5. Other Relevant Data

No.	Name	Media	Year	Issued by
1	Organization structure of Ministry of Education	Hard copy	2018	Ministry of Education
2	Budget of Ministry of Education from 2015/16 to 2018 (6 Month)	Hard copy	2018	Ministry of Education
3	Organization structure of Department of TVET	Soft copy	2018	Ministry of Education
4	Numbers of DG, DDG, Officers and Staffs of Department of TVET	Soft copy	2018	Ministry of Education
5	Job description of Department of TVET and	Hard copy	2018	Ministry of Education
6	Budget of Department of TVET from 2015/16 to 2017/18 (6 Month)	Soft copy	2018	Ministry of Education
7	Organization structure of GTI	Soft copy	2018	Ministry of Education
8	Total expenses of GTI from 2015/16 to 2017/18	Soft copy	2018	Ministry of Education
9	Expenses of each GTI from 2015/16 to 2017/18	Soft copy	2018	Ministry of Education
10	Number of Graduates from GTI to TU	Soft copy	2018	Ministry of Education
11	Number of Students at each GTI from 2013/14 to 2017/18	Soft copy	2018	Ministry of Education
12	Numbers of Certified and Dropout students from 2013/14 to 2018/19	Hard copy	2018	Ministry of Education
13	Numbers of Enrollees and Certified Students from 2013/14 to 2017/18	Hard copy	2018	Ministry of Education
14	GTI Teachers' academic background	Soft copy	2018	Ministry of Education
15	MOU's with Development Partners	Hard copy	2018	Ministry of Education
16	TVET schools under DTVET supported by International Organizations	Hard copy	2018	Ministry of Education
17	Time schedule of Teachers' Training by DTVET	Hard copy	2018	Ministry of Education
18	Technical assistances by Development partners	Hard copy	2018	Ministry of Education
19	Introduction of GTI Insein	Soft copy	2018	GTI Insein
20	Introduction of GTI Shwe Pyi Thar	Soft copy	2018	GTI Shwe Pyi Thar
21	Timetable of Mechanical Engineering Department of GTI Shwe Pyi Thar	Hard copy	2018	GTI Shwe Pyi Thar
22	Timetable of Electric Power Engineering Department of GTI Shwe Pyi Thar	Hard copy	2018	GTI Shwe Pyi Thar
23	Syllabuses of Department of English	Hard copy	2018	GTI Shwe Pyi Thar
24	Syllabuses of Department of Mathematics	Hard copy	2018	GTI Shwe Pyi Thar

No.	Name	Media	Year	Issued by
25	Syllabuses of Department of Chemistry	Hard copy	2018	GTI Shwe Pyi Thar
26	Syllabuses of Department of Physics	Hard copy	2018	GTI Shwe Pyi Thar
27	Syllabuses of Department of Electrical Power Engineering	Hard copy	2018	GTI Shwe Pyi Thar
28	Syllabuses of Department of Mechanical Engineering	Hard copy	2018	GTI Shwe Pyi Thar
29	Automotive Technology Semester I& II	Hard copy	2018	Ministry of Education
30	Generation, Transmission and Distribution Semester I & II	Hard copy	2018	Ministry of Education
31	Applied Electronics Semester I & II	Hard copy	2018	Ministry of Education
32	Refrigeration and Air Conditioning Semester II	Hard copy	2018	Ministry of Education
33	English Semester I & II	Hard copy	2018	Ministry of Education
34	Engineering Science Semester I & II	Hard copy	2018	Ministry of Education
35	Engineering Science（Engineering Physics）Semester I & II	Hard copy	2018	Ministry of Education
36	Engineering Science（Engineering Chemistry）Semester I & II	Hard copy	2018	Ministry of Education
37	Engineering Mathematics Semester I & II	Hard copy	2018	Ministry of Education
38	Technical High School (Aung San) land registration	Soft copy	2018	YCDC
39	Water Pipeline Map of Insein (Hydrants map)	Soft copy	2018	YCDC
40	Chemical Analysis report on water sample	Soft copy	2018	YCDC
41	Myanmar National Building Code (MNBC)	Soft copy	2016	Ministry of Construction
42	Singapore Fire Code	Soft copy	2013	Singapore Civil Defense Force
43	Singapore Fire Code Handbook	Soft copy	2013	Singapore Civil Defense Force
44	Singapore and Myanmar Vocational Training Centre, Brochure	Hard copy		SMVTI, MOE
45	SMVTI Block Layout Plan	Hard copy	2018	SMVTI, MOE
46	Government Technical Institute (Shwe Pyi Thar)	Soft copy		GTI Shwe Pyi Thar
47	Government Technical Institute (Insein)	Soft copy		GTI Insein

6. References

6-1. Geotechnical Survey Report

6-2. Topographical Survey Map

6-3. Underground Water Survey Report

6-4. Environmental Management Plan

REPORT

ON

GEOLOGICAL SURVEY
FOR
THE PROJECT FOR THE ESTABLISHMENT OF JAPAN-MYANMAR VOCATIONAL TRAINING INSTITUTE (AUNG SAN) LOWER MINGALARDON ROAD, SINGUU WARD, AUNG SAN, INSEIN TOWNSHIP, YANGON REGION

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MATSUDA CONSULTANTS INTERNATIONAL CO., LTD

JUNE 2018

Submitted by

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REPORT ON GEOLOGICAL SURVEY FOR THE ESTABLISHMENT OF JAPAN-MYANMAR VOCATIONAL TRAINING INSTITUTE (AUNG SAN)

1.0 INTRODUCTION

1.1 General

Geotechnical investigations are needed to take up to ascertain the nature and properties of soils available at different locations of site at various depths, safe bearing capacity and settlements of soil. It's also carried out for designing a right type of foundation safely and economically, a designer must possess sufficient information about the physical properties and the arrangement of underlying materials. The field and laboratory investigations required to get this essential information is known as soil exploration.

Geo-Friends Engineering and Construction Co., Ltd was assigned to investigate (2) boreholes of project area in order to know physical and mechanical properties of soil in the proposed area which is situated in Lower Mingalardon Road, Singuu Ward, Aung San, Insein township, Yangon Region.

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1.2 Objective of Investigation

The objectives of investigation includes,

- To identify the soil type, thickness and distribution of soil strata on project area.
- To evaluate the penetration resistant, permeability and fluctuation of groundwater table at project area.
- To recognize the physical and mechanical properties of soil layers.
- To evaluate the geotechnical design parameters from the results of field and laboratory test.
- To evaluate the appropriate foundation design and construction methods, such as excavation and dewatering, in terms of safe and economy.

1.3 Scope of work

Site investigation, including boring work, field tests were carried out in accordance with ASTM D 1586-99 "Code of Practice for Site Investigations".

- Soil Boring and Sampling

  Setting out the borehole points and site clearance works were carried out by the contractor at each borehole location to avoid delayed work prior to commencement of the site investigation work. The boreholes were drilled by rotary method. Drilling fluid was pumped down via the hollow drilling rods and cutting bit to wash out the soil remnants. The diameter of the borehole is 100mm.

  Disturbed soil samples were taken by using spoon sampler (50mm OD & 35mm ID), driven by hammer with standard weight (63.5kg) from the constant height (760mm), kept inside two containers and the rest were kept inside plastic bags. Undisturbed soil samples were recovered by using thin-walled sampler (for soft soil).

- Standard Penetration Test

  Standard penetration tests were carried out at intervals of 1.0 m up to 6.0 m thereafter followed by 1.5 m or instructed by the Client and the tests were carried out in accordance with ASTM D 1586-99. The SPT tests service for the following purposes:

  a) To determine the relative density or consistency of soils, and
  b) To recover disturbed samples for visual inspection

  This empirical dynamic penetration test determines the resistance of soils to the penetration of a split barrel sampler (spoon sampler) of 50mm external diameter, driven by a 63.5 kg automatic drop hammer, allowing a free fall of 760mm. The penetration resistance, N value is the number of blows required to effect a 300mm penetration below the seating drive which was, for this project, taken as completed at 150mm penetration. Standard penetration tests were also conducted when the sub-soils were too stiff for undisturbed soil samples to be obtained.

  The values of N obtained in this investigation are recorded in borehole logs attached in the Appendices of BOREHOLE LOGS.

- Ground water investigation

  Groundwater level measurement was made in all boreholes during the soil investigation work, usually before commencing of work in the morning and after completion of work in the evening.

- Installation and monitoring of water standpipe

  Water standpipes were installed in selected completed boreholes and at depths specified by the contractor. A slotted 55 mm diameter PVC pipe was installed at the installation depth followed by backfilling of borehole with clean sand.

  The water standpipe was monitored for ten days. The water standpipe installation diagram and monitoring results are shown in the Appendices.

- Description of laboratory testing

  The laboratory test program is essential to evaluate the soil properties as scheduled by the Client. All soil tests were carried out at Contractor's own laboratory. Generally, the following tests are carried out in accordance with ASTM Standard "Methods of Test for Civil Engineering Purposes" if samples are enough for laboratory testing.

  - Physical property tests

    1. Moisture Content, Bulk & Dry Density Determination(ASTM D2216)
    2. Index Test (Atterberg Limits)(ASTM D4318)

3. Particle Size Distribution (Sieve & Hydrometer)(ASTM C136 & D422)

- Strength and Compressibility Properties
  1. Direct Shear Test (UU) (ASTM D 3080)
  2. Triaxial Test (UU) (ASTM D 2850)
  3. Triaxial Test (CU) (ASTM D 4767)
  4. Unconfined Compression Test (ASTM D 2166)
  5. One Dimensional Consolidation Test (ASTM D 2435)

- Submission of final report

1.4 Project Location

Project area is located in Lower Mingalardon Road, Singuu Ward, Aung San, Insein township, Yangon Region. The Google earth view is presented in Figure – 1.1.

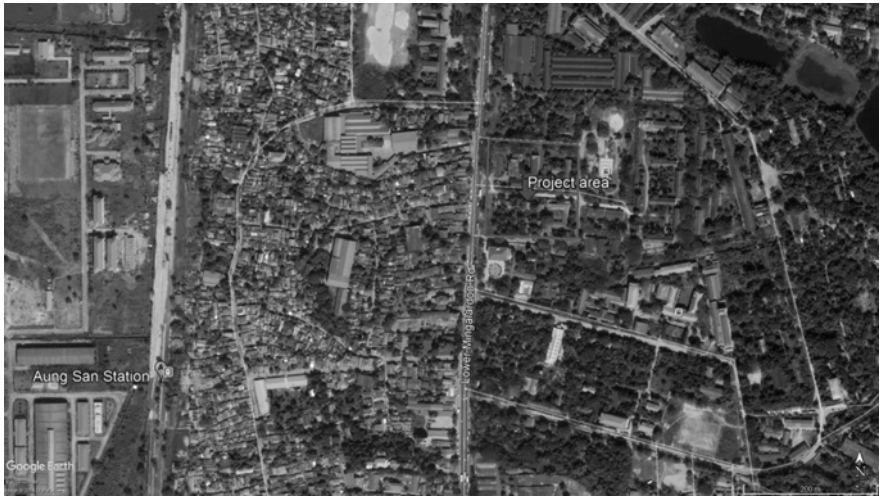

Figure - 1.1 : Google earth view of the project area

1.5 Project Duration

Geo-Friends Engineering and Construction Co., Ltd conducted soil investigation work at the designated area of Lower Mingalardon Road, Singuu Ward, Aung San, Insein township, Yangon Region. The field soil investigation work was started from 27th May 2018 and finished at 31st May 2018. All field and laboratory works were undertaken by Geo-friends Engineering & Construction Co. Ltd. under the supervision of our supervisors.

The executed detailed working schedule is illustrated in Table – 1.1.

Photo - 1.1 : Mobilization of Equipment

Table - 1.1 : Actual Working Schedule of Geotechnical Investigation Works

Working schedule of Geological Survery for the Project for the Establishment of Japan-Myanmar Vocational Training Institute (Aung San)																														
Sr.No	Description	Drilling Depth (m)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25			
			May-18						Jun-18																					
			26	27	28	29	30	31	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19			
1	Setting the drilling stage																													
2	Soil Investigation at BH-1	43.95																												
3	Soil Investigation at BH-2	30.45																												
4	Demoblization to Store																													
5	Lab testing																													
6	Report Preparation																													
7	Submission of final report																													
		74.40	Total Boreholes = 2																											

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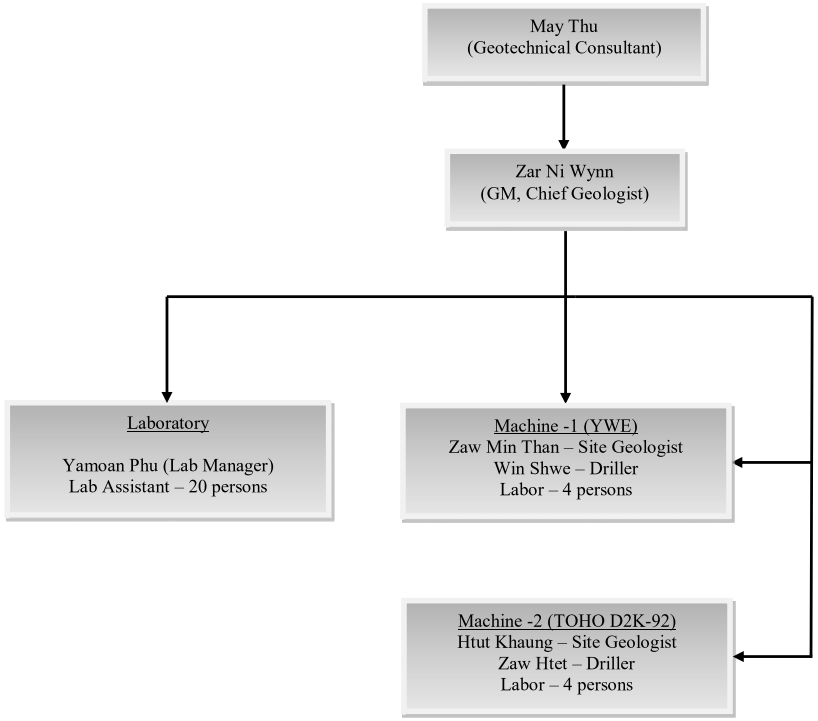
1.6 Project Team Organization chart



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1.7 Equipment Applied in the Project

1.7.1 Boring Equipment

One number of boring equipment of TOHO D2K-92 and one number of YWE were applied in field investigation works to study general condition of soil layers under planned area for future construction. The photos of boring equipment were presented in following photo – 1.2.

