4).

The existing rural road from National Road 41 in the direction of Yae Twi Gyi will need to be upgraded to a project access road in sections and a new road will need to be constructed that bypasses the village and continues onto the dam site. Estimates of the compensation costs for infrastructure and land are provided in Section 12.3.4.

There may also be minor compensation costs related to the construction of the new bridge and possible new roads linking that to NR 41. It will only be possible to estimate this after a detailed design is completed. The section of the road from the upgrade stress of NR 41 to the bridge will remain in accordance with the planned government upgrade as this route will not be essential for the project except limited vehicular traffic.

Rural Roads Development – Right Bank (Zone 4a)

NR 41 runs parallel to the river on the right bank in Zone 4a. This is a paved road and facilities good market access for these villages along the road and in villages on each side. Rural roads to the villages are not paved but in reasonable condition with some simple structures and drainage due to the fact that most are raised above the surrounding fields. In the wet season, some of these roads become muddy but villagers are still able to use the roads throughout the year.

The government presently has no immediate plans for upgrading village rural roads on the right bank. The Department of Border Affairs and National Races in Taunggyi indicated that this was not a prioritized area but was aware that the present conditions were not satisfactory as the roads were often damaged during the wet season and by heavy loads

The upgrade of these rural roads are not connected to the project schedule but linked indirectly to the upgrade of National Road 41 to which these roads would be linked. However, as a benefit sharing measure it is proposed that the following roads are assessed and upgraded:

- NR 41 to the village of Naungcho Gyi (approximately 12 km or 7.5 miles) via several other village sites;
- NR 41 to Naung Lin, Yae Maung Tan, Meh Poke and Naung Cho Kone (approximately 15 km or 9.5 miles).

The estimated costs for sealed surface (asphalt) amounts to 125 000 USD x 17 miles = 2.125 million USD. Additional costs of culverts and other features will likely bring the cost to 2.5 million USD.

In terms of schedule, it is proposed that these roads be considered first as they will be to villages closest to project activities in terms of traffic and reservoir impacts. It may be possible to start the work on one part of the road in the preconstruction phase in order to indicate to stakeholders, both local government and villagers, the intensions of the project.

Rural Roads Development – Upper Left Bank (Zone 4b)

The rural road leading from NR 41 to the villages of Thar Si and Pin Ping is in very poor condition as the road passes through steep terrain with gullies and streams. Sections of the road are virtually impassable during the wet season and have deep ruts due to heavy traffic. The first 5km would require considerable repair and possible realignment. These roads are presently not part of any government plans and no survey has been undertaken for these sections.

The upgrade of these rural roads are not connected to the project schedule but linked indirectly to the upgrade of National Road 41 to which these roads would be linked. The National Road 41 upgrade probably needs to be finished before rural roads can be upgraded.

This bank of the river is presently under the nominal control of the Shan State Army South and any work along this route would have to follow an agreement between the SSAS and the government in terms of security.

The road areas that are proposed for assessment and upgrade include:

- NR 41 to the village of Thar Si (approximately 10 km or 6 miles) but the first 5 km will require considerable work with culverts and drainage due to the steep terrain and present very poor condition of the route.
- From Thar Si to Pin Ping (approximately 10 km or 6 miles) – the terrain is flatter here with little need of culverts

The estimated costs for sealed surface (asphalt) amounts to 125,000 USD x 12 miles = 1.5 million USD, while additional costs of culverts and other features will likely bring the cost to 1.8 million USD.

In terms of schedule, it is proposed that these roads be considered second as they will provide access to villages near to project activities on the left bank but not affected by traffic or construction activities.

