ရန်ကုန်တိုင်းဒေသကြီးအစိုးရအဖွဲ့

ရန်ကုန်မြို့တော်စည်ပင်သာယာရေးကော်မတီ

အင်ဂျင်နီယာဌာန(ရေစီးရေလာစီမံခန့်ခွဲမှု)

ရေစီးရေလာလုပ်ငန်းများ ကောင်းမွန်စေရန် ဆောင်ရွက်ခြင်း

အင်ဂျင်နီယာဌာန(ရေစီးရေလာစီမံခန့်ခွဲမှု)၏ ရည်မှန်းချက်

    ရန်ကုန်မြို့တော်စည်ပင်သာယာရေးကော်မတီ၊ အင်ဂျင်နီယာဌာန(ရေစီးရေလာစီမံခန့်ခွဲမှု)သည် ရန်ကုန် မြို့တွင်း ရေကြီးရေလျှံမှုလျှော့နည်းပပျောက်စေရေးနှင့် ရေစီးရေလာစနစ်များ စဉ်ဆက်မပြတ်ကောင်းမွန်စေရေး အတွက် ချောင်းကြီး၊ မြောင်းကြီးများ တူးဖော်ရှင်းလင်းခြင်း၊ ရေထုတ်ပြွန်များ ပြုပြင်တည်ဆောက်ခြင်း၊ မြစ်ထွက် ပေါက်ရေတံခါးများ အသစ်တပ်ဆင်ခြင်း၊ လမ်းဘေးရေမြောင်းများ ရှင်းလင်းခြင်း၊ ရေစီးရေလာအဆောက်အအုံများ ပြုပြင်ထိန်းသိမ်းခြင်း၊ စသည့်လုပ်ငန်းများကို စဉ်ဆက်မပြတ် ဆောင်ရွက်ပေးလျက်ရှိပါသည်။

ရန်ကုန်မြို့၏ ရေစီးရေလာစနစ်

ရန်ကုန်မြို့၏ ရေစီးရေလာစနစ်မှာ မြို့နယ်များအလိုက် ချောင်း၊ မြောင်း၊ မြစ်ထွက်ပေါက်များမှ တစ်ဆင့် မြစ်များ/ ပင်လယ်ဝများ အတွင်းသို့ စီးဆင်းခြင်းဖြစ်ရာ-

- လှိုင်သာယာ၊ ရွှေပြည်သာ၊ အင်းစိန်၊ မရမ်းကုန်း၊ လှိုင်၊ ကမာရွတ်၊ ကြည့်မြင်တိုင်၊ အလုံ၊ လမ်းမတော်မြို့နယ်များမှ လှိုင်မြစ်အတွင်းသို့ ချောင်းကြီး(၂၂)ချောင်းဖြင့်လည်းကောင်း၊

- ဒဂုံမြို့သစ်(ဆိပ်ကမ်း)မြို့နယ်မှ ပဲခူးမြစ်အတွင်းသို့ ချောင်းကြီး(၈)ချောင်းဖြင့်လည်းကောင်း၊

- တာမွေ၊ မင်္ဂလာတောင်ညွှန့်၊ ဒဂုံမြို့သစ်(မြောက်ပိုင်း)၊ ဒဂုံမြို့သစ်(တောင်ပိုင်း)၊ ဒဂုံမြို့သစ်(အရှေ့ပိုင်း)၊ မြောက် ဥက္ကလာပ၊ တောင်ဥက္ကလာပ၊ ရန်ကင်းမြို့နယ်များမှ ငမိုးရိပ်ချောင်းအတွင်းသို့ ချောင်းကြီး(၂၀)ချောင်းဖြင့် လည်း ကောင်း၊

- ပုဇွန်တောင်မြို့နယ်မှ ပုဇွန်တောင်ချောင်း အတွင်းသို့ ချောင်းကြီး(၁)ချောင်းဖြင့် လည်းကောင်း စီးဆင်းလျက်ရှိ ပါသည်။

ရန်ကုန်မြို့တွင်း(၈)မြို့နယ်ဖြစ်သော (ကြည့်မြင်တိုင်၊ အလုံ၊ လမ်းမတော်၊ လသာ၊ ပန်းဘဲတန်း၊ ကျောက် တံတား၊ ဗိုလ်တထောင်၊ ပုဇွန်တောင်)မှ သုံးစွဲရေများအား မြစ်ထွက်ပေါက်(၃၆)ခုနှင့် ချောင်း(၅)ချောင်းတို့ဖြင့် ရန်ကုန်မြစ်၊ လှိုင်မြစ် နှင့် ပုဇွန်တောင်ချောင်း အတွင်းသို့ စွန့်ထုတ်ပါသည်။

ရန်ကုန်မြို့တွင်းမှ လှိုင်မြစ်၊ ပဲခူးမြစ်၊ ပုဇွန်တောင်ချောင်းနှင့် ငမိုးရိပ်ချောင်းအတွင်းသို့ စီးဆင်းသော ချောင်းအရေအတွက်မှာ အောက်ပါအတိုင်းဖြစ်ပါသည်-

(က)   လှိုင်မြစ်သို့ ချောင်း   ၂၂ ချောင်း

(ခ)   ပုဇွန်တောင်ချောင်းသို့ ချောင်း   ၁ ချောင်း

(ဂ)   ငမိုးရိပ်ချောင်း သို့ ချောင်း   ၂၀ ချောင်း

(ဃ)   ပဲခူးမြစ်သို့ ချောင်း   ၈ ချောင်း

         စုစုပေါင်း   **၅၁ ချောင်း**
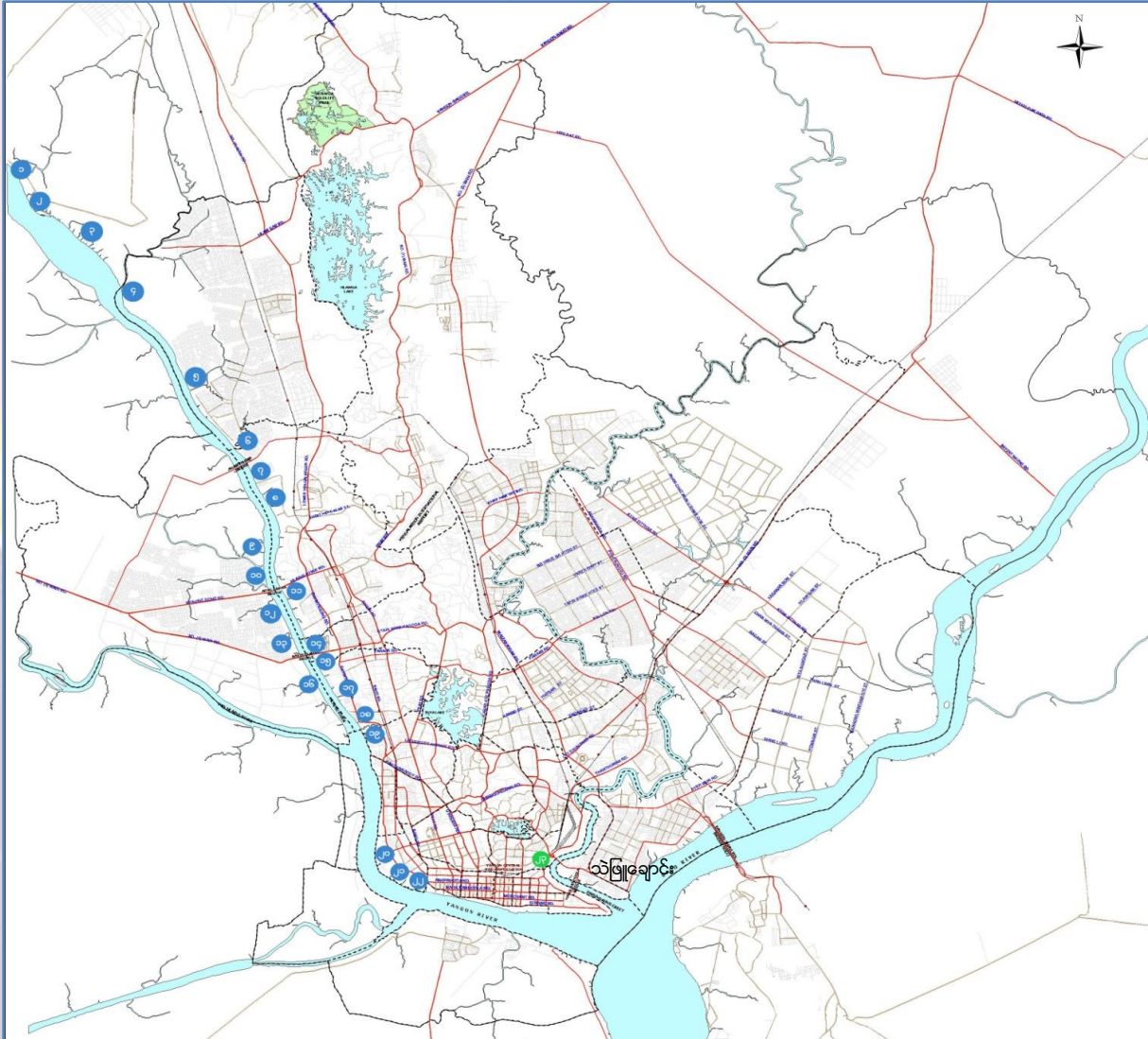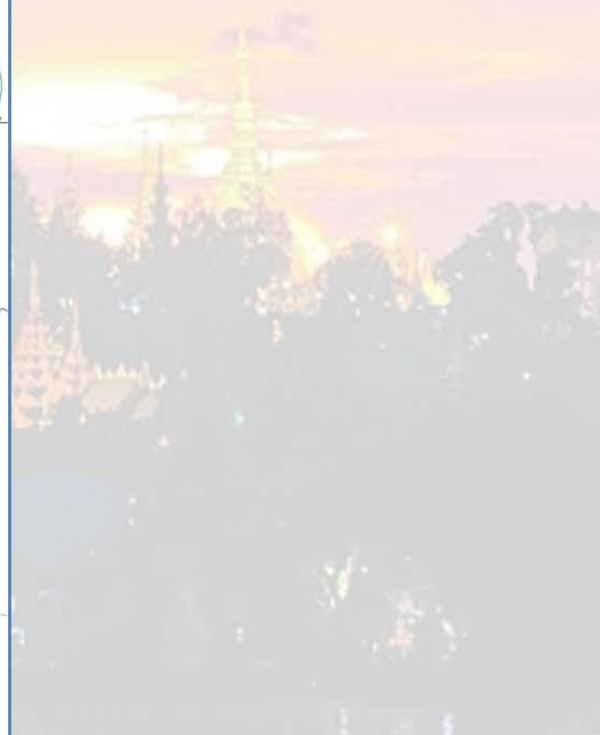
လှိုင်မြစ်အတွင်းသို့ စီးဝင်သော အဓိကချောင်းကြီး(၂၂) ချောင်း

အညွှန်း

၁ လိန်ကုန်းချောင်း
၂ သမင်တက်ရိုချောင်း
၃ တူးချောင်း
၄ ကျူချောင်း
၅ ဉ္ဇသတ်ရိုးချောင်း
၆ တံကူခြံချောင်း
၇ ရွှာမချောင်း
၈ ကသွယ်ချောင်း
၉ ရွှေလင်ပန်းချောင်း
၁၀ လှိုင်သာယာချောင်း
၁၁ ပေါက်တောချောင်း
၁၂ သာယာကုန်းချောင်း
၁၃ ရှမ်းချောင်း
၁၄ ရိုးကြီးချောင်း
၁၅ သမိုင်းချောင်း
၁၆ ညောင်ချောင်း
၁၇ ပိတောက်ချောင်း
၁၈ ချောင်းဝချောင်း
၁၉ ကမာရွတ်ချောင်း
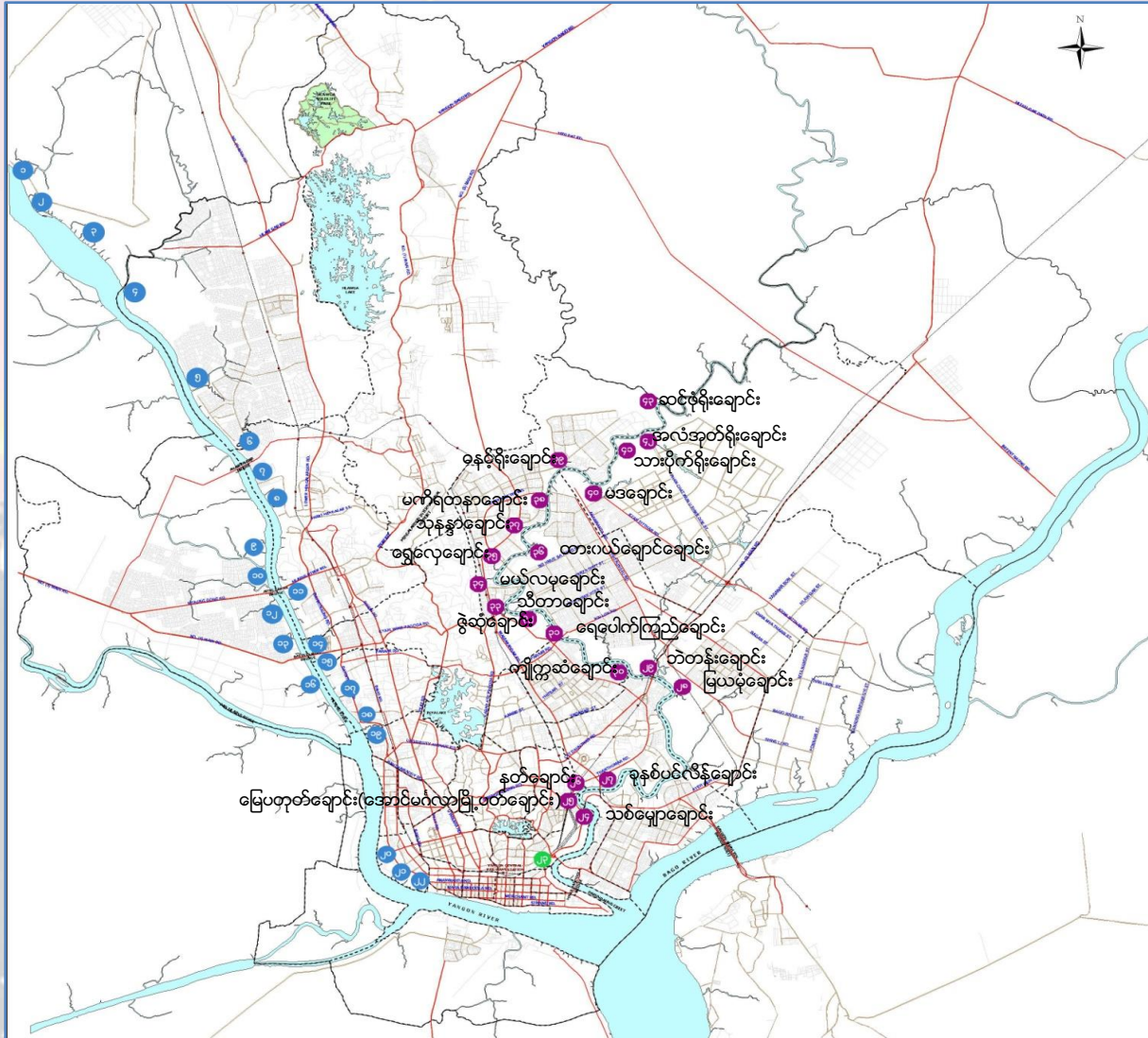၂၀ ကွင်းကျောင်းချောင်း
၂၁ သစ်မျှောချောင်း
၂၂ ရွာသစ်ချောင်း

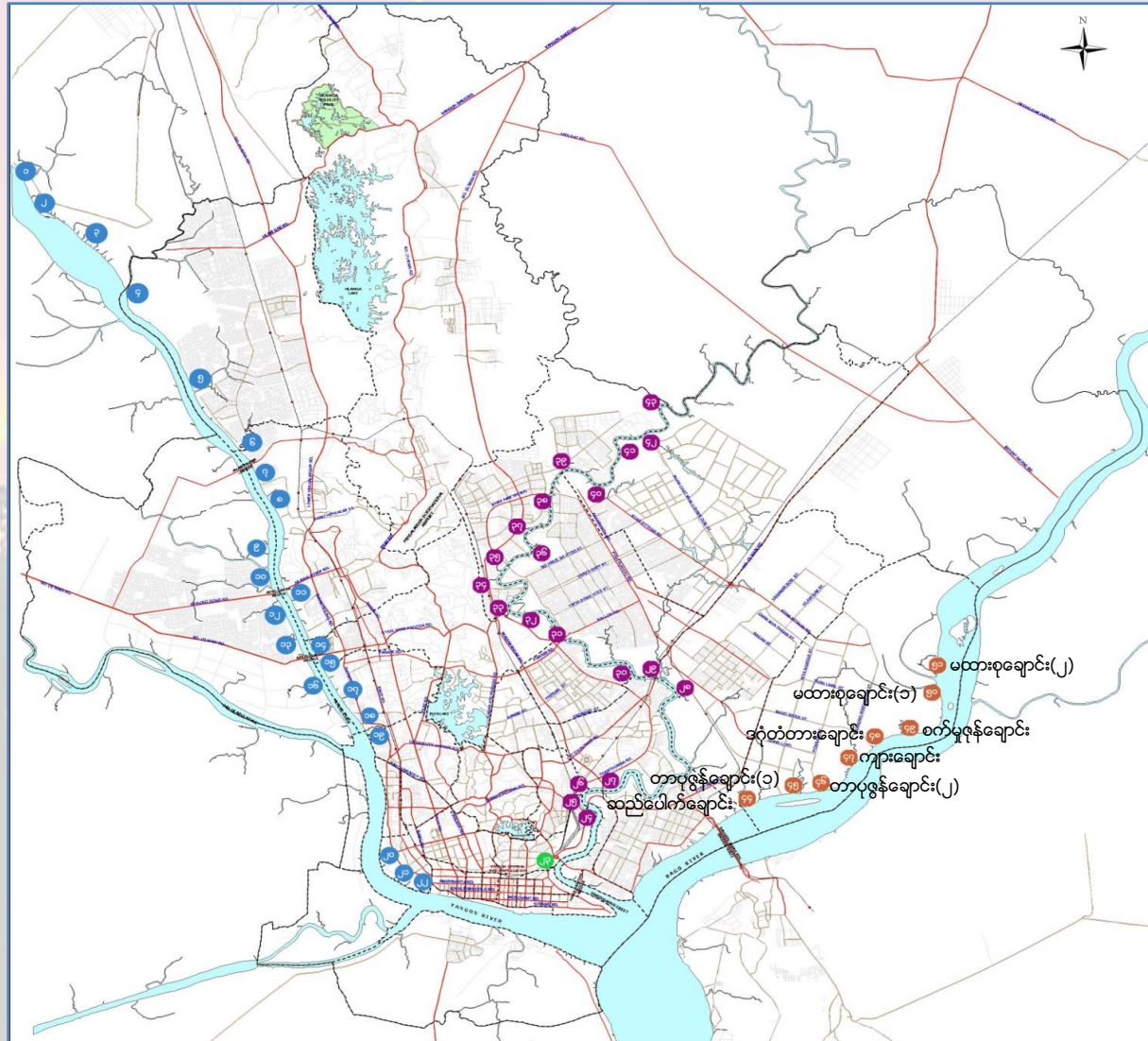ပုဇွန်တောင်ချောင်းအတွင်းသို့ စီးဝင်သည့် အဓိကချောင်းကြီး(၁)ချောင်း

ငမိုးရိပ်ချောင်းအတွင်းသို့ စီးဝင်သည့် အဓိကချောင်းကြီး(၂၀)ချောင်း

အညွှန်း

- ၂၄ သစ်မျှောချောင်း
- ၂၅ မြေပတုတ်ချောင်း
- ၂၆ နတ်ချောင်း
- ၂၇ ခုနစ်ပင်လိန်ချောင်း
- ၂၈ မြယမုံချောင်း
- ၂၉ ဘဲတန်းချောင်း
- ၃၀ ကျိုက္ကဆံချောင်း
- ၃၁ ရေပေါက်ကြည်ချောင်း
- ၃၂ ဖွဲဆုံချောင်း
- ၃၃ သီတာချောင်း
- ၃၄ မယ်လမုချောင်း
- ၃၅ ရွှေလှေ့ချောင်း
- ၃၆ ထားဝယ်ချောင်ချောင်း
- ၃၇ သုနန္ဒာချောင်း
- ၃၈ မဏိရတနာချောင်း
- ၃၉ ခနင်းရိုးချောင်း
- ၄၀ မဒချောင်း
- ၄၁ သားပိုက်ရိုးချောင်း
- ၄၂ အလံအုတ်ရိုးချောင်း
- ၄၃ ဆင်ဖုံရိုးချောင်း

ပဲခူးမြစ်အတွင်းသို့ စီးဝင်သည့် အဓိကချောင်းကြီး(၈)ချောင်း

အညွှန်း

- ၄၄ ဆည်ပေါက်ချောင်း
- ၄၅ တာပွန်ချောင်း(၁)
- ၄၆ တာပွန်ချောင်း(၂)
- ၄၇ ကျားချောင်း
- ၄၈ ဒဂုံတံတားချောင်း
- ၄၉ စက်မှုဇုန်ချောင်း
- ၅၀ မထားစုချောင်း(၁)
- ၅၁ မထားစုချောင်း(၂)

ရန်ကုန်မြစ်၊ လှိုင်မြစ်နှင့် ပုဇွန်တောင်ချောင်းများသို့ မြို့တွင်း(၈)မြို့နယ်မှ
စွန့်ထုတ်ပစ်သော ချောင်းနှင့်မြစ်ထွက်ပေါက်များ အခြေပြပုံ

မြစ်ထွက်ပေါက်ကျ(၃၆)ခု

၁။ ဟံသာဝတီလမ်းမြစ်ထွက်ပေါက်
၂။ ဗိုလ်စောပုလမ်းမြစ်ထွက်ပေါက်
၃။ နီဗွာန်လမ်းမြစ်ထွက်ပေါက်
၄။ နတ်စင်လမ်းမြစ်ထွက်ပေါက်
၅။ ရွှေလှိုင်လမ်းမြစ်ထွက်ပေါက်
၆။ ကျောင်းကြီးလမ်းမြစ်ထွက်ပေါက်
၇။ ဘားကရာလမ်းမြစ်ထွက်ပေါက်
၈။ တောလမ်းမြစ်ထွက်ပေါက်
၉။ ပန်းလှိုင်လမ်းမြစ်ထွက်ပေါက်
၁၀။ ပုလဲနှင့်ငါးမြစ်ထွက်ပေါက်
၁၁။ ဝါးတန်းလမ်းမြစ်ထွက်ပေါက်
၁၂။ လမ်းသစ်လမ်းမြစ်ထွက်ပေါက်
၁၃။ ဘုန်းကြီးလမ်းမြစ်ထွက်ပေါက်
၁၄။ လမ်းမတော်လမ်းမြစ်ထွက်ပေါက်
၁၅။ (၁၉)လမ်းမြစ်ထွက်ပေါက်
၁၆။ (၂၂)လမ်းမြစ်ထွက်ပေါက်
၁၇။ ရွှေတိဂုံဘုရားလမ်းမြစ်ထွက်ပေါက်
၁၈။ ရွှေဘုံသာလမ်းမြစ်ထွက်ပေါက်
၁၉။ ဆူးလေဘုရားလမ်းမြစ်ထွက်ပေါက်
၂၀။ မဟာဗန္ဓုလပန်းခြံလမ်းမြစ်ထွက်ပေါက်
၂၁။ ပန်းဆိုးတန်းလမ်းမြစ်ထွက်ပေါက်
၂၂။ နန်းသီတာမြစ်ထွက်ပေါက်
၂၃။ ဗိုလ်အောင်ကျော်လမ်းမြစ်ထွက်ပေါက်
၂၄။ သိမ်ဖြူလမ်းမြစ်ထွက်ပေါက်
၂၅။ ဗိုလ်မြတ်ထွန်းလမ်းမြစ်ထွက်ပေါက်
၂၆။ ဗိုလ်တထောင်ဘုရားလမ်းမြစ်ထွက်ပေါက်
၂၇။ ဗိုလ်တထောင်စျေးလမ်းမြစ်ထွက်ပေါက်
၂၈။ စန္ဒကူးလမ်းမြစ်ထွက်ပေါက်
၂၉။ မြနန္ဒာလမ်းမြစ်ထွက်ပေါက်
၃၀။ ရေဝန်လမ်းမြစ်ထွက်ပေါက်
၃၁။ ရေဆိုးသန့်စင်စက်ရုံမြစ်ထွက်ပေါက်
၃၂။ ရောမြိုင်လမ်းမြစ်ထွက်ပေါက်
၃၃။ ရေတပ်ပင်မစက်မှုလက်မှုတပ်မြစ်ထွက်ပေါက်
၃၄။ အောက်ပုဇွန်တောင်လမ်းမြစ်ထွက်ပေါက်
၃၅။ သီတာမြစ်ထွက်ပေါက်
၃၆။ ညောင်တန်းမြစ်ထွက်ပေါက်

ချောင်း(၅)ချောင်း

၁။ ကွင်ကျောင်းချောင်း
၂။ သစ်တောချောင်း
၃။ သစ်မျှောချောင်း
၄။ ရွာသစ်ချောင်း
၅။ သဲဖြူချောင်း

မြို့တွင်း(၈)မြို့နယ်၏ မြစ်ထွက်ပေါက်များ

ဟံသာဝတီလမ်းမြစ်ထွက်ပေါက်

ဗိုလ်စောပုလမ်းမြစ်ထွက်ပေါက်

နိဗ္ဗာန်လမ်းမြစ်ထွက်ပေါက်

နတ်စင်လမ်းမြစ်ထွက်ပေါက်

မြို့တွင်း(၈)မြို့နယ်၏ မြစ်ထွက်ပေါက်များ

ရွှေလှိုင်လမ်းမြစ်ထွက်ပေါက်

ကျောင်းကြီးလမ်းမြစ်ထွက်ပေါက်

ဗားဂရာလမ်းမြစ်ထွက်ပေါက်

တောလမ်းမြစ်ထွက်ပေါက်

မြို့တွင်း(၈)မြို့နယ်၏ မြစ်ထွက်ပေါက်များ

ပန်းလှိုင်လမ်းမြစ်ထွက်ပေါက်

ပုလဲနှင့်ငါးမြစ်ထွက်ပေါက်


ဝါးတန်းလမ်းမြစ်ထွက်ပေါက်

လမ်းသစ်လမ်းမြစ်ထွက်ပေါက်

အင်ဂျင်နီယာဌာန(ရေစီးရေလာစီမံခန့်ခွဲမှု)၏ လုပ်ငန်းတာဝန်များ

အင်ဂျင်နီယာဌာန(ရေစီးရေလာစီမံခန့်ခွဲမှု)၏ လုပ်ငန်းတာဝန်များမှာ အောက်ပါအတိုင်းဖြစ်ပါသည်-

(၁) ရန်ကုန်မြို့တော်စည်ပင်သာယာရေးကော်မတီပိုင် နယ်နိမိတ်အတွင်း ရေကြီးရေလျှံမှုလျော့ နည်းစေရန်နှင့် ချောင်းကြီး၊ မြောင်းကြီးများ၊ မြေအောက်ရေမြောင်းများနှင့် မြစ်ထွက်ပေါက်များတွင် ရေစီးရေလာ တိုးတက်ကောင်းမွန်စေရန် စဉ်ဆက်မပြတ် ထိန်းသိမ်းဆောင်ရွက်ခြင်း။