Photo - 1.2 : Boring Equipments

1.7.2 Laboratory Instruments

The principal instruments applied for soil laboratory tests are as shown in the following table.

Table - 1.2 : Applied Laboratory Instruments

Instrument Name	Manufacturer and Type
1. Electric Balance	ELE, Made in UK
2. Atterberg's Limit Test Apparatus	ELE, Made in UK
3. One dimensional consolidation test machine	ELE, Made in UK
4. Direct shear test machine	ELE, Made in UK
5. Triaxial	ELE, Made in UK
6. UCS	NL, Made in Malaysia
7. Triaxial (CU/CD)	HUMBOLDT, Made in USA

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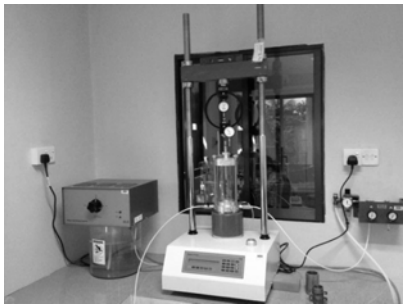

Photo - 1.3 : Triaxial Test

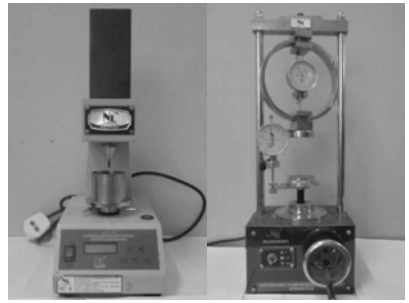

Photo - 1.4 : Liquid Limit Test and UCS

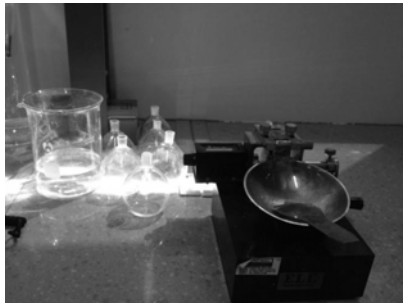

Photo - 1.5 : Liquid Limit Test

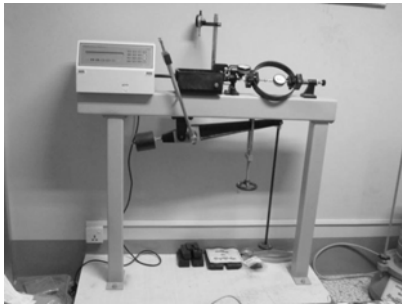

Photo - 1.6 : Direct Shear Test

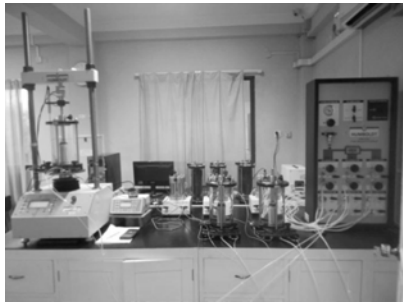

Photo - 1.7 : Triaxial Test (CU)

Photo - 1.8 : Consolidation Test

2.0 TOPOGRAPHY

The overburden soil of the projet site is mainly composed of clay, silt and sand.

Photo - 2.1 : Views of the project area

2.1 General Geology

2.1.1 Introduction

Yangon is geomorphically situated between Sittaung River in the east and Ayeyarwaddy River in the west and it is also the southern extensional rolling region of BagoYoma. Yangon City is generally bounded by Hlaing River in the west, Yangon River in the south and Bago River in the east respectively. The approximate length of Yangon City is 20 miles in N-S and 15 miles in E-W which made aerial extent about 300 square miles.

2.1.2 Physiography of Yangon

The dominant physical feature of Yangon is the Yangon-Mingaladon Ridge, an anticlinal ridge which morphologically looks like as a homoclinal ridge. At the north, the elevation is greater than 150 feet and the regional slope is towards the south. The base of the Shwedagon Pagoda is more than 100 feet with respect to the sea level. The other small ridge called the Thingangyun Ridge may be considered as the northern continuation of the Thanlyin-Kyauktan Ridge.

Yangon area can be topographically recognized as; (i) *rolling and hilly area* in the central part with the ridges; (ii) *flat rolling area* especially within the Mingaladone and along the eastern and western limbs of Thanlyin-Kyauktan Ridge; (iii) *lake area* occupied by Hlawga Lake, Inya Lake and Kandawgyi Lake which lies nearly N-S that parallel to the trend of ridges and regional geological structures; (iv) *swampy* area occupied at Dala and Thilawa in the south, at the vicinity of Panhlaing River in the southwest, around PazundaungChaung in the southeast and tidal influent area of Nagmoeyeik Chaung; and (v) *alluvial area* covered at west of Yangon-Mingaladon Ridge and Hlaing River, and at some parts in Insein, Gyogon, Kamayut, Kyeemyindine, Alone.

The most common drainage pattern through Yangon area is dendritic and the modification and variation of the pattern sometimes due to structural controls. All drainage texture as

coarse, medium and fine are readily observed in Yangon area. Fine texture drainage can also be expected when the precipitation in an area is intense and the water table is not near the ground surface. This reveals that the amount or intensity of precipitation and the relative elevation of the water table also affect the drainage texture. The drainage system in Yangon area can be observed as: (i) *headwater channels or gullies* developed especially in the area between Mingaladon and Aungsanmyo and at the north of Hlawga Lake but poorly seen on the eastern flank of the Yangon-Mingaladon Ridge; (ii) *tributaries* observed as about 16 streams within Yangon area; and (iii) *the major streams* such as Hlaing-Yangon River, Panhlaing River and Pazundaung-NgamoeyeikChaung.

2.1.3 Regional Geological Setting

Yangon and its surrounding region include ridges and deltaic low lands and also extensional rolling region of BagoYoma anticlinorium. The area is located in a N-S trending sedimentary basin containing a thick Tertiary and Quaternary deposits. Tertiary deposits belong to the Hlawga shale of lower Pegu Group, Thadugan sandstone (lower) and Besapet alternation (upper) of upper Pegu Group, and Arzarnigon sandrock (lower) and Danyingon clay (upper) of Irrawaddy Formation. Quaternary sediments of older and younger alluvium deposits are widely distributed throughout the Yangon area.

Table - 2.1 : Regional Lithostratigraphic Units of Yangon Area and BagoYoma

System	Series	Yangon Area	Bago Yoma
Quaternary	Recent	Young Alluvium	Alluvium
	Pleistocene	Valley-fill Deposit	
Tertiary	Pliocene	Danyingon Clay	Irrawaddy Formation
		Arzanigon Sandrock	
	Miocene	Besapet Alternation	Obogon Formation
		Thadugan Sandstone	Kyaukkok Formation
	Oligocene (?)	Hlawga Shale	?

The regional dip is toward the east having a low to moderate dip angle and the western dip slope is very narrow often covered by the younger alluvium. Yangon area is complicated by numerous folding resulting in a characteristic an echelon folding system of rocks of BagoYoma, regarded as Hlawga anticline, Yangon-Mingaladon anticline, Thingangyun-Thanlyinancline and Twante anticline. These folded structures were strongly cut across by numerous faults trending nearly E-W to ENE-WSW.

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The Yangon-Mingaladon ridge is a long narrow anticlinal ridge of an anticlinal fold plunging definitely towards the north and the physiographic evidence of the nose of the anticline is observed at Danyingon. This Yangon-Mingaladon anticline is an asymmetrical rather than a symmetrical one. At its northern extremity, this anticlinal ridge extends toward north as the western flank of a regional syncline trending west of Hlegu, through Htaukkyant. The anticlinal structure of the ridge becomes distinct and identifiable at Danyingon and at the west of Mingaladon airport.

The Sagaing Fault, a recently active dextral strike-slip fault is regional recognized as the possible marker for the Neogene structural development feature. It is a recently active dextral strike-slip fault and actually cross cutting the eastern central basin. The largest fault in Yangon area named as Mingaladon Fault is observed as a lineament in the paddy field east of Mingaladon airport. This fault is considered as a normal fault and the fault plane is estimated to be dipping in a southeast to east direction. Another distinct fault namely Danyingon Fault is recognized as a lithologic boundary between rocks of Upper Pegu Group and Irrawaddy Formation within the Hlawga anticline. This fault can be easily observed in the field due to the juxtaposition of two different rock units especially around Hlawga Lake.

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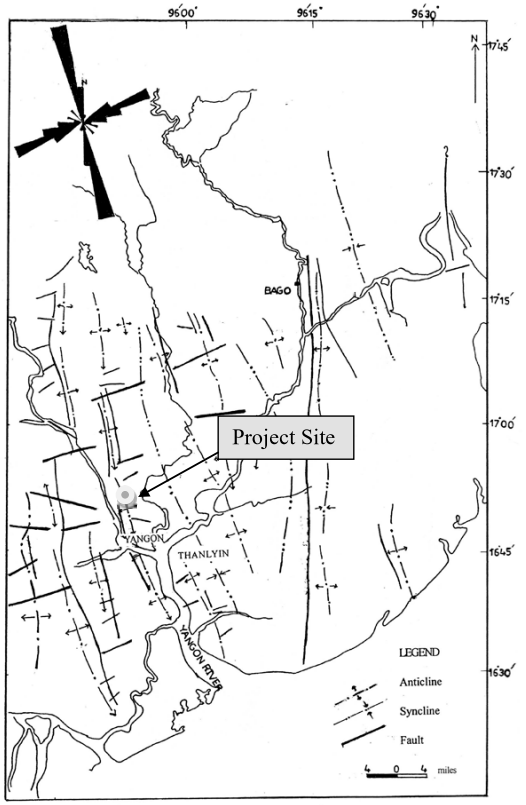

Figure - 2.1 : Regional structural map of the Yangon area (MOGE)

According to Win Naing (1972), the general succession of rocks underlying at the Yangon area is as follows:

Formation	**Age**	
Younger Alluvium	Recent	- Quaternary
Valley Filled Deposits	Pleistocene	- Quaternary
Unconformity		
Danyingon Clay	Pliocene	- Irrawaddy Formation
Arzanigone Sandrocks	Pliocene	

2.2 Sediments of the Tertiary Age

2.2.1 Pegu Group

Pegu Group includes Besapet alternation, Thardugan sandstone and Hlawga shale.

- ***Besapet Alternation:*** It consists of shale and thinly laminated sandstones, which are exposed in the vicinity of Besapet Lake. They are characterized by bluish grey to greenish grey, bedded to non-bedded, silty shale with very thin parting of micaceous sandstones, and yellowish brown, fine to medium grained, soft micaceous and carbonaceous sandstones with calcareous concretions in places. A few fossiliferous beds are noted in this formation.
- ***Thardugan Sandstone:*** It consists of bluish grey to brownish grey, fine to medium grained micaceous and argillaceous sandstones with ferruginous band along the bedding planes. These sandstone sometimes contain nodules of silty and pot hole are common in calcareous sandstone due to leaching away of nodules from these sandstones. Poorly observed fossils are found in this formation.
- ***Hlawga Shale:*** Shales and laminated clays of this formation are considered to be the core of the Hlawga anticline.

2.2.2 Irrawaddy Formation

This formation includes two lithostratigraphic units. They are Danyingon clays and Arzarnigon sand rocks.

- ***Danyingone Clay:*** It consists of blue clays, siltstones, with interbedded sand rocks. The clays bands show current bedding, well recognized in Htanbingon section. Fossil woods have been found. It clays layers are thinly laminated. Remarkable lateritization occurs on these sediments.
- ***Arzarnigon Sandrocks:*** These formations are loose to very dense and generally unconsolidate to consolidate. These sand rocks may appear clear or contain admixture of silt, clay and fine gravel at various percentage. These sand rocks are slightly pervious to pervious. Bluish grey colored, thinly laminated and thick bedded clay with ferrugeneous thin band and interbedded with buff to brownish colored soft and very fine grained sand rocks are well exposed.