Rural Roads Development – Lower Left Bank (Zone 4c)

National Road 41 is presently being upgraded from Nawnghkio to Lawksawk and the existing state of this route is fair to good. One rural road leads from Kyauk Ku town to the villages of Tawng Hkan and Hpet Yin Kone, which are closest to the project area south of the dam site. The road is not paved but in reasonable condition with some simple structures and drainage. Although the road is not connected to the project schedule, it is proposed to upgrade them as a benefit sharing measure. The section that is proposed for upgrade and improvement starts at Kyauk Ku on Road NR 41 and runs to the village of Hpet Yin Kone via Tawng Hkan (approximately 12 km or 7.5 miles). There are many other villages in the area which will be able to benefit from this upgraded section of the road.

The estimated costs for sealed surface (asphalt) amounts to 125,000 USD x 7.5 miles = 940 000 USD. Additional costs of culverts and other features will likely bring the cost to 1 million USD.

In terms of schedule, it is proposed that these roads be considered third as they will provide access to villages on the left bank that are not directly affected by traffic or construction activities.

Contracting Arrangements

Most government departments have staff that not only work on design and supervision but also full-time work crews for construction, repair and maintenance. These are local mobile work teams who draw a salary from the government departments to which they are attached. Hence, work forces are already available and the Project will need to coordinate with government as to availability in relation to ongoing programs and activities. This will determine the schedule unless companies are hired in addition to these work forces.

A government tendering process is used for acquiring construction materials. There are lists of qualified companies and a selection process. This process will need to be vetted so that it is completely transparent and compliant with SN Power and IFC standards for selecting contractors.

The government has qualified design teams and can provide detailed technical documents after surveying the different routes. The Company will need qualified engineers, either staff or consultants, to check the designs, bills of qualities and selection of suppliers.

Right-of-Way and Compensation

There are different Right-of-Way (RoW) measurements for different road standards. Although these standards are defined there is evidence, especially in villages and built up areas, of encroachment into the RoW since in rural areas this is not always enforced systematically. Much will depend on the road alignment and avoiding structures but it is likely that some structures will need to be removed and relocated or new structures built so that there is no loss of physical structures.

A detailed assessment will be required after the draft road alignment is studied and options are presented. Only detailed planning will reveal whether there are compensation issues to be address in the road upgrades. Any expenses in this regard should be covered by contingency funds for CDI activities.

Rural Electrification

All villagers in the project direct and indirect impact areas mentioned rural electrification during consultations. There were strong opinions in terms of expectations since it was understood that a hydropower investment would increase electricity production for the country and be located adjacent to areas without electricity at present. Except for a few micro-hydro schemes that run when water is available and a limited number of solar panels, there are presently only small tractor driven generator sets that provides villages in the project area with electricity. People also use car batteries for televisions.

Villages in this area are not a priority and are category 'C', as the government is putting its resources into main lines along road corridors and not primarily extensions into rural areas.

The government agencies have provided estimates of the cost of establishing rural lines based on ongoing rates and prices and approximations in USD:

- 11kV transmission line 1 mile = 23.7 million Kyats (17,500 USD);
- 11kV/400V transformer for 100 Household = 11.5 Million Kyats (8,500 USD);
- 400V distribution line 1 mile = 33.1 million Kyats (24,500 USD);
- Connection fee per household of 250 USD.

These costs have been used for estimating budgets for the rural electrification initiatives.

Rural Electrification – Lower Left Bank (Zone 4c)

None of the villages off the main road (NR 41) have access to electricity but there is evidence that the government is planning or has been planning to install electricity as some concrete poles were observed along the road into Hpet Yin Kone. No solar or micro-hydro plants were observed in this area.

The project will consider electrification of two villages with a total estimated population of 1,257 people divided on 277 households. Further extension of the line on this bank would also be possible but this would be for settlements outside the project impacted area and would be covered by the government or part of project assistance during operation. The two villages considered for electrification are

- Tawng Hkan
- Hpet Yin Kone

The transmission line along NR 41 will facilitate this extension of the grid to villages in the lower left bank (Zone 4c). Hence, this work could commence first before other lines are in place that would facilitate extension of the grid to other rural areas.