(၂) ကော်မတီနှင့် ဌာနမှပေးအပ်သော ရေစီးရေလာလုပ်ငန်းတာဝန်များအား အောင်မြင်ပြီးမြောက်စေရန် ကြပ်မတ် ဆောင်ရွက်ခြင်း။

(၃) ရေစီးရေလာလုပ်ငန်းများနှင့်ပတ်သက်၍ လိုအပ်သောလုပ်ငန်းစီမံကိန်းများရေးဆွဲခြင်း၊ ဒီဇိုင်းပုံထုတ်ခြင်း၊ ခန့်မှန်း တန်ဖိုးများ စိစစ်အတည်ပြုခြင်းနှင့် ရေစီးရေလာလုပ်ငန်းများနှင့်ပတ်သက်သော တည်ဆောက်ရေးလုပ်ငန်းများအား အကောင်အထည်ဖော် ဆောင်ရွက်ခြင်း။

(၄) ရေစီးရေလာလုပ်ငန်းများနှင့်ပတ်သက်၍ နိုင်ငံတကာမိတ်ဖက်အဖွဲ့အစည်းများ၊ ကော်မတီအောက်ရှိ အခြားသော ဌာနများ၊ အခြားသောဝန်ကြီးဌာနများ၊ ပုဂ္ဂလိကကုမ္ပဏီများနှင့်ပူးပေါင်းဆောင်ရွက်ရာတွင် ဦးစီးတာဝန်ယူဆောင်၍ အဆင်ပြေချောမွေ့စေရန် ပေါင်းစပ်ညှိနှိုင်း ဆောင်ရွက်ခြင်း။

(၅) ရေစီးရေလာလုပ်ငန်းများအတွက် ကော်မတီမှ လျာထားသတ်မှတ်သော အခွန်အခများ ပြည့်မီစွာရရှိရေးအတွက် ကြီးကြပ် ကွပ်ကဲခြင်း။

အင်ဂျင်နီယာဌာန(ရေစီးရေလာစီမံခန့်ခွဲမှု)၏ လုပ်ငန်းတာဝန်များ မှအဆက်

(၆)   ရေစီးရေလာလုပ်ငန်းများဆောင်ရွက်ရာတွင် ကော်မတီမှအတည်ပြုထားသောရန်ပုံငွေအား ထိရောက်စွာဆောင်ရွက်နိုင်
ရန် ကြီးကြပ်ကွပ်ကဲခြင်း။

(၇)   ရန်ကုန်မြို့တော်စည်ပင်သာယာရေးကော်မတီနယ်နိမိတ်အတွင်းရှိ ချောင်းကြီး၊ မြောင်းကြီးများအား နယ်နိမိတ် သတ်
မှတ်ဆောင်ရွက်ခြင်းနှင့် တည်ဆောက်ပြီး ရေစီးရေလာအဆောက်အအုံများအား ပြုပြင်ထိန်းသိမ်းခြင်း။

(၈)   ရေစီးရေလာလုပ်ငန်းများဆောင်ရွက်ရာတွင် အသုံးပြုရသော ကော်မတီပိုင် စက်ယန္တရားများနှင့် ပစ္စည်းများအား ပြုပြင်
ထိန်းသိမ်းခြင်းနှင့် စီမံခန့်ခွဲခြင်း။

(၉)   ရေစီးရေလာစီမံခန့်ခွဲမှုရှိ အရာထမ်း၊ အမှုထမ်းများအား လုပ်ငန်းတာဝန်များ စနစ်တကျ ခွဲဝေတာဝန်ပေးအပ်ခြင်းနှင့်
ဝန်ထမ်းသက်သာချောင်ချိရေးကို ဂရုပြုဆောင်ရွက်ပေးခြင်း။

(၁၀)   ကော်မတီမှ သီးခြားပေးအပ်သော တာဝန်များ ထမ်းဆောင်ခြင်း။
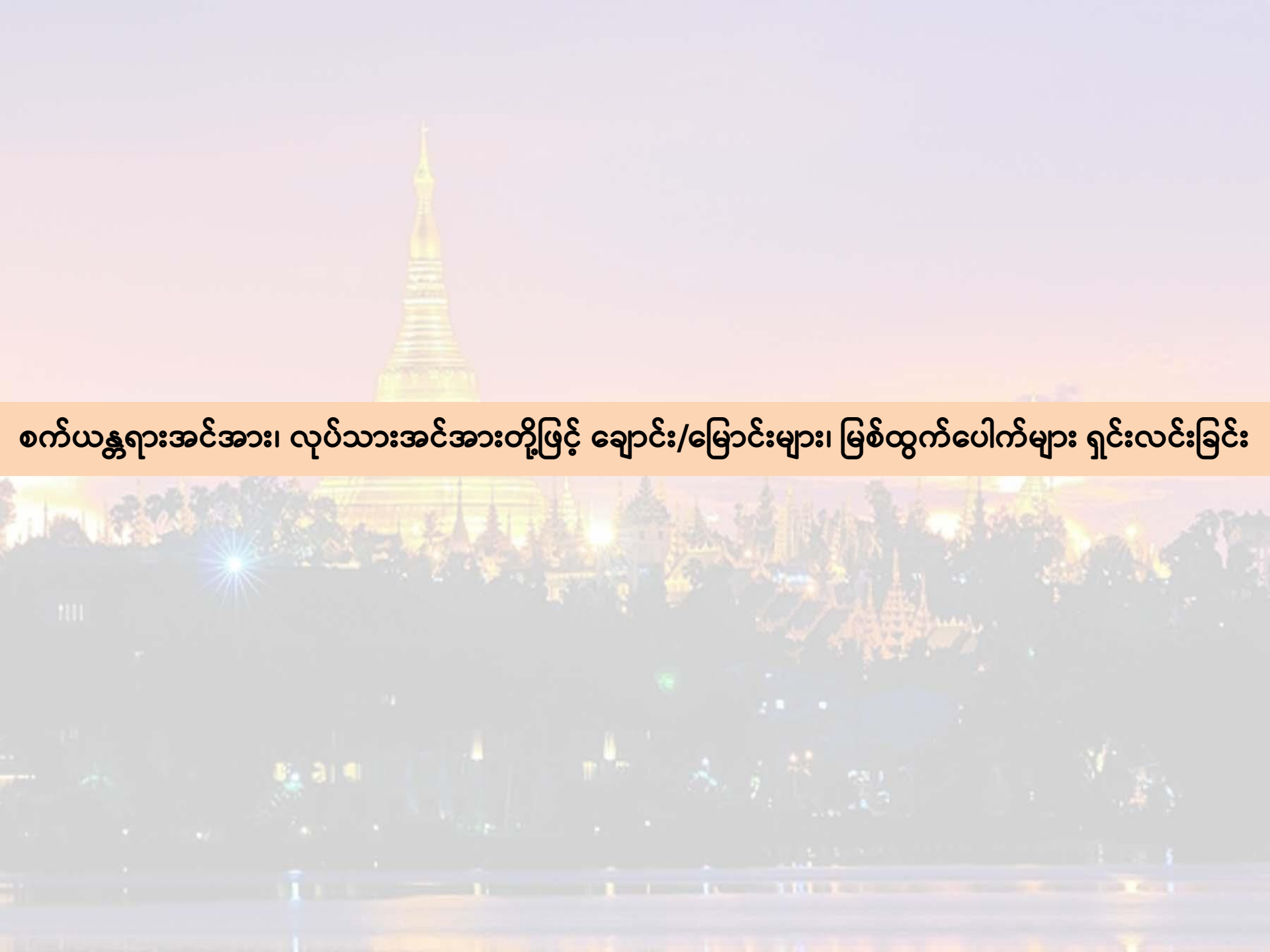
စက်ယန္တရားအင်အား၊ လုပ်သားအင်အားတို့ဖြင့် ချောင်း/မြောင်းများ၊ မြစ်ထွက်ပေါက်များ ရှင်းလင်းခြင်း

ရွှေပြည်သာမြို့နယ်၊ (၅)ရပ်ကွက်ရှိ ဉ္ဇသတ်ရိုးချောင်း ရှင်းလင်းခြင်း

ဆောင်ရွက်ဆဲ

ဆောင်ရွက်ပြီး

လှိုင်သာယာ(အရှေ့ပိုင်း)မြို့နယ်၊ ရန်ကုန်– ပုသိမ်လမ်း(ဗိုလ်အောင်ကျော်လမ်းနှင့် သောင်ကြားချောင်းကြား) ရေစုကန်ပြန်လည်တူးဖော်ခြင်း

ဆောင်ရွက်ဆဲ

ဆောင်ရွက်ပြီး

လှိုင်သာယာ(အနောက်ပိုင်း)မြို့နယ်၊ တွံတေးလမ်း(BOC အဝိုင်းနှင့် ပန်းလှိုင်တံတားကြား) ရေစုကန်ပြန်လည်တူးဖော်ခြင်း

ဆောင်ရွက်ဆဲ

ဆောင်ရွက်ပြီး

သာကေတမြို့နယ်၊ ၁/အနော်မာရပ်ကွက်၊ အမှတ်(၁၄) မြစ်ထွက်ပေါက် ရှင်းလင်းခြင်း

ဆောင်ရွက်ဆဲ

2021/05/04 09:42

ဆောင်ရွက်ပြီး

မဆောင်ရွက်မီ

ဆောင်ရွက်ပြီး

မြောက်ဥက္ကလာပမြို့နယ်၊ ရိုးလေးချောင်း ရှင်းလင်းခြင်း

ဆောင်ရွက်ဆဲ

ဆောင်ရွက်ပြီး

သာကေတမြို့နယ်၊ မင်းနန္ဒာလမ်း (အမှတ်–၁၄ မြစ်ထွက်ပေါက်ရေမြောင်း)ရှင်းလင်းခြင်း

ဆောင်ရွက်ဆဲ

ဆောင်ရွက်ပြီး

မင်္ဂလာတောင်ညွန့်မြို့နယ်၊ သစ်တောမြစ်ထွက်ပေါက် ရှင်းလင်းခြင်း

ဆောင်ရွက်ဆဲ

ဆောင်ရွက်ပြီး

ဒဂုံမြို့သစ်(မြောက်ပိုင်း)မြို့နယ်၊ အမှတ်(၄၁)တိုးချဲ့ရပ်ကွက်၊ ရာဇဓိရာဇ်မြောင်း ရှင်းလင်းခြင်း

ဆောင်ရွက်ဆဲ

ဆောင်ရွက်ပြီး

အလုံမြို့နယ်၊ သစ်တောရပ်ကွက်ရှိ ရန်ကုန်မြစ်အတွင်းသို့ စီးဝင်သော သစ်တောမြောင်းမကြီး(သစ်တောချောင်း) ရှင်းလင်းခြင်း

ဆောင်ရွက်ဆဲ

ဆောင်ရွက်ပြီး

ဒဂုံမြို့သစ်(မြောက်ပိုင်း)မြို့နယ်၊ အားကစားဥယျာဉ်စီမံကိန်းအတွင်းဖြတ်သန်းစီးဆင်းသည့်ဘဲတန်းချောင်း (မောင်းမကန်ကမ်းသာလမ်းနှင့် ပြည်ထောင်စုလမ်းကြား)ရေစီးရေလာကောင်းမွန်စေရေးဆောင်ရွက်ခြင်း

ဘဲတန်းချောင်း(ပြည်ထောင်စုလမ်းနှင့် မောင်းမကန်ကမ်းသာလမ်းကြား) ချောင်းဖြောင့်တူးဖော်မည့်ပုံစံ

N

0   100   200ft

30.0ft   30.0ft
30.0ft
3302.7ft

Bridge
Major Contour
Minor Contour
Road
Road
WATER PIPE
Building
hight Point
Bench Mark
Main Canal
Proposed Canal

မူလချောင်း
အရှည် ၈၂၉၀၀ ပေ အကျယ် ၈၂၀ ပေ
ဆောင်ရွက်ပြီးစီးသည့်ချောင်း
အရှည် ၈၂၃၀၀ ပေ အကျယ် ၈၅၀ ပေ

ဒဂုံမြို့သစ်(မြောက်ပိုင်း)မြို့နယ်၊ ဘဲတန်းချောင်း(မောင်းမကန်ကမ်းသာလမ်းနှင့် ပြည်ထောင်စုလမ်းကြား)
ရေစီးရေလာကောင်းမွန်စေရေးဆောင်ရွက်ခြင်း

ဒဂုံမြို့သစ်(မြောက်ပိုင်း)မြို့နယ်၊ ဘဲတန်းချောင်း(မောင်းမကန်ကမ်းသာလမ်းနှင့် ပြည်ထောင်စုလမ်းကြား)
ရေစီးရေလာကောင်းမွန်စေရေးဆောင်ရွက်ခြင်း

Flood Control Pump များတပ်ဆင်ခြင်း
မှတ်တမ်းဓါတ်ပုံများ

မိုးရာသီကာလ မိုးသည်းထန်စွာရွာသွန်းချိန်နှင့် ထူးကဲဒီရေတက်ချိန်တိုက်ဆိုင်သည့်အချိန်များတွင် ရေကြီးရေလျှံမှု မဖြစ်ပေါ်စေရေးအတွက် အောက်ဖော်ပြပါနေရာ(၉)ခုတွင် Flood Control Pump များ တပ်ဆင်ထားရှိပါသည်–

၁။ လမ်းမတော်မြို့နယ်၊ ရွှာသစ်ချောင်း ရေထိန်းတံခါး

၂။ လသာမြို့နယ်၊ (၂၂)လမ်းထိပ် အမှတ်(၆)ရေတံခါး

၃။ ပန်းဘဲတန်းမြို့နယ်၊ ရွှေတိဂုံဘုရားလမ်း မြစ်ထွက်ပေါက် ရေတံခါး

၄။ ကျောက်တံတားမြို့နယ်၊ ဆူးလေဘုရားလမ်းမြစ်ထွက်ပေါက် ရေတံခါး

၅။ ကျောက်တံတားမြို့နယ်၊ မြို့တော်ခန်းမရှေ့ ရေစုကန်

၆။ တာမွေမြို့နယ်၊ နတ်ချောင်းရေတံခါး

၇။ တာမွေမြို့နယ်၊ ခုနစ်ပင်လိန်ချောင်း ရေထိန်းတံခါး

၈။ တောင်ဥက္ကလာပမြို့နယ်၊ ကျိုက္ကဆံချောင်း ရေထိန်းတံခါး

၉။ တောင်ဥက္ကလာပမြို့နယ်၊ ရေပေါက်ကြည်ချောင်း ရေထိန်းတံခါး
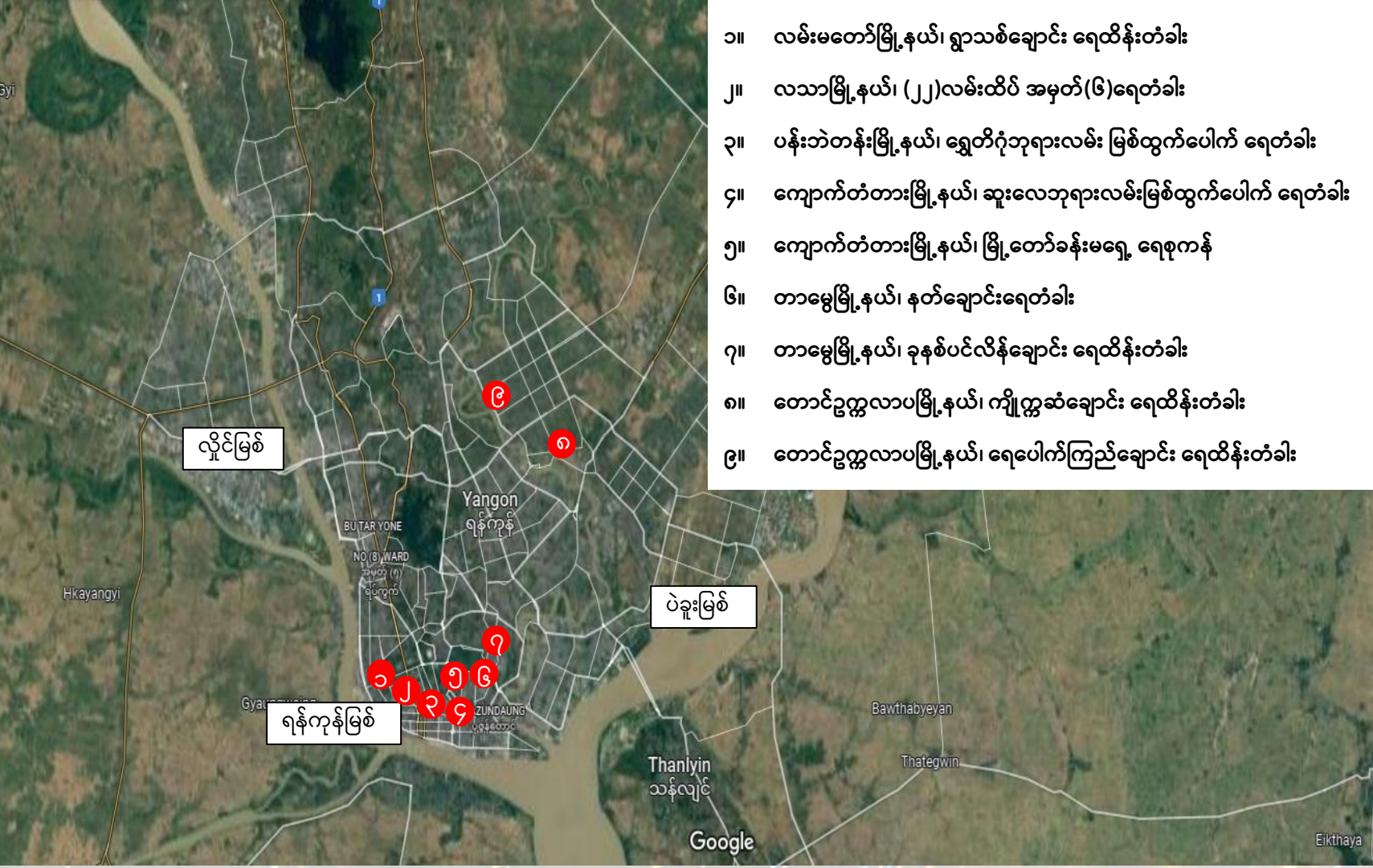
Flood Control Pump ဆိုင်ရာအချက်အလက်များ

စဉ်	မြို့နယ်	ရေတံခါးအမည်	Pump Capacity (gal/ hr)	Pump No.	Total Pump Capacity (gal/hr)	Engine Power kw (hp)	Inlet Pipe ∅ (in)	Outlet Pipe ∅ (in)	မှတ်ချက်
၁	လမ်းမတော်	ရွာသစ်ချောင်း	190000	1	190000	40 kw(60 hp)	12"	12"	
၂	လသာ	(၂၂)လမ်း	250000	1	250000	90 kw(125 hp)	16"	18"	HDPE DN 450(ပိုက် အပြင် Dia ၁၈ လက်မ) (မြေပေါ် ၂၀၄ မီတာ + မြေအောက် ၅၉ မီတာ) =စုစုပေါင်း ၂၆၃ မီတာ
၃	ပန်းဘဲတန်း	ရွှေတိဂုံဘုရားလမ်း	55000	1	55000	70 kw(98 hp)	6"	12"	
၄	ကျောက်တံတား	ဆူးလေဘုရားလမ်း	220000	1	220000	90 kw(125 hp)	14"	12"	
၅	ကျောက်တံတား	မြို့တော်ခန်းမရှေ့ရေစုကန်	26400	3	79200	2.2 kw(3 hp)	6"	6"	မီးစက်(၁)လုံး 16Kw/21.5 HP
၆	တာမွေ	နတ်ချောင်း	190000	1	190000	40 kw(60 hp)	12"	12"	
၇	တာမွေ	ခုနှစ်ပင်လိန်ချောင်း	330000	3	990000	40 kw(60 hp)	16"	16"	
၈	တောင်ဥက္ကလာပ	ကျိုက္ကဆံချောင်း	44000	3	132000	65.5 kw(98 hp)	6"	6"	
၉	တောင်ဥက္ကလာပ	ရေပေါက်ကြည်ချောင်း	44000	2	88000	65.5 kw(98 hp)	6"	6"	
	စုစုပေါင်း			16	2194200				

Yangon River Tide

	AM		PM	1 Nov Tue	2 Nov Wed	3 Nov Thu	4 Nov Fri	5 Nov Sat	6 Nov Sun
HIGH (+0630) ↑		6:52AM 5.68m		7:40PM 4.9m	7:59AM 5.19m / 9:20PM 4.63m	9:42AM 4.87m / 11:13PM 4.75m	11:27AM 4.92m	00:26AM 5.1m / 12:38PM 5.17m	1:15AM 5.5m / 1:29PM 5.45m	1:55AM 5.86m / 2:11PM 5.68m
LOW (+0630) ↓	1:17AM 2.08m		2:01PM 1.8m		2:18AM 2.5m / 3:11PM 2.14m	3:43AM 2.77m / 4:42PM 2.27m	5:28AM 2.7m / 6:10PM 2.1m	6:50AM 2.3m / 7:15PM 1.78m	7:47AM 1.82m / 8:04PM 1.48m	8:33AM 1.41m / 8:45PM 1.28m
Sun ▲▼		☀ 6:01AM	☀ 5:34PM		6:02AM 5:34PM	6:02AM 5:33PM	6:02AM 5:33PM	6:03AM 5:33PM	6:03AM 5:32PM	6:04AM 5:32PM
Moon Set Rise		⌒ 11:47AM	⌒ 11:08PM		◑ 00:11AM 12:42PM	1:11AM 1:31PM	2:09AM 2:15PM	3:03AM 2:55PM	3:57AM 3:33PM	4:10PM
Wind (km/h)	15	5	10	10	10	10	10	10	5	

၂၀၂၂ခုနှစ်၊ အောက်တိုဘာလ(လပြည့်)အတွက် ဒီရေနှင့်ရေတံခါး ပိတ်/ဖွင့်ချိန်ဇယား

ရက်စွဲ	ရေပြည့်ချိန်	ရေအနက် (မီတာ)	ရေတံခါး ပိတ်ချိန်	ရေတံခါး ဖွင့်ချိန်	မှတ်ချက်
၈.၁၀.၂၀၂၂ စနေ	၃း၁၈	၅.၆၃	၁း၁၈	၅း၁၈	
	၁၅း၂၄	၆.၀၄	၁၃း၂၄	၁၇း၂၄	
၉.၁၀.၂၀၂၂ တနင်္ဂနွေ	၃း၄၈	၆.၁၆	၁း၄၈	၅း၄၈	လပြည့်
	၁၅း၅၇	၆.၂၀	၁၃း၅၇	၁၇း၅၇	
၁၀.၁၀.၂၀၂၂ တနင်္လာ	၄း၁၆	၆.၃၁	၂း၁၆	၅း၁၆	
	၁၆း၂၉	၆.၂၂	၁၄း၂၉	၁၈း၂၉	
၁၁.၁၀.၂၀၂၂ အင်္ဂါ	၄း၄၅	၆.၃၃	၂း၄၅	၆း၄၅	
	၁၇း၀၄	၆.၁၄	၁၅း၀၄	၁၉း၀၄	
၁၂.၁၀.၂၀၂၂ ဗုဒ္ဓဟူး	၅း၁၈	၆.၂၇	၃း၁၈	၇း၁၈	
	၁၇း၄၀	၅.၆၆	၁၅း၄၀	၁၉း၄၀	
၁၃.၁၀.၂၀၂၂ ကြာသာပတေး	၅း၅၃	၆.၁၆	၃း၅၃	၇း၅၃	
	၁၈း၁၈	၅.၇၈	စောင့်ကြည့်		
၁၄.၁၀.၂၀၂၂ သောကြာ	၆း၃၀	၅.၆၈	၄း၃၀	၈း၃၀	
	၁၈း၅၆	၅.၅၁	စောင့်ကြည့်		

* မှတ်ချက်

(၁) ဒီရေဇယားသည် မူမှန်သော မိုးလေဝသအခြေနေတွင် တွက်ချက်ထားပြီး ထူးခြားသောမိုးလေဝသအခြေနေတွင် ပြောင်းလဲနိုင်ပါသည်။

(၂) ရေတံခါးပိတ်ချိန်မှာ (၄)နာရီခန့်ကြာသဖြင့် မိုးကြီးလျှင် ရေလျှံမှုဖြစ်ပေါ်နိုင်ပါသည်။
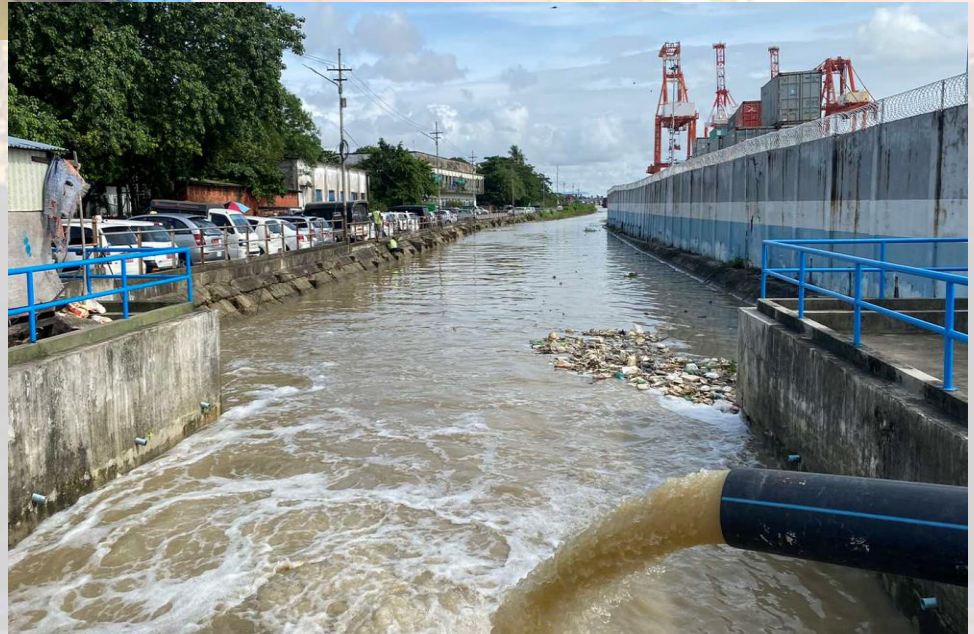
Pump အရေအတွက်– ၁ လုံး

ရေထွက်နှုန်း   – ၁၉၀,၀၀၀ ဂါလံ

ပါဝါ   – ၄၀ Kw, ၆၀ HP

ရေထွက်ပိုက်အရွယ် – Intel Pipe =၁၂ လက်မ

                            Outlet Pipe = ၁၂လက်မ

လသာမြို့နယ်၊ ကမ်းနားလမ်းနှင့် (၂၂)လမ်းထိပ် အမှတ်(၆)ရေတံခါးတွင် Flood Control Pump တပ်ဆင်ခြင်း

Pump အရေအတွက်– ၁ လုံး

ရေထွက်နှုန်း   – တစ်နာရီ ၁၁၄၁ ကုဗမီတာ (၂၅၀,၀၀၀ ဂါလံ)