2.2.3 Sediments of the Quaternary Age

- ***Valley-fill deposits*:** It consists of a thick sequence of loose, highly pervious, interbedded sand and fine to very coarse gravels.
- ***Younger Alluvium:*** This formation was deposited in recent time and thus, it blanketed the areas which are affected by tidal action. It is estimated to be about 20 m to 70 m with variation according to depositional environments. This formation consists essentially of yellowish grey, bluish grey, brownish grey silts and clays.

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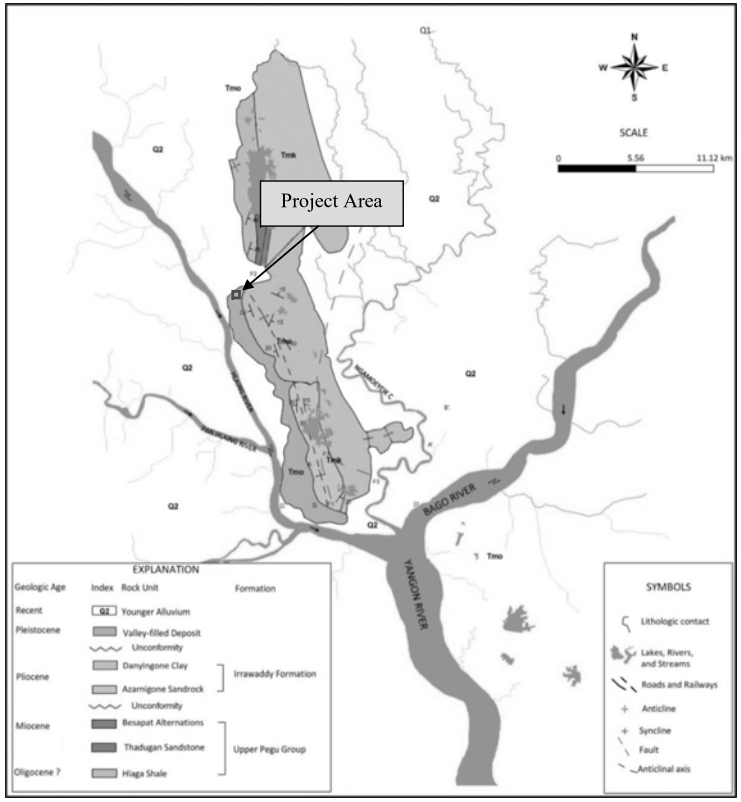


Figure - 2.2 : Geological Map of the Greater Yangon (Win Naing, 1972)

2.3 Location of Boring Points

The locations, levels and coordinates of investigation points of boring points were designated by the client. The numbers of borehole and termination depth are also decided by the client side. The locations of boreholes are presented in Figure - 2.3.

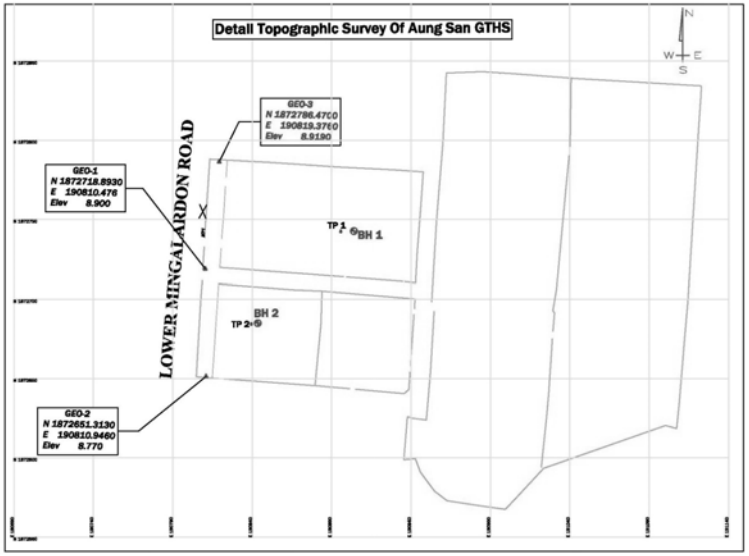


Figure - 2.3 : Plan Map of Investigation Boring Points

Table - 2.2 : Coordinates of Borehole Points

Borehole	Coordinates		Elevation (m)
	E	N	
BH-1	190904.100	1872742.629	8.639
BH-2	190843.559	1872684.984	8.512

3.0 LABORATORY TEST RESULTS

There were two numbers of investigation boring points at project site. Some selected numbers of disturbed and undisturbed samples were sent to office's laboratory to test physical and mechanical properties of soil in consulting with expert's discretion. ***The detailed laboratory results are expressed in Appendixes.*** The entire tests were carried out in accordance with the ASTM standard.

The physical properties tests include the following items.

- Natural Moisture Content Test
- Specific Gravity Test
- Particle Size Analysis Test
  - Grain Size Distribution Test
  - Hydrometer Test
- Atterberg's Limits Test
  - Liquid Limit Test
  - Plastic Limit Test

The mechanical properties tests includes-

- Triaxial Test (UU)
- Direct Shear
- One dimensional consolidation test

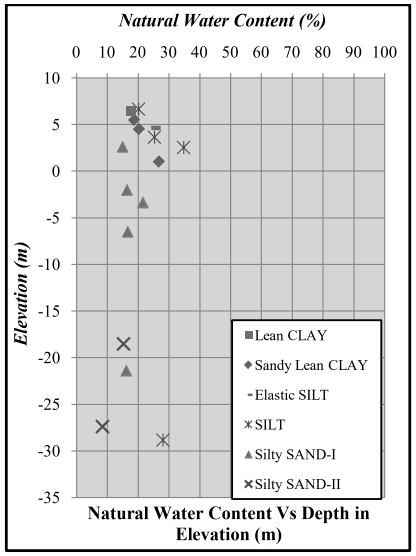
3.1 Property of Soil

Physical property tests and mechanical property testes were done for investigation. The detailed laboratory test results are illustrated in Appendix.

3.1.1 Natural Moisture Content Test

Moisture content, bulk & dry density of representative soil samples were determined for the identification, classification and correlation of the soil types encountered.

Natural moisture content tests are carried out on soil samples for required different soil layers at office's laboratory in accordance with ASTM D2216 and the variation of water content with depth in elevation with reference to project bench mark can be seen in Graph – 3.1.



Graph - 3.1 : Nature Water Content vs. Depth in Elevation (m)

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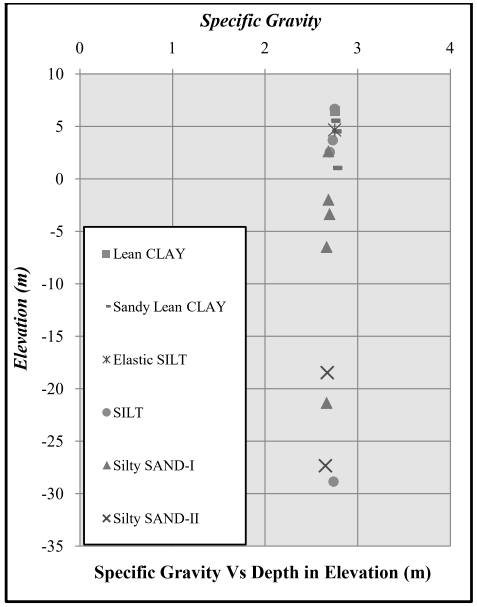
3.1.2 Specific Gravity Test

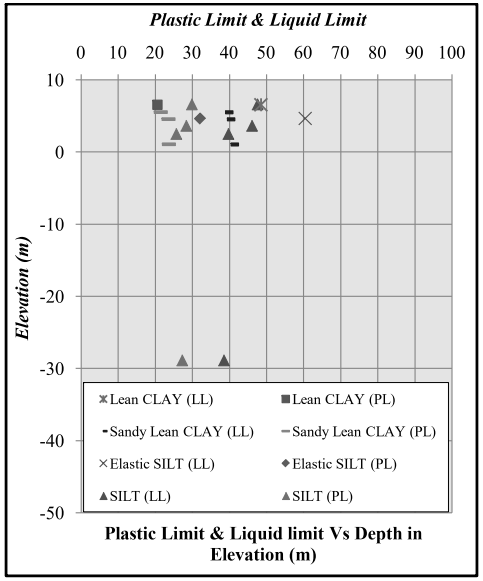
The specific gravity tests in this project were carried out in accordance with ASTM C 127 at office's laboratory. The relationship between specific gravity and depth in elevation of each soil layer is shown in Graph-3.2.



Graph - 3.2 : Specific Gravity vs. Depth in Elevation (m)

3.1.3 Atterberg's Limit Test

The Atterberg's Limit tests can be performed from SPT disturbed and undisturbed samples by ASTM D 4318 at office's laboratory. Graph-3.3 illustrates the Plastic Limit and Liquid Limit of each soil layer versus depth in elevation.



Graph - 3.3 : Plastic Limit & Liquid Limit vs. Depth in Elevation (m)

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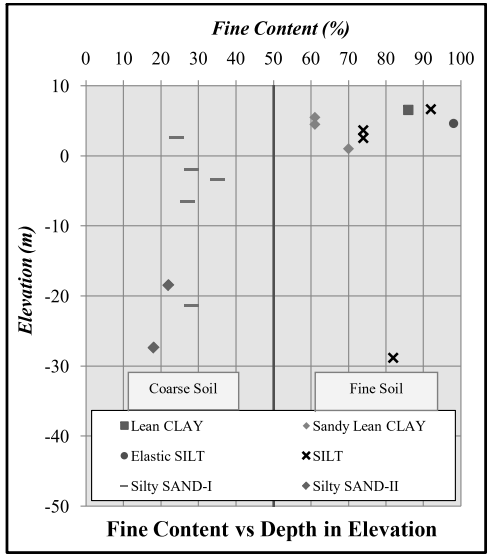
Geological Survey for the Project for the Establishment of Japan-Myanmar Vocational Training Institute (Aung San)
Lower Mingalardon Road, Singuu Ward, Aung San, Insein Township, Yangon Region

3.1.4 Grain Size Analysis Test

After completion of Atterberg's Limit Test, grain size distribution tests were done by ASTM C 136 and D422. Graph-3.4 is illustrated the grain size distribution of each soil layer versus depth in elevation.



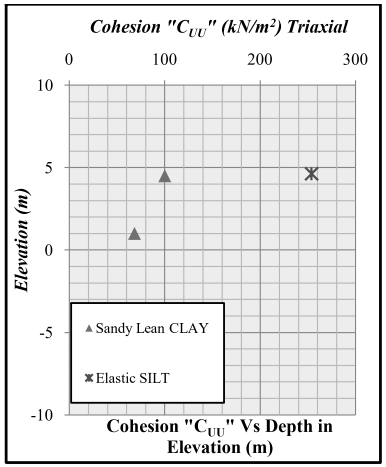
Graph - 3.4 : Fine Content vs. Depth in Elevation (m)

3.2 Mechanical Properties of Soil

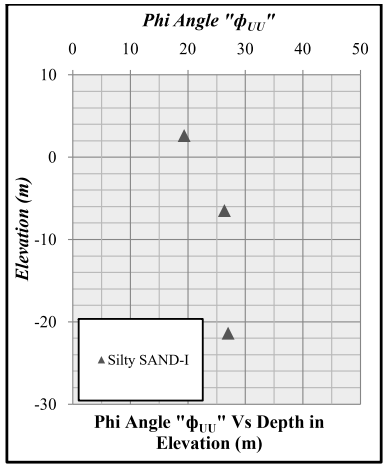
In order to obtain the mechanical properties for engineering analysis, triaxial tests (UU), direct shear tests and one dimensional consilidation tests were performed with undisturbed and disturbed samples at office laboratory.

3.2.1 Triaxial test (UU) and Direct Shear Test

Triaxial test (UU) and Direct shear tests were performed with undisturbed and disturbed samples according to ASTM D 2850 and ASTM D 3080 standard. Graph-3.5 and Graph-3.6 indicate the relationship between cohesion (C) and (ϕ) versus their elevations at investigation area.



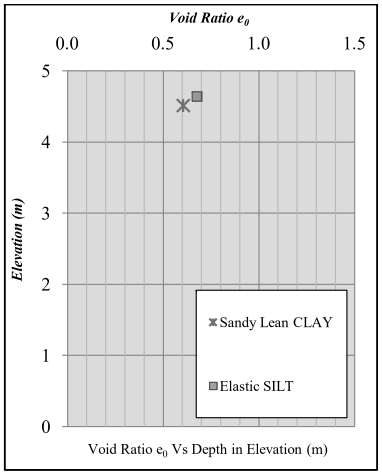
Graph - 3.5 : Cohesion "C_{UU}" vs. Depth in Elevation (m)



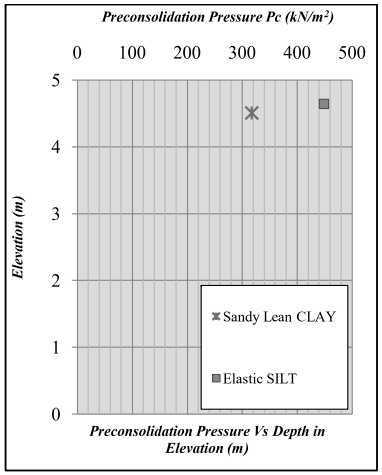
Graph - 3.6 : Phi "ϕ_{UU}" vs. Depth in Elevation (m)

3.2.2 One Dimensional Consolidation Test

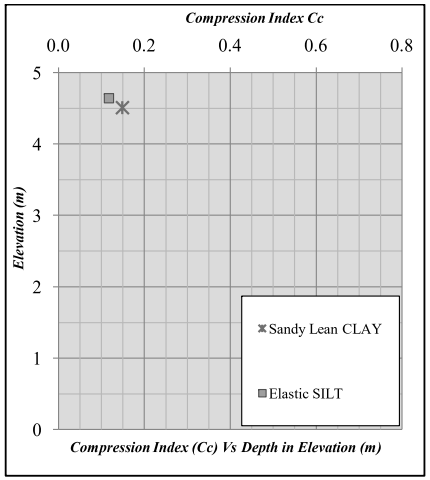
The one dimensional consolidation tests were carried out with undisturbed samples. These tests were carried out in accordance with standard ASTM D 2435. Graph-3.7 to Graph-3.9 indicate the relationship between (e_0), (P_c) and (C_c) versus their depth in elevation at investigation area.