It is difficult to estimate costs as the extent of project support will be based on the overall scope of rural electrification assistance and support, and approval of government plans and surveys. However, the following costs have been used as a basis for arriving at a tentative total cost for the electrification of these two villages:

- 11kV line for ca. 7.5 miles: 131 000 USD;
- At least 4 substation facilities: 36,000 USD (depends on the village population);
- 400V line in villages (approximately 6 miles): 147,000.

Total cost for Phase 1 would be approximately 314,000 USD

<u>Rural Electrification – Right Bank (Zone 4a)</u>

The urban area of Nawnghkio has a grid connection which provides it with a relatively stable electricity supply. From Nawnghkio there is a line 11 kV line that goes to the military facilities on the Right Bank. There is evidence of some solar panels for domestic use and small units for charging mobile phones and two mini-hydro plants that work intermittently for providing electricity to temples and community buildings. People also use car batteries for televisions.

It will be necessary to see if there are any synergies between the project needs and electricity supply to the site along NR 41 corridor which could reduce the cost of providing costs.

The project will consider electrification of the following villages:

- Ma Gyi Yae and village along the road;
- Nawnghkio Gyi and villages along that route (Hpar Thun, Nyang Taw and Nawng Lin (1));
- Nawng Lin (2), Yae Maung Tan, Meh Poke and Nawnghkio Kone;
- Yae Twi Gyi.

A transmission line (government or project) needs to be in place along the access road south of Nawnghkio in order to facilitate further extension of the grid to villages along the right bank of the project. The timing of when this rural electrification work can commence will depend on the demands for electricity by the project during construction and how these may be accommodated in relation to rural electrification.

It is difficult to estimate costs as the extent of project support will be based on the overall scope of rural electrification assistance and support, and approval of government plans and surveys. It is expected that the electrification of villages will be done in four different phases so that the construction costs will be spread out over time.

Phase 1: Yae Twin Gyi should be electrified first as it is the village closest to the construction area. Other villages (Met Hlut, Loi Pang, Taung Gyi and Ah Nauk Kone) along this route may also be included. The following cost estimates have been applied to arrive at a tentative cost for village electrification in Phase 1:

- Line from NR 41 to Yae Twin Gyi approximately 4 miles: 70,000 USD;
- 10 substations: 85,000 USD;
- 400V line in villages (approximately 6 miles): 147,000.

Based on these figure the total cost for Phase 1 would be approximately 302,000 USD

Phase 2 In this phase villages in the upper parts of Zone 4a will be connected to the grid from the town of Nawnghkio. The following cost estimates have been applied to arrive at a tentative cost for village electrification in Phase 2:

- Line from Nawnghkio to Nawnghkio Gyi and villages along that route (Hpar Thun, Nyang Taw and Nawng Lin (1) – approximately 10 km or 7 miles: 122,500 USD;
- 8 substations: 68,000 USD;
- 400V line in villages (approximately 8 miles): 196,000 USD.

Based on these figures the total cost for Phase 2 would be approximately 386,500 USD.

Phase 3 Electrification in phase 3 will cover villages in the upper parts of Zone 4a, the next group along a rural road leading to the edge of the Plateau. The following cost components have been assumed:

- Line Nawng Lin (2), Yae Maung Tan, Meh Poke and Nawnghkio Kone – approximately 15 km or 9.5 miles: 162 250 USD;
- 8 substations: 68,000 USD;
- 400V line in villages (approximately 8 miles): 196,000 USD.

Total cost for Phase 3 would be approximately 430,250 USD

Phase 4 Phase 4 will consist of one village along the road to the bridge in Zone 4a. The following cost components have been assumed:

- Yae Twi Gyi – approximately 4 miles: 70 000 USD
- 2 substations: 17,000 USD
- 400V line in villages (approximately 2 miles): 49,000 USD

Total cost for Phase 4 would be approximately 136,000 USD

Rural Electrification – Upper Left Bank (Zone 4b)

There are a few houses in this zone that utilize small solar panels and batteries for specific needs, like charging mobile phones or televisions. Electrification of this zone is presently not part of any government plans and no survey has been undertaken for these villages. In addition, this zone is nominally under the control of the Restoration Council for the Shan State (RCSS) which limits government development initiatives in the area.