ပါဝါ   – ၉၀ Kw, ၁၂၅ HP

ရေထွက်ပိုက်အရွယ် – Intel Pipe =၁၆ လက်မ

　　　　　　　　　　Outlet Pipe = ၁၈ လက်မ

ပိုက်အမျိုးအစား   – HDPE DN 450

ပိုက်အရှည်   – စုစုပေါင်း ၂၆၃ မီတာ

　　　　　　　　　　(မြေပေါ် ၂၀၄မီတာ + မြေအောက် ၅၉မီတာ)

Pump အရေအတွက်– ၁ လုံး

ရေထွက်နှုန်း   – ၂၂၀,၀၀၀ ဂါလံ

ပါဝါ   – ၉၀ Kw, ၆၀ HP

ရေထွက်ပိုက်အရွယ် – Intel Pipe =၁၄ လက်မ

Outlet Pipe = ၁၂လက်မ

Pump အရေအတွက်– ၁ လုံး

ရေထွက်နှုန်း   – ၅၅,၀၀၀ ဂါလံ

ပါဝါ   – ၇၀ Kw, ၉၈ HP

ရေထွက်ပိုက်အရွယ် – Intel Pipe = ၆ လက်မ

Outlet Pipe = ၁၂လက်မ

Pump အရေအတွက်– ၃လုံး

Pump အမျိုးအစား – Submersible

ရေထွက်နှုန်း   – ၂၆,၄၀၀ ဂါလံ x ၃

စုစုပေါင်း (၇၉,၂၀၀ ဂါလံ)

ပါဝါ   – ၂.၂ Kw, ၃ HP

ရေထွက်ပိုက်အရွယ် – Intel Pipe =၁၂ လက်မ

Outlet Pipe = ၁၂လက်မ

တာမွေမြို့နယ်၊ နတ်ချောင်းရေတံခါးတွင် Flood Control Pump ဖြင့်ရေများစုပ်ထုတ်ခြင်း

Pump အရေအတွက်– ၁ လုံး

ရေထွက်နှုန်း - ၁၉၀,၀၀၀ ဂါလံ

ပါဝါ - ၄၀ Kw, ၆၀ HP

ရေထွက်ပိုက်အရွယ် – Intel Pipe = ၁၂ လက်မ

Outlet Pipe = ၁၂ လက်မ

တာမွေမြို့နယ်၊ ခုနစ်ပင်လိန်ချောင်းရေတံခါးတွင် Flood Control Pump ဖြင့်ရေများစုပ်ထုတ်ခြင်း

Pump အရေအတွက်– ၃ လုံး

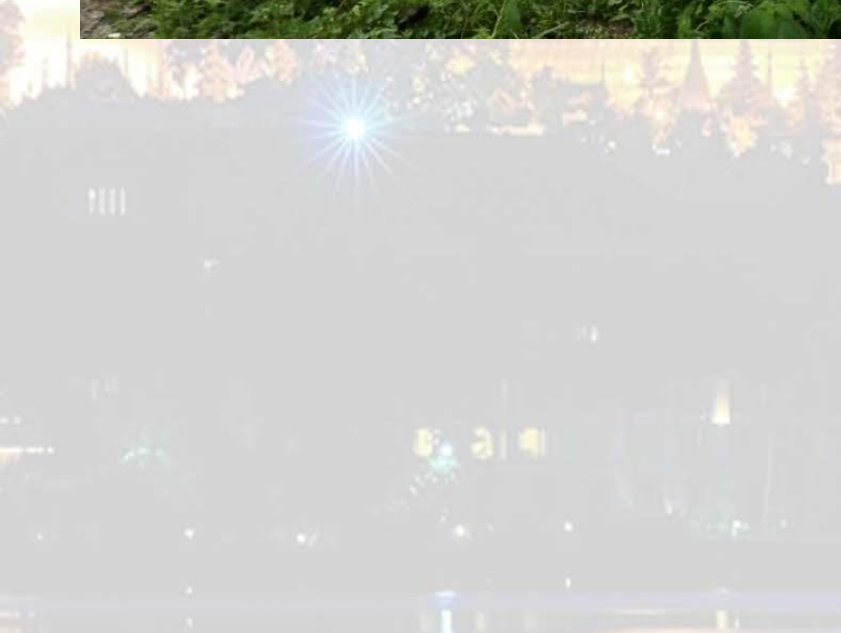ရေထွက်နှုန်း   – ၃၃၀,၀၀၀ ဂါလံ x ၃

                       စုစုပေါင်း (၉၉၀,၀၀၀ ဂါလံ)

ပါဝါ   – ၄၀ Kw, ၆၀ HP

ရေထွက်ပိုက်အရွယ် – Intel Pipe = ၁၆ လက်မ

                       Outlet Pipe = ၁၆ လက်မ

Pump အရေအတွက်– ၃ လုံး

ရေထွက်နှုန်း   - ၄၄,၀၀၀ ဂါလံ x ၃

                     စုစုပေါင်း (၁၃၂,၀၀၀ ဂါလံ)

ပါဝါ   - ၆၅.၅ Kw, ၉၈ HP

ရေထွက်ပိုက်အရွယ် – Intel Pipe = ၆ လက်မ

                   Outlet Pipe = ၆ လက်မ

Pump အရေအတွက်– ၂ လုံး

ရေထွက်နှုန်း　　　 – ၄၄,၀၀၀ ဂါလံ x ၂

　　　　　　　 စုစုပေါင်း (၈၈,၀၀၀ ဂါလံ)

ပါဝါ　　　　 – ၆၅.၅ Kw, ၉၈ HP

ရေထွက်ပိုက်အရွယ် – Intel Pipe = ၆ လက်မ

　　　　　 Outlet Pipe = ၆ လက်မ

ရေစီးရေလာအခြေခံအဆောက်အအုံများ တည်ဆောက်ခြင်း

ဗိုလ်တထောင်မြို့နယ်၊ ဗိုလ်မြတ်ထွန်း မြစ်ထွက်ပေါက် မြေထိန်းနံရံ ပြုလုပ်ခြင်း
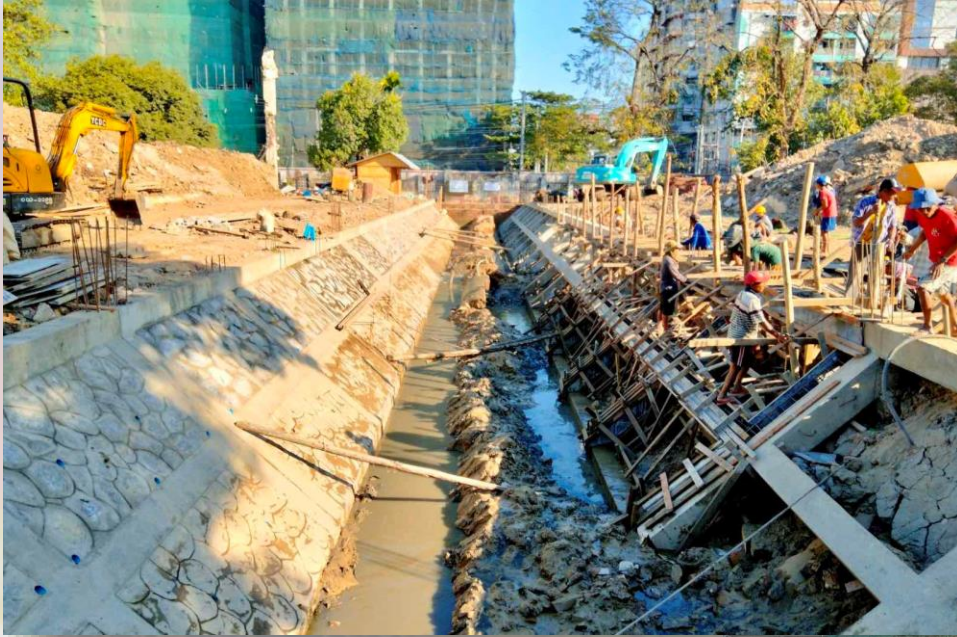

မဆောင်ရွက်မီ

ဆောင်ရွက်ဆဲ

ဗိုလ်တထောင်မြို့နယ်၊ ဗိုလ်မြတ်ထွန်း မြစ်ထွက်ပေါက် မြေထိန်းနံရံ ပြုလုပ်ခြင်း

ဆောင်ရွက်ဆဲ

ဆောင်ရွက်ပြီး

ဗိုလ်တထောင်မြို့နယ်၊ ကုန်သည်လမ်း မြန်မာ့မီးရထားဝင်းအတွင်းရှိ ဗိုလ်မြတ်ထွန်းလမ်း မြေအောက်ရေမြောင်း ပြုပြင်ခြင်း

မဆောင်ရွက်မီ

ဆောင်ရွက်ပြီး

ကျောက်တံတားမြို့နယ်၊ မြို့တော်ခန်းမရှေ့တွင် ဂါလံ(၁၀၀၀၀၀)ဆံ့ ရေစုကန် တည်ဆောက်ခြင်း

ဆောင်ရွက်ဆဲ

ဆောင်ရွက်ပြီး

ဒေါပုံမြို့နယ်၊ အလင်းရောင်မြစ်ထွက်ပေါက် မြေထိန်းနံရံ ပြုလုပ်ခြင်း

မဆောင်ရွက်မီ

ဆောင်ရွက်ပြီး

ရန်ကင်းမြို့နယ်၊ ဆည်မြောင်းချောင်း မြေထိန်းနံရံ ပြုလုပ်ခြင်း

မဆောင်ရွက်မီ

ဆောင်ရွက်ပြီး

တောင်ဥက္ကလာပမြို့နယ်၊ ရေပေါက်ကြည်ချောင်း ရေထိန်းတံခါး မြေထိန်းနံရံ ပြုလုပ်ခြင်း

မဆောင်ရွက်မီ

ဆောင်ရွက်ပြီး

လှိုင်မြို့နယ်၊ ပိတောက်ချောင်း မြေထိန်းနံရံ ပြုလုပ်ခြင်း

မဆောင်ရွက်မီ

ဆောင်ရွက်ပြီး

သာကေတမြို့နယ်၊ အမှတ်(၄) မြစ်ထွက်ပေါက် မြေထိန်းနံရံ ပြုလုပ်ခြင်း
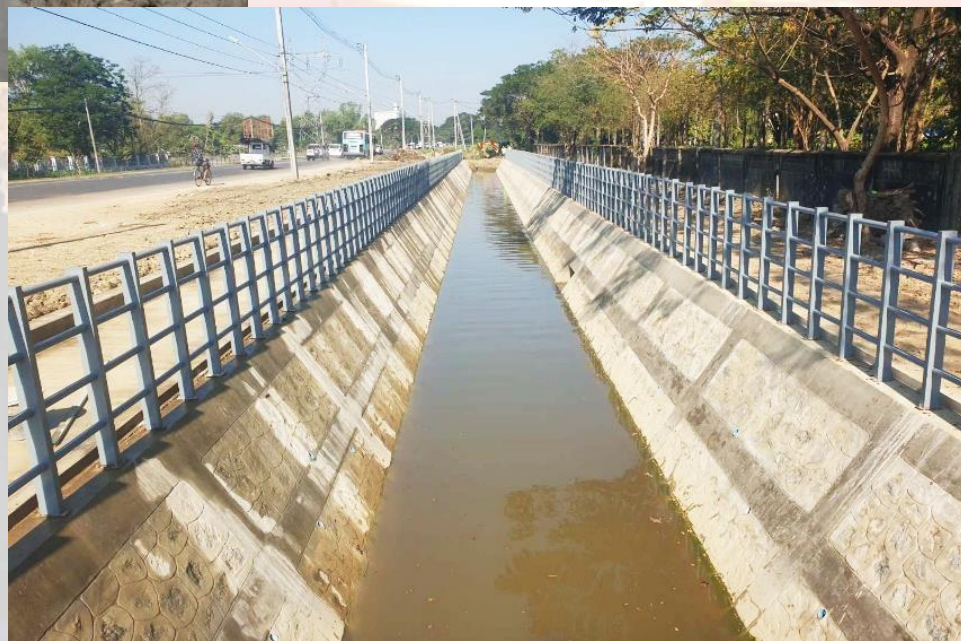

မဆောင်ရွက်မီ

ဆောင်ရွက်ပြီး

ဒဂုံမြို့သစ်(တောင်ပိုင်း)မြို့နယ်၊ ပြည်ထောင်စုလမ်း (အရှေ့ဖက်ခြမ်း) (ဆေးရုံရှေ့)ရေမြောင်း မြေထိန်းနံရံ ပြုလုပ်ခြင်း

မဆောင်ရွက်မီ

ဆောင်ရွက်ပြီး

တာမွေမြို့နယ်၊ မေတ္တာညွန့်ရပ်ကွက်၊ မီးရထားလမ်း(အရှေ့ဘက်ခြမ်း)၊ စက်မှု(၁)လမ်းဘေးရေမြောင်း မြေထိန်းနံရံပြုလုပ်ခြင်း

မဆောင်ရွက်မီ

ဆောင်ရွက်ပြီး

လှိုင်မြို့နယ်၊ ဘုရင့်နောင်လမ်း (စစ်ကြောရေးနှင့် တည်းခိုရေး စခန်းရှေ့) အုတ်ရေမြောင်း ပြုလုပ်ခြင်း

မဆောင်ရွက်မီ

ဆောင်ရွက်ပြီး

မရမ်းကုန်းမြို့နယ်၊ ပါရမီလမ်း(ခုပ်ဖူစားသောက်ဆိုင်အနီး) အင်းယားကန်အတွင်းသို့စီးဝင်သော ရေစစ်ကန် ပြုပြင်ခြင်း

မဆောင်ရွက်မီ

ဆောင်ရွက်ပြီး

ရေမြောင်းရှင်းလင်းမှု မှတ်တမ်းဓါတ်ပုံများ

ဆောင်ရွက်ဆဲ

ဆောင်ရွက်ပြီး

မင်္ဂလာဒုံမြို့နယ်၊ ကေရာဇ်ရပ်ကွက်၊ ဈေးလမ်းရေမြောင်း ရှင်းလင်းခြင်း

ဆောင်ရွက်ဆဲ

ဆောင်ရွက်ပြီး

ဆောင်ရွက်ဆဲ

ဆောင်ရွက်ပြီး

ပုဇွန်တောင်မြို့နယ်၊ (၅၂)လမ်း၊ အနော်ရထာလမ်းနှင့် မဟာဗန္ဓုလလမ်းကြား ရေမြောင်းရှင်းလင်းခြင်း

ဆောင်ရွက်ဆဲ
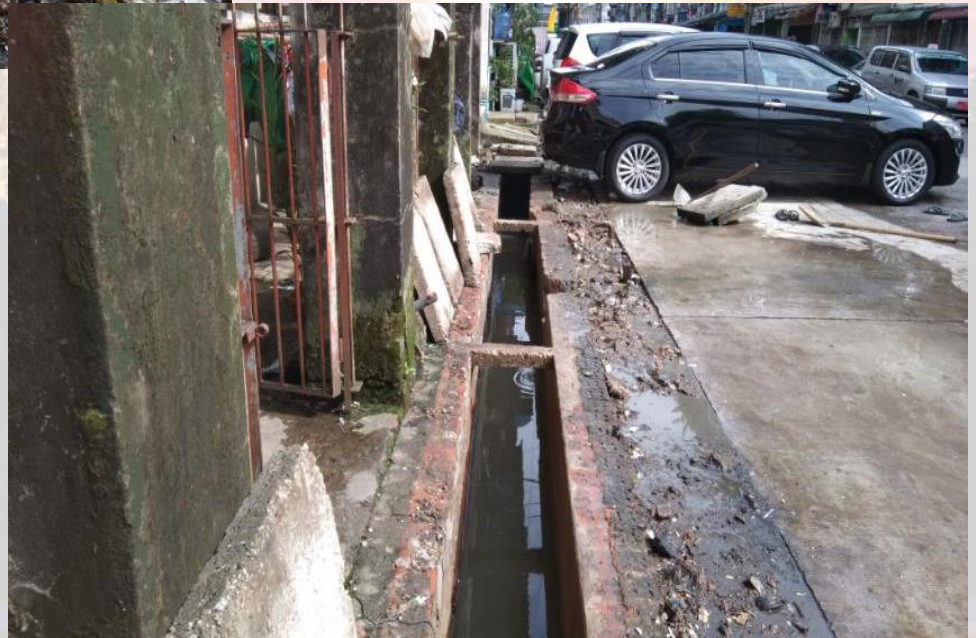
ဆောင်ရွက်ပြီး

မရမ်းကုန်းမြို့နယ်၊ ကျိုက်ပိုင်းဘုရားလမ်း (Terminal ဆီဆိုင်အနီး) ရေမြောင်းရှင်းလင်းခြင်း

ဆောင်ရွက်ဆဲ

ဆောင်ရွက်ပြီး

ဒဂုံမြို့သစ်(မြောက်ပိုင်း)မြို့နယ်၊ (၄၇)ရပ်ကွက်၊ ဗိုလ်မှူးဗထူးလမ်း ရေမြောင်းရှင်းလင်းခြင်း

မဆောင်ရွက်မီ

ဆောင်ရွက်ပြီး

ကျောက်တံတားမြို့နယ်၊ (ကမ်းနားလမ်း၊ ပန်းဆိုးတန်းလမ်းနှင့်ပန်းခြံလမ်းကြား) ရေမြောင်းရှင်းလင်းခြင်း

မဆောင်ရွက်မီ

ဆောင်ရွက်ပြီး

အလုံမြို့နယ်၊ ဆင်မင်းလမ်းနှင့် ကမ်းနားလမ်းထောင့် ရေမြောင်းရှင်းလင်းခြင်း

မဆောင်ရွက်မီ

ဆောင်ရွက်ပြီး

ရွှေပေါက်ကံမြို့နယ်၊ (၁၅)ရပ်ကွက်၊ ပင်းယလမ်း ရေမြောင်းရှင်းလင်းခြင်း

ဆောင်ရွက်ဆဲ

ဆောင်ရွက်ပြီး
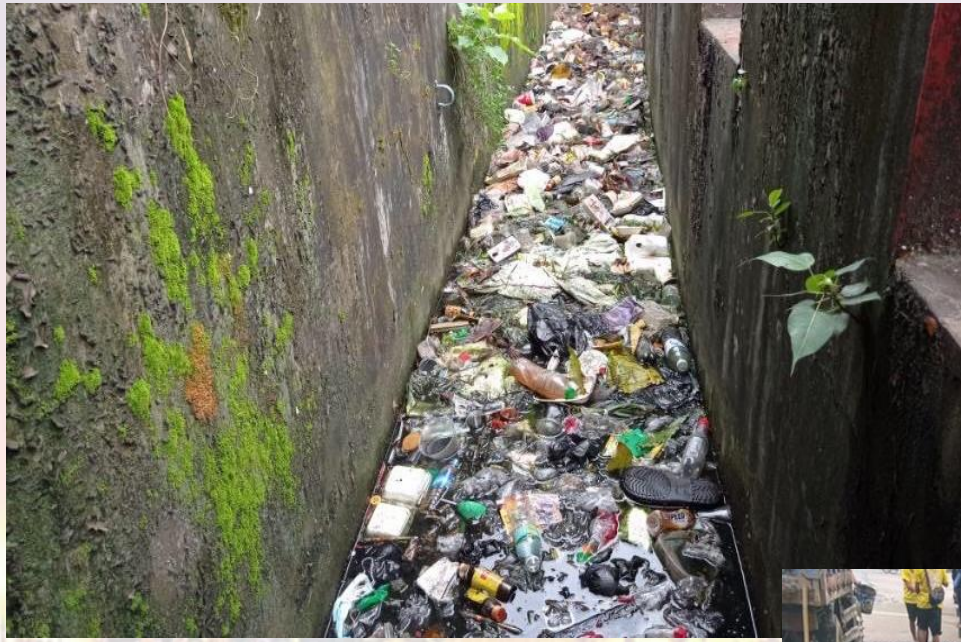
ဆောင်ရွက်ဆဲ

ဆောင်ရွက်ပြီး

ရန်ကုန်မြို့တော်စည်ပင်သာယာရေးဥပဒေ(၂၀၁၈)တွင်ပြဋ္ဌာန်းထားသော ရေစီးရေလာစီမံခန့်ခွဲမှုနှင့်သက်ဆိုင်သည့်ဥပဒေ

အခန်း(၁၈)။ ရေနုတ်မြောင်းများဖောက်လုပ်ခြင်း၊ ပြုပြင်ထိန်းသိမ်းခြင်း

ပုဒ်မ၁၄၅။ ကော်မတီသည် မြို့တော်နယ်နိမိတ်အတွင်းမှ ရေများကို စွန့်ထုတ်ရန်အတွက် အသုံးပြုသည့် မြေပေါ်မြေ အောက် ရေနုတ်မြောင်းများနှင့် ဆက်စပ်လုပ်ငန်းများကို တည်ဆောက်ခြင်း၊ ပြုပြင်ခြင်း၊ ထိန်းသိမ်းခြင်း၊ ကြီးကြပ်ခြင်း တို့ဆောင်ရွက်ရမည်။

ပုဒ်မ၁၄၆။ ကော်မတီသည် မည်သည့်စွန့်ပစ်ရေကိုမဆို မြစ်ချောင်းများအတွင်းသို့စွန့်ထုတ်ရာတွင် စနစ်တကျစီမံခန့်ခွဲ ဆောင်ရွက်ရမည်။

ပုဒ်မ၁၄၇။ ကော်မတီသည် မြို့တော်နယ်နိမိတ်အတွင်းရှိ ရေမြောင်းများ၊ ချောင်းများ၏ နယ်နိမိတ်များကို သတ်မှတ် ခြင်းနှင့် ထိန်းသိမ်းစီမံခန့်ခွဲခြင်းတို့ကို ဆောင်ရွက်ရမည်။ ထို့အပြင် ရေမြောင်းများကို တိုးချဲ့ခြင်း၊ ပြုပြင်ဆောင် ရွက်ခြင်း၊ တည်ဆောက်ခြင်း၊ ရေမြောင်းများပေါ်တွင် တံတားဆောက်လုပ်ခြင်း၊ ရေထုတ်ပြွန်နှင့်ရေမြောင်းများကို ရေစီးရေလာကောင်းမွန်စေရန် စီမံခြင်းတို့ကိုဆောင်ရွက်ရမည်။

ပုဒ်မ၁၄၈။ ကော်မတီသည် အသုံးပြုရန် မလိုအပ်သည့် ရေမြောင်းများ၊ ရေတွင်းများကို ဖြတ်တောက်ခြင်း၊ ပိတ်ဆို့ ခြင်း သို့မဟုတ် မြေဖို့ခြင်း ပြုနိုင်သည်။ ထို့အပြင် လိုအပ်ပါက အခြားရေနုတ်မြောင်း တစ်ခုကို အသုံးပြုခွင့်ရစေရန် စီမံဆောင်ရွက်ပေးရမည်။

ရေနုတ်မြောင်းများဖောက်လုပ်ခြင်း၊ ပြုပြင်ထိန်းသိမ်းခြင်း မှအဆက်

ပုဒ်မ၁၄၉။ ကော်မတီသည် လိုအပ်ပါက စွန့်ပစ်ရေများနှင့်ပတ်သက်၍ စီမံခန့်ခွဲခွင့်ရှိသည်။

ပုဒ်မ၅၀။ မြို့တော်နယ်နိမိတ်အတွင်းရှိ အဆောက်အဦနှင့် ခြံဝင်းများအတွင်းမှ မိုးရေများကို ကော်မတီပိုင်မြောင်းများ အတွင်းသို့ စနစ်တကျစွန့်ထုတ်စေရမည်။

ပုဒ်မ၅၁။ အဆောက်အအုံပိုင်ရှင် သို့မဟုတ် မြေပိုင်ရှင်တစ်ဦးဦးက မိမိပိုင်ရေမြောင်းကို ကော်မတီပိုင် ရေမြောင်းနှင့် ဆက်သွယ်ဖောက်လုပ်ရန် လိုအပ်ပါက ကော်မတီသို့ တင်ပြဆောင်ရွက်ရမည်။

ပုဒ်မ၅၂။ ကော်မတီသည် မြို့တော်နယ်နိမိတ်အတွင်း အဆောက်အအုံတစ်ခုထက်ပိုသော အဆောက်အအုံ အစုအဖွဲ့ ဆောက်လုပ်မည်ဆိုပါက သတ်မှတ်ထားသောစံချိန်စံညွှန်းအတိုင်း ရေနုတ်မြောင်းများဖောက်လုပ်ခြင်းကို သက်ဆိုင်ရာ အဆောက်အအုံပိုင်ရှင် သို့မဟုတ် အသုံးပြုသူများအား တာဝန်ယူဆောင်ရွက်ရန် ညွှန်ကြားရမည်။

ပုဒ်မ၅၃။ ကော်မတီသည် မြို့တော်နယ်နိမိတ်အတွင်း ဖောက်လုပ်ထားရှိသော ပုဂ္ဂလိကပိုင်ရေနုတ်မြောင်းအား အခြားပြည်သူများက အသုံးပြုလိုသဖြင့် မူလရေမြောင်းပိုင်ရှင်၏ သဘောတူညီချက်ဖြင့် တင်ပြလျှောက်ထားလာပါက စည်းကမ်းချက်များနှင့်အညီ ပူးတွဲ သုံးစွဲခွင့်ပြုနိုင်သည်။

ရေနုတ်မြောင်းများဖောက်လုပ်ခြင်း၊ ပြုပြင်ထိန်းသိမ်းခြင်း မှအဆက်

ပုဒ်မ၁၅၄။ ကော်မတီသည် မြို့တော်နယ်နိမိတ်အတွင်း ရေမြောင်းဖောက်လုပ်ခြင်း၊ လမ်းလွှဲခြင်း၊ ရေမြောင်း အသုံးပြု ခွင့်ပေးခြင်း၊ ပူးတွဲပိုင်ဆိုင်ခွင့်ပေးခြင်း၊ ရေမြောင်း အစိတ်အပိုင်းများ ပြုပြင်ထိန်းသိမ်းခြင်း၊ ရေမြောင်းများ ပိတ်ဆို့ခြင်း ကိုတားမြစ်ခြင်း၊ ရေစီးရေလာကောင်းမွန်ရေး ဆောင်ရွက်ခြင်းဆိုင်ရာ လိုက်နာရမည့် စည်းကမ်းများကို ထုတ်ပြန်ထား ရှိရမည်။