Graph - 3.7 : Void Ratio e_0 vs. Depth in Elevation (m)



Graph - 3.8 : Preconsoildation pressure (P_c) vs. Depth in Elevation (m)



Graph - 3.9 : Compression Index (C_c) vs. Depth in Elevation (m)

4.0 GEOTECHNICAL ENGINEERING CONSIDERATIONS

4.1 Characteristics of Soil Strata Relying on Field Test

There have been (2) numbers of boreholes; depths of boreholes are of varying from 30.45 m to 43.95 m with the performance of Standard Penetration Tests. In this operation, six numbers of layers have been recognized. The soil layers are classified in accordance with their physical properties and/or their relative density or consistency. The boring logs are attached at Appendix. The six different layers observed in project area are described from top to bottom as follows.

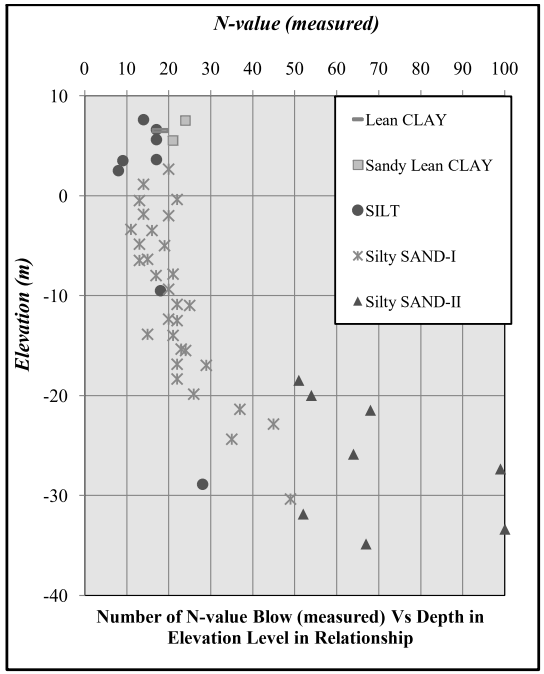
1. SILT
2. Elastic SILT
3. Sandy Lean CLAY
4. Lean CLAY
5. Silty SAND-I
6. Silty SAND-II

4.2 Bearing stratum

According to investigation results, six different layers have been identified in this area. The soil layers that can be used as reliable bearing layer should generally have N-value of round about 10 in light load structures (<50kN/m^2) and that of N-value over 30 in heavy load structures (>50kN/m^2). The range of N-value for each layer is illustrated in Table-4.1 and N-value measured in the field Vs elevation is also presented in Graph – 4.1.

Table - 4.1 : Range of N-value (Measured) from Different Soil Layers in Project Area

Sr No.	Soil layer	N value (Measured)					Minimum	Maximum	Average
		10	20	30	40	50 & > 50			
1	SILT						8	28	16
2	Elastic SILT						UD		
3	Sandy Lean CLAY						21	24	22
4	Lean CLAY						18	18	18
5	Silty SAND-I						11	49	22
6	Silty SAND-II						51	100	69



Graph - 4.1 : Number of N-Value (measured) vs Depth in elevation

4.3 Soil Profile

The present site investigation report is mainly based on the Code of practice for site investigations, ASTM D 1586-99. In the boring logs, the consistency/ density of the subsoils are based on SPT N-values and laboratory test results of soils.

Based on the borehole data and in-situ tests results obtained from the boreholes, the underlying subsoils can be sub-divided into the following layers:

- Top Soil Layer (0 to ~ 1.5 m) and
- Younger Alluvium (~ 1.5 m to ~6.0 m)
- Valley Filled Deposit (~6.0 m to termination of boreholes)

4.3.1 Younger Alluvium and Valley Filled Deposit

Younger Alluvium is observed from about 1.5 m to ~6.0 m both boreholes. It is mainly composed of very stiff to hard CLAY of low plasticity and firm to very stiff SILT of low plasticity to high plasticity.

Valley Filled Deposit is mainly observed from ~6.0 m to termination of both boreholes. It is chiefly composed of medium dense to very dense Silty SAND.

4.4 List of Geological Cross-Section

Please see the following soil profile (cross section) in Appendix.

SECTION	BOREHOLES
1	BH-1 ~ BH-2

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5.0 CONSIDERATION OF DESIGN PARAMETER AND BEARING CAPACITY

5.1 Consideration of Design Parameter

The geotechnical parameters can be evaluated from many ways such as field in situ testing, laboratory testing and so on. Some of the design parameters cannot be evaluated directly neither from field tests nor laboratory tests due to the unfavorable nature of deposit or investigation methods. However, some parameters would be derived from the other instrumental testing of past events and some mechanical and physical properties obtained from field and laboratory tests. For evaluating the stability of ground, the shear strength parameters are significant. The geotechnical design parameters required for foundation design analysis are listed as below-

C_u Cohesion of soil (kN/m^2)
ϕ Friction angle of soil (angle of internal friction in degree)
γ_d Dry unit weight of soil (kN/m^3)
γ_{sat} Saturated unit weight of soil (kN/m^3)
γ' Effective unit weight of soil below water table (kN/m^3)
E Modulus of elasticity of soil (kN/m^2)

5.1.1 Cohesion (C_u)

The cohesive strength also known as un-drained shear strength of cohesive soil is normally evaluated from the unconfined compression test. The cohesive strength C_u can be derived from–

$$C_u = \frac{q_u}{2}$$

Where- C_u = cohesive strength (kN/m^2)
q_u = unconfined compressive strength (kN/m^2)

C_u also can be considered from SPT-N values as follows,

$C_u = (20/3)*N$ (According to Japanese code)

$C_u = 6.25 * N$ (According to Terzaghi code)

Hence, the cohesive strength ($\mathbf{C_u}$) is evaluated from SPT N-Value and compared with the laboratory results and the table of general relation of consistency and unconfined compressive strength of clay (Table – 5.1). For Sandy soil layer, the value of "C_u" is taken as '0'.

Table - 5.1 : General Relationship of Consistency and Unconfined Compression Strength of Clays

Consistency	q_u	
	kN/m^2	ton/ft^2
Very soft	0-25	0-0.25
Soft	25-50	0.25-0.5
Medium stiff (Firm)	50-100	0.5-1
Stiff	100-200	1-2
Very Stiff	200-400	2-4
Hard	>400	>4

5.1.2 Friction angle (ϕ)

The friction angle of the granular soil can be directly evaluated from the SPT N-value and also compared with the friction angle of granular soils which is evaluated from their average SPT N-value, in accordance with Table – 5.2. For the cohesive soil layers, their friction angles can be taken as '0'.

According to Hatakanda and Uchida (1996)

$$\phi = 3.5 * (N)^{1/2} + 22.3$$

Where;

ϕ = friction angle of the soil

N = SPT-N value

This equation ignores particle size. Most tests are done on medium to coarse sands. SPT-N values for fine sand will have a lower friction angle while coarse sands will have a larger friction angle. Modified equations are described as below;

For Fine Sand; $\phi = 3.5 * (N)^{1/2} + 20$

For Medium Sand; $\phi = 3.5 * (N)^{1/2} + 21$

For Coarse Sand; $\phi = 3.5 * (N)^{1/2} + 22$

Typical values of ϕ are presented in Table – 5.2.

Table - 5.2 : Typical values for internal friction angles

Soil	Type of test		
	Unconsolidated undrained UU	Consolidated undrained CU	Consolidated drained CD
Gravel			
Medium size	40-45°		40-55°
Sandy	35-40°		35-50°
Sand			
Loose dry	28-34°		
Loose saturated	28-34°		
Dense dry	35-46°		43-50°
Dense saturated	1-2°less than dry sand		43-50°
Silt or silty sand			
Loose	20-22°		27-30°
Dense	25-30°		30-35°
Clay	0°if saturated	3-20°	20-42°

5.1.3 Saturated Unit Weight of Soil (γ_{sat})

The saturated soil defines as the soil located below the water table. The saturated unit weight of soil can be evaluated directly from the field density test or equation.-

$$\gamma_{sat} = \frac{G_s\gamma_w + e\gamma_w}{1+e}$$

Where- γ_{sat} = saturated unit weight of soil (kN/m^3)

γ_w = saturated unit weight of water (kN/m^3)

G_s = specific gravity of soil

e = void ratio of soil ($e = wG_s$ for saturated soil)

The G_s and w can be resulted from laboratory tests of collected "Disturbed Samples".

5.1.4 Effective Unit Weight of Soil (γ')

The effective unit weight of soil under water table can be evaluated from the equation-

$$\gamma' = \gamma_{sat} - \gamma_w$$

Where- γ' = effective unit weight of soil (kN/m^3)

γ_{sat} = saturated unit weight of soil (kN/m^3)

γ_w = unit weight of water (kN/m^3)

The unit weight of water in SI unit is $9.81 kN/m^3$ (or) $10 kN/m^3$.

5.1.5 Modulus of Elasticity of Soil (E_s)

The modulus of elasticity or Young's modulus of a soil is an elastic soil parameter most commonly used in the estimation of settlement from static loads. Young's soil modulus, E_s, may be estimated from empirical correlations, laboratory test results on undisturbed specimens and results of field tests. Laboratory tests that may be used to estimate the soil modulus are the triaxial unconsolidated undrained compression or the triaxial consolidated undrained compression tests. Field tests include the plate load test, cone penetration test, standard penetration test (SPT) and the pressuremeter test.

$E_s$from SPT-N value correlations,

For Sand,

$$E_s = P_a \times 8 \times N_{60} \quad \text{(Schmertmann 1970)}$$

$$E_s = 700 \times N \quad (kN/m^2) \text{ (Japanese code)}$$

For Normally consolidated Clay,

$$E_s = 250\ C_u \text{ to } 500\ C_u (kN/m^2) \text{ (Schmertmann 1970)}$$

For Over consolidated Clay,

$$E_s = 750\ C_u \text{ to } 1000\ C_u (kN/m^2) \text{ (Schmertmann 1970)}$$

Table - 5.3 : Typical E_s values

Soil	E_s (kN/m^2)
Loose sand	10500-24000
Medium dense sand	17250-27600
Dense sand	34500-55200
Silty sand	10350-17250
Sand and gravel	69000-172500
Soft clay	4100-20700
Medium clay	20700-41400
Stiff clay	41400-96600

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**** According to USCS soil classification system, if sand % is greater than 50%, it can be said that clayey sand or silty sand. If clayey sand has sand % of between 50% and 60%, it can be taken as undisturbed sample (UD) during field investigation and UCS tests or triaxial (UU) tests can be done and cohesion (C_u) value can also be obtained from these tests. So, careful judgment should be made for clayey sand which might have cohesion property as well as friction angle.**

If the designer would like to get effective design parameter such as c′ and ϕ′, please take reference to Table – 5.2 for granular soil and Table – 5.4 for cohesive soil.

Table - 5.4 : ϕ'_{crit} for clayey soil (BS 8002-1994)

Plasticity index (PI)	ϕ' (degree)
15	30
30	25
50	20
80	15

In the absence of reliable laboratory test data, the conservative values of ϕ' given in above mentioned table may be used with c'=0.

5.2 Determination of bearing capacity of shallow footing

The bearing capacity of shallow foundation is generally calculated based on the proposed building plan and structural loads that are indicated by client. The client do not propose the structural plan of the proposed project. So, the dimension of footing is considered as unit meter squared (1m x 1m) and the depth of footing (D_f) is calculated for various depth of 1.5 to 6.0 m. So, the designer can use easily this bearing capacity (kN/m^2) or (ton/ft^2) values for various depths. The detailed calculation of shallow foundation is described in Appendix.

If the design parameters can be got by using neither correlation from SPT-N value nor laboratory test results, the estimated bearing capacity for shallow footing can be consider by using “Modified Terzaghi’s Formula”.