The Project could consider electrification of Thar Si and Pin Ping which together have a population of around 3000 people. Further extension of the line on this bank would also be possible but this would be for settlements outside the project impacted area and be the responsibility of the government.

Discussions with technical teams from the government proposed that the most cost-effective means of extending the grid to these villages would be to link up with a 11kV line on the right bank rather than construct a new line along the existing track. The following conditions need to be in place before such an extension can be supported by the project:

- Identify the best location for the 11kV line on the right bank near the villages of Nawnghkio Gyi or Nawng Lin for a possible crossing. This will depend on surveys and the best location where a line can be continued over the river to the upper left bank;
- Since this bank of the river is presently under the nominal control of the RCSS, any work would have to follow an agreement between this organization and the government in terms of security;

The estimated costs of constructing an 11kV line to villages in Zone 4b and distribution system within the villages have been calculated as follows:

- 11kV line for ca. 10 km: 175,000 USD;
- Additional high towers for river crossing: 0.5 million USD;
- 4 substation facilities: 50,000 USD;
- 400V line in villages (approximately 3 miles): 61,500 USD.

The total cost for electrification of Thar Si and Pin Ping has been estimated at approximately 786,500 USD

12.5.5 Other Interventions

In the village consultations improved water supply has been suggested as one possible community development intervention in addition to road improvement and electrification. Today the project area villages are in general relying on mainly surface water sources and poorly protected shallow wells for their water supply. This lack of clean water supply is along with poor sanitation facilities part of the reason for a relatively high incidence of that diarrhoea in the villages.

The Project will through further consultations and discussions with local authorities consider funding improvement of water supply in targeted villages with poor water supply facilities in order to improve health conditions and to lessen the work burden, in particular for women and children who normally are those in the household responsible for fetching water.

As improving only the water supply probably will be insufficient for improving health conditions in villages the Project will also consider improvement of sanitation facilities such as latrines to be implemented alongside the water supply.

If improved water supply and sanitation facilities are prioritised as desirable community interventions by local authorities and communities, more detailed plans will be developed and costed before a final decision regarding these possible community interventions are taken. A total amount of 200 000 USD has been stipulated for investments in water supply and for the whole 6 year construction period.