ပုဒ်မ၁၅၅။ ကော်မတီသည် မြို့တော်နယ်နိမိတ်အတွင်းရှိ ရေနုတ်မြောင်းများနှင့် မြစ်ချောင်းများအတွင်းသို့ အမှိုက်စွန့် ပစ်မှုမရှိစေရေး စစ်ဆေးခြင်း၊ ကြပ်မတ်ခြင်းနှင့် အရေးယူဆောင်ရွက်ခြင်းတို့ ပြုလုပ်ရမည်။
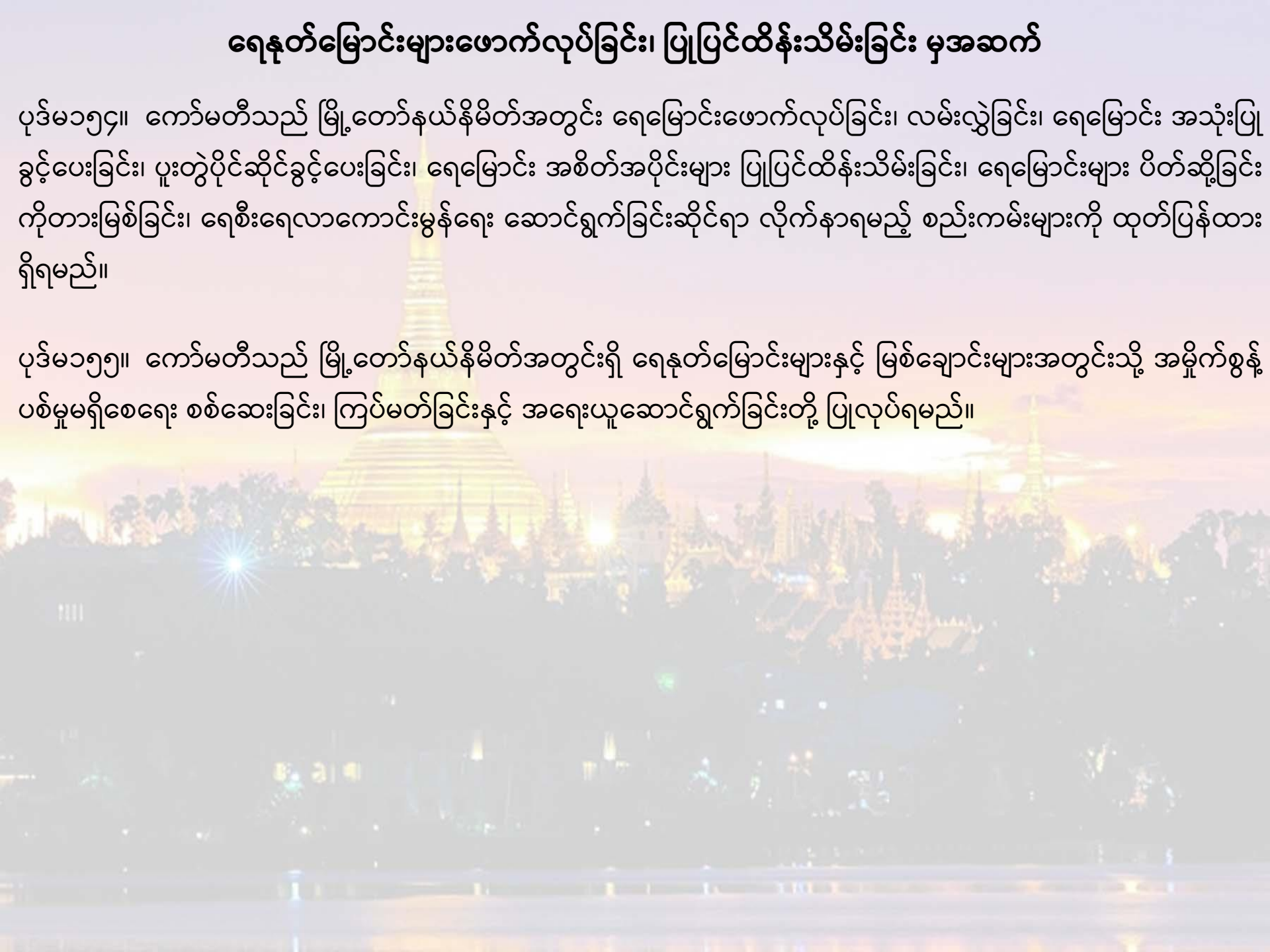
ရေနုတ်မြောင်းများဆိုင်ရာ ပြစ်မှုနှင့် ပြစ်ဒဏ်များ

စဉ်	ပုဒ်မ	ပုဒ်မခွဲ	ပြစ်မှု	ပြစ်ဒဏ်များ		မှတ်ချက်
				ပထမအကြိမ်ကျူးလွန်မှု	ဆက်လက်ကျူးလွန်မှု	
၈၃	၃၁၇	(က)	ကော်မတီ၏ ခွင့်ပြုချက်မရှိဘဲ မြို့တော်နယ်နိမိတ် အတွင်းရှိ သဘာဝမြစ်ချောင်း၊ မြစ်ထွက်ပေါက်ကိုဖြစ် စေ၊ ယင်း၏အစိတ်အပိုင်းကိုဖြစ်စေ၊ ရေမြောင်းကိုဖြစ် စေ၊ မြေအောက်ရေမြောင်းကိုဖြစ်စေ၊ သဘာဝရေစီး ကြောင်းကိုဖြစ်စေ တစ်နည်းနည်းဖြင့် ပိတ်ဆို့ခြင်း၊ ရေ လမ်းကြောင်း ပြောင်းလဲစေခြင်း၊ ရေစီးရေလာကိုအ နှောင့်အယှက်ဖြစ်စေခြင်း၊ မြေဖို့ခြင်း၊ လွဲပြောင်းစီးဆင်း စေခြင်း။	ငွေဒဏ်ကျပ်(၅) သိန်းမှ ကျပ် (၁၀) သိန်းအထိ ချ မှတ်ရမည်။	ထောင်ဒဏ် (၁) နှစ်အ ထိချမှတ်ရမည်။	
၈၄	၃၁၇	(ခ)	မြို့တော်နယ်နိမိတ်အတွင်းရှိ အများပြည်သူဆိုင်ရာလမ်း ဘေး ရေမြောင်းငယ်၊ ရေမြောင်းကြီး၊ မြစ်နှင့်မြစ်ထွက် ပေါက်များ၊ ချောင်းများအတွင်းသို့ စွန့်ပစ်ပစ္စည်းများ၊ ရေဆိုးများစီးဝင်စေခြင်း၊ စွန့်ပစ်ခြင်း၊ ပိတ်ဆို့စေခြင်း။	ငွေဒဏ်ကျပ်(၅)သောင်း မှ ကျပ်(၃)သိန်းအထိဖြစ် စေ၊ ထောင်ဒဏ်(၃)လ အထိဖြစ်စေ၊ ဒဏ်နှစ်ရပ် လုံး ဖြစ်စေချမှတ်ရမည်။		
၈၅	၃၁၇	(ဂ)	မြို့တော်နယ်နိမိတ်အတွင်း အဆောက်အအုံပရိဝုဏ် (ပရဝဏ်)အတွင်းမှ ထွက်ရှိလာသော ရေဆိုးများကို အများ ပြည်သူဆိုင်ရာ ရေမြောင်းများ၊ မြစ်ချောင်းများ အတွင်းသို့ ခွင့်ပြုချက်မရှိဘဲ စွန့်ထုတ်ခြင်း၊ ဖောက် ထုတ်ခြင်း၊ စီးဆင်းစေခြင်း။	ငွေဒဏ်ကျပ် (၁)သိန်းမှ ကျပ် (၅) သိန်း အထိဖြစ် စေ၊ ထောင်ဒဏ် (၆)လ အထိဖြစ်စေ၊ ဒဏ်နှစ်ရပ် လုံးဖြစ်စေ ချမှတ်ရမည်။		

ရေနတ်မြောင်းများဆိုင်ရာ ပြစ်မှုနှင့် ပြစ်ဒဏ်များ မှအဆက်

စဉ်	ပုဒ်မ	ပုဒ်မခွဲ	ပြစ်မှု	ပြစ်ဒဏ်များ		မှတ်ချက်
				ပထမအကြိမ်ကျူးလွန်မှု	ဆက်လက်ကျူးလွန်မှု	
၈၆	၃၁၇	(ဃ)	ကော်မတီ၏ ခွင့်ပြုချက်မရှိဘဲ မြို့တော်နယ်နိမိတ် အတွင်း ရေမြောင်း၊ ရေထုတ်ပြွန်၊ ရေတံခါး၊ ချောင်းကာ နံရံ၊ ရေကန်ကာနံရံ၊ မြေထိန်းနံရံတို့ကို အသစ်တည် ဆောက်ခြင်း၊ ပြုပြင်ခြင်း၊ ဖျက်ဆီးခြင်း။	ငွေဒဏ်ကျပ် (၅)သိန်း မှ ကျပ် (၁၀)သိန်း အထိ ချမှတ်ရမည်။	ထောင်ဒဏ် (၆) လ အထိချမှတ်ရမည်။	

Myanmar National Building Code 2020 – Part 5 D တွင်ပါရှိသော

Drainage and Sanitation အပိုင်း တင်ပြချက်

5D.5.5.11 Storm Water Drainage

5D.5.5.11.1 General

The object of storm water drainage is to collect and carry, the rain-water collected within the premises of the building, for suitable disposal.

5D.5.5.11.2 Design factors

Estimate of the quantity that reaches the storm water drain depends on the following factors:

a) Type of soil and its absorption capacity determined by its soil group.

b) Ground slope and the time in which the area is drained.

c) Intensity of the rainfall for a design period.

d) Duration of the rain/storm.

5D.5.5.11.2.1 Imperviousness

The soil conditions and the ground slope determine the impermeability factor. Impermeability factor is the proportion of the total rainfall received on the surface which will be discharging into a storm water drain after allowing for initial abstraction (in local pond and lakes), ground absorption by evaporation, vegetation and other losses. The net flow reaching the storm water drain is called runoff. The percentage of imperviousness of the drainage area may be obtained from available data for a particular area.

In the absence of such data, the following values may serve as a guide:

Type of area	Imperviousness factor*(percent)*
Commercial and industrial areas	70-90
Residential areas (high density)	60-75
Residential areas (low density)	35-60
Parks and underdeveloped areas	10-20

5D.5.5.11.2.2 Terrain modeling

Areas planned for urbanization from agricultural land, forest or low-grade land for example, low lying areas prone to flooding, marshy or abandoned quarries, etc need detailed and careful consideration with respect to its drainage. A detailed contour survey shall be carried out not only with respect to the site but also the surrounding areas to verify the quantity/area contributing runoff, presence of any low lying and natural water body acting as holding pond or any natural drain passing through the area and beyond whose filling up or diversion may cause water logging problem on the site or to the surrounding areas.

The planning of the area should ensure that:

a) All areas become self-draining by gravity with respect to the high flood level of the area or the drainage channels passing whichever is higher.

b) As far as possible, natural drainage pattern with respect to the whole area be maintained except when low lying areas need to be filled up for grading purposes.

c) The drainage in the area shall be planned in accordance with the natural slopes.

d) Levels of the main highway or road connecting to the property shall be determined to ensure proper drainage and protection of the site.

e) The formation levels of the entire area shall be prepared to determine proposed formation levels by preparing a terrain model which will show the proposed the site contours, ground and road levels and connections to all services including storm water disposal system.

5D.5.5.11.2.3 Design frequency

Storm water drainage system for an urbanized area is planned on the basis of the design frequency of the storm which shall be determined by the designer. Frequency is the period in which the selected design intensity recurs in a given period of time in years. If data are not available, use rainfall intensity as (3 - 5) in/hr.

5D.5.5.11.2.4 Time of concentration

Time of concentration is the time required for the rainwater to flow to reach the farthest point of the drainage system or the outfall under consideration. Time of concentration is equal to the inlet time plus the time required for the flow to reach the main or branch drain. The inlet time is the time dependent on the distance of the farthest point in the drainage area to the inlet of the manhole and the surface slopes, etc and will vary between 5 min to 30 min.

In highly developed sections for example with impervious surfaces it may be as low as 3 min or lower (with good slopes) as in building terraces and paved areas. Correspondingly the design intensity for the drainage for such areas will be much higher. Rainwater pipes have to be designed for an intensity for a very low time of concentration.

5D.5.5.11.2.5 Natural infiltration

In planning any area with buildings, layout with paved and non-permeable surfaces, care should be taken to allow maximum discharge of the rain-water to flow directly or indirectly to permeate into the ground for enabling the ground water to be recharged. Some of the techniques which allow infiltration that may be considered are:

a) Use of brick paved open jointed storm water drains.

b) Providing bore holes in the storm water drains.

c) Using paving tiles with open joints which enable water to percolates as it flows on it.

5D.5.5.11.3 Combined system

A combined system of drainage is one which carries the sewerage as well as the runoff from the storm water drainage. Relevant applicable statutory rules/ regulations may not allow such system in new areas and the sewerage and the storm water drainage have to be separate and independent of each other. Such systems are however existing in many old cities and the storm water may have to be discharged into the combined drainage system.

Where levels do not permit for connection to a public storm water drain, storm water from courtyards of buildings may be connected to the public sewer, provided it is designed to or has the capacity to convey combined discharge. In such cases, the surface water shall be admitted to the soil sewer through trapped gullies in order to prevent the escape of foul air.

5D.5.5.11.4 Discharging into a watercourse

It may often be convenient to discharge surface water to a nearby road side drain, stream, or a watercourse. The invert level of the outfall shall be about the same as the normal water level in the watercourse or ideally should be above the highest flood level of the watercourse. The out- fall shall be protected against floating debris by a screen. Perimeter drain should be provided and must be properly designed to carry storm water/ storm water + effluent from STP.

5D.5.5.11.5 Discharge to a public storm water drain

Where it is necessary to connect the discharge rainwater into a public storm water drain, such drains shall be designed for the intensity of rain based on local conditions, but in no case shall they be designed for intensity of rainfall of less than 2 inches / hour. Rainwater from each building plot shall be connected to the storm water drainage through a separate pipe or an open public drain directly. No trap shall be installed before the connection.

5D.5.5.11.6

Rain-water pipes for roof drainage

5D.5.5.11.6.1

The roofs of a building shall be so constructed or framed as to permit effectual drainage of the rain-water there from by means of a sufficient number of rain-water pipes of adequate size so arranged, jointed and fixed as to ensure that the rainwater is carried away from the building without causing dampness in any part of the walls or foundations of the building or those of an adjacent building.

5D.5.5.11.6.2

The rain-water pipes shall be fixed to the outside of the external walls of the building or in recesses or chases cut or formed in such external wall or in such other manner as may be approved by the Authority.

5D.5.5.11.6.3

Rain-water pipes conveying rain- water shall discharge directly or by means of a channel into or over an inlet to a surface drain or shall discharge freely in a compound, drained to surface drain but in no case shall it discharge directly into any closed drain.

5D.5.5.11.6.4

Whenever it is not possible to discharge a rain-water pipe into or over an inlet to a surface drain or in a compound or in a street drain within 100 ft from the boundary of the premises, such rain-water pipe shall discharge into a gully trap which shall be connected with the street drain for storm water and such a gully- trap shall have a screen and a silt catcher incorporated in its design.

5D.5.5.11.6.5
If such streets drain is not available within 100ft of the boundary of the premises, a rain-water pipe may discharge directly into the kerb drain and shall be taken through a pipe outlet across the foot path, if any, without obstructing the path.

5D.5.5.11.6.6
A rain water pipe shall not discharge into or connect with any soil pipe or its ventilating pipe or any waste pipe or its ventilating pipe nor shall it discharge into a sewer unless specifically permitted to do so by the Authority, in which case such discharge into a sewer shall be intercepted by means of a gully trap.

5D.5.5.11.6.7
Rain-water pipes shall be constructed of cast iron, PVC, asbestos cement, galvanized sheet or other equally suitable material and shall be securely fixed.

5D.5.5.11.6.8
The factors that decide the quantity of rain water entering are:
a) Intensity of rainfall, and
b) Time of concentration selected for rain-water pipe.

A bell mouth inlet at the roof surface is found to give better drainage effect, provided proper slopes are given to the roof surface. The spacing of rain-water pipes depends on the locations available for the down takes and the area which each pipe serves. The spacing will also be determined by the amount of slopes that can be given to the roof. The recommended slopes for the flat roofs with smooth finish would be 1:150 to 1:133, with rough stone/tiles 1:100 and for gravel set in cement or losely packed concrete finish 1:75 to 1:66. The effective strainer area should preferably be 1.5 to 2 times the area of pipe to which it connects to considerably enhance the capacity of rain water pipes.
The rain water pipes of cast iron (coefficient of roughness 0.013) shall normally be sized on the basis of roof areas according to Table 26. The vertical down take rain-water pipes, having a bell mouth inlet on the roof surface with effective cross-sectional area of grating 1.5 to 2 times the rain-water pipe area, may be designed by considering the outlet pipe as weir.

For full circumference of pipe acting as weir, the roof area (RA) for drainage may be worked out by using $RA = (0.084 \times d^{s_2})/I$
Where
d = Pipe diameter; mm
I = Intensity of rainfall (mm/h)

Table 26 Sizing of Rain-Water Pipes for Roof Drainage
(Clause 5.5.11.6.8)

Dia of Pipe	Average Rate of Rainfall (mm / hour)					
(mm)	50	75	100	125	150	200
	Roof Area (m²)					
50	29.70	19.80	14.85	11.88	9.90	7.42
65	57.23	38.15	28.61	22.89	19.08	14.31
75	81.84	54.56	40.92	32.74	27.28	20.46
100	168.00	112.00	84.00	67.20	56.00	42.00
125	293.48	195.66	146.74	117.39	97.83	73.37
150	462.95	308.64	231.48	185.18	154.32	115.74

NOTE – For rain-water pipes of other materials, the roof areas shall be multiplied by (0.013/coefficient of roughness of surface of that material).

ရန်ကုန်မြို့ပြဖွံ့ဖြိုးရေးစီမံခန့်ခွဲမှုစီမံကိန်း(Yangon Urban Development Management Project) အရ ဖွံ့ဖြိုးရေးခွင့်ပြုမိန့်ဆိုင်ရာ စည်းမျဉ်းစည်းကမ်းများ (Development Permit Rules & Regulations)တွင် ပါရှိသော ရေစီးရေလာစီမံခန့်ခွဲမှုနှင့် သက်ဆိုင်သည့် လုပ်ထုံးလုပ်နည်း မူကြမ်း (Draft Technical Guidelines for Design Rainwater Drainage Work in Development Area)

Draft Technical Guidelines for Design of Rainwater Drainage Work in Development Area and Supplemental Explanations

Rules and Regulations

The rainwater drainage work in the development area must be designed properly in terms of structural durability, capacity, and layout, in order to drain rainwater runoff occurring from the development area and prevent the development area and its surroundings from flooding due to rainwater runoff released from these areas, with due consideration of the following points.

- Rainfall characteristics in the region where the development area is located
- Scale and layout of the development area and surrounding environment
- Topography and subsoil conditions of the land to be developed
- Types of buildings and associated facilities to be constructed
- Scales and layouts of buildings and associated facilities to be constructed
- Conditions of the existing drainage where the rainwater runoff released from the development area

Supplemental Explanations:

The purpose of the rainwater drainage work is to prevent the development area and its surroundings from flooding due to rainwater runoff released from these areas. In developing the rainwater drainage work, the planning, design, and construction of required facilities must be based on the assessments of the rainfall-runoff characteristics in these areas through the series of the surveys and analyses for the captioned points. The draft technical guidelines described hereunder comprise the basic technical requirements followed by the general methodologies for materializing the objectives of this Section.

Technical Guidelines

1. Basic Technical Requirements for Rainwater Drainage Work

The rainwater drainage work must drain rainwater runoff from the development area effectively. Channels and conduits should be designed in terms of gradient and flow capacity enough for draining rainwater runoff estimated from the scale and topography of the development area, types of buildings and associated facilities to be constructed, rainfall intensity, and other conditions as required.

The rainwater drainage work in the development area must be connected with the public water body including river, channel, and conduit, or the sea nearby, in order to drain rainwater runoff from the development area effectively, with due consideration of flow capacity, water use, and any particular conditions of the public water body downstream. Rainwater retention facility having a temporary storage for rainwater runoff occurring from the development area or any other facility as appropriate can be installed, with due consideration of the limitation in flow capacity of the public water body downstream.

Supplemental Explanations:

The basic technical requirements for the rainwater drainage work are summarized as follows.

- The rainwater drainage work comprising channels and conduits in the development area must be constructed properly in terms of the flow capacity determined by gradient and flow cross sectional area, in order to discharge rainwater runoff occurring form the development area under the post-development condition.

- The outfall located at the downstream end of the rainwater drainage work in the development area must be connected with a public water body. The public water body downstream of the outfall should be investigated and evaluated to confirm that the rainwater runoff released from the development area flows down properly to the downstream end of the public water body.

- The rainwater drainage work in the development area should include the rainwater runoff control measures (e.g. storage facility, infiltration facility) when the need for such facilities are identified through the investigation and evaluation of the public water body downstream of the outfall. In case public water body will be developed for the other purpose, it is desirable to secure a required capacity of storage facility with the capacity of 600 m^3/ha at minimum for the area where the water surface is decreased.

The technical guidelines hereunder describe the key considerations and methodologies essentially to meet the basic technical requirements for designing the function and capacity of the rainwater drainage work in the development area.
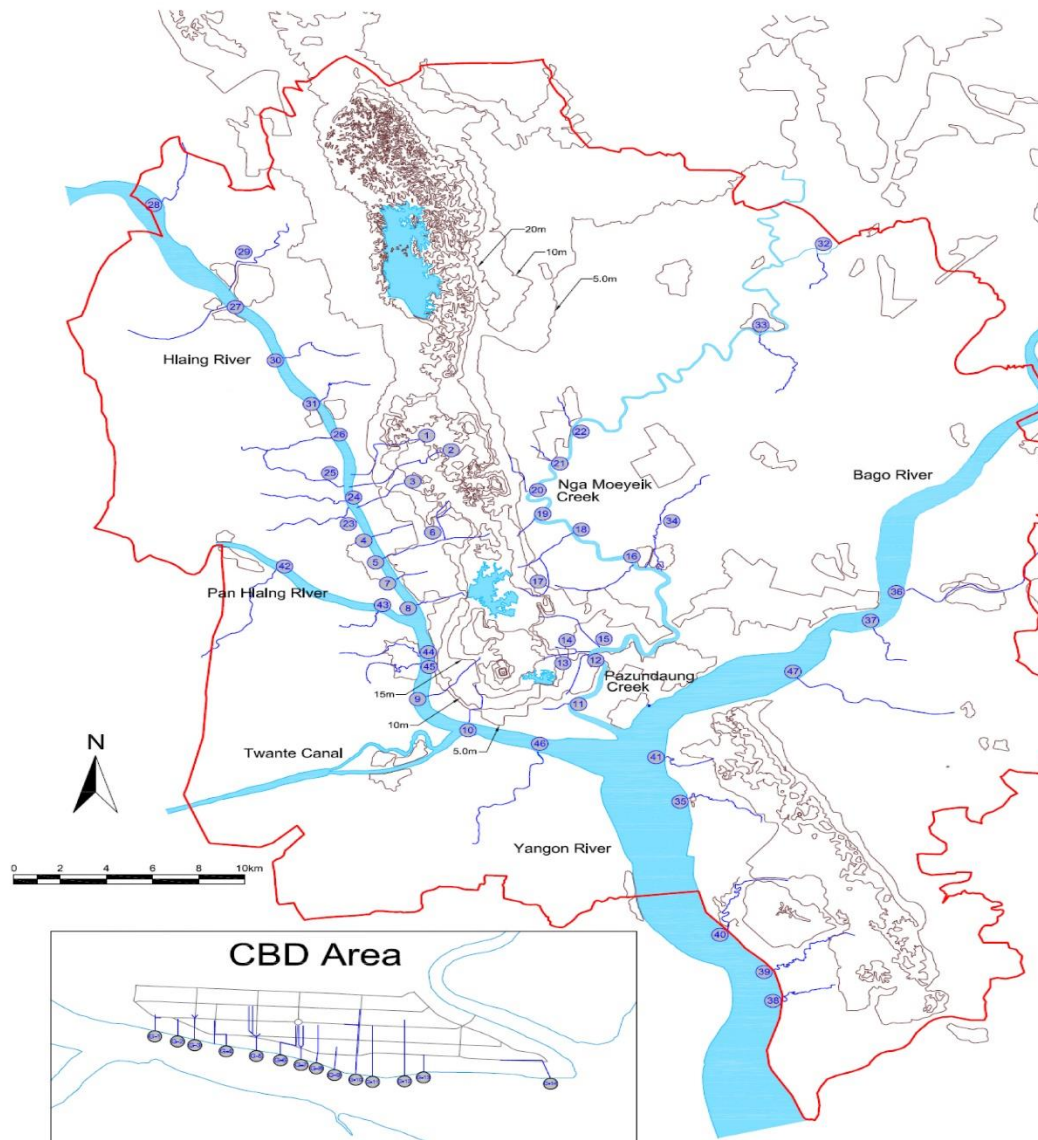
2. Classifications of Rainwater Drainage

The rainwater drainage in Yangon City, including open channels and conduits, are broadly classified into the following.

- River (e.g. Yangon River, Hlaing River, Pazundaung Creek, Bago River)
- Main Drainage Creek
- Secondary Drainage (Open Channel or Box Culvert)
- Tertiary Drainage (Roadside Culvert)

Supplemental Explanations:

Source: Preparatory Survey on the Project for the Improvement of Water Supply, Sewerage and Drainage System in Yangon City, JICA, 2014

Figure 1   Rivers and Main Drainage Creeks around the Yangon City

Locations and example images of the rivers, main drainage creeks are shown in Figure 1, and secondary/tertiary drainage in Yangon City are shown in Figure 2. The classifications of rainwater drainage provide the following ideas for those relating to the development area as shown in Figure 2.

- Rainwater Drainage Connected with the Outfall of Development Area: River, Main Drainage Creek, Secondary or Tertiary Drainage, developed and managed by public

- Rainwater Drainage within Development Area: Secondary or Tertiary Drainage, developed and managed by developer

Figure 2   Example Images of Rivers, Main Drainage Creeks, and Secondary/Tertiary Drainage in Yangon City
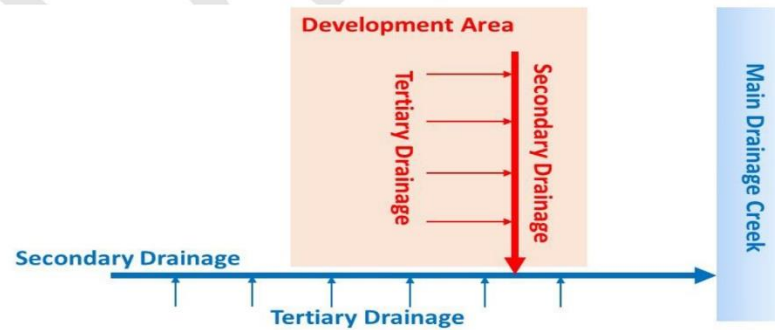

Figure 3   Image of Development Area and Main Drainage Creeks, and Secondary/Tertiary Drainage

3. Preparatory Survey for Rainwater Drainage Work

For planning the rainwater drainage work in the development area, the preparatory survey should be carried out to clarify the following.

(1) Locations of existing rainwater drainage including river, creek, open channel, and conduit and the rainwater drainage network formed by interconnections of these.

(2) The management boundary of existing rainwater drainage and the need for any adjustment with the boundary of the planned development area.

(3) Locations where rainwater runoff concentrating and flow conditions through existing drainage

(4) Size, structural feature, and flow capacity of existing rainwater drainage to be connected with the rainwater drainage work in the development area.

Supplemental Explanations:

For meeting the basic technical requirements as described in Section 1. Basic Requirements for Rainwater Drainage Work, the rainwater drainage work should be planned with due consideration of the existing conditions of the development area and its surroundings to be surveyed. The preparatory survey should cover the whole catchment area of the existing rainwater drainage network as shown in Figure 4, where the development area is involved herein. The following existing drainage section located downstream should be surveyed in terms of size, structural feature, and flow capacity.