The Terzaghi bearing capacity equation is given below,

$$q_{ult} = (c \times N_c \times S_c) + (q \times N_q) + (0.5 \times B \times N_r \times \gamma \times S_r)$$

Where

q_{ult} = the ultimate bearing capacity

c = cohesion of the soil

N_c = Terzaghi bearing capacity factor (obtained from Table – 5.5)

S_c = Shape factor (obtained from Table – 5.6)

q = effective stress at the bottom of the footing ($\gamma \times d$)

d = distance from ground surface to the bottom of the footing

= effective density of soil

B = width of the shorter dimension of the footing

N_r = Terzaghi bearing capacity factor (obtained from Table – 5.5)

N_q =Terzaghi bearing capacity factor (obtained from Table – 5.5)

γ = effective density of soil

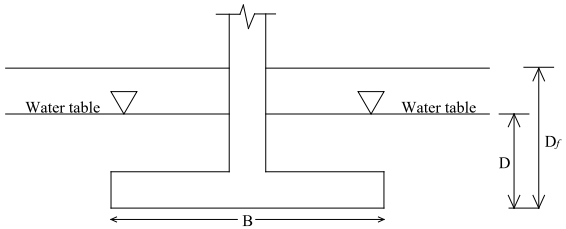
S_r = shape factor (obtained from Table – 5.5)

5.2.1 Effect of water table on bearing capacity

The predicting formulations for bearing capacity were based on the assumption;

Case I – Water table above bottom of footing ($0 \le D \le D_f$)

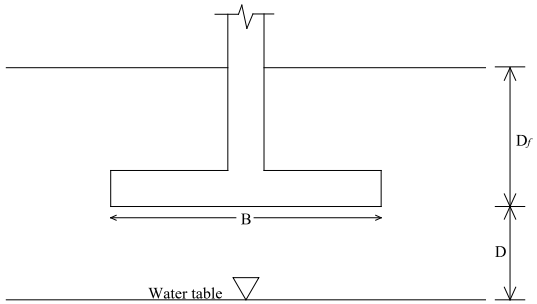
When the water table is above the bottom of the footing, the second and third term of the bearing capacity equation is needed to be modified as following.



$$q_{ult} = cN_c + \left[\gamma\left(D_f - D\right) + (\gamma_{sat} - \gamma_w)D\right]N_q + \frac{1}{2}(\gamma_{sat} - \gamma_w)BN_r$$

Case II – Water table at or below bottom of footing

When the water table is below the bottom of the footing, the last term of the bearing capacity equation is modified by replacing the unit weight of the soil with an average value as shown as below.



$$q_{ult} = cN_c + \gamma D_f N_q + \frac{1}{2}\gamma_{avg} BN_r$$

$$\gamma_{avg} = \frac{\gamma D + (\gamma - \gamma_w)(B - D)}{B} \qquad D \le B$$

$= \gamma$ D > B

Table - 5.5 : Bearing Capacity Factors

ϕ	N_c	N_q	N_γ
0°	5.7	1.0	0.0
5°	7.3	1.6	0.5
10°	9.6	2.7	1.2
15°	12.9	4.4	2.5
20°	17.7	7.4	5.0
25°	25.1	12.7	9.7
30°	37.2	22.5	19.7
35°	57.8	41.4	42.4
40°	95.7	81.3	100.4
45°	172.3	173.3	297.5
50°	347.5	415.1	415.1

Table - 5.6 : Shape Factors for Terzaghi bearing capacity equation

	Sc	Sr
Square footings	1.3	0.8
Strip footings (Wall)	1.0	1.0
Round footings	1.3	0.6

5.3 Liquefaction potential evaluation and analysis

Soil liquefaction occurs in loose, saturated and cohesionless soil (sands and silts) and sensitive clays when a sudden loss of strength and loss of stiffness is experienced, sometimes resulting in large, permanent displacement of the ground. Even thin lenses of loose saturated silts and sand may cause an overlying sloping soil mass to slide laterally along the liquefied layer during earthquakes.

According to the National Center for Earthquake Engineering Research (NCEER), the liquefaction can occur under the following conditions;

- Geological age and origin
- Lower fine contents and plasticity index
- Degree of saturation (location of water table)
- Soil penetration resistance

5.3.1 Criteria for Liquefaction Potential

1. *Geologic age and origin*: If a soil layer is a fluvial, lacustrine or Aeolian deposit of Holocene age, a greater potential for liquefaction for liquefaction exists than for till, residual deposits or older deposits.
2. *Fines content and plasticity index*: Liquefaction potential in a soil layer increases with decreasing fines content and plasticity of the soil. In general, soils with a significant plasticity are not susceptible to liquefaction. Based on the Chinese findings, (Seed and Idriss, 1982) recommended that soils with significant ***plastic fines should be evaluated forpossible liquefaction based on the Atterberg limits***.
    - Percent finer than 0.005 mm ≤ 20%
    - (Liquid Limit +1%) ≤ 35%
    - (Water content +2%) ≥0.9*(Liquid Limit+1%)

    A soil with plastic fines should be considered vulnerable to significant loss of strength or liquefaction in an earthquake if the measured index properties fall within these bounds.
3. *Saturation*: Although low water content soils have been reported to liquefy, at least 80 to 85 % saturation is generally deemed to be a necessary condition for soil liquefaction. The highest anticipated temporal phreatic surface elevations should be considered when evaluating saturation.
4. *Depth below ground surface*: If a soil layer is within 20 m (~60 ft) from the ground surface, it is more likely to liquefy than deeper layers.

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5.3.2 Procedures for Liquefaction Analysis

Liquefaction analysis is performed by the method of the National Center for Earthquake Engineering Research (NCEER)'s guideline as follows;

1) Calculation of cyclic resistance ratio

For $(N_1)_{60} \leq 30$

$$100 * \mathrm{CRR}_{M=7.5} = \frac{95}{34-(N_1)_{60}} + \frac{(N_1)_{60}'}{1.3} - \frac{1}{2} \quad (1)$$

Where;

$\mathrm{CRR}_{M=7.5}$ = the cyclic resistance ratio for a Mw=7.5 earthquake

$(N_1)_{60}'$ = the corrected SPT blow count

The value of $\mathrm{CRR}_{M=7.5}$ must be adjusted for the magnitude of the earthquake under consideration. This is done with a magnitude scaling factor (MSF);

$$CRR = CRR_{M=7.5} * MSF \quad (2)$$

Where,

MSF = Magnitude scaling factor

- For Mw < 7.0: $\mathrm{MSF} = 10^3 * M_w^{-3.46}$
- For Mw ≥ 7.0: $\mathrm{MSF} = 10^{2.24} * M_w^{-2.56}$

For the corrected SPT blow count $(N_1)_{60}$

$$(N_1)_{60} = N_{SPT} * C_N * C_E * C_B * C_S * C_R \quad (3)$$

Where;

N_{SPT} = the measured blow count in the field

C_N = correction factor for atmosphere

$$C_N = \sqrt{\frac{P_a}{\sigma'_{v_0}}} \leq 2.0$$

C_E = correction for energy delivered by the SPT hammer and can be estimated from the average values given by Seed et al. (1985)

Country	Hammer type	Hammer release	CE
United states	Safety	Rope and pulley	1.0
United states	Donut	Rope and pulley	0.75
Japan	Donut	Rope and pulley, Special throw release	1.12
Japan	Donut	Free fall	1.3

C_B = correction for the borehole diameters

Diameter of boreholes	C_B
65 mm to 115 mm (2.5 to 4.5 in)	1.00
150 mm (6 in)	1.05
200 mm (8 in)	1.15

C_S = correction for the sampler

C_S = 1.2 for split spoon sampler and 1.0 for a standard sampler

C_R= correction for the loss of energy through reflection in short lengths

- For $z \leq 3$ m: C_R= 0.75
- For $3 < z < 9$ m: C_R= (15+z)/24
- For $z \geq 9$ m: C_R=1.0 where z is the length of drill rod in meter

Next step is needed to compute $(N_1)_{60}'$

$$(N_1)_{60}' = (N_1)_{60} + \Delta(N_1)_{60} \quad (4)$$

- For $F_c \leq 5\%$ $\Delta(N_1)_{60}$= 0.0
- For $5 < F_c < 35\%$ $\Delta(N_1)_{60}$= 7*(F_c-5)/30
- For $F_c \geq 35\%$ $\Delta(N_1)_{60}$= 7.0

(Where F_c is percent finer than 0.075 mm)

2) Calculation of Cyclic Stress Ratio Induced by Earthquake

$$CSR = 0.65 * \frac{a_{max}}{g} * \frac{\sigma_{v0}}{\sigma_{v0}'} \gamma_d \quad (5)$$

CSR = cyclic stress ratio

a_{max}= maximum peak horizontal acceleration

g = acceleration due to gravity (m/s^{-2})

σ_{v0}= total overburden stress

σ_{v0}'= effective overburden stress

γ_d= stress reduction factor

$$\gamma_d = 1.0 + 1.6 * 10^{-6}(z^4 - 42 * z^3 + 105z^2 + 4200z) \quad (6)$$

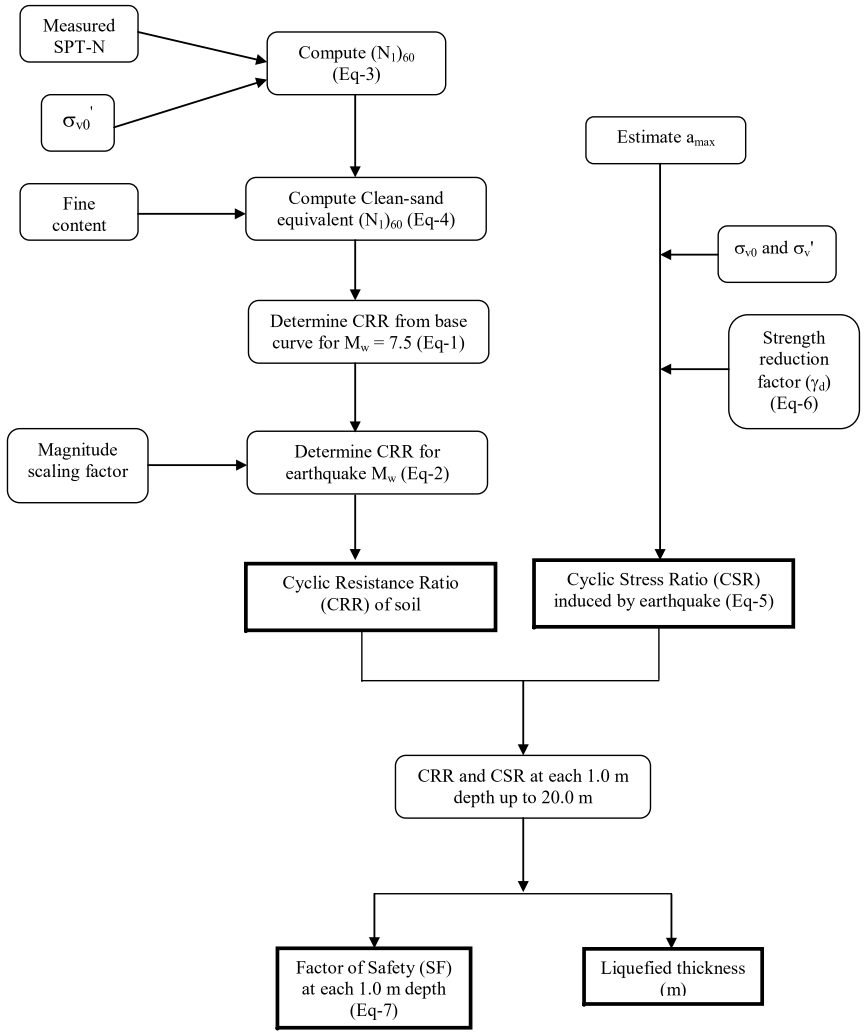
Where z is the depth below the ground surface in meters.

3) Prediction of Liquefied thickness

The factor of safety against liquefaction (FS) is defined with (Ishihara 1993; Seed and Harder 1990) as follow;

$$\boldsymbol{FS = \frac{CRR}{CSR}} \quad (7)$$

Using a factor of safety less than 1.0 (FS < 1.0) against liquefaction is not considered a sound engineering practice. This is because a factor of safety less than 1.00 indicates failure is likely to occur.



Flow chart - 5.1: Liquefaction Analysis

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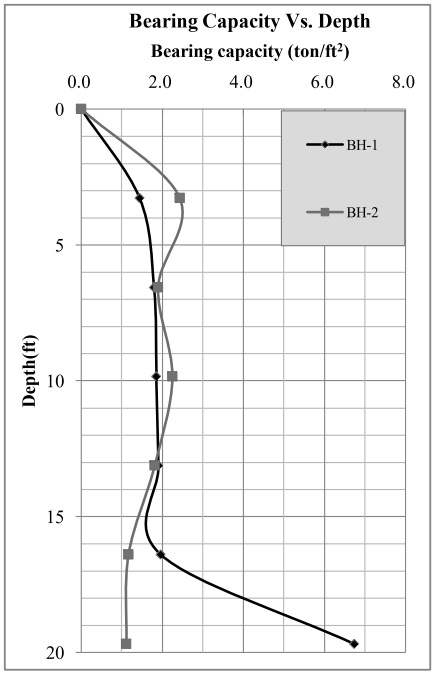
6.0 CONCLUSION AND RECOMMENDATION

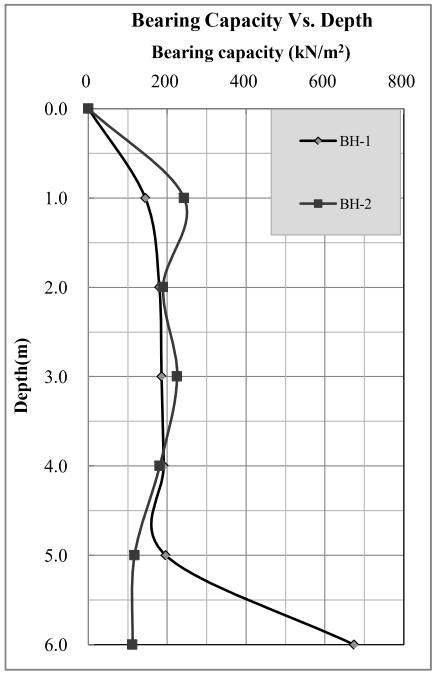
6.1 Conclusion

6.1.1 Bearing Capacity of shallow foundation

By using modified Terzaghi's bearing capacity equation, the bearing capacity of shallow foundation for each depth can be described as Graph –6.1 and 6.2. The calculation sheet of bearing capacity is presented in Appendix. For depths which are deeper than 6.0 m (~20ft) should not be considered for shallow footing for proposed project. If the client wants to use driven pile foundation for proposed project, these deeper depths can be calculated with suitable pile size for respective bearing capacity (end bearing + skin friction).