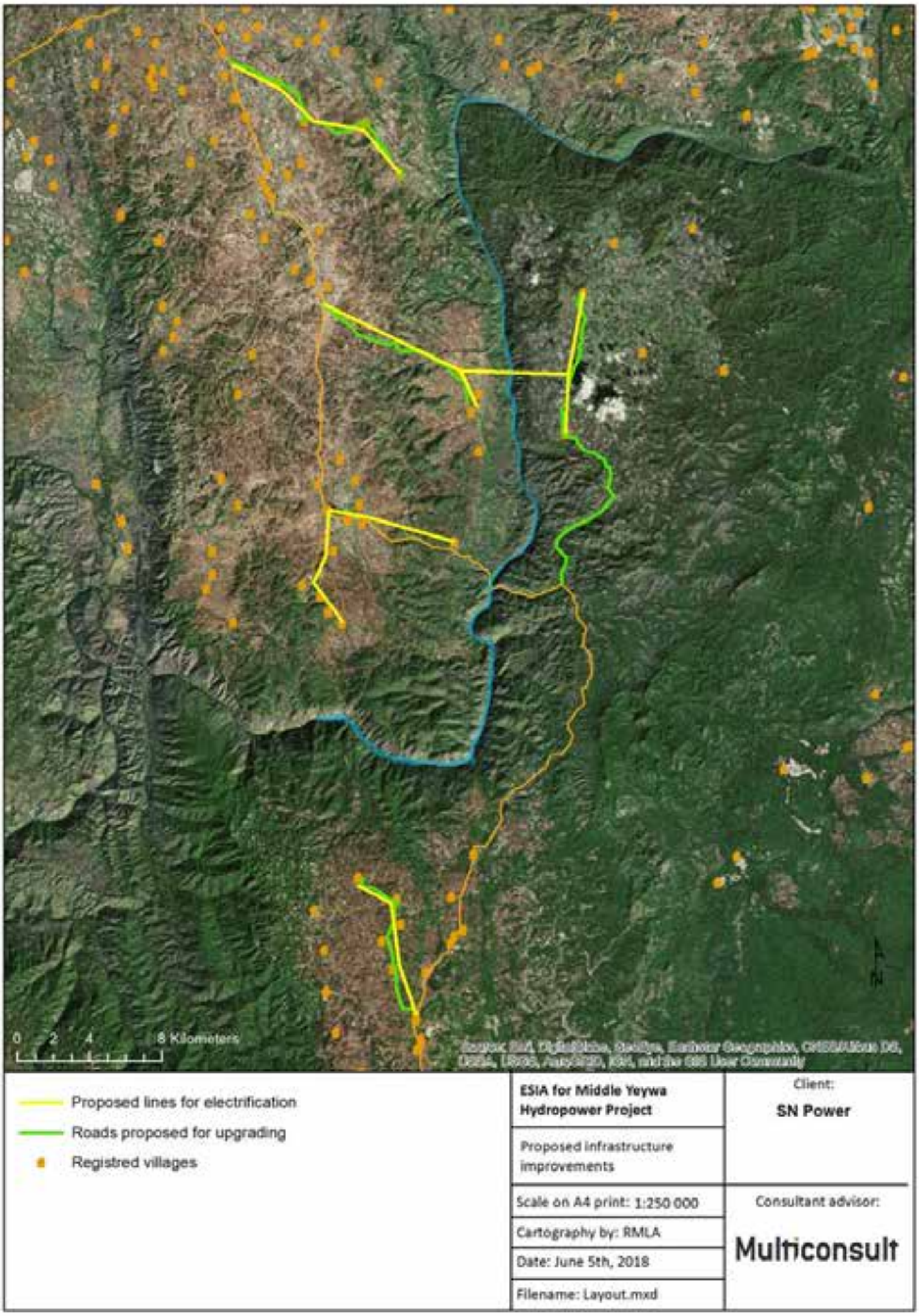

Figure 12-4: Proposed villages road improvement and transmission lines for village electrification

12.5.6 Budget and Schedule

The total Community Development Initiative budget will amount to 8 305 250 USD. The breakdown per year and type of initiative is shown in the table below.

Table 12-1: Community Development Initiative Budget

No	Item	Zone	Pre-constr	Construction Phase						Total
			Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	
1	NR 41 to the village of Naungcho Gyi Road Upgrade	4a	200 000	800 000	200 000					1 200 000
2	NR 41 to Naung Lin, Yae Maung Tan, Meh Poke and Naung Cho Kone Road	4a		300 000	1 000 000					1 300 000
3	NR 41 to the village of Thazi Road	4b			200 000	800 000				1 000 000
4	From Thazi to Bin Bine Road	4b				200 000	600 000			800 000
5	NR 41 at Kyawk Ku to the village of Hpet Yin Kone via Tawng Hkan Road	4c					200 000	800 000		1 000 000
6	Kyawk Ku to the village of Hpet Yin Kone via Tawng Hkan electrification	4c	100 000	214 000						314 000
7	Ma Gyi Yae and villages along the road - electrification	4a		302 000						302 000
8	Nawnghkio Gyi via Hpar Thun, Nyang Taw and Nawng Lin villages electr.	4a			386 500					386 500
9	Nawng Lin (2), Yae Maung Tan, Meh Poke and Nawnghkio Kone electr.	4a			430 250					430 250
10	Yae Twi Gyi village electrification	4a				136 000				136 000
11	Thazi and Bin Bine electrification	4b				786 500				786 500
12	Additional support for electrification of villages near project impact areas						100 000	100 000	100 000	300 000
13	Water Supply and other possible interventions (to be identified)			20 000	40 000	40 000	40 000	40 000	20 000	200 000
14	Assistance for Road Maintenance						50 000	50 000	50 000	150 000
	Total budget for Community Development Initiatives	Na	**300 000**	**1 636 000**	**2 256 750**	**1 962 500**	**990 000**	**990 000**	**170 000**	**8 305 250**