- Secondary Drainage: Section from the outfall of the development area to the junction of the main drainage creek or river

- Tertiary Drainage: Section from the outfall of the development area to the junction of the secondary drainage, main drainage creek, or the river

For the purpose of the preparatory survey, utilization of the digital topographic data developed under the Yangon Mapping Project is recommended for delineating the survey area, studying rainwater drainage network on a preliminary basis, preparing plans of detail field surveys (e.g. rainwater drainage network, management boundary, rainwater runoff concentration and flow condition, and drainage section located downstream of the development area), and compiling the results of the preparatory survey.
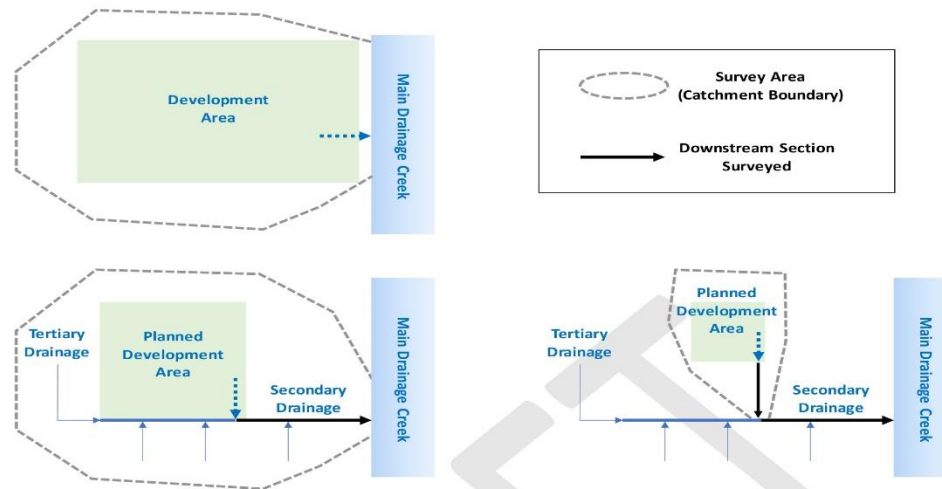
Figure 4   Image of Preparatory Survey Area

4.   Design Scale of Rainwater Drainage Work

> The design scale of the rainwater drainage work in the development area should be given with due consideration of the following.
>
> -   Located in Urbanization Area (UA): 10-year Return Period
> -   Located in Guided Urbanization Area (GUA): 10-year Return Period
> -   Pump Drainage Required: 10-year Return Period

Supplemental Explanations:

The design scale of the rainwater drainage work should be selected considering conformity with the design scale of the major drainage creek (or river) improvement, potential socio-economic impacts due to flooding in the development area and its surroundings, and work quantity and cost-effectiveness.

•   YCDC intends to implement the main drainage creek improvement works (e.g. Japanese ODA project, World Bank project) to cope with a flood occurring in a 10-year return period. The main drainage creeks to be improved by the JICA ODA project cover 3 to 8 km², respectively. Meanwhile, the majority of the development areas in Yangon City and the suburbs cover 1 km² (247 acres) or less. Considering the conformity with the design scale of the major drainage creek improvement, the design scale of the rainwater drainage work is should be 10-year return period or less.

7

- The design scale of the rainwater drainage work in the development area located in the UA and GUA should be 10-year return period, considering potential socio-economic impacts due to flooding in the development area and its surroundings.

- The design scale of the rainwater drainage work in the development area to require pump drainage should be 10-year return period, considering potential socio-economic impacts due to flooding in the development area.

5. Rainwater Runoff Released from Development Area

In the case of a rainfall intensity within the design scale of the rainwater drainage work, the peak of rainwater runoff released from the development area to the downstream should not exceed that estimated under the pre-development land use condition.

Supplemental Explanations:

The urban developments are likely to cause an increase of rainwater runoff when the natural features on the ground are changed into buildings and paved surfaces as shown in Figure 5. Then, the rainwater runoff peak is anticipated to increase and exceed the flow capacity of the existing drainage located downstream of the outfall from the development area. As a result, the area along the downstream of the outfall is threatened by the risk of flooding.
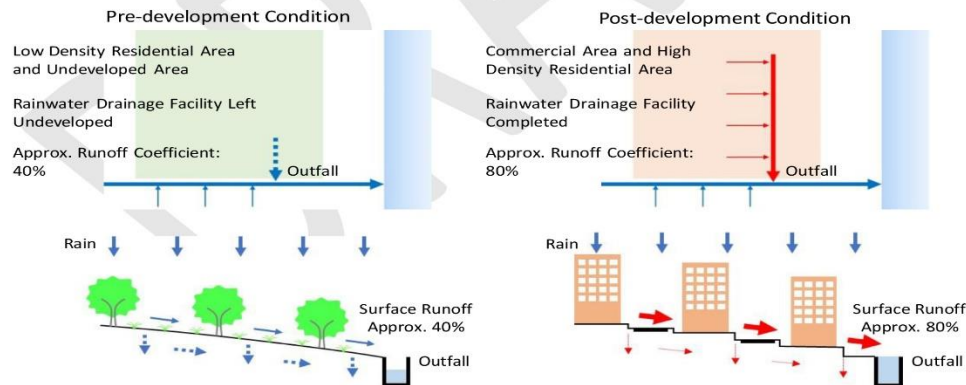
Figure 5   Image of Rainwater Runoff Peak Anticipated to Increase

Considering the situations above, introduction of the rainwater runoff control measures, including rainwater retention facility and/or rainwater infiltration facility, should be taken into consideration in order to alleviate a rapid increase of rainwater runoff released from the development area.

The peak of rainwater runoff released from the development area to the existing drainage

located downstream should be regulated as shown in Figure 6 in order to minimize the risk of flooding in the existing drainage located downstream of the development area. Meanwhile, the rainwater runoff reduction measures are considered as optional for the development area less than 1 acre (0.405 ha) since an increase of rainwater runoff released from such a development area cause less impact on the existing drainage located downstream. It will be required to discuss with YCDC taking into consideration the surrounding condition of development area.
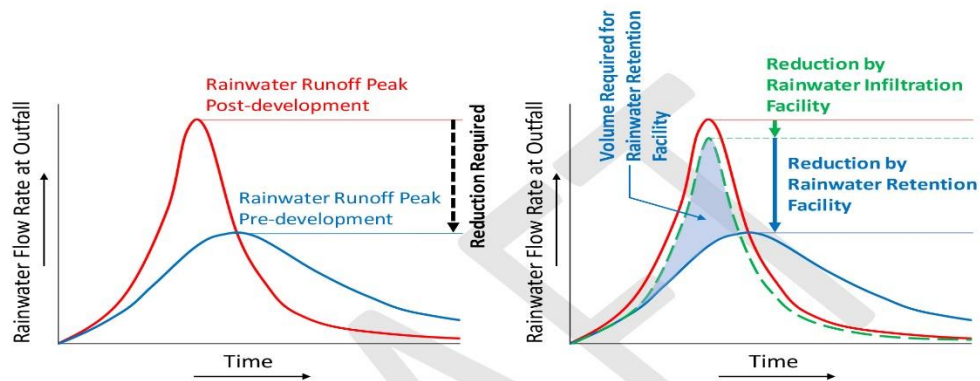
Figure 6   Image of Rainwater Runoff Peak to be Regulated

General Methodologies

6.   Design Flow for Rainwater Drainage Work

The peak flow rate computed by the Rational Method should be applied for design of rainwater drainage facility.

$Q = 1/360 \times C \times I \times A$

where:
Q = Peak flow rate of rainwater runoff (m³/s)
C = Runoff coefficient
I = Average rainfall intensity during time of rainwater runoff concentration (mm/hour)
A = Drainage area (ha)

Supplemental Explanations:

The draft technical guidelines provide in principle the general methodologies based on the Rational Method in designing the rainwater drainage work of the development area described

hereunder and in the succeeding sections.

The majority of the development areas are scaled less than 1 km^2 (247 acres). Therefore, the Rational Method is considered as applicable commonly for estimating rainwater runoff within such a scale of drainage area since it tends to give conservative side estimates through the simplified computation method. The Rational Method is well-known and commonly applied in the different countries for the design purpose of rainwater drainage work in urbanized catchment.

The parameters of the Rational Method are set in the following manners.

- Runoff coefficient (C) is computed as described later in Section 7. Runoff Coefficient for Design of Rainwater Drainage Work.

- In selecting an average rainfall intensity, the duration of rainfall is considered as equivalent to time of rainwater runoff concentration (t_c) that is computed as described later in Section 8. Time of Runoff Concentration for Design of Rainwater Drainage Work. Average rainfall intensity (I) during time of rainwater runoff concentration is selected as described later in Section 9. Rainfall Intensity, Duration, and Frequency (IDF) for Design of Rainwater Drainage Work.

- Drainage area (A) is a sub-catchment area to the upstream of a runoff computation point selected.

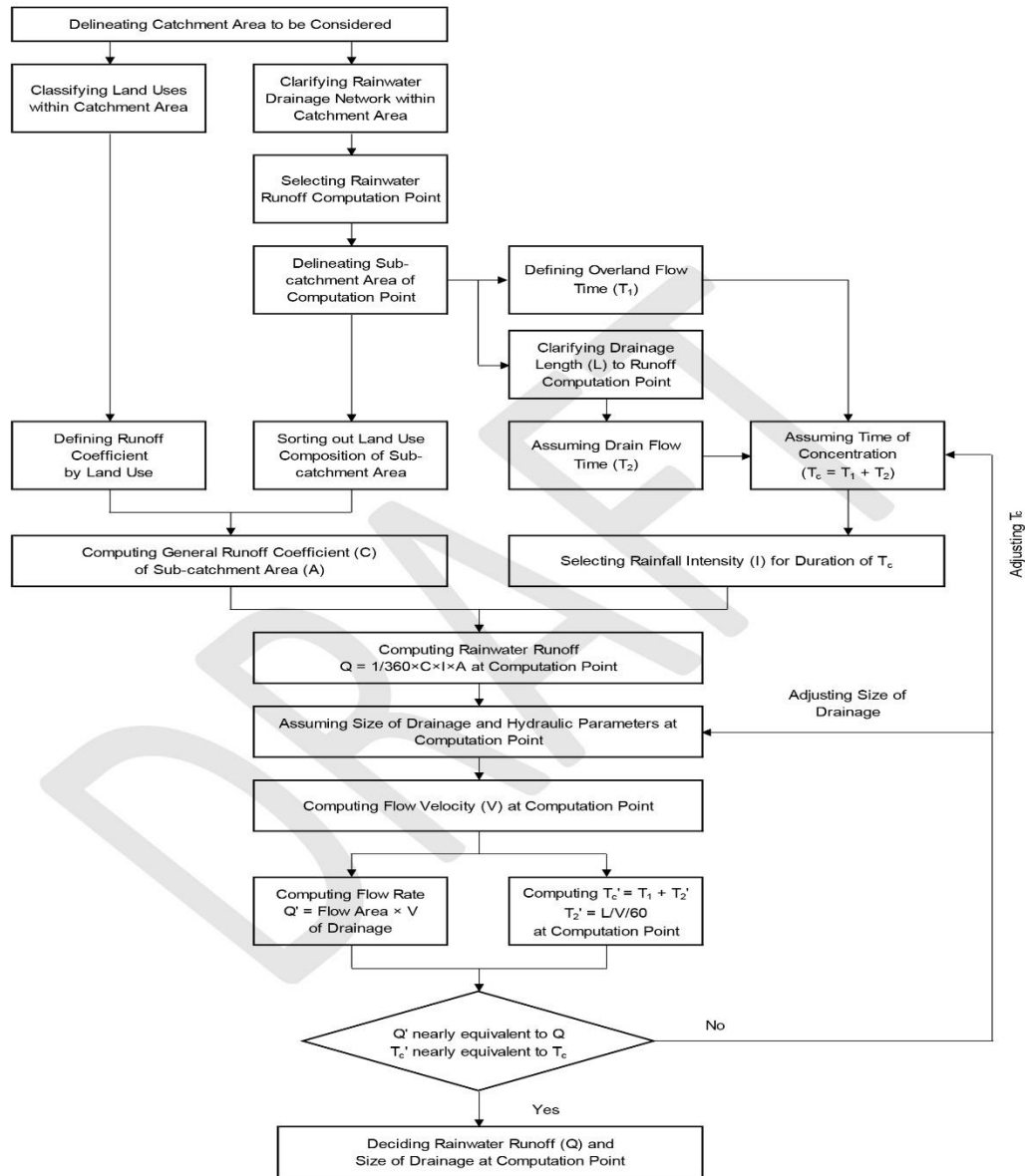Flowchart of the Rational Method is shown in Figure 7.

Figure 7   Flowchart of the Rational Method

Meanwhile, the development area is located in the region where the limitations of the Rational Method are anticipated, the application of hydrodynamic simulation analysis should be discussed for computing design flow of the rainwater drainage work. Details should be discussed individually by development project besides the draft technical guidelines herein.

The Rational Method is applicable for computing the peak flow rate of rainwater runoff in waterways without retardation effects. Meanwhile, the waterways in the rural flatlands of Yangon City are prone the retardation effects due the gentle topographic gradient coupled with the influence of the backwater intrusion caused by the high tide of the river. Therefore, it is anticipated that the Rational Method would not fit rainwater runoff computations in a large-scale development in the rural flatland. In a such case, it is recommended to perform hydrodynamic simulation analysis of the rainwater drainage system.

Table 2 suggests the application of the Rational Method or the hydrodynamic simulation analysis, depending on the hydraulic condition and scale of the development area. Table 3 shows the highest tide levels in Yangon City in reference to the YCDC's documents.

Table 2   Application of Rational Method or Hydrodynamic Simulation Analysis

Hydraulic Condition	Rational Method	Hydrodynamic Simulation Analysis
No tidal influence on waterway downstream of the development area	Applicable for any scale of the development area	Recommended be applied as an option for the large-scale development area
Tidal influence on waterway downstream of the development area	Applicable except for the large-scale development area; tidal influence is minimal on the rainwater drainage work within the development area	Recommended to be applied for the large-scale development area; tidal influence is anticipated on the rainwater drainage work within the development area

(Note) Large-scale development area covers 5 acres or more as defined in the draft rules and regulations for development permissions.

Table 3   Highest Tide Levels in Yangon City

River	HHWL (MSL)	Source	Remark
Yangon River in the vicinity of Yangon Port	+4.04	Yangon City Development Committee, Improvement of Aung Chan Tar Canal, Final Report, Mary 2019	Based on the water level records at Yangon gauging station
Ngamoyeik River in South Okkalapa Township	+4.31	Yangon City Development Committee, Design of Main Streams Improvement and Outfall Structures (North Okkalapa, South Okkalapa, & Thingangyun Townships), Final Report, March 2018	Based on the water level records at Myin Thar gauging station in South Okkalapa Township

(Note) For example, the following free software to perform the hydrodynamic simulation analysis are opened to the public.

- HEC-HMS and HEC-RAS
  Developed and opened to the public by the Hydrologic Engineering Center within the U.S. Army Corps of Engineers. Hydrologic Modeling System (HMS) simulates rainwater runoff and River Analysis System (RAS) performs hydrodynamic simulation of river channel.

- EPA SWMM
  Developed and opened to the public by the United States Environmental Protection Agency (EPA). Storm Water Management Model (SWMM) performs hydrodynamic simulation by rainfall runoff model in combination with hydraulic model of rainwater drainage network for urbanized catchment

7.   Runoff Coefficient for Design of Rainwater Drainage Work

A general runoff coefficient for the entire development area should be computed as a weighted average of runoff coefficients corresponding respectively to land surface covers within the development area.

Supplemental Explanations:

The runoff coefficients shown in Table 4, presented in the YCDC's design document prepared in 2018 for improvement of the main drainage creeks to be implemented under the JICA ODA

project, is considered as applicable. The YCDC's design document gives the runoff coefficients corresponding respectively to the land surface covers, which coincide generally with the land use categories in the development area. A general runoff coefficient can be computed as a weighted average of runoff coefficients corresponding respectively to land surface covers within the development area. In addition, it is recommended to refer to other references describing these values corresponding to different land surface covers where required for computing the general runoff coefficients under the pre-development condition.

Table 4   Runoff Coefficient by Land Surface Cover

Area	Runoff Coefficient (%)
Commercial / Business Lots	90
Asphalt Concrete Roads	90
Residential Lots	80
Mixed Industrial Lots	70
Parks / Gardens/ Lawns	40
Natural Forest	30

Source: Yangon City Development Committee, Design of Main Streams Improvement and Outfall Structures (North Okkalapa, South Okkalapa, & Thingangyun Townships), Final Report, March 2018

8.   Time of Runoff Concentration for Design of Rainwater Drainage Work

Time of Runoff Concentration (t_c) is computed as the sum of Overland Flow Time (t_1) and Drain Flow Time (t_2).

Overland Flow Time (t_1) is a time elapsing for rainwater flowing from the most distant ridge in a subdivided unit drainage area to a drainage (channel or conduit).

Drain Flow Time (t_2) is a time elapsing for rainwater flowing through a drainage (channel or conduit) from the upstream end to a runoff computation point.

Supplemental Explanations:

An image of Time of Concentration (t_c), Overland Flow Time (t_1), and Drain Flow Time (t_2) is shown in Figure 8.
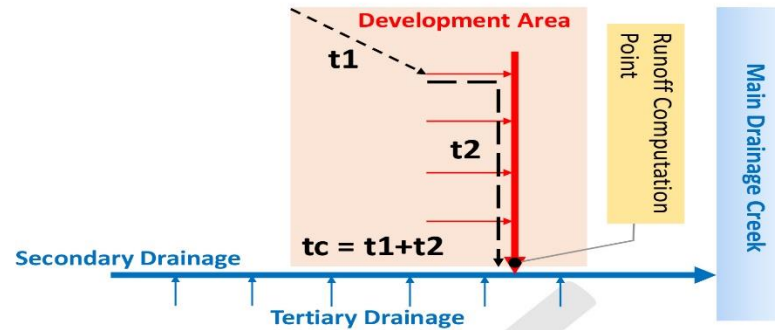
Figure 8   Image of Time of Rainwater Runoff Concentration in Development Area

(1) Overland Flow Time (t_1)

Overland flow time (t_1) varies depending on distance, gradient, and roughness on the ground of a minimum sub-catchment unit. The estimation methods of t_1 are described in the different references. Some references provide the ranges of t_1 by grade of urbanization. Others give the empirical equations for estimating t_1.

Overland flow time (t_1) is suggested in reference to the ranges of t_1 by grade of urbanization as follows, while the use of an empirical equation for estimating t_1 is a possible option.

- t_1 = 5 minutes (the minimum suggested) for the development areas

- t_1 = 5 minutes for densely populated sub-catchments and t_1 = 10 minutes for moderately populated sub-catchments, where the rainwater drainage work is already developed

The rainwater drainage work is not well-developed as a whole in the suburban and rural region. Some of the references suggest t_1 > 10 minutes for less populated or rural sub-catchments.

(2) Drain Flow Time (t_2)

Drain flow time (t_2) is computed as an accumulation of t_2 for length and flow velocity of each drainage segment from upstream end to a runoff computation point as show in Figure 9. Assuming gradient and cross section of each drainage segment, drain flow time (t_2) is computed by the Manning's Equation as described in Section 10. Hydraulic Calculation for Design of Rainwater Drainage Work later.

t_2 = L / V / 60

where,
t_2 = Drain flow time by drainage segment (min)
L = Length of drainage segment (m)

15

V = Flow velocity in drainage segment (m/s)

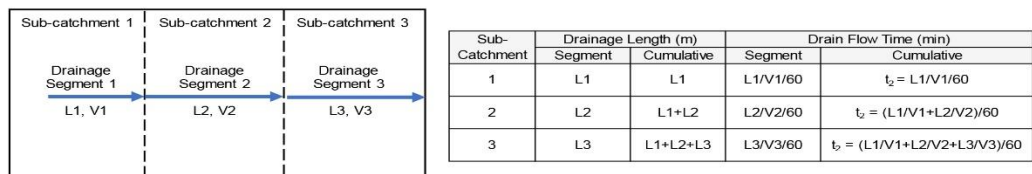| Sub-Catchment	Drainage Length (m)		Drain Flow Time (min)	
	Segment	Cumulative	Segment	Cumulative
1	L1	L1	L1/V1/60	t_2 = L1/V1/60
2	L2	L1+L2	L2/V2/60	t_2 = (L1/V1+L2/V2)/60
3	L3	L1+L2+L3	L3/V3/60	t_2 = (L1/V1+L2/V2+L3/V3)/60

Figure 9   Computation of Drain Flow Time (t_2)

9. Rainfall Intensity, Duration, and Frequency (IDF) for Design of Rainwater Drainage Work

> Rainfall IDF applicable for the design of rainwater drainage work should be based on available rainfall records and an analytical methodology commonly recognized as acceptable for representing the generalized characteristics of rainfall in Yangon City.

Supplemental Explanations:

The rainfall IDF shown in Table 5 and Figure 10, presented in the YCDC's design document prepared in 2018 for improvement of the main drainage creeks to be implemented under the JICA ODA project, is considered as applicable. This rainfall IDF was prepared, using the analytical methodology developed by Myanmar Meteorology & Hydrology Department and Irrigation Department, based on the rainfall records at Kabar-Aye station for the period of 1962-2016. This rainfall IDF is described in the paper issued by Yangon Technical University (May 2018) and is also applied in the World Bank project for the rainwater drainage work in the Central Business District (CBD).

Table 5   Rainfall IDF in Yangon City

Duration (min)	ARI / Rainfall Intensity (mm/hour)		
	2-year	5-year	10-year
5	163.4	233.6	286.6
10	122.6	175.2	214.9
15	103.5	147.9	181.5
30	71.7	102.5	125.8
60	45.4	64.9	79.6
120	28.2	40.4	49.5
180	20.7	29.5	36.2
360	12.6	17.9	22.0
720	7.6	10.8	13.3
1440	4.6	6.6	8.1

Source: Yangon City Development Committee, Design of Main Streams Improvement and Outfall Structures (North Okkalapa, South Okkalapa, & Thingangyun Townships), Final Report, March 2018

INTENSITY- DURATION - FRENQUENCY CURVES FOR YANGON
(Yangon Rainfall Record = 1962 - 2016)
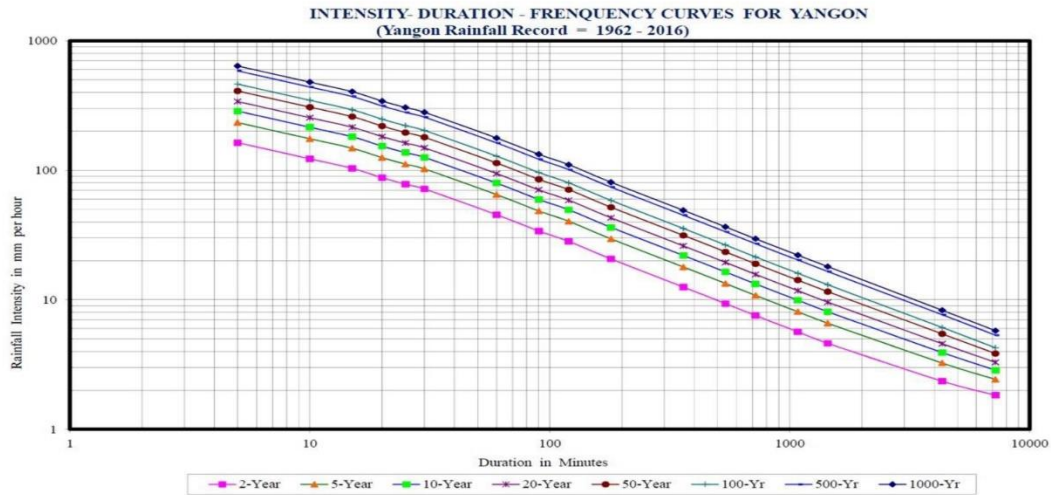
Source: Yangon City Development Committee, Design of Main Streams Improvement and Outfall Structures (North Okkalapa, South Okkalapa, & Thingangyun Townships), Final Report, March 2018

Figure 10 Rainfall IDF in Yangon City

10. Hydraulic Calculation for Design of Rainwater Drainage Work

Size (or flow capacity) of drainage channel or conduit is designed by using the Manning's Equation.

$$Q = A \times V = A \times 1/n \times R^{2/3} \times i^{1/2}$$

where,

Q = Peak flow rate of rainwater runoff (m^3/s)

A = Flow area inside drainage channel or conduit (m^2)

V = Flow velocity inside drainage channel or conduit (m/s)

n = Manning's roughness coefficient

R = Hydraulic radius (= A/S) (m)

S = Wetted perimeter inside drainage channel or conduit (m)

i = Slope of drainage channel or conduit

Supplemental Explanations:

The peak flow rate of rainwater runoff is computed by the Rational Method described in Section 6. Design Flow for Rainwater Drainage Work. Then the rainwater drainage channel or conduit

is sized through hydraulic calculation by using the Manning's Equation

YCDC's design document prepared in 2018 describes the following Manning's roughness coefficient (n) and design flow velocity (V) and these are considered as acceptable. In addition, it is recommended to refer to other references describing these values corresponding to various cross-sectional shapes and materials of the rainwater drainage.

Manning's Roughness:

Lined Drains or Culverts	= 0.014
Rubble Drains	= 0.020
Earth Drains	= 0.035

Flow Velocity:

Minimum Self Clean Velocity	= 0.75 m/s
Maximum Velocity: Lined Drains and Culverts	= 4.0 m/s
Maximum Velocity: Earth Drains	= 1.2 m/s

11. Rainwater Runoff Hydrograph

> Rainwater runoff hydrograph should be prepared for planning the capacity of the rainwater retention pond.

Supplemental Explanations:

A required storage capacity of the rainwater retention pond should be studied considering the peak of rainwater runoff as well as the volume of rainwater runoff during a rainstorm duration. Therefore, the rainwater runoff hydrograph should be prepared in the form of the time-series data of rainwater runoff rate. The following two methods are applicable examples for preparing the rainwater runoff hydrograph.