Graph - 6.1 : Allowable bearing capacity (ton/ft^2) vs. depth (ft)



Graph - 6.2 : Allowable bearing capacity (kN/m^2) vs. depth (m)

6.2 General Suggestions

When evaluating the bearing capacity of proposed area of respective boreholes, laboratory test results as well as the results derived from SPT-N values correlation were also considered. The estimated allowable, average and minimum bearing capacity for each depth is described in Table – 6.1.

Table - 6.1 : Allowable, average and minimum bearing capacity

Depth (m)	BH-1 (ton/ft^2)	BH-2 (ton/ft^2)	Average allowable bearing capacity (ton/ft^2)	Minimum allowable bearing capacity (ton/ft^2)
0	0.00	0.00	0.00	0.00
1	1.44	2.43	1.93	1.44
2	1.80	1.89	1.84	1.80
3	1.86	2.22	2.04	1.86
4	3.20	4.14	3.67	3.20
5	1.96	1.10	1.53	1.10
6	6.73	1.03	3.88	1.03

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- For shallow footing, Structural engineer can adjust and choose the various depths to meet the suitable bearing capacity requirement for the proposed building. From safety point of view, minimum allowable bearing capacity value should be used for different depths. **Nevertheless, the structural engineer should keep in mind that the bearing pressure under footing base will effect up to 1~2B (B= footing width).**
- Soil liquefaction is a major cause of damage during earthquakes. Modern engineering treatment of liquefaction related issues evolved initially in the wake of the two devastating earthquakes of 1964, the 1964 Niigata and 1964 Great Alaska earthquakes, in which seismically-induced liquefaction produced spectacular and devastating effects. The possibility of liquefaction (liquefaction potential) is high in loose sand deposits of sand. In contrast, liquefaction is unlikely to occur in dense sandy deposits. *Liquefaction is not possible when there is no ground water. Loose sandy deposit with high ground water table is mostly found in land reclamation (relative density being around 40%), young age of sand means no significant cementation and few experience of strong earthquake shaking. Liquefaction mostly occurs along the abandon of channels of rivers and their alluvial plain.* ("Geotechnical Earthquake Engineer" 2008, Chapter 18.11, Ikuo Towhata, Professor of Geotechnical Engineering, Department of Civil Engineering, University of Tokyo).
- **For the present site**, Liquefaction potential is "LOW" in both boreholes. The liquefaction potential is evaluated according to NCEER method as described in Section 5.3 and the calculation sheets are presented in Appendix. The maximum peak ground acceleration for Yangon region by CQHP (Committee for Quality Control of High-rise Building Project) is 0.2 g.
- To prevent earthquake effect, structural engineer should also consider above mentioned earthquake intensity for this proposed project. The Modified Mercalli (MM) Scale of 7.5 would also be suggested for design purpose for proposed structure.

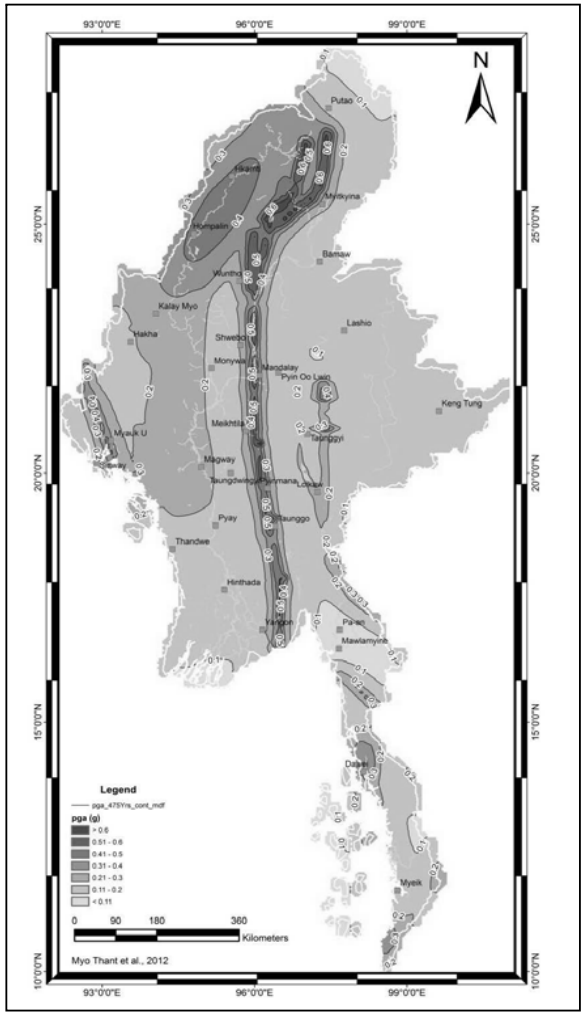

Figure - 6.1 : Probabilistic seismic hazard map of Myanmar (Myo Thant et al., 2012)

May Thu
B.E (Civil) YTU
M.E (Civil) Geotechnical (Tokyo University)
PE (Geotechnical) MEng.C

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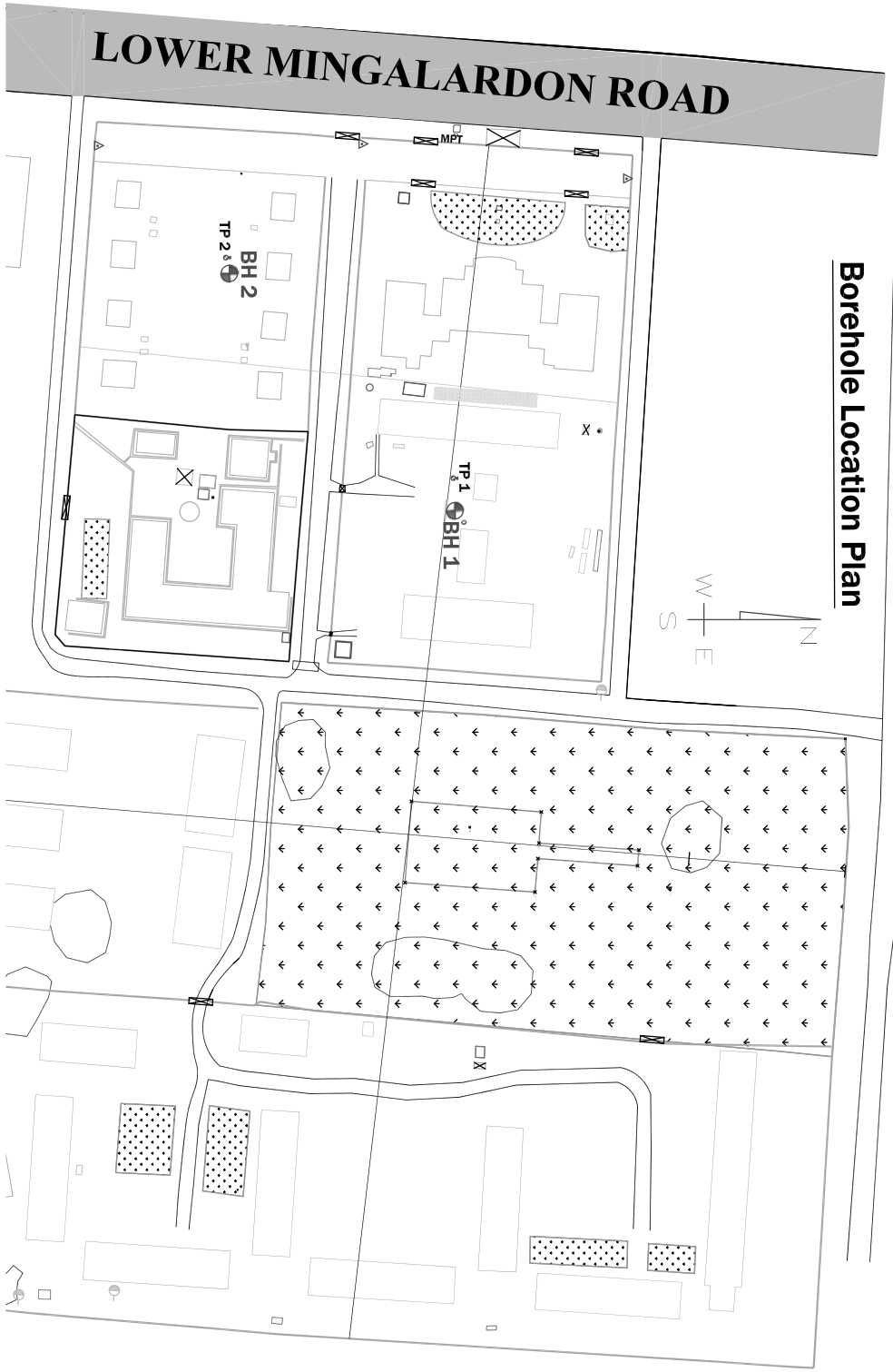
APPENDICES



Borehole Location Plan

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BORE HOLE No. **BH-1**

B O R I N G L O G (FOR DESIGN PARAMETERS CONSIDERATION)

Sheet No. 1 OF 2

PROJECT NAME : Geological Survey for the Project for the Establishment of Japan-Myanmar Vocational Training Institute (Aung San)
BORING EQUIPMENT : YWE
DATE : 27/5/18 – 31/5/18

LOCATION : Lower Mingaladon Road, Singuu Ward, Aung San, Insein Township, Yangon Region
BORING METHOD : Rotary Drilling Method
LOGGED BY : Zaw Min Than

GROUND LEVEL : 8.639 m
ORIENTATION : Vertical
CLIENT

COORDINATE : N : 1872742.629 , E : 190904.100
DEPTH : 43.95 m
GROUND WATER LEVEL : 10.56 m

MATSUDA Consultants International Co., Ltd.

SCALE (m)	ELEVATION (m)	DEPTH GL - (m)	THICKNESS (m)	DIAGRAM	COLOUR	RELATIVE DENSITY (or) CONSISTENCY	SOIL NAME	SOIL DESCRIPTION	DATE & DEPTH (m)	CASING (DEPTH (m) & DIAMETER (mm))	WATER DEPTH (m)	STANDARD PENETRATION TEST METHOD (ASTM D 1586-99) DEPTH GL - (m)	N-Value (Blows / 30cm)	CURVE OF BLOW N-Value (Blows / 30cm) 0 20 40 60 80 100	SAMPLING SAMPLE (Type & No.)	DEPTH GL - (m)	TCR (%)	SCR (%)	RQD (%)	SCALE (m)
1	7.639	1.00	1.00					Top soil layer, Yellowish brown, Sandy SILT with pieces of bricks.				1.0	14/30		SPT-1	0.45 1.0 1.45				1
2					Yellowish brown	Stiff to very stiff	SILT	Stiff to very stiff, Yellowish brown mottled reddish brown, Low plasticity, SILT with trace of sand.				2.0	17/30		SPT-2	2.0 2.45				2
3										3.00 ϕ110		3.0	17/30		SPT-3	3.0 3.45				3
4	4.639	4.00	3.00									4.0	30/40		UD-1	4.0 4.45				4
5	3.639	5.00	1.00		Yellowish brown		Elastic SILT	Yellowish brown mottled reddish brown, High plasticity, Elastic SILT.				5.0	17/30		SPT-4	5.0 5.45				5
6	2.639	6.00	1.00		Gray	Very stiff	SILT	Very stiff, Gray mottled yellowish brown, Low plasticity, SILT with sand.				6.0	20/30		SPT-5	6.0 6.45				6
7					Yellowish brown							7.0	14/30		SPT-6	7.0 7.45				7
8					Gray							8.0				8.0 8.45				8
9												9.0	22/30		SPT-7	9.0 9.45				9
10												10.0				10.0				10
11											10.56		14/30		SPT-8	10.45 11.0 11.45				11
12												12.0	11/30		SPT-9	12.0 12.45				12
13												13.0				13.0				13
14												14.0	13/30		SPT-10	13.45 14.0 14.45				14
15												15.0	15/30		SPT-11	15.0 15.45				15
16												16.0				16.0				16
17						Medium dense to dense	Silty SAND-I	Medium dense to dense, Yellowish brown mottled gray, gray mottled yellowish brown and yellowish brown, Fine to medium grained sand, Silty SAND-I.	16.95 27/5/18			17.0	21/30		SPT-12	16.45 17.0 17.45				17
18												18.0	20/30		SPT-13	18.0 18.45				18
19					Yellowish brown							19.0				19.0				19
20												20.0	22/30		SPT-14	19.45 20.0 20.45				20
21												21.0	20/30		SPT-15	21.0 21.45				21
22												22.0				22.0				22
23												23.0	15/30		SPT-16	22.45 23.0 23.45				23
24												24.0	23/30		SPT-17	24.0 24.45				24
25												25.0				25.0				25
26												26.0	22/30		SPT-18	25.45 26.0 26.45				26
27												27.0	22/30		SPT-19	27.0 27.45				27
28												28.0				28.0				28
29									28.95 29/5/18			29.0	26/30		SPT-20	28.45 29.0 29.45				29
30												30.0	37/30		SPT-21	30.0 30.45				30