12.6 Workforce Recruitment and Employment

12.6.1 Overall Goals and Objectives

The overall goal of the workforce recruitment strategy is to ensure that the local population benefit from the employment opportunities created by the Middle Yeywa HPP. As is the case with most hydropower in developing economies, populations in project impacted areas indicated a keen interest in obtaining work during the construction phase. There are a number of opportunities and challenges regarding using local labour. The advantages include providing income directly to local communities, improving skills and long-term opportunities for workers through work experience, reducing the size of work camps and impacts on the local communities, possible reduction of costs for the developer and contractors, and obtaining support from local communities during the construction phase.

However, there are some challenges as well. Contractors often prefer to use trusted and tried workers and can be reluctant to use local labour that are often concerned with other tasks, such as labour requirements during harvesting or taking days off for local festivals and events. Contractors are also often unwilling to use resources to train new workers.

In addition, the project area is relatively prosperous in terms of income levels due to investments in cash crops, market access and relatively good infrastructure and services. The expectations for salaries could be higher than what contractors are willing to pay given that there would be workers available from previous projects at potentially lower rates.

12.6.2 Roles and Responsibilities

The contactors will have the direct responsibility for selecting and recruiting workers of the different categories that they will need. However, SNP will retain the overall responsibility for following up on the recruitment process to ensure that the requirements with regard to hiring national and local workers, specified in the tender documents and in the concession agreement between SNP and the Government, are fully complied with.

12.6.3 Staffing and Organisational Aspects

The Environmental and Social Unit will be responsible for following up the workers recruitment process by the contractors and the sub-contractors. The requirement to preferably recruit local workers shall be specified in the tender documents. The Social Management and Consultation Team will cooperate closely with Nawnghkio Township government authorities and village authorities when it comes to planning and implementation of specific activities. The Social Management and Consultation Team will also monitor the number of local workers hired by the contactors and will facilitate the recruitment as needed by acting as a link between the local villages and contractors.

12.6.4 Specific Activities

Tender Documents

Clauses in the contractor Tender Documents will stipulate that contractors should give preference to local labour over labour from outside the region for similar work. It is proposed that the contactor shall be required to recruit at least 30% of the total workforce locally. Measures will be taken to ensure that labour recruitment is carried out in a fair and transparent manner by contractors and the Company. It will necessary for the Project to work closely with local authorities and villages in facilitating local employment using the following methods:

- Compiling lists of skilled and semi-skilled village and local able-bodied workers with local leaders in the direct impacted areas near the construction site, along the reservoir and along the access roads;
- Provide these lists to contractors prior to mobilisation and monitoring the contractors' local recruitment;
- Consider establishing a recruitment centre with local authorities to ensure an orderly recruitment process;
- Keep statistics on the number of local workers and establish a target level with contractors.

Training and Skills Development

Discussions have been held with the Department of Border Affairs and Development of National Races in Taunggyi in order to obtain information on government training programs carried out by the Human Resource Unit of this department. The unit has regular programs covering teacher training, vocational training (carpentry, masonry and rebar work), and these are implemented by mobile training teams in cooperation with technical colleges. The Project will through the ESU engage with this unit to explore possibilities arranging training courses for local people so that they can acquire skills and qualify them for work on the Project. Training that can enable local people to become suppliers of produce and services will also be considered.