(1) Rational Unit Hydrograph Method

Time series of rainfall intensity (hyetograph) peaking at the center of the rainstorm duration are prepared by using the rainfall IDF as shown in Figure 11, comprising a rainfall intensity for each time step equivalent to time of runoff concentration (t_c) for the total time period enough for the duration of the rainstorm events recorded in Yangon City.
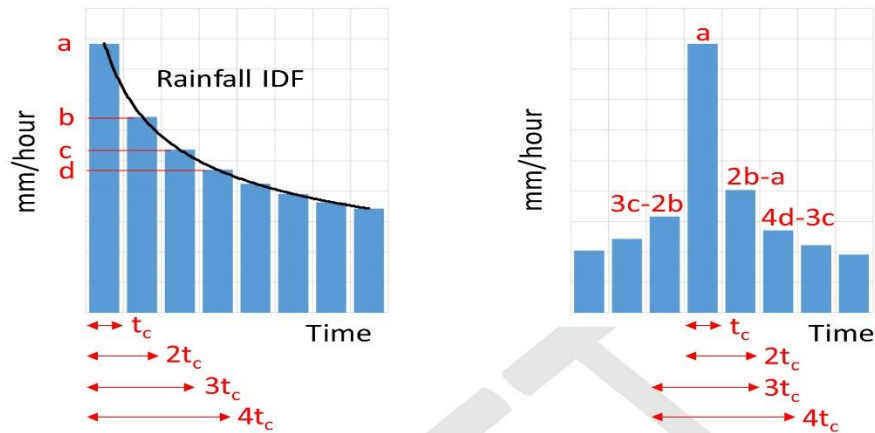
Figure 11 Preparation of Rainfall Hyetograph

An image of Rational Unit Hydrograph for a time of concentration (t_c) is shown in Figure 12 (left). The rainwater runoff in each time step is computed from the corresponding rainfall intensity by using the Rational Method for preparing the rainwater runoff hydrograph as shown in Figure 12 (right).
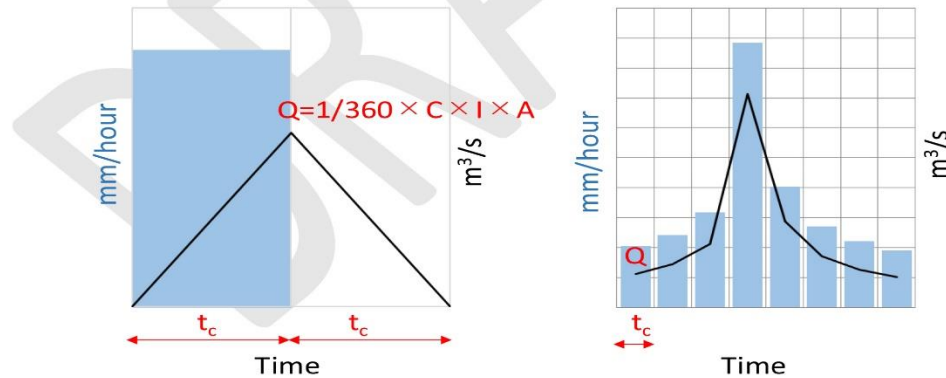
Figure 12   Preparation of Rainwater Runoff Hydrograph by Rational Unit Hydrograph Method

(Note) The method of the rearrangement is described in the different references in Japan and other countries. For an example, refer to Section 3.7 Translation of IDF curve into rainfall hyetograph, Manual on Storm Water Drainage Systems, Volume-I, Part-A: Engineering Design, First Edition, May 2019, Central Public Health and Environment Engineering Organization (CPHEEO), Ministry of Housing Urban Affairs, Government of India.

(2) Time Area Method

Time Area Method is to prepare the rainwater runoff hydrograph, considering a lag-time of rainwater runoff from each sub-catchment divided in conformity with computation time step equivalent to runoff travel time as shown in Figure 13. The rainwater runoff by each time step is computed as shown in Table 6.
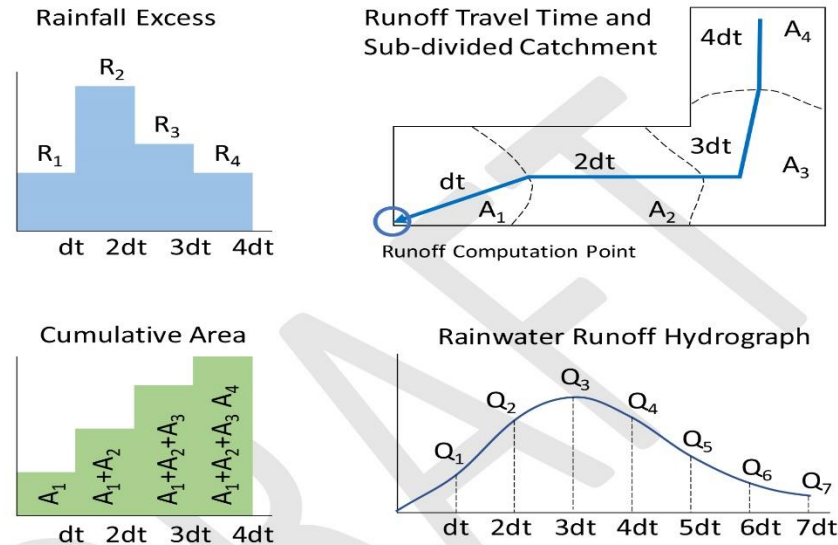

Figure 13   Preparation of Rainwater Runoff Hydrograph by Time Area Method

Table 6   Rainfall IDF in Yangon City

Time	Rainfall Excess	Rainwater Runoff by Sub-catchment				Sum (1) thru (4)
		(1) A_1	(2) A_2	(3) A_3	(4) A_4	
dt	R_1	$A_1 \times R_1$				Q_1
2dt	R_2	$A_1 \times R_2$	$A_2 \times R_1$			Q_2
3dt	R_3	$A_1 \times R_3$	$A_2 \times R_2$	$A_3 \times R_1$		Q_3
4dt	R_4	$A_1 \times R_4$	$A_2 \times R_3$	$A_3 \times R_2$	$A_3 \times R_1$	Q_4
5dt			$A_2 \times R_4$	$A_3 \times R_3$	$A_3 \times R_2$	Q_5
6dt				$A_3 \times R_4$	$A_3 \times R_3$	Q_6
7dt					$A_3 \times R_4$	Q_7

(Note) The Time Area Method is described in the different references. For an example, refer to Chapter 2 Quantity Design Fundamentals and Chapter 7 Detention Pond, Urban Stormwater Management Manual for Malaysia, MSMA 2nd Edition, 2012, Department of Irrigation and Drainage (DID), Government of Malaysia.

12. Required Storage Capacity of Rainwater Retention Pond

Storage capacity of rainwater retention pond for alleviating an increase of the peak of rainwater runoff occurring from the development area is designed by applying the reservoir storage routing to compute time-dependent relationships between rainwater inflow, outflow, and storage successively by the following equation.

$$dS/dt = (I_1 + I_2)/2 - (O_1 + O_2)/2$$

$$(I_1 + I_2)/2 + (S_1/dt + O_1/2) - O_1 = S_2/dt + O_2/2$$

where,

dS : Change in storage volume of retention pond in time interval ($= t_c$) (m^3)

dt : time interval $= t_c$ (min)

I_1, I_2 : Rainwater inflow into retention pond at last and current time step (m^3/s)

O_1, O_2 : Outflow from retention pond at last and current time step (m^3/s)

S_1, S_2 : Storage volume from retention pond at last time and current time step (m^3/s)

Supplemental Explanations:

The reservoir storage routing is to compute a rainwater runoff stored in the retention pond (dS) as a balance between inflow (I) and outflow (O) successively by time step (dt) and then results in a required storage volume of the rainwater retention pond consequently as shown in Figure 14. Flowchart of the reservoir storage routing is shown in Figure 15.
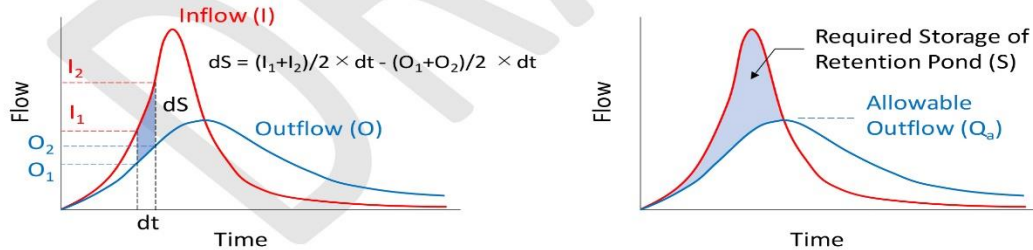

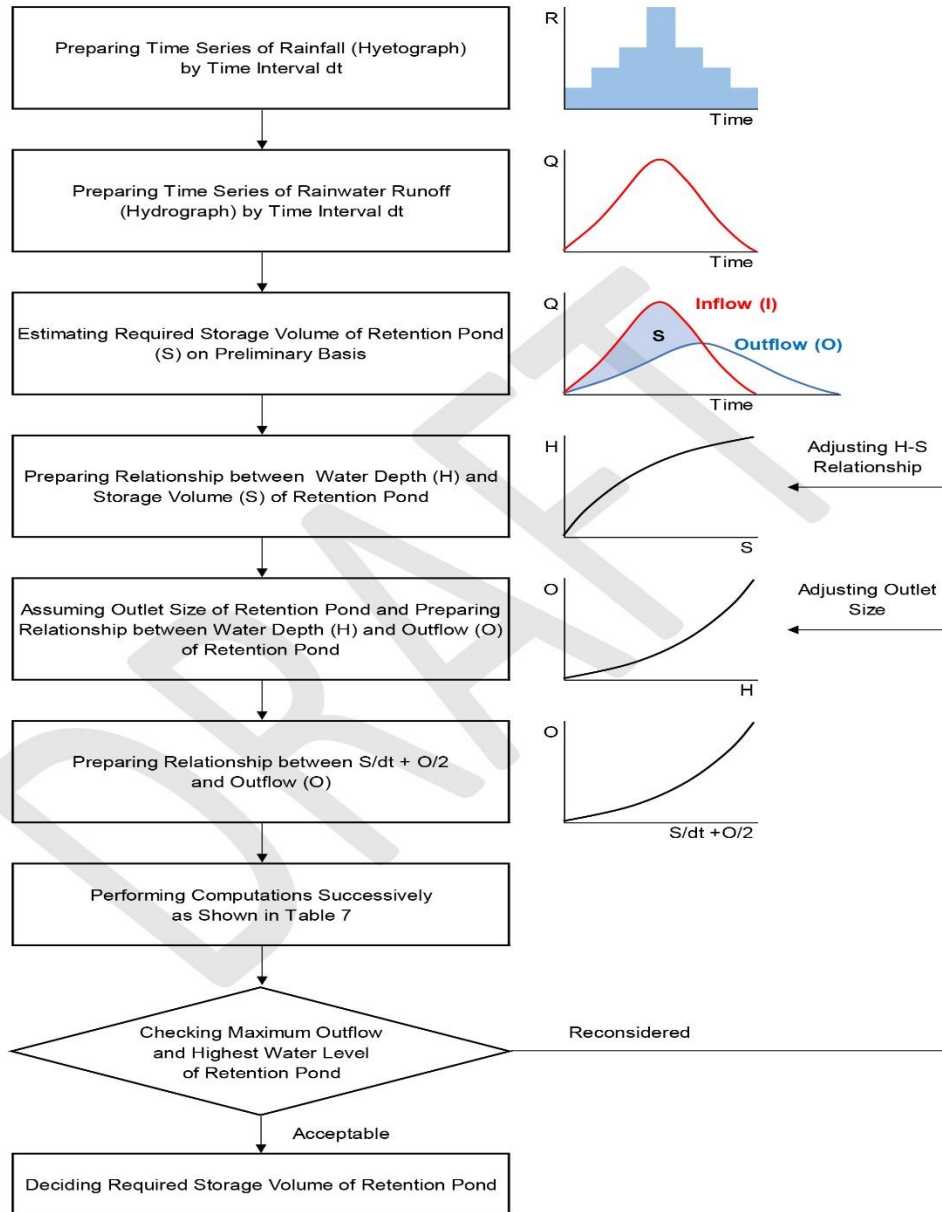Figure 14   Computation of Required Storage Volume of Retention Pond

Figure 15   Flowchart of Reservoir Storage Routing

The flowchart of the reservoir storage routing is explained below.

- Time series of rainfall intensity (hyetograph) are prepared in reference to Section 12. Rainwater Runoff Hydrograph.

- Time series of rainwater runoff (hydrograph) are prepared in reference to Section 12. Rainwater Runoff Hydrograph. These are the inputs of the inflows (I) into the retention pond.

- Required storage capacity of the retention pond is computed on a preliminary basis by using the simplified equation as described later in this Section.

- Relationship between water depth (H) and storage volume (S) of the retention pond is prepared.

- Outlet of the retention pond is dimensioned. Relationship between water depth (H) and outflow (O) of the retention pond is prepared.

- Based on H vs. S and H vs. O, relationship between $S/dt+O/2$ and O is prepared.

- Successive computations are performed as shown in Table 7. Resulting from the computations, the maximum found in column (7) is the maximum outflow (O_{max}) from the retention pond. The maximum found in column (8) is the highest water level (H_{max}) of the retention pond. The maximum of the storage volume (S_{max}) corresponds to H_{max} and is derived from the H-S relationship.

- The required storage capacity of the retention pond is regarded as S_{max} when the following two conditions are satisfied simultaneously.

  - Allowable Outflow (Q_a) > Maximum Outflow (O_{max})
  - Ground Level of Development Area + Freeboard > Highest Water Level (H_{max})

- When these conditions are not satisfied, required storage capacity, dimensions of outlet, H vs. S, H vs. O, and $S/dt+O/2$ vs. O should be adjusted. And then the successive computations should be performed again.

Table 7   Computation Table of Reservoir Storage Routing

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Time Step	Inflow m^3/s	$(I_1+I_2)/2$ m^3/s	$S_1/dt+O_1/2$ m^3/s	O_1 m^3/s	$S_2/dt+O_2/2$ m^3/s	O_2 m^3/s	H_2 m
1	I_1 Zero for first timestep		Zero for first timestep	Zero for first timestep	(3)+(4)-(5)	Derived from S/dt + O/2 vs. O, resulting from figure in column (6)	Derived from H vs. O, resulting from figure in column (7)
2	I_2 Derived from hydrograph	Average of inflows	Equal to figure of column (6) in the last time step	Equal to figure of column (7) in the last time step	(3)+(4)-(5)	Derived from S/dt + O/2 vs. O, resulting from figure in column (6)	Derived from H vs. O, resulting from figure in column (7)
3	-ditto-	-ditto-	. -ditto-	-ditto-	-ditto-	-ditto-	-ditto-
4	-ditto-	-ditto-	. -ditto-	-ditto-	-ditto-	-ditto-	-ditto-
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.

Images of the reservoir storage routing are illustrated in Figure 16. When inflow (I) is larger than outflow (O), water depth (H) and storage volume (S) increase with time elapsed. At the time when outflow (O) becomes equivalent to inflow (I), outflow (O), water depth (H), and storage volume (S) are maximized. Afterward inflow (I) becomes smaller than outflow (O), water depth (H) and storage volume (S) decrease with time elapsed.
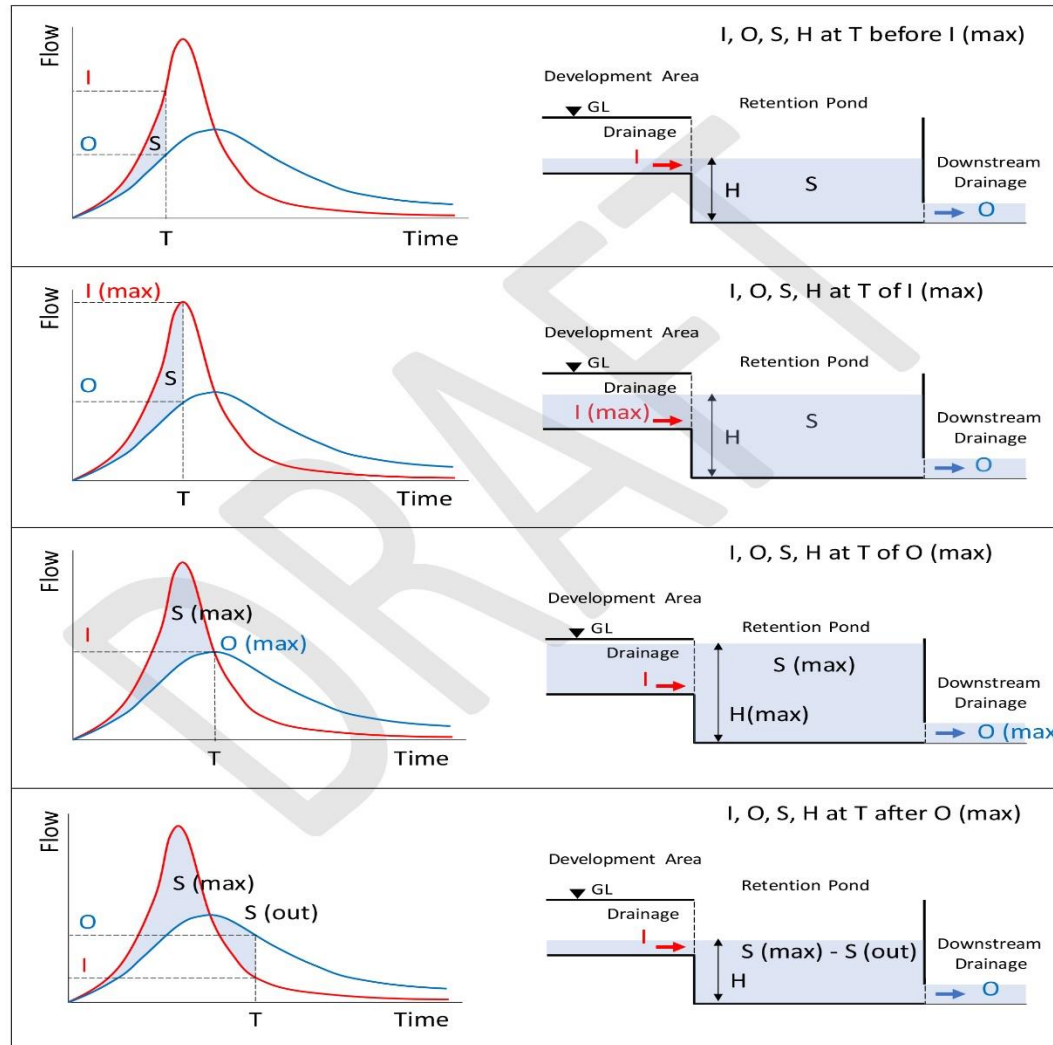

Figure 16   Images of Reservoir Storage Routing

(Note) The method of the reservoir storage routing is described in the different references. For an example, refer to Chapter 2 Quantity Design Fundamentals and Chapter 7 Detention Pond, Urban Stormwater Management Manual for Malaysia, MSMA 2nd Edition, 2012, Department of Irrigation and Drainage (DID), Government of Malaysia.

(Note) Besides the reservoir storage routing, some references provide simplified equations for computing a required storage volume of retention pond. Such equations are applicable as well for estimating an approximate storage volume of the retention pond on a preliminary basis and designing the small-scale retention pond (e.g. on-site retention facility). A Japanese reference provides the following equation.

$$V_i = (R_i - R_c/2) \times 60 \times T_i \times C \times A \times 1/360$$

where,

V_i : Required storage volume of retention pond for rainfall duration T_i (m^3)

R_i : Rainfall intensity for duration T_i (mm/hour)

R_c : Rainfall intensity corresponding to allowable outflow (Q_a) from the development area (mm/hour), $R_c = Q_a \times 360 / C / A$

T_i : Rainfall duration (min)

C : Runoff coefficient after development

A : Development Area (ha)

The maximum of V_i is identified through computations attempted with different rainfall durations (T_i) and thus considered as the required storage volume (S) of the retention pond.

13. Rainwater Runoff Control Measures
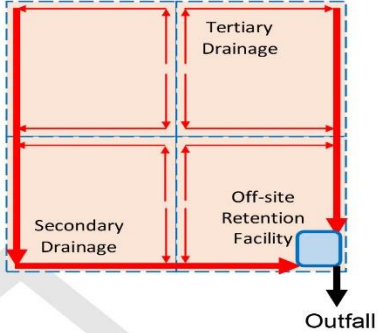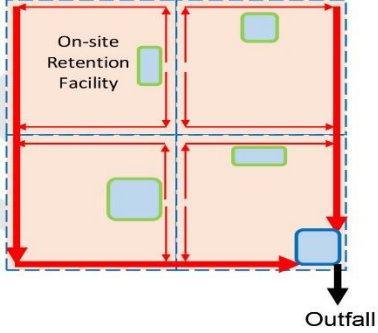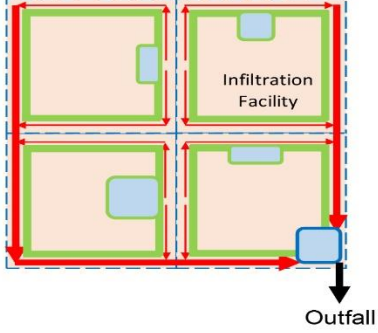
For alleviating the peak of rainwater runoff released from the development area, it is recommended that the rainwater runoff control should be achieved by combination of the following types of facilities.

- Off-site Retention Facility
- On-site Retention Facility
- Infiltration Facility

Supplemental Explanations:
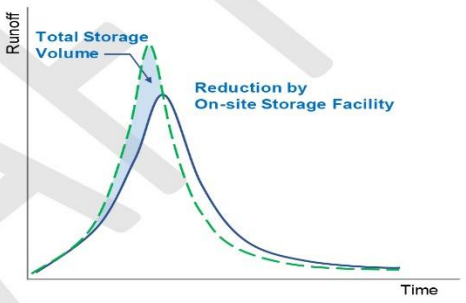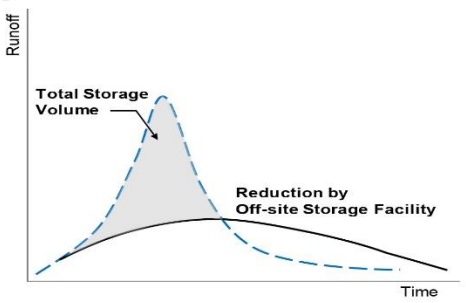
The rainwater runoff control measures are explained briefly as shown in Table 8. Various types of rainwater runoff control measures are described in the different references.

Table 8 Rainwater Control Measures

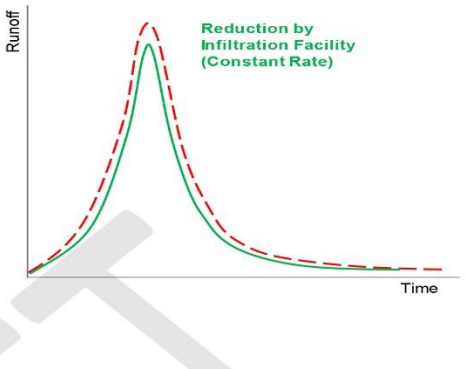| Classification	Image
Off-site Retention Facility Rainwater runoff is collected through open channels and conduits in the development area and is regulated by rainwater retention pond located at the downstream end for alleviating the peak of rainwater runoff released from the development area.	
On-site Retention Facility Open spaces (e.g. car parking, green park, sports field) and rooftop/underground of buildings in the development area are used as temporary rainwater storage for delaying time of rainwater runoff concentration into channel or conduit nearby.	
Infiltration Facility Infiltration facilities (e.g. permeable gully, permeable trench, permeable pavement) increase an infiltration rate of rainwater into the ground and reduce rainwater runoff discharging into channels and conduits.	

Effects by the rainwater runoff control measures are evaluated by deducting rainwater runoff reductions from the rainwater runoff hydrograph at the downstream end of the development area as shown in Table 9. Rainwater runoff reductions deducted from the hydrograph are computed in the following manners.

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Table 9 Effects by Rainwater Control Measures

Effect	Image
Step 1: Infiltration Facility Total of rainwater infiltration rates (m³/hour) by a number of infiltration facilities is deduced from the rainwater runoff hydrograph at the downstream end of the development area. (Example) Permeable Gully： Design Infiltration Rate (m³/hour/unit) × No. of Units Permeable Trench Design Infiltration Rate (m³/hour/m) × Total Length Permeable Pavement： Design Infiltration Rate (m³/hour/m²) × Total Area	Reduction by Infiltration Facility (Constant Rate)
Step 2: On-site Retention Facility Total of rainwater runoff reductions by a number of on-site retention ponds designed as per Section 13. Required Storage Capacity of Rainwater Retention Pond is deduced from the rainwater runoff hydrograph resulting from Step 1.	Total Storage Volume / Reduction by On-site Storage Facility
Step 3: Off-site Retention Facility Designed as per Section 13. Required Storage Capacity of Rainwater Retention Pond for reducing the maximum outflow against the rainwater hydrograph resulting from Step 2.	Total Storage Volume / Reduction by Off-site Storage Facility

In case infiltration facility will be installed, it is necessary to investigate the soil condition, groundwater level, surrounding structures and wells to be affected due to the development. It is suggested to refer the C), D), E), F), G) in the Section 14 Some Useful References Suggested below.

14. Some Useful References Suggested

(Note) The subjects described in the guidelines are further detailed in the different references as exampled below. It is recommended to utilize the guidelines coupled with some of the references as required.

A) Yangon City Development Committee, Design of Main Streams Improvement and Outfall Structures (North Okkalapa, South Okkalapa, & Thingangyun Townships), Final Report, March 2018

B) Study on Drainage Capacity by Using Modified Rational Method and Storm Water Management Model, Mi Pale, Kyi, Dr. Win Win Zin, U Tin Maung, Department of Civil Engineering, Yangon Technical University, May 2018

C) Code of Practice on Surface Water Drainage, Sixth Edition - December 2011 with amendments under Addendum No.1 - June 2013, Public Utility Board (PUB), Government of Singapore

D) Managing Urban Runoff, Drainage Handbook, 1st Edition: June 2013, Public Utility Board (PUB), Government of Singapore

E) Active, Beautiful, Clean Waters, Design Guidelines, 4th Edition: July 2018, Public Utility Board (PUB), Government of Singapore

F) On-site Storm Water Detention Tank Systems, Technical Guide, Public Utility Board (PUB), Government of Singapore

G) Urban Stormwater Management Manual for Malaysia, MSMA 2nd Edition, 2012, Department of Irrigation and Drainage (DID), Government of Malaysia

H) Manual on Storm Water Drainage Systems, Volume-I, Part-A: Engineering Design, First Edition, May 2019, Central Public Health and Environment Engineering Organization (CPHEEO), Government of India

I) Guidelines for Planning and Design of Sewer System and Explanations, Japan Sewerage Works Association, Edition 2019 (in Japanese)

J) Technical Guidelines of Rainwater Water Retention Facility, and Explanations and Examples, Japan River Association, Edition 2007 (in Japanese)

K) Technical Guidelines of Catchment-wide Rainwater Retention Facilities, Association of Rainwater Storage and Infiltration Technology, Edition 2007 (in Japanese)

L) Technical Guidelines of Rainwater Infiltration Facilities, Association of Rainwater Storage and Infiltration Technology, Edition 2019 (in Japanese)

ဌာနမှပြဋ္ဌာန်းနိုင်ရန် စီစဉ်ဆောင်ရွက်ထားသည့် ရေစီးရေလာနှင့်သက်ဆိုင်သော

လုပ်ထုံးလုပ်နည်းမူကြမ်း

CODE OF PRACTICE (DRAFT) on

SURFACE WATER DRAINAGE (Drainage Design)

DRAINAGE DESIGN AND CONSIDERATIONS

1.Selection of the Appropriate Method for Calculating Runoff

To select the appropriate method, the TxDOT designer should consider, at a minimum, the following:

- Information required for design or evaluation and where that information is needed. For example, if the TxDOT project requires designing a culvert, the rational method, which computes peak only, may be adequate. However, if the TxDOT project is affected by or will affect behavior of a detention or retention pond, a runoff hydrograph will be required for the evaluation.
- Data available to develop the required hydrologic information. For example, the designer must determine if flow records are available from a stream gauge at or near the location of interest. If not, frequency analysis to find the design flow is not possible, nor is proper calibration of a conceptual model that will compute a hydrograph.
- Conditions in the watershed that may limit applicability of alternative models. For example, regression equations for Texas were estimated for watersheds with less than 10 percent impervious cover. If the watershed upstream of the point of interest has more impervious cover, the equations are not applicable. Similarly, if ponds, lakes, and depressions in the watershed will affect runoff by storing water, the rational equation will not be appropriate, as it does not simulate behavior of these features.