NOTES

Relative density description		Consistency description	
Relative density	SPT N-Value (/mm)	Consistency	SPT N-Value (/mm)
Very loose	0 - 4	Very soft	under 2
Loose	4 - 10	Soft	2 - 4
Medium dense	10 - 30	Firm	5 - 8
Dense	30 - 50	Stiff	9 - 15
Very dense	over 50	Very stiff	16 - 30
		Hard	over 30

Sample key

- D-1 Disturbed sample (SPT sample)
- U-1 Undisturbed Sample (Piston sampler)
- D-2 Undisturbed Sample (Denison sampler)
- Rock core sample (Single core tube)
- Rock core sample (Double core tube)
- Rock core sample (Core lost)
- Water sample
- W.C

RQD (%)	Term
0 - 25	Very poor
25 - 50	Poor
50 - 75	Fair
75 - 90	Good
90 - 100	Excellent

Planner structure

Term	Spacing (mm)
Very thick	> 2000
Thick	600 - 2000
Medium	200 - 600
Thin	60 - 200
Very thin	20 - 60
Thickly laminated	6 - 20
Thinly laminated	< 6

Discontinuities

Term	Spacing (mm)
Very widely spaced	> 2000
Widely spaced	600 - 2000
Medium spaced	200 - 600
Closely spaced	60 - 200
Very closely spaced	20 - 60
Extremely closely spaced	< 20

Remarks

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service@geo-friends.com

Revision No. Rev-0
Revision Date 12/06/18
Site Geologist : Zaw Min Than
Operator : Win Shwe
Checked by : May Thu

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BORE HOLE No. **BH-1** | **B O R I N G L O G (FOR DESIGN PARAMETERS CONSIDERATION)** | Sheet No. 2 OF 2

PROJECT NAME : Geological Survey for the Project for the Establishment of Japan-Myanmar Vocational Training Institute (Aung San)
BORING EQUIPMENT : YWE
DATE : 27/5/18 – 31/5/18
LOCATION : Lower Mingaladon Road, Singuu Ward, Aung San, Insein Township, Yangon Region
BORING METHOD : Rotary Drilling Method
LOGGED BY : Zaw Min Than
GROUND LEVEL : 8.639 m
ORIENTATION : Vertical
CLIENT : MATSUDA Consultants International Co., Ltd.
COORDINATE : N : 1872742.629 , E : 190904.100
DEPTH : 43.95 m
GROUND WATER LEVEL : 10.56 m

SCALE (m)	ELEVATION (m)	DEPTH GL - (m)	THICKNESS (m)	DIAGRAM	COLOUR	RELATIVE DENSITY (or) CONSISTENCY	SOIL NAME	SOIL DESCRIPTION	DATE & DEPTH (m)	CASING (DEPTH (m) & DIAMETER (mm))	WATER DEPTH (m)	STANDARD PENETRATION TEST TEST METHOD (ASTM D 1586-99) DEPTH GL - (m)	N-Value (Blows / 30cm)	CURVE OF BLOW 0 20 40 60 80 100	SAMPLING SAMPLE (Type & No.)	SAMPLING DEPTH GL - (m)	TCR (%)	SCR (%)	RQD (%)	SCALE (m)
31					Yellowish brown	Medium dense to dense	Silty SAND-I	Medium dense to dense, Yellowish brown mottled gray, gray mottled yellowish brown and yellowish brown, Fine to medium grained sand, Silty SAND-I.				31.0	45/30		SPT-22	31.45				31
32												32.0				32.0				32
33												33.0	35/30		SPT-23	33.0				33
34	-25.861	34.50	28.50									34.0				33.45				34
35					Yellowish brown	Very dense	Silty SAND-II	Very dense, Yellowish brown, Fine to medium grained sand, Silty SAND-II with gravels.				35.0	64/30		SPT-24	34.45				35
36												36.0	99/30		SPT-25	36.0				36
37	-28.861	37.50	3.00									37.0				36.45				37
38					Gray	Very stiff	SILT	Very stiff, Gray, Low plasticity, SILT with sand.				38.0	28/30		SPT-26	37.45				38
39	-30.361	39.00	1.50									39.0	49/30		SPT-27	38.45				39
40					Yellowish brown	Dense	Silty SAND-I	Dense, Yellowish brown, Fine to medium grained sand, Silty SAND-I.				40.0	52/30		SPT-28	39.45				40
41	-31.861	40.50	1.50									41.0				40.45				41
42					Yellowish brown	Very dense	Silty SAND-II	Very dense, Yellowish brown mottled reddish brown and yellowish brown, Fine to medium grained sand, Silty SAND-II with trace of gravels.	42.38			42.0	100/25		SPT-29	41.45				42
43									30/5/18			43.0				42.45				43
44	-35.311	43.95	3.45						43.95			44.0	67/30		SPT-30	43.45				44
									31/5/18							44.45				
45								Remark : Soil classification is based on visual classification at some depths where the physical tests are not carried out.				45.0				45.45				45
46												46.0				46.45				46
47												47.0				47.45				47
48												48.0				48.45				48
49												49.0				49.45				49
50												50.0				50.45				50
51												51.0				51.45				51
52												52.0				52.45				52
53												53.0				53.45				53
54												54.0				54.45				54
55												55.0				55.45				55
56												56.0				56.45				56
57												57.0				57.45				57
58												58.0				58.45				58
59												59.0				59.45				59
60												60.0				60.45				60

NOTES

Relative density description		Consistency description	
Relative density	SPT N-Value (/30cm)	Consistency	SPT N-Value (/30cm)
Very loose	0 - 4	Very soft	under 2
Loose	4 - 10	Soft	2 - 4
Medium dense	10 - 30	Firm	5 - 8
Dense	30 - 50	Stiff	9 - 15
Very dense	over 50	Very stiff	16 - 30
		Hard	over 30

Sample key: Disturbed sample (SPT sample); Undisturbed Sample (Piston sampler); Undisturbed Sample (Denison sampler); Rock core sample (Single core tube); Rock core sample (Double core tube); Rock core sample (Core lost); Water sample

RQD (%)	Term
0 - 25	Very poor
25 - 50	Poor
50 - 75	Fair
75 - 90	Good
90 - 100	Excellent

Planner structure

Term	Spacing (mm)
Very thick	> 2000
Thick	600 - 2000
Medium	200 - 600
Thin	60 - 200
Very thin	20 - 60
Thickly laminated	6 - 20
Thinly laminated	< 6

Discontinuities

Term	Spacing (mm)
Very widely spaced	> 2000
Widely spaced	600 - 2000
Medium spaced	200 - 600
Closely spaced	60 - 200
Very closely spaced	20 - 60
Extremely closely spaced	< 20

Remarks

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Revision No. Rev-0
Revision Date 12/06/18
Site Geologist : Zaw Min Than
Operator : Win Shwe
Checked by : May Thu

BORE HOLE No. **BH-2** | **B O R I N G L O G (FOR DESIGN PARAMETERS CONSIDERATION)** | Sheet No. 1 OF 2

PROJECT NAME : Geological Survey for the Project for the Establishment of Japan-Myanmar Vocational Training Institute (Aung San)
BORING EQUIPMENT : TOHO (CD-2)
DATE : 27/5/18 ~ 30/5/18
LOCATION : Lower Mingaladon Road, Singuu Ward, Aung San, Insein Township, Yangon Region
BORING METHOD : Rotary Drilling Method
LOGGED BY : Htut Khaung
GROUND LEVEL : 8.512 m
ORIENTATION : Vertical
CLIENT : MATSUDA Consultants International Co., Ltd.
COORDINATE : N : 1872684.984 , E : 190843.559
DEPTH : 30.45 m
GROUND WATER LEVEL : 10.56 m

SCALE (m)	ELEVATION (m)	DEPTH GL - (m)	THICKNESS (m)	DIAGRAM	COLOUR	RELATIVE DENSITY (or) CONSISTENCY	SOIL NAME	SOIL DESCRIPTION	DATE & DEPTH (m)	CASING (DEPTH (m) & DIAMETER (mm))	WATER DEPTH (m)	STANDARD PENETRATION TEST TEST METHOD (ASTM D 1586-99) DEPTH GL - (m)	N-Value (Blows / 30cm)	CURVE OF BLOW 0 20 40 60 80 100	SAMPLING SAMPLE (Type & No.)	SAMPLING DEPTH GL - (m)	TCR (%)	SCR (%)	RQD (%)	SCALE (m)
								Top soil layer, Dark gray, Sandy Lean CLAY.				1.0	24/30		SPT-1	0.45				
1	7.512	1.00	1.00		Brownish yellow	Very stiff	Sandy Lean CLAY	Very stiff, Brownish yellow mottled reddish brown, Low plasticity, Sandy Lean CLAY (Lateritic soil).				2.0	18/30		SPT-2	1.0				1
2	6.512	2.00	1.00		Yellowish brown	Very stiff	Lean CLAY	Very stiff, Yellowish brown mottled reddish brown, Low plasticity, Lean CLAY with trace of sand (Lateritic soil).				3.0	21/30		SPT-3	2.0				2
3	5.512	3.00	1.00							3.00 ϕ110		4.0	40/70		UD-1	3.0				3
4					Reddish brown	Very stiff	Sandy Lean CLAY	Very stiff, Reddish brown, Low plasticity, Sandy Lean CLAY.				5.0	9/30		SPT-4	3.45				4
5	3.512	5.00	2.00									6.0	8/30		SPT-5	4.0				5
6					Reddish brown	Firm to stiff	SILT	Firm to stiff, Reddish brown mottled gray and gray mottled yellowish brown, Low plasticity, SILT with sand.				7.0				4.45				6
7	1.012	7.50	2.50		Gray							8.0	40/80		UD-2	5.0				7
8					Yellowish brown		Sandy Lean CLAY	Yellowish brown, Low plasticity, Sandy Lean CLAY.				9.0	13/30		SPT-6	5.45				8
9	-0.488	9.00	1.50									10.0			SPT-7	6.0				9
10												11.0	20/30			6.45				10
11											▽ 10.56	12.0	16/30		SPT-8	7.0				11
12												13.0				7.45				12
13					Brownish yellow	Medium dense	Silty SAND-I	Medium dense, Brownish yellow, Fine to medium grained sand, Silty SAND-I.				14.0	19/30		SPT-9	8.0				13
14												15.0	13/30		SPT-10	8.45				14
15									15.00 27/5/18			16.0				9.0				15
16												17.0	17/30		SPT-11	9.45				16
17												18.0	18/30		SPT-12	10.0				17
18	-9.488	18.00	9.00									19.0				10.45				18
19					Yellowish brown	Very stiff	SILT	Very stiff, Yellowish brown, Low plasticity, SILT.				20.0	25/30		SPT-13	11.0				19
20	-10.988	19.50	1.50									21.0	22/30		SPT-14	11.45				20
21												22.0	21/30		SPT-15	12.0				21
22					Brownish yellow	Medium dense	Silty SAND-I	Medium dense, Brownish yellow and yellowish brown, Fine to medium grained sand, Silty SAND-I.				23.0	24/30		SPT-16	12.45				22
23												24.0				13.0				23
24												25.0	29/30		SPT-17	13.45				24
25								Remark : Soil classification is based on visual classification at some depths where the physical tests are not carried out.				26.0				14.0				25
26					Yellowish brown							27.0	51/30		SPT-18	14.45				26
27	-18.488	27.00	7.50						27.00 29/5/18			28.0				15.0				27
28					Yellowish brown	Very dense	Silty SAND-II	Very dense, Yellowish brown, Fine to medium grained sand, Silty SAND-II with trace of gravels.				29.0	54/30		SPT-19	15.45				28
29												30.0	68/30		SPT-20	16.0				29
30	-21.938	30.45	3.45						30.45 30/5/18							16.45				30

NOTES

Relative density description		Consistency description	
Relative density	SPT N-Value (/30cm)	Consistency	SPT N-Value (/30cm)
Very loose	0 - 4	Very soft	under 2
Loose	4 - 10	Soft	2 - 4
Medium dense	10 - 30	Firm	5 - 8
Dense	30 - 50	Stiff	9 - 15
Very dense	over 50	Very stiff	16 - 30
		Hard	over 30

Sample key: Disturbed sample (SPT sample); Undisturbed Sample (Piston sampler); Undisturbed Sample (Denison sampler); Rock core sample (Single core tube); Rock core sample (Double core tube); Rock core sample (Core lost); Water sample

RQD (%)	Term
0 - 25	Very poor
25 - 50	Poor
50 - 75	Fair
75 - 90	Good
90 - 100	Excellent