The following programs will be considered for local communities in the vicinity of the project:

- English language skills;
- Carpentry;
- Brick laying;
- Rebar work;
- Agricultural production techniques for food product (vegetable cultivation);
- Processing of local agricultural products, (fruit based snacks etc.).

12.6.5 Budget and Schedule

Cost in connection with workforce recruitment and employment will be covered by the contractors under their construction contact budgets. For covering expenses and allowances for local authorities in connection organising and monitoring the recruitment of local labourers, an annual budget of 5 000 USD per year for the pre-construction phase and the first three years of the construction phase has been stipulated.

For training and skills development a lump sum of 10 000 USD for the same period has been stipulated

12.7 Occupational Health and Safety

12.7.1 Overall Goals and Objectives

The overall goal of the occupational health and safety (OHS) measures to be put in place is to safeguard the health of the workers and to prevent accidents leading to injuries. However, if accidents do occur, the objective is to make sure that routines for providing lifesaving first-aid and stabilisation of the injured workers are in place.

12.7.2 Roles and Responsibilities

SNP will have the overall responsibility for providing necessary medical treatment facilities and ambulance services at the construction site. In addition, SNP will be responsible for monitoring the OHS performance of the contactors, making sure that they comply with all OHS requirements in their contracts as well as national legal OHS requirements.

The contactors will have the responsibility for training all workers in work safety routines and provide them with the necessary personal protection equipment (PPE).

12.7.3 Staffing and Organisational Aspects

An OHS Unit will be established within the project organisation and adequately staffed with OHS specialists and inspectors so that regular inspections can be made at all job sites. The OHS Unit will not be a part of the ESU but the two units will cooperate and coordinate as needed, for instance in connection with issues concerning handling of hazardous waste.

12.7.4 Specific Activities

Occupational Health and Safety Planning by Contactors

The contractors will be required to submit an Occupational Health and Safety (OHS) plan which as a minimum has the following content:

- Description of the their overall OHS policy and its goals;
- Description of potential hazards and risks to workers' safety and health arising from each working site environment;
- Identification of sources of injury and harm that can be eliminated by preventive and/or protective measures;
- Identification of risks that cannot be completely eliminated but can be reduced by preventative measures.

Awareness and Training

In order to achieve the objectives defined in the OHS plan, the contractors should ensure that personnel on all levels in the organisation are aware of and participate in OHS activities.

The contractors shall be required to establish and maintain the necessary arrangements to ensure that all persons with OHS responsibilities at all levels are competent to perform their duties and responsibilities. The contractor shall also be required provide initial and refresher OHS training for all workers. The developer will establish a OHS unit to monitor and supervise the contractors in relation to compliance and standards. This unit will be part of the technical team but will be working closely in coordinating site inspection visits with the ESU and representatives of the contractor.

Incidents Reporting and Investigations

The contractor shall be required to identify, investigate, record and report all incidents including accidents, near misses, diseases, and environmental incidents. The findings and conclusions of every investigation shall be reported to the OHS Unit without delay. The contractor shall notify the Project Developer's HSE Unit and the Project Manger immediately when any accident occurs, whether on site or off site. Such initial notification may be verbal and shall be followed by a written comprehensive report within 24 hours of the incident.

Emergency Preparedness and Response

The contractor shall be required to establish and maintain emergency preparedness and response measures, including first-aid stations, fire-fighting equipment, trained personnel and an evacuation plan in case of emergencies and serious accidents.

The emergency preparedness and response plan shall describe how to provide rapid and effective countermeasures to contain and control incidents and to prevent or limit undesired consequences. The emergency preparedness and response plan shall outline the following:

- Notification and warning procedures, including coordination with the OHS Unit;
- Evacuation procedures;
- First-aid facilities and equipment;
- Procedures for rescue of people and treatment of the injured.