Methods acceptable for estimating peak discharges and runoff hydrographs for TxDOT design and evaluation include, but are not limited to the following:
1. **Statistical Analysis of Stream Gauge Data**(records in excess of 20 years stream gauge data require)
2. **Omega EM Regression Equations**.(should not be used for 1 sq mile(640 acres), reliable 10sq mile drainage area)
3. **Rational Method**.
4. **Hydrograph Method**.

Rational Method

This simple conceptual method estimates peak runoff rate for a selected frequency. It is appropriate for urban and rural watersheds less than 200 acres (80 hectares) in which natural or man-made storage is minor. It relies on an assumption that the design flow of a specified frequency is caused by rainfall of the same frequency. This method is best suited to the design of urban storm drain systems, small side ditches and median ditches, and driveway pipes.(HYDRAULIC DESIGN MANNUAL SEPT 2019)

Assumptions and Limitations

Use of the rational method includes the following assumptions and limitations:

❖ The method is applicable if tc for the drainage area is less than the duration of peak rainfall intensity.
❖ The calculated runoff is directly proportional to the rainfall intensity.
❖ The frequency of occurrence for the peak discharge is the same as the frequency of the rainfall producing that event.
❖ Rainfall is distributed uniform throughout the duration of the storm.
❖ The frequency of occurrence for the peak discharge is the same as the frequency of the rainfall producing that event.
❖ Rainfall is distributed uniformly over the drainage area.
❖ The minimum duration to be used for computation of rainfall intensity is 10 minutes. If the time of concentration computed for the drainage area is less than 10 minutes, then 10 minutes should be adopted for rainfall intensity computations.
❖ The rational method does not account for storage in the drainage area. Available storage is assumed to be filled.

The above assumptions and limitations are the reason the rational method is limited to watersheds 200 acres or smaller. If any one of these conditions is not true for the watershed of interest, the designer should use an alternative method.

The rational method represents a steady inflow-outflow condition of the watershed during the peak intensity of the design storm. Any storage features having sufficient volume that they do not completely fill and reach a steady inflow-outflow condition during the duration of the design storm cannot be properly represented with the rational method. Such features include detention ponds, channels with significant volume, and floodplain storage. When these features are present, an alternate rainfall-runoff method is required that accounts for the time-varying nature of the design storm and/ or filling/ emptying of floodplain storage. In these cases, the hydrograph method is recommended.

The rational formula estimates the peak rate of runoff at a specific location in a watershed as a function of the drainage area, runoff coefficient, and men rainfall intensity for a duration equal to the time of concentration. The rational formula is:

$$Q = \frac{CIA}{Z}$$

Where:

Q = maximum rate of runoff (cuft/sec or m3/sec.)
C = runoff coefficient
I = average rainfall intensity (in./hr. or mm/hr.)
A = drainage area (ac or ha)
Z = conversion factor, I for English, 360 for metric

The steps in developing and applying the rational method are illustrated in Figure.


```
┌─────────────────────────────────┐
│     Area is less than 200 acres  │
└─────────────────────────────────┘
                 ⇩
┌─────────────────────────────────┐
│   Estimate time of concentration │
└─────────────────────────────────┘
                 ⇩
┌─────────────────────────────────┐
│    Determine design rainfall     │
│    intensity for duration for    │
│       selected frequency         │
└─────────────────────────────────┘
                 ⇩
┌─────────────────────────────────┐
│   Configure rational equation    │
│    model; estimate parameter     │
└─────────────────────────────────┘
                 ⇩
┌─────────────────────────────────┐
│     Compute design peak flow     │
└─────────────────────────────────┘
                 ⇩
┌─────────────────────────────────┐
│         Validate / verify        │
└─────────────────────────────────┘
```
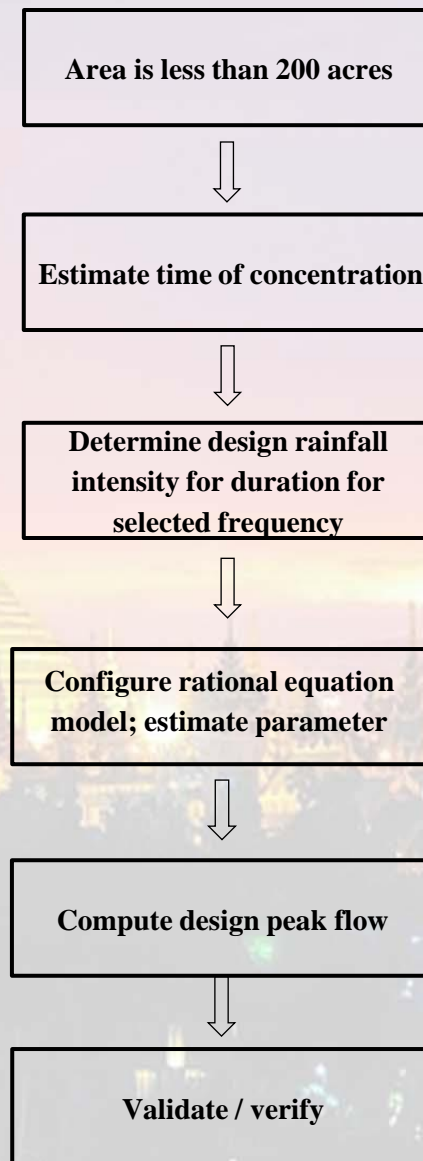
Figure: Steps in developing and applying the rational method

Hydrograph Method

A hydrograph represents runoff as it varies over time at a particular location within the watershed. The area integrated under the hydrograph represents the volume of runoff. Estimation of a runoff hydrograph, as opposed to the peak rate of runoff, is necessary for watersheds with complex runoff characteristics. The hydrograph method also should be used when storage must be evaluated, as it accounts explicitly for volume and timing of runoff. The hydrograph method has no drainage area size limitation. **(TxDOT, Hydraulic Design Manual, September 2019)**

The hydrograph method is applicable for watersheds in which tc is longer than the duration of peak rainfall intensity of the design storm. Precipitation applied to the watershed model is uniform spatially, but varies with time. The hydrograph method accounts for losses (soil infiltration for example) and transforms the remaining (excess) rainfall into a runoff hydrograph at the outlet of the watershed. Because the resulting runoff hydrograph is a time series of flow values, the method provides a peak flow value as well as volume of runoff. This makes the method suitable for design problems requiring runoff volume as a design parameter. **(TxDOT, Hydraulic Design Manual, September 2019)**

Unit Hydrograph Methods (Source: Urban Drainage Design Manual (U.S, Aug 2013))

A unit hydrograph is defined as the direct runoff hydrograph resulting from a rainfall event that has a specific temporal and spatial distribution and that lasts for a unit duration of time. The ordinates of the unit hydrograph are such that the volume of direct runoff represented by the area under the hydrograph is equal to one millimeter of runoff from the drainage area.(6) In the development of a unit hydrograph, there are several underlying assumptions made such as uniform rainfall intensity and duration over the entire watershed. To minimize the effects of non-uniform intensity, a large storm that encompasses the majority of the watershed should be employed. Additionally, storm movement can effect the runoff characteristics of the watershed. Storms moving down a long and narrow watersheds will produce a higher peak runoff rate and a longer time to peak. In order to overcome these limitations, limit use of unit hydrographs to drainage areas less than 2590 km2 (1000 mi2).

- **Snyder Synthetic Unit Hydrograph**

In 1938, Mr. Franklin Snyder developed a means to generate a synthetic unit hydrograph. The Corps of Engineers extensively adopted the Snyder method for many hydrological situations. In the Snyder method, empirically defined terms and the physiographic characteristics of the drainage basin are used to determine a unit hydrograph. The key parameters which are explicitly calculated are the lag time, the unit hydrograph duration, the peak discharge, and the hydrograph time widths of 50 and 75% of the peak discharge. With these points, a characteristic unit hydrograph is sketched. The volume of this hydrograph is then checked to ensure it equals one millimeter of runoff. If it does not, it is adjusted accordingly. A typical Snyder hydrograph is shown in Figure.

In the figure:

T_R = Duration of unit excess rainfall, hr

T_L = Lag time from the centroid of the unit rainfall excess to the peak of the unit hydrograph, hr

t_p = Time to peak flow of hydrograph, hr

W_{50}, W_{75} = Time width of unit hydrograph at discharge equal to 50 and 75%, hr

T_b = Time duration of the unit hydrograph, hr

Snyder initially applied his Unit Hydrograph for watersheds in the Appalachian highlands; however, the general method has been successfully applied throughout the country by appropriate modification of empirical constants employed in the method.(6) HDS 2 provides additional information and an example problem that describes the procedures for computing the Snyder Synthetic Unit Hydrograph.
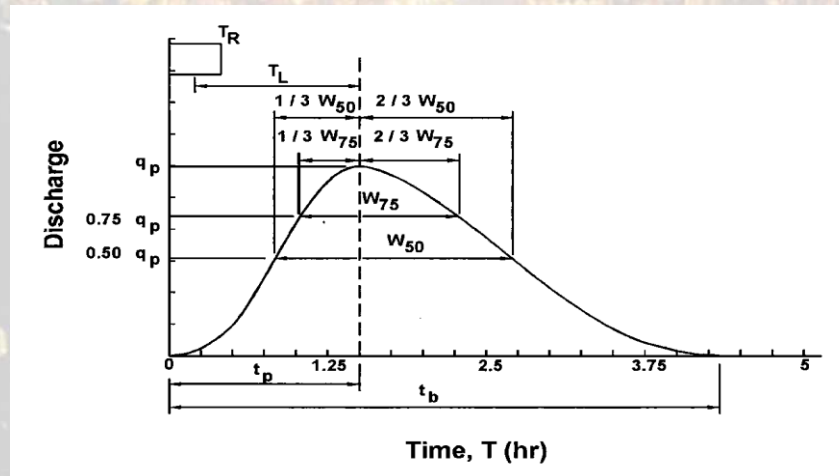
Figure.   Snyder synthetic hydrograph definition (Source: Urban Drainage Design Manual (U.S, Aug **2013**))

- ## **SCS (NRCS) Tabular Hydrograph**

The Soil Conservation Service (now known as the National Resources Conservation Service) has developed a tabular method used to estimate partial composite flood hydrographs at any point in a watershed. This method is generally applicable to small, nonhomogeneous areas which may be beyond the limitations of the Rational Method. It is applicable for estimating the effects of land use change in a portion of the watershed as well as estimating the effects of proposed structures.

The basis of the SCS Tabular Hydrograph method is a series of unit discharge hydrographs expressed in cubic meters of discharge per second per square kilometer (cubic feet of discharge per second per square mile) of watershed per millimeter (in) of runoff. A series of these unit discharge hydrographs are provided for a range of subarea times of concentration (Tc) from 0.1 hr to 2 hours, and reach travel times (Tt) from 0 to 3 hours.

The tabular method determines the hydrograph ordinates for a specific time by multiplying together the runoff depth, the subarea, and the tabular hydrograph unit discharge value for that time as determined from the tables.

$$q = q_t \, A \, Q_D \quad (3\text{-}21)$$

where:

q = Hydrograph ordinate for a specific time, m^3/s (ft^3/s)

q_t = Tabular hydrograph unit discharge from appropriate table, $m^3/s/km^2mm$ ($ft^3/s/mi^2/in$)

A = Sub-basin drainage area, km^2 (mi^2)

Q_D = Runoff depth, mm (in)

Assumptions and limitations inherent in the tabular method are as follows:

• Total area should be less than 800 hectares (2000 acres). Typically, subareas are far smaller than this because the subareas should have fairly homogeneous land use
• Travel time is less than or equal to 3 hours
• Time of concentration is less than or equal to 2 hours
• Drainage areas of individual subareas differ by less than a factor of five

2.Time of Concentration

The peak runoff (Qr) occurs at the point of design when all parts of the catchment receiving a steady, uniform rainfall intensity are contributing to the outflow at this point. This condition is met when the duration of rainfall equals the time of concentration (tc). The time of concentration (tc) consists of the overland flow time (to) plus the drain flow time from the most remote drainage inlet to the point of design (td), viz. tc = to + td.

The overland flow time (to) varies from 5 minutes to 15 minutes, depending on the overland travel distance, land topography and characteristics. The drain flow time (td) shall be estimated from the hydraulic properties of the drainage channel.(PUB 2018 7th EDITION)

Time of Concentration (t_c) is the time required for an entire watershed to contribute to runoff at the point of interest for hydraulic design; this time is calculated as the time for runoff to flow from the most hydraulically remote point of the drainage area to the point under investigation. Travel time and t_c are functions of length and velocity for a particular watercourse. A long but steep flow path with a high velocity may actually have a shorter travel time than a short but relatively. The designer must identify the flow path along which the longest travel time is likely to occur.

In watersheds with low (flat) topographic slope, the calculation of t_c using commonly accepted equations with slope in the denominator often results in unreasonably large values. That is, as the slope approaches zero, the travel time approaches infinity. In addition, since intensity is a function of depth divided by t_c, a long t_c produces a very small intensity and thus small flow rate. Cleveland et al. 2012 recommends an adjustment of 0.0005 to the slope in both the Kerby and Kirpich methods to allow more realistic results for low topographic slope watersheds.

❖ The adjusted slope becomes S_{low} slope = S_0 + 0.0005 (dimensionless)
❖ If the slope is less than 0.002 ft/ft (0.2%), a low slope condition exists and the adjusted slope should be used.
❖ If the slope is between 0.002 ft/ft (0.2%) and 0.003 ft/ft(0.3%), the situation is transitional and the user must use judgment on whether or not to use the low slope adjustment.

When runoff is computed using the rational method, t_c is the appropriate storm duration and in turn determine the appropriate precipitation intensity.

When peak discharge and stream flow timing are computed using the hydrograph method, t_c is used to compute certain rainfall-runoff parameters for the watershed. The value of t_c is used as an input to define the appropriate storm duration and appropriate precipitation depth.**(HYDRAULIC DESIGN MANNUAL SEPT 2019**)

(Time of concentration is the time required for the rainwater to flow to reach the farthest point of the drainage system or the outfall under consideration. Time of concentration is equal to the inlet time plus the time required for the flow to reach the main or branch drain. The inlet time is the time dependent on the distance of the farthest point in the drainage area to the inlet of the manhole and the surface slopes, etc and will vary between 5 min to 30 min.

In highly developed sections, for example with impervious surfaces it may be as low as 3 min or lower (with good slope) as building terraces and paved areas. Correspondingly, the design intensity for the drainage for such areas will be much higher. Rainwater pipes have to be designed for an intensity for a very low time of concentration. (MNBC; 5D.5.5.11.2.4))

3.Runoff Coefficient

The runoff coefficient(C) depends on the degree and type of development within the catchment. Catchments are classified according to the expected general characteristics when fully developed. The C values are as follows:(SG PUB2018)

Characteristics of catchment when fully developed	Value of C
Roads, highways, airport runways, paved up areas	1.00
Urban areas fully and closely built up (heavy Industrial, Downtown)	0.90
Residential/industrial areas densely built up	0.80
Residential/industrial areas not densely built up	0.65
Rural areas with fish ponds and vegetable gardens	0.45
Parks & cemetery	0.1 – 0.25
Playground	0.2 – 0.35
Asphalt Cement Street	0.7 – 0.95
Travel drive ways & walks	0.3

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Note: For catchments with composite land use or surface characteristics,   a weighted value of C may be adopted.

Table: **Runoff Coefficients for Urban Watersheds (TxDOT, Hydraulic Design Manual, September 2019)**

Type of drainage area	Runoff coefficient
Business:	
Downtown areas	0.70-0.95
Neighborhood areas	0.30-0.70
Residential:	
Single-family areas	0.30-0.50
Multi-units, detached	0.40-0.60
Multi-units, attached	0.60-0.75
Suburban	0.35-0.40
Apartment dwelling areas	0.30-0.70
Industrial:	
Light areas	0.30-0.80
Heavy areas	0.60-0.90
Parks, cemeteries	0.10-0.25
Playgrounds	0.30-0.40
Railroad yards	0.30-0.40

Unimproved areas:	
Sand or sandy loam soil, 0-3%	0.15-0.20
Sand or sandy loam soil, 3-5%	0.20-0.25
Black or loessial soil, 0-3%	0.18-0.25
Black or loessial soil, 3-5%	0.25-0.30
Black or loessial soil, > 5%	0.70-0.80
Deep sand area	0.05-0.15
Steep grassed slopes	0.70
Lawns:	
Sandy soil, flat 2%	0.05-0.10
Sandy soil, average 2-7%	0.10-0.15
Sandy soil, steep 7%	0.15-0.20
Heavy soil, flat 2%	0.13-0.17
Heavy soil, average 2-7%	0.18-0.22
Heavy soil, steep 7%	0.25-0.35
Streets:	
Asphaltic	0.85-0.95
Concrete	0.90-0.95
Brick	0.70-0.85
Drives and walks	0.75-0.95
Roofs	0.75-0.95

YCDC PROPOSAL

Type of drainage area	Runoff coefficient
Business:	
Downtown areas	0.70-0.95
Neighborhood areas	0.30-0.70
Residential:	
Single-family areas	0.30-0.50
Multi-units, detached	0.40-0.60
Multi-units, attached	0.60-0.75
Suburban	0.35-0.40
Apartment dwelling areas	0.30-0.70

Industrial:			
Light areas	0.30-0.80		
Heavy areas	0.60-0.90		
Parks, cemeteries	0.10-0.25		
Playgrounds	0.30-0.40		
Railroad yards		0.30-0.40	
Lawns:			
Sandy soil, flat 2%		0.05-0.10	
Sandy soil, average 2-7%		0.10-0.15	
Sandy soil, steep 7%		0.15-0.20	
Heavy soil, flat 2%		0.13-0.17	
Heavy soil, average 2-7%		0.18-0.22	
Heavy soil, steep 7%		0.25-0.35	
Streets:			
Asphaltic		0.85-0.95	
Concrete		0.90-0.95	
Brick		0.70-0.85	
Drives and walks		0.75-0.95	
Roofs		0.75-0.95	

4.Rainfall Intensity

For a storm of return period (T) years, the rainfall intensity (I) is the average rate of rainfall from such a storm having a duration equal to the time of concentration (tc). The rainfall intensity (I) can be obtained from the Intensity-Duration-Frequency (IDF) curves by estimating the duration of rainfall (equals to the time of concentration, tc) and selecting the required return period of (T) years.

$$I = \frac{b}{(t_c+d)^e}$$

Where:

I   = design rainfall intensity (in./hr.)

t_c = time of concentration (min) as discussed in Section 11

e, b, d =   coefficients based on rainfall IDF data

5. The Intensity-Duration-Frequency (IDF) curves

sample
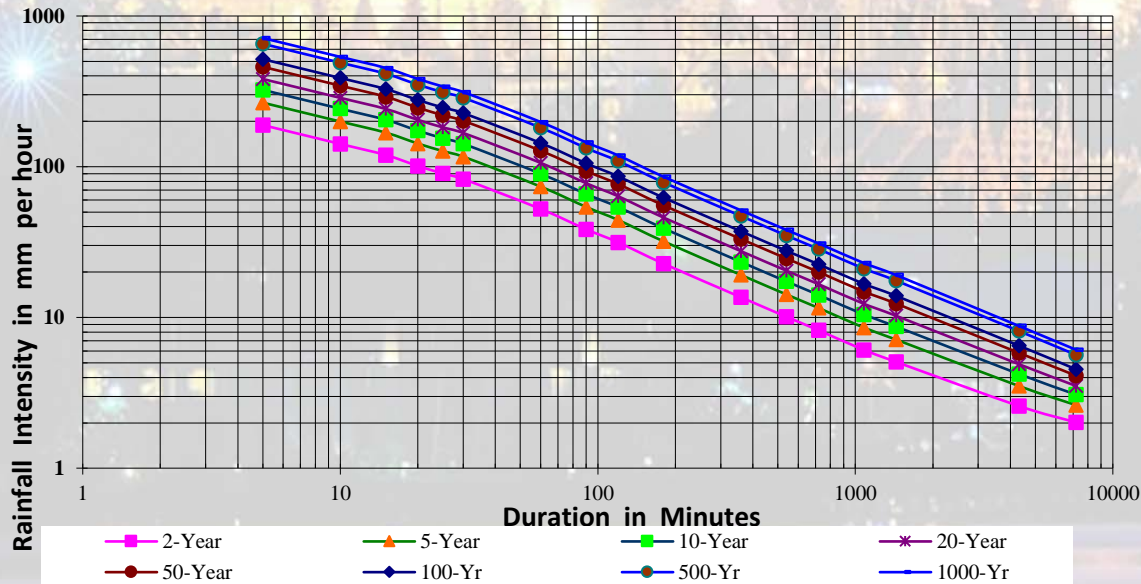
YCDC will be adopted IDF curve from Prof Dr. Win Win Zin(YTU)

Design Frequency (MNBC; 5D.5.5.11.2.3)

Storm water drainage system for an urbanized area is planned on the basis of the design of the storm which shall be determined by the designer. Frequency is the period in which the selected design intensity recurs in a given period of time in years.

Singapore Code

Area Served by Drainage System	Return Period (T)
Catchment of less than 100 ha	10 years
Catchment of 100 to 1000 ha	25 years
Catchment of more than 1000 ha	50 years
Airport runway or any area as specified by the Board	100 years

BS EN 752.2008

Location	Design storm return period (years)	Design flooding return period (years)
Rural	1 years	10 years
Residential areas	2 years	20 years
City centers/ industrial/		
Commercial areas:		
- With flooding check	2 years	30 years
- Without flooding check	5 years	-
Underground railways/ underpasses	10 years	50 years

(Urban Storm water Management Manual for Malaysia) NEPS

Type of Development (See Note 1)	Minimum ARI (years) (See Note 2)	
	Minor System (See Note 3)	Major System (See Note 3)
Residential		
- Bungalow and semidetached dwellings	5 years	50 years
- Link house/ apartment	10 years	100 years
Commercial and business center	10 years	100 years
Industry	10 years	100 years
Sport field, park and agricultural land	2 years	20 years
Infrastructure/ utility	5 years	100 years
Institutional building/ complex	10 years	100 years

Recommended Design Return Period for various types of urban

No.	Urban Catchment	Return Period	
		Mega Cities	Other Cities
1.	Central Business and commercial	Once in 5 years	Once in 2 years
2.	Industrial	Once in 5 years	Once in 2 years
3.	Urban Residential		
	Core Area	Once in 5 years	Once in 2 years
	Peripheral Area	Once in 2 years	Once in 1 years
4.	Open space, Parks and landscape	Once in 6 months	Once in 6 months
5.	Airports and other critical infrastructure*	Once in 100 years	Once in 50 years

YCDC

Design Frequency Return Period

The return periods (T) adopted for the design of drainage systems in YANGON CITY shall be as follows
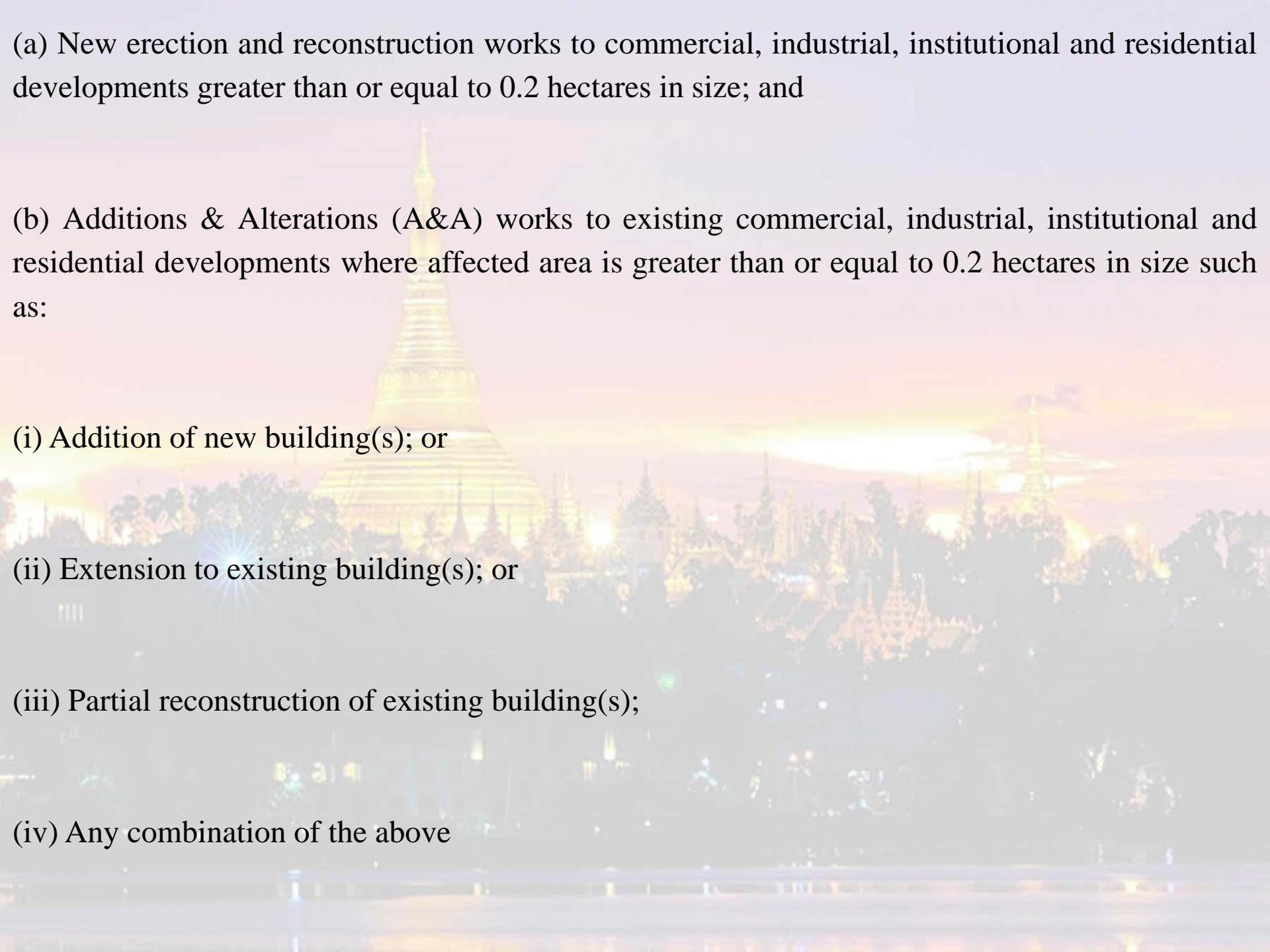
Flood zone	Usage	Proposed Area /Catchment area	Drainage type	Return period
Low	Residential Mixed used Industrial Office & School		Inhouse drain Public drain Box culvert	
Medium				
High				

Table

5.Maximum Allowable Peak Runoff <mark>(Planning Guidance: page 25, table 5)</mark>

<mark>Discharge flow rate does not exceed limits set by YCDC (m³/s)</mark>

The following types of developments are required to control the peak runoff discharged from the affected development sites:

(a) New erection and reconstruction works to commercial, industrial, institutional and residential developments greater than or equal to 0.2 hectares in size; and

(b) Additions & Alterations (A&A) works to existing commercial, industrial, institutional and residential developments where affected area is greater than or equal to 0.2 hectares in size such as:

(i) Addition of new building(s); or

(ii) Extension to existing building(s); or

(iii) Partial reconstruction of existing building(s);

(iv) Any combination of the above

(The maximum allowable peak runoff to be discharged to the drains will be calculated based on a runoff coefficient of 0.55, and for design storms with a return period of 10 years and for various storm durations of up to 4 hours (inclusive).) About 20 percentage of actual discharge can be allowable to YCDC drains.