Training drills should include rescue, evacuation, first-aid, fire-fighting (use of different extinguishing agents and fire truck), communicating and use of communication equipment.

The contractor shall be required to produce accessible consultation sheets for review in case of emergency situations. These should have phone numbers for police, fire-fighters, hospital, site manager, etc.

Medical Screening

In order to facilitate placement decisions and early detection of occupational diseases, pre-placement and periodic medical screening of all workers is required. The medical check shall be performed by qualified medical personnel. The contractors shall keep health records of all their personnel.

Malaria and Disease Prevention

Special precautions shall be taken by the contractors at their own expense to keep the incidence of malaria and other diseases as low as possible. The contractor shall spray with approved insecticide the interiors of buildings on a regular basis. All pools of water and other likely mosquito breeding places within and adjacent to the works area shall either be eliminated or sprayed in an approved manner. The contractors shall provide mosquito nets to workers and prophylactic treatment for malaria.

Safety Equipment and Regulations

The contractor shall be required to provide proper safety equipment and draw up emergency regulations, including fire and electric shock prevention, stretchers and first-aid boxes, together with rescue facilities, as well as properly trained personnel to administer these.

Lifesaving vests and lifesaving rings shall be available at construction sites bordering the river and reservoir.

The contractor shall provide adequate training regarding justification for and use of safety equipment to all workers. The contractor shall make basic safety equipment available, and enforce use of such equipment during all working operations that may expose workers to occupational health hazards.

Minimum requirement to Personal Protective Equipment (PPE) for all personnel at site are:

- Protective helmet / hardhat;
- Protective footwear/safety boots;
- Appropriate work gloves;
- Working clothing with strong colours and wide reflecting bands;
- Safety goggles or over specs.

Additional PPE such as ear, eye and respiratory protection or fall protection, shall be provided when required to avoid occupational health incidents or illnesses as stipulated in regulatory requirements, and/or material safety data sheet.

The contractor shall provide hearing protection for all workers working around equipment or at locations with a noise level of 80 dB(A) or more (e.g. heavy equipment and drills, blasting activities). An appropriate instrument at site to measure noise levels shall be provided for this.

All workers handling hazardous materials shall be trained and provided with suitable PPE, including footwear, masks, protective clothing and goggles, emergency eyewash, and shower stations.

All restricted plant facilities shall be labelled with caution signs, especially those with potential risk for workers. Moreover, all construction areas shall be marked and fenced to avoid accident caused by unauthorised entry.

12.7.5 Budget and Schedule

The costs for OHS training for workers and provision of PPE will be borne by the contactors. The personnel and operational costs for OHS Unit is not part of the SMP budget but will be covered by other allocations under the budget for the project organisation.

12.8 Summary of SMP Budget

Table 12-2 below summarises the budget for the Social Management Plan for the Middle Yeywa HPP. The Community Development Initiatives is the largest cost item with 8,305,250 USD. The total SMP budget amounts to 8,938,750 USD.

It should be noted that the cost estimates can only be indicative at this stage of project development and may change considerably as the project planning progresses.

Table 12-2: Summary of the SMP Budget

No	Item	Pre-constr	Construction Phase						Total
		Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	
1	Stakeholder Management Plan	10 000	5 000	5 000	5 000	2 500	2 500	2 500	32 500
2	Compensation	167 000	167 000	137 000					471 000
3	Social Management for Construction Areas	15 000	45 000	20 000	20 000	10 000	10 000	10 000	130 000
4	Community Development Initiatives	300 000	1 636 000	2 256 750	1 962 500	990 000	990 000	170 000	8 305 250
Total Social Mangement Plan Budget		**492 000**	**1 853 000**	**2 418 750**	**1 987 500**	**1 002 500**	**1 002 500**	**182 500**	**8 938 750**

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