Peak runoff reduction can be achieved through the implementation of such structure:
(i) Detention tanks;

(ii) Retention/sedimentation ponds;

(iii) Wetlands;

(iv) Bio retention swales;

(v) Bioretention basins or rain gardens;

(vi) Porous pavements, etc.

(vii) Improvement of existing drains till main outlet (YCDC current regulation)

Harvesting in regular rainfall areas (MNBC; 5D.5.5.12.3.1)

In areas having rainfall over a larger period in a year for example, in hilly areas and coastal regions, constant and regular rainfall can be usefully harvested and stored in suitable water tanks. Water is collected through roof gutters and down take pipes. Provision should be made to divert the first rainfall after a dry spell so that any dust, soot, leaves etc, are drained away before the water is collected into the water tank. The capacity of the water tank should be enough for storing water required for consumption between two dry spells. The water tank should be located in a well protected area and should not be exposed to any hazards of water contamination from any other sources. The water shall be chlorinated using chlorine tablets or solution to maintain a residual chlorine of approximately 1 ppm. The tanks must have an overflow to a natural water courses or to any additional tanks.

Harvesting in urban areas (MNBC; 5D.5.5.12.3.2)

In urban areas with the rainfall limited during the monsoon period usually from 15-90 days roof top rain-water cannot be stored and used as mentioned above and is best used for recharging the ground water. For individual properties and plots the roof top rain-water should be diverted to existing open or abandoned tube wells. In a well building complex the system should be laid out so that the runoff is discharged bore-wells as per designs specified by the Authority.

6. Computation of Discharge Capacity

Steady Uniform Flow Condition

Drains are designed for steady uniform flow conditions and one-dimensional method of analysis is used.

Manning's Formula

Drains shall be designed to have discharge capacities (Qc) adequate to cope with the estimated peak runoffs (Qr). The size, geometry and the bed gradient of a drain determine its discharge capacity (Qc). With the required discharge capacity (Qc) determined [which must be equal to or larger than the peak runoff (Qr)], the size of the drain is computed from the Manning's Formula:

$$Qc \; = \; \frac{1}{n} A R^{\frac{2}{3}} S^{\frac{1}{2}}$$

Where;

Q_c = discharge capacity of drain (m_3/s)

n   = roughness coefficient

A = flow area (m2)

P = wetted perimeter (m)

R =   A/P = hydraulic radius (m)

S =   bed gradient

The maximum rate of discharge flow shall be taken as thrice the average rate, allowance being made in addition for any exceptional peak discharges. A good average rule is to allow for a flow of liquid waste from buildings at the rate of 3 litres per minute per 10 persons.

Roughness Coefficient

The value of the roughness coefficient (n) depends on the drain's flow surface and is given below:

Boundary Condition	Roughness Coefficient (n)
Unplasticised Polyvinyl Chloride (UPVC)	0.0125
Concrete	0.0150
Brick	0.0170
Earth	0.0270
Earth with stones and weed	0.0350
Gravel	0.0300

Note: Where there are different flow surfaces within a drain section equivalent, roughness coefficient may be used.

Table : Manning's Roughness Coefficients for Open Channels

Type of Channel	Manning's n
B. Excavated or dredged channels	
1. Earth, straight and uniform	0.016-0.020
a. Clean, recently completed	0.016-0.020
b. Clean, after weathering	0.018-0.025
c. Gravel, uniform section, clean	0.022-0.030
d. With short grass, few weeds	0.022-0.033
2. Earth, winding and sluggish	
a. No vegetation	0.023-0.030
b. Grass, some weeds	0.025-0.033
c. Deep weeds or aquatic plants in deep channels	0.030-0.040
d. Earth bottom and rubble sides	0.028-0.035
e. Stony bottom and weedy banks	0.025-0.040
f. Cobble bottom and clean sides	0.030-0.050
g. Winding, sluggish, stony bottom, weedy banks	0.025-0.040
h. Dense weeds as high as flow depth	0.050-0.120
3. Dragline-excavated or dredged	
a. No vegetation	0.025-0.033
b. Light brush on banks	0.035-0.060
4. Rock cuts	
a. Smooth and uniform	**0.025-0.040**
b. Jagged and irregular	0.035-0.050
5. Unmaintained channels	
a. Dense weeds, high as flow depth	0.050-0.120
b. Clean bottom, brush on sides	0.040-0.080
c. Clean bottom, brush on sides, highest stage	0.045-0.110
d. Dense brush, high stage	0.080-0.140
C. Lined channels	
1. Asphalt	0.013-0.016
2. Brick (in cement mortar)	0.012-0.018
3. Concrete	
a. Trowel finish	0.011-0.015
b. Float finish	0.013-0.016
c. Unfinished	0.014-0.020
d. Gunite, regular	0.016-0.023
d. Gunite, regular	0.016-0.023
e. Gunite, wavy	0.018-0.025
4. Riprap (n-value depends on rock size)	0.020-0.035
5. Vegetal lining	0.030-0.500

Table : Manning's Roughness Coefficients for Closed Conduits (ASCE 1982, FHWA 2001)

Material	Manning's n
Asbestos-cement pipe	0.011-0.015
Brick	0.013-0.017
Cast iron pipe	
Cement-lined & seal coated	0.011-0.015
Concrete (monolithic)	
Smooth forms	0.012-0.014
Rough forms	0.015-0.017
Concrete pipe	0.011-0.015
Box (smooth)	0.012-0.015
Corrugated-metal pipe -- (2-1/2 in. x 1/2 in. corrugations)	
Plain	0.022-0.026
Paved invert	0.018-0.022
Spun asphalt lined	0.011-0.015
Plastic pipe (smooth)	0.011-0.015
Corrugated-metal pipe -- (2-2/3 in. by 1/2 in. annular)	0.022-0.027
Corrugated-metal pipe -- (2-2/3 in. by 1/2 in. helical)	0.011-0.023
Corrugated-metal pipe -- (6 in. by 1 in. helical)	0.022-0.025
Corrugated-metal pipe -- (5 in. by 1 in. helical)	0.025–0.026
Corrugated-metal pipe -- (3 in. by 1 in. helical)	0.027–0.028
Corrugated-metal pipe -- (6 in. by 2 in. structural plate)	**0.033–0.035**
Corrugated-metal pipe -- (9 in. by 2-1/2 in. structural plate)	0.033–0.037
Corrugated polyethylene	0.010–0.013
Smooth	0.009-0.015
Corrugated	0.018–0.025
Spiral rib metal pipe (smooth)	0.012-0.013
Vitrified clay	
Pipes	0.011-0.015
Liner plates	0.013-0.017
Polyvinyl chloride (PVC) (smooth)	0.009-0.011

Table note: Manning's n for corrugated pipes is a function of the corrugation size, pipe size, and whether the corrugations are annular or helical (see USGS 1993).

YCDC will adopt ASCE manning's roughness coefficient (n).

Maximum Velocity and minimum velocity

The velocity of flow in a drain shall not be too great to cause excessive scouring or hydraulic jumps. Hence the velocity of flow in a concrete-lined drain shall be limited to a maximum of 3.0 m/s or below the critical velocity, whichever is lower. For an earth stream, the maximum velocity shall be limited to 1.5 m/s. Further limitation of the maximum velocity shall be complied with when specified by the Board. (Citation)

On the other hand, it is undesirable to employ gradients giving a velocity of flow greater than 8 ft/s. Where it is unavoidable, cast iron pipes shall be used. The approximate gradients, which give a velocity of 8 ft /s for pipes of various sizes. (MNBC 5D.5.5.3.5.2.4).

Sub-critical Flow

Drains are designed to carry sub-critical flows. Critical state of flow exists when the Froude Number is equal to one. An open channel flow at or near the critical state shall be avoided as under such a condition the water surface is unstable and wavy. In order to secure greater flow efficiency, channel flow shall be designed so that the Froude Number shall fall within the range from 0.8 decreasing to such minimum value as to achieve a practical flow depth and permissible flow velocity.

Freeboard

Freeboard refers to the depth from the top of the drain (cope/bank) to the top of the water surface in the drain at design flow condition. Sufficient freeboard shall be provided to prevent waves or fluctuation of the water surface from overflowing the cope/bank. Generally, a depth of freeboard equivalent to 15% of the depth of the drain is required.

7.DRAINAGE STRUCTURES AND FACILITIES

7.1.Drain and Culvert

All U-shaped drains and box culverts shall be designed to be hydraulically adequate, structural sound and geotechnically stable in accordance with the current codes, specifications and requirements.

All roadside drains shall be constructed in accordance with DWMA specifications shown in Drawing No. 1 or such other drawings to be issued by MNBC.

7.2. Transition

A transition is required where there is a change of drain cross-section. The purpose of a transition is to change the shape of flow and surface profile in such a manner that minimum energy losses occur and cross waves and other turbulence are reduced. This may be achieved using tapering walls with no sudden changes of cross-section. The minimum length of a transition shall be 1.5 times the width of the wider drain section.

7.3. Curves and Bends

The presence of curves or bends in drain alignment is sometimes unavoidable. Difficulties in design often arise because of the complexity of the flow around a curved path. A drain curve will increase frictional loss and lead to the danger of serious local erosion due to spiral flow. Hence, the radius of any horizontal curve shall be as large as possible, consistent with the general terrain, in order to reduce the super elevation of the water surface and preserve the freeboard. A horizontal curve shall have a minimum radius of 3 times the width of the drain channel.

The benching of the drain at the bend shall be configured to minimize sedimentation at the inner side of the bend. For this purpose, the dry weather flow channel at the bend shall be aligned towards the outer side of the bend, with the centre of the channel spaced at a quarter of the drain width from the outer cope of the drain.

7.4.Sump for Drain Intersections

A sump of sufficient size shall be provided where drains converge. The minimum internal width of the sump shall not be less than 1.5 times the width of the drain leading away from the sump. Drains shall enter the sump at angles less than a right angle and at different levels wherever possible. The invert level of the downstream drain shall be lower than the invert level of the sump so that no stagnant water will collect in the sump.

7.5.Drain Connection to Existing Drain

-Drain connection shall not join an existing drain at an angle that is against its flow. Invert level of the drain connection shall be as high as hydraulically possible and must not be lower than the benching level of the drain receiving the flow.

 -At all T-junctions of roads with one or more of the connecting side roads sloping down towards the junction, drop-inlet chambers shall be provided at every 3m or alternatively.Slot-outlets may also be used where an existing roadside drain is less than 500 mm deep or at areas outside the road carriageways such as carparks.

-The size of openings and discharge pipe into the storm water drainage system has to be at least 250 mm diameter. The discharge pipe that is constructed has to avoid 90 degree bend for discharge towards downstream

7.6.Safety Railings

Standard safety railings shall be provided for all open drains more than 2.0 m deep.

Grating over Closed Drain/Culvert

All gratings provided over closed drains/culverts shall be hinged to fixed frames securely embedded into the drain structures. Mild steel heavy duty gratings shall be used for closed drains subjected to vehicular loadings, whereas light duty gratings shall only be used for pedestrian loadings. The gratings, frames and chequered plates shall be galvanized. The details of the gratings and chequered plates shall be designed in accordance with the Land Transport Authority's latest Standard Details of Road Elements.

Where a culvert runs across the road, no sump/grating shall be sited on the road carriageway. Where necessary, sumps with galvanized mild steel gratings shall be provided at the two side-tables of the road. In the case of a dual carriageway, a sump with galvanized heavy duty mild steel grating shall be provided at the centre divider.

The size and spacing of gratings required shall be based on the internal width of the closed drain, as follows:

Internal Width (W)	Grating Size	Grating Spacing
W > 4 m	850 mm x 1000 mm in addition 4 m x 2 m (opening)	50 m (staggered) 500 m
2 m < W ≤ 4 m	850 mm x 1000 mm in addition 1.5 m x 1.5 m (opening)	50 m (staggered) 500 m
750 mm < W ≤ 2 m	850 mm x 1000 mm	6 m (for drain ≤ 1 m deep) or 18 m (for drain > 1 m deep)
W ≤ 750 mm	700 mm x 850 mm*	6 m

Note: (i) Rungs shall be embedded at the drain wall at every opening/grating for closed drains with internal depth equal to or greater than 0.9m in accordance with Clause 9.10.

(ii) For drain or drainage reserve within the development site, maintenance opening shall comply with the requirements specified in Clause 5.4c.

* Subject to approval of the Board, if the minimum size of closed drain as specific in Clause 4.3.1 cannot be met, the details of the Grating may be designed in accordance with the drawing as shown in Drawing No. 7A or 7B

Where a closed drain exceeds 3 m deep, access shaft (2 m by 1.5 m) may be required by the Board. If the access shaft is deeper than 4 m, intermediate platform shall be provided as shown in Drawing No. 3.

Entrance Culvert/Crossing

Where an entrance culvert/crossing is proposed at a stretch of closed drain, gratings/ openings shall be provided at the closed drain sections upstream and downstream of the proposed entrance culvert/ crossing.

Live Loads on Drains

In the design of drains, stability of the slope and upheaval shall be considered. A nominal live load surcharge of 10 kN/m$_2$ shall be taken into consideration in the design of drains except as qualified by Clause 9.13.2 and Clause 9.13.4.

For drains that are adjacent to roads and are affected by vehicular loading, a live load surcharge of 20 kN/m$_2$ shall be taken into consideration in the design of drains.

Culverts carrying vehicular loading shall be designed to withstand bridge loading in accordance with Land Transport Authority's standards.

For drains that are required to install 4 m x 2 m grating as stipulated in Clause 5.4.cii, the drains shall be designed to withstand bridge loading in accordance with Land Transport Authority's standards.

8. PUMPED DRAINAGE SYSTEM

The minimum design and operation criteria for the pumped drainage system shall be as follows:

(a) The pumping capacity shall be adequate to cater for immediate discharge of the storm water ingress of not less than 150 millimetres per hour from the entire source catchment area; i.e.:
where P = pumping capacity (m_3/s)
I = rainfall intensity (mm/hr)
A = catchment area contributing to ingress of storm water (m_2)

(b) There shall be minimally one complete set of back-up pumping equipment, including back-up pumps and pumping mains. The pumped drainage system shall be supported by a generator should the main power supply fail.

(c) The pumping installation shall be designed with an automated device to start the pumping operation at times of storm water ingress, with operational option for manual control to override the automated device whenever desired.

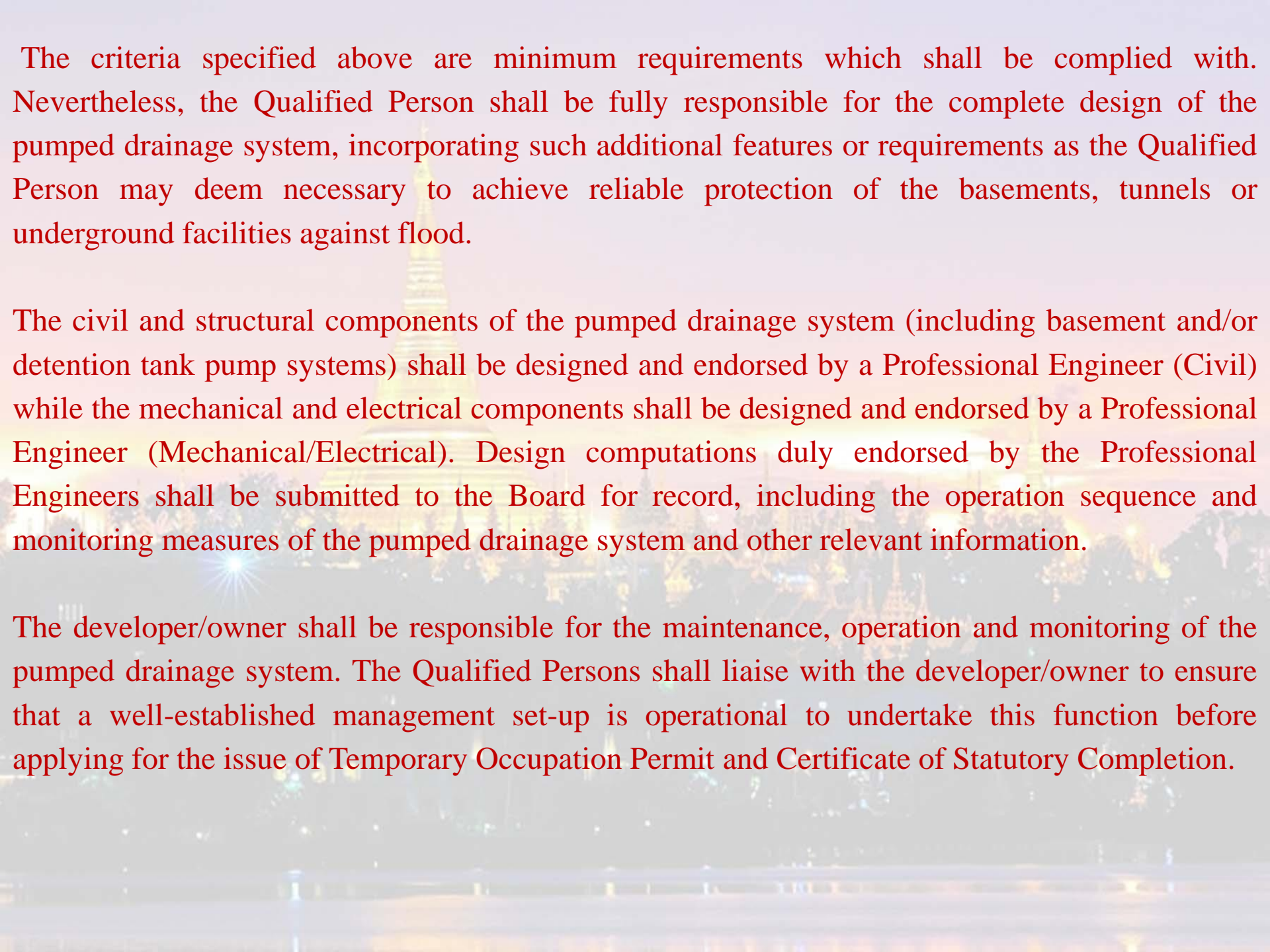(d) Adequate pump sump shall be provided with sufficient

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Adequate pump sump shall be provided with sufficient storage capacity to cater for the total quantum of inflow from the entire source catchment area over a duration of at least 3 hours or such longer period as may be deemed necessary by the Qualified Person or as required by the Board for the re-activation of the pumping installation in the event of emergency breakdown/repairs or power failure, based on the maximum recorded rainfall given below:

Duration (hrs)	3	4	5	6	12	24
Total Rainfall (mm)						
	196.9	210.6	253.4	281.9	376.7	533.2

(e) The Qualified Person shall formulate and implement a well-regulated procedure for the maintenance, operation and monitoring of the pumped drainage system.

(f) The base of the pump sump shall be designed with a gradient of 1:40 or steeper, and which shall be graded towards the pumps. The pumps shall be located within a small sump pit which should be deeper than the pump sump so that there will be no stagnant water in the pump sump at all times.

The criteria specified above are minimum requirements which shall be complied with. Nevertheless, the Qualified Person shall be fully responsible for the complete design of the pumped drainage system, incorporating such additional features or requirements as the Qualified Person may deem necessary to achieve reliable protection of the basements, tunnels or underground facilities against flood.

The civil and structural components of the pumped drainage system (including basement and/or detention tank pump systems) shall be designed and endorsed by a Professional Engineer (Civil) while the mechanical and electrical components shall be designed and endorsed by a Professional Engineer (Mechanical/Electrical). Design computations duly endorsed by the Professional Engineers shall be submitted to the Board for record, including the operation sequence and monitoring measures of the pumped drainage system and other relevant information.

The developer/owner shall be responsible for the maintenance, operation and monitoring of the pumped drainage system. The Qualified Persons shall liaise with the developer/owner to ensure that a well-established management set-up is operational to undertake this function before applying for the issue of Temporary Occupation Permit and Certificate of Statutory Completion.

General (MNBC; 5D.5.5.10.1)

A manhole or inspection chamber shall be capable of sustaining the loads which may be imposed on it, exclude sub-soil water and be water-tight. The size of the chamber should be sufficient to permit ready access to the drain or sewer for inspection, cleaning and rodding and should have a removable cover of adequate strength, constructed of suitable and durable material. Where the depth of the chamber so requires, access rungs, step irons, ladders or other means should be provided to ensure safe access to the level of the drain or sewer. If the chamber contains an open channel, benching should be provided having a smooth finish and formed so as to allow the foul matter to flow towards the pipe and also ensure a safe foothold.

No manhole or inspection chamber shall be permitted inside a building or in any passage therein. Further, ventilating covers shall not be used for domestic drains. At every change of alignment, gradient or diameter of a drain, there shall be a manhole or inspection chamber. Bends and junctions in the drains shall be grouped together in manholes as far as possible.

Maximum Spacing of manholes (MNBC; 5D.5.5.10.2)

The maximum spacing of manholes for a given pipe size should be as follows:

Pipe Diameter	Maximum Spacing of Manhole
inches	feet
Up to 6	50
> 6 to 12	100
>12 to 18	150
>18 to 36	250
Beyond 36	300 or spacing shall depend upon local condition and shall be gotten approved by the Authority

Where the diameter of a drain is increased, the crown of the pipes shall be fixed at the same level and the necessary slope given in the invert of the manhole chamber. In exceptional cases and where unavoidable, the crown of the branch sewer may be fixed at a lower level, but in such cases the peak flow level of the two sewers shall be kept the same.

Size of manhole (MNBC; 5D.5.5.10.3)

The manhole or chamber shall be of such size as will allow necessary examination or clearance of drains. The size of manhole shall be adjusted to take into account any increase in the number of entries into the chamber.

Manholes may be rectangular, arch or circular type. The minimum internal size of manholes, chambers (between faces of masonry) shall be as follows (MNBC; 5D.5.5.10.3.1):

(a) <u>Rectangular Manholes</u>

(1) For depths less than 3 feet 3 feet x 2 feet 8 inches
(2) For depths from 3 feet and up to 8 feet 4 feet x 3 feet

(b) <u>Arch Type Manholes</u>

(a) For depths of 8 feet and above 4 feet 6 inches x 3 feet

NOTE—The width of manhole chamber shall be suitably increased more than 3feet on bends, junctions or pipes with diameter greater than 1 feet 6 inches so that benching width in either side of channel is minimum 8 inches.

(c) Circular Manholes

(1) For depths above 3 feet and up to 5 feet 6 inches 3 feet - diameter
(2) For depths above 5 feet 6 inches and up to 7 feet 6 inches 4 feet - diameter
(3) For depths above 7 feet 6 inches and up to 29 feet 6
inches 5 feet - diameter
(4) For depths above 29 feet 6 inches and up to 46 feet 6 feet – diameter

NOTES

1 In adopting the above sizes of chambers, it should be ensured that these sizes accord with full or half bricks with standard thickness of mortar joints so as to avoid wasteful cutting of bricks.

2 The sizes of the chambers may be adjusted to suit the availability of local building materials and economics of construction.

3 The access shaft shall be corbelled inwards on three sides at the top to reduce its size to that of the cover frame to be fitted or alternatively the access shaft shall be covered over by a reinforced concrete slab of suitable dimensions with an opening for manhole cover and frame.

ဆောက်လုပ်ခွင့်တင်တဲ့အဆောက်အဦရှေ့မှာ **Public Drain** မရှိခဲ့လျှင်

Whenever it is not possible to discharge a rain-water pipe into or over an inlet to a surface drain or in a compound or in a street drain within 100ft from the boundary of the premises, such rain-water pipe shall discharge into a gully trap which shall be connected with the street drain for storm water and such a gully-trap shall have a screen and a silt catcher incorporated in its design. (MNBC; 5D.5.5.11.6.4)

If such streets drain is not available within 100ft of the boundary of the premises, a rain-water pipe may discharge directly into the kerb drain and shall be taken through a pipe outlet across the foot path, if any, without obstructing the path. (MNBC; 5D.5.5.11.6.5)

နိဂုံး

ရန်ကုန်မြို့တော်စည်ပင်သာယာရေးကော်မတီ၊ အင်ဂျင်နီယာဌာန(ရေဆီးရေလာစီမံခန့်ခွဲမှု)အနေဖြင့် ရန်ကုန်မြို့ တော်စည်ပင်သာယာရေးကော်မတီ ဥက္ကဋ္ဌ(မြို့တော်ဝန်)နှင့် ကော်မတီဝင်များ၏ လမ်းညွှန်ချက်များနှင့်အညီ လုပ်ငန်း များစံချိန်စံညွှန်းများနှင့်ညီညွတ်ရေး၊ အချိန်မီပြီးစီးရေး၊ ဘဏ္ဍာရေးစည်းမျဉ်းစည်းကမ်းများနှင့်အညီ ငွေကြေး၊ ပစ္စည်း၊ လုပ်အားခများ လေလွင့်ဆုံးရှုံးမှုမရှိစေရေးတို့အတွက် စစ်ဆေးကြပ်မတ်၍ လုပ်ငန်းများဆောင်ရွက်လျက်ရှိရာ အုတ် ရေမြောင်းများ၊ Box Culvert များ ချောင်းကြီး၊ မြောင်းကြီးများ၊ မြစ်ထွက်ပေါက်များတွင် မြေထိန်းနံရံများ ဆောင် ရွက်ခြင်း၊ ရေထိန်းတံခါးများပြုပြင်မွမ်းမံပေးခြင်းရေထိန်းတံခါးများတွင် Flood Control Pump များ တပ်ဆင်ပေး ခြင်း၊ ရေမြောင်းများ၊ မြစ်ထွက်ပေါက်များအား စက်ယန္တရားများနှင့် လုပ်သားအင်အားများအသုံးပြု၍ စဉ်ဆက်မပြတ် ရှင်းလင်းပေးလျက် ရှိခြင်းတို့ကြောင့် မြို့နယ်အသီးသီးတွင် ရေဆီးရေလာစနစ်ပိုမိုကောင်းမွန်လာပြီး ရေကြီးရေလျှံမှု လျော့နည်းသွားကြောင်း တွေ့ရှိရပါသည်။

သို့ဖြစ်ပါ၍ ရန်ကုန်မြို့တော်စည်ပင်သာယာရေးကော်မတီအနေဖြင့် မြို့နယ်အသီးသီးတွင် ရေကြီးရေလျှံမှုလျော့ နည်းစေပြီး ရေဆီးရေလာပိုမိုကောင်းမွန်အောင်ဆောင်ရွက်ပေးခြင်းကြောင့် အများပြည်သူလူမှုအကျိုးစီးပွား ထိခိုက်မှု လျော့ပါးသက်သာစေပြီး ပြည်သူများ၏ကျန်းမာရေးနှင့် ပတ်ဝန်းကျင်ဂေဟစနစ်အား စိတ်လုံခြုံမှုရှိစေနိုင်မည့် အကျိုး ကျေးဇူးများ ရရှိလာမည်ဖြစ်ပါကြောင်း တင်ပြအပ်ပါသည်။

Thank You for Your Attention