Planner structure

Term	Spacing (mm)
Very thick	> 2000
Thick	600 - 2000
Medium	200 - 600
Thin	60 - 200
Very thin	20 - 60
Thickly laminated	6 - 20
Thinly laminated	< 6

Discontinuities

Term	Spacing (mm)
Very widely spaced	> 2000
Widely spaced	600 - 2000
Medium spaced	200 - 600
Closely spaced	60 - 200
Very closely spaced	20 - 60
Extremely closely spaced	< 20

Remarks

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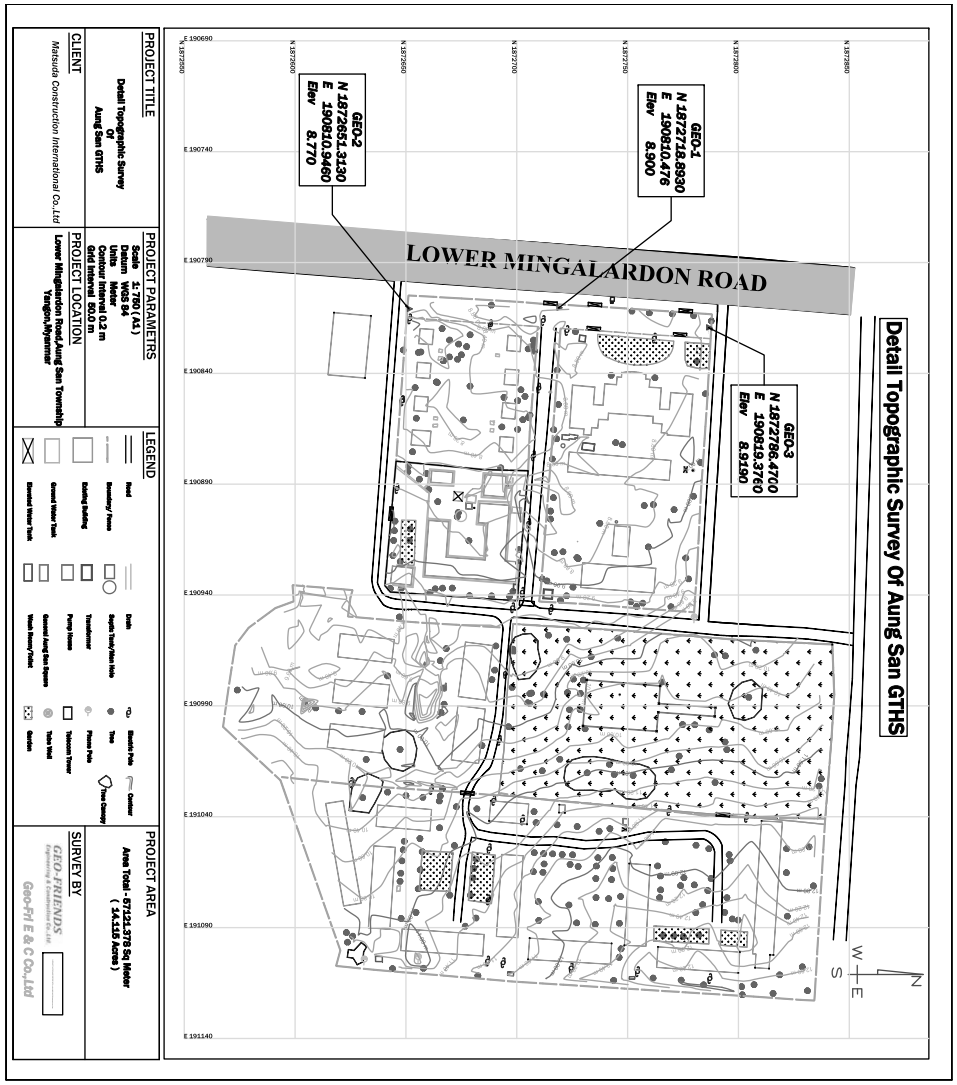
Revision No. Rev-0
Revision Date 12/06/18
Site Geologist : Htut Khaung
Operator : Zaw Htet
Checked by : May Thu



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GROUND WATER SURVEY REPORT

GROUNDWATER CAPACITY MEASURING TEST FOR THE PROJECT FOR THE ESTABLISHMENT OF JAPAN-MYANMAR VOCATIONAL TRAINING INSTITUTE (AUNG SAN)

@

LOWER MINGALADON ROAD, SINGUU WARD, AUNG SAN, INSEIN TOWNSHIP, YANGON REGION

MATSUDA CONSULTANTS INTERNATIONAL CO., LTD.

(REVISED)

18th AUGUST 2018

Submitted by

GEO-FRIENDS
Engineering & Construction Co.,Ltd.

1136(B), Thumingalar Road, 6 Block, South-Okkalapa Township, Yangon, MYANMAR
Tel: (959) 42010 7757; (951) 2331431
Email: service@geo-friends.com

Ø6"TUBE WELL DRILLING WORK,

AQUIFER AND WELL TEST REPORT

GTHS COMPOUND, AUNG SAN,

INSEIN TOWNSHIP

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CONTENTS

" Revised Summary Short Report "

1. Introduction

At the Japan-Myanmar Vocational Training Institute (Aung San), the ϕ 6" tubewell one number drilling work, pumping test and water sample chemical analysis of recent well & existing well are done in July 2018.

2. ϕ 6" well drilling

The ϕ 6"pvc well one number were drilled at near the north-east fencing 16° 55' 05.16" N, 96° 05' 55.74" E.

The drilling work with skit mounted drill machine water jetting reverse circulating method were drill tend to 500 ft depth. (Well log attached)

The coarse sand aquifer two layers were found at the depth 120'-200' Alluvial valley filled deposit yellow sand layer and the second at the depth 400'-480' Older alluvial blue sand layer.

These blue sand layer water quality may be high iron content and these medium sand water yield may be less than coarse sand.

The first yellow sand layer is good water quality and high yield quantity. So that φ 6" well were constructed by ϕ 6"pvc hand slotted screen 40' (160'-200') with casing 160' & sand trap 100'. The well developing were made water jet, serge, air lifting method with high yield pump and high compressor. (Well design, well data, water sample chemical test attached.

3. The pumping test

The 100 mmϕ submersible pump 5.5 HP were installed with 2" pvc 100' pipe. The test row one week were made water yield 3000 gph to 6000 gph. The pumping test 4 days were made.

According to pumping test data

(a) ϕ 6" well maximum yield is 6000 gph (27.27 m^3ph)

(b) Maximum water level is 11.80 mtr to 14.30 mtr (from ground level 0.0 mtr). It can be say (-11.80 m level) to (-14.30 m level)

(c) Water level recovery is nearly static level within 24 hr from 24 hr pumping drawdown level.

4. Water quality

The water quality is good potable water of 200' depth level yellow sand layer. The chemical lab test result of recent well & existing tubewellbe attached.

5. Conclusion

(a) Recent ϕ 6" well water quality and water yield may be enough for school.

It may be get 3000 gph x 8 hr running = 24000 gal per day.

(b) The next standby ϕ 6" well one number will be need.

Water Well Design

Collected the sample of the formation penetrated at each 3 meters interval. Describe the detail information were thoroughly checked and the detail logs of the well was presented and water well design of the investigation well is shown in Figure (6.1)

Table (6.1) Summary of Lithological Log ofØ 6" PVC Tube Well No (1)

Depth(ft)		Thickness	Lithology	Remark
From	To			
0	10	10	Overburden, soil, sandy clay, yellow	
10	20	10	Sand, fine, yellow, clayey	
20	40	20	Sand, fine, yellow	
40	60	20	Sand, fine, yellow	
60	80	20	Sand, fine to medium, yellow	
80	100	20	Sand, medium to coarse, yellow	
100	120	20	Sand, coarse,dark yellow	
120	140	20	Sand, coarse, yellow	
140	160	20	Sand, coarse, yellow	
160	180	20	Sand, coarse, fine gravel, yellow	
180	200	20	Sand, coarse, yellow	
200	220	20	Sand, fine, dark yellow	
220	240	20	Sand, fine, dark yellow, bluish	
240	260	20	Sand, fine, dark grey	
260	280	20	Sand, medium, dark grey	
280	300	20	Sand, medium, blue	
300	320	20	Sand, fine, blue ,slaty layer	
320	340	20	Clay, blue, sandy	
340	360	20	Clay, blue, sandy	
360	380	20	Sand, fine, dark blue	
380	400	20	Sand, fine, blue	
400	420	20	Sand, medium, blue	
420	440	20	Sand, medium, blue, slaty layer interbedded	
440	460	20	Sand, medium to coarse, dark blue	
460	480	20	Sand, medium, blue	
480	500	20	Sand, fine, blue,slaty layer interbedded	

Appendix (A)

Ø6"PVC TUBE WELL (Investigation Well)

Well Data

1. Well No	- Ø6" Well No (1)
2. Location	- GTHS Compound, Aung san, Insein Township, Northern District, Yangon, Myanmar.
3. Client	- MATSUDA COSULANTS INTERNATIONAL INC
4. Well size	- Diameter 6"
5. Well depth	- 300'
6. Bore hole depth	- 500'
7. Bore hole size	- Ø12 "
8. Well casing pipe	- Ø6" PVC pipe 13.5 class, thickness 11mm
9. Well screen pipe	- Ø6" PVC pipe 13.5 class, hand slotted
10. Well profile	- Top to bottom
	Ø6" PVC pipe casing pipe - 160 ft
	Ø6" PVC screen - 40 ft
	Ø6" PVC sand trap - 100 ft
11. Static Water Level	- 40 ft
12. Pumping Water Level	- 60ft
13. Water Yield	- 6000 gph
14. Suitable pump	- Ø4" submersible pump, HST, KSB Cora 18/9, 4HP, 18-20 mH 4000-5000 gph, setting depth 100 ft with 2" Ø PVC discharge pipe

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1. Introduction

To determine the aquifer characteristics for groundwater capacity measurement, the following tests are done in the site of Japan-Myanmar Vocational Training Institute (Aung San).

I. Step-drawdown Test or Well Performance Test
II. Recovery of Step Test
III. Constant Discharge Test and
IV. Recovery Test

Step-draw down Test and Recovery of Step Test

Start date 5.7.18
Finished date 5.7.18

Constant Discharge Test

Start date 6.7.18
Finished date 7.7.18

Recovery Test

Start date 7.7.18
Finished date 8.7.18

2. Location

The investigation site of Japan-Myanmar Vocational Training Institute, (Aung San) in Insein, Township, which lies in the northern parts of Yangon. The site lies between 16 °55’05.16”N and 96 ° 05’55.74”E. Show in figure (2.1)

Figure (2.1) Location Map of the Investigation Site Area

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3.Topography and Drainage

The site lies at the western part of Shwedagon-Mingalardon Anticlinal ridge. It is a low flat area.Elevation is about 30 ft above sea level.Hlaing River is situated in the west of the site.Drainage pattern is generally dendritic pattern .Streams areflowing from east to west into Hlaing River. It is shown in figure (3.1).

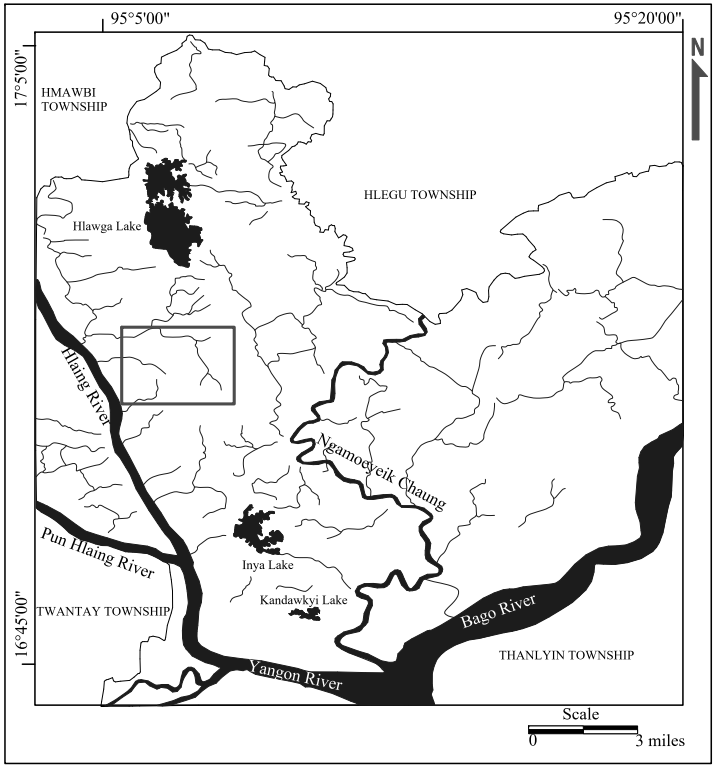


Figure (3.1) Drainage Map of Yangon Area

4. Climate

Generally, the climate condition of Yangon is tropical monsoons climate with two seasons, the wet and dry.The wet condition occurs from mid May to mid October. The annual rainfall in this area is about 110 inches.

5. Regional Geologic Setting

Yangon area includes deltaic land being southern continuation of BagoYoma of north-south trending basin containing thick Tertiary and Quaternary deposits.

5.1.Pegu Group (Tertiary)

Marine sandstone and shale deposits of Oligocene and Miocene belong to Pegu Group. The age of marine sandstones exposed at Thadugan was found to be Miocene (Win Naing 1972). This group includes three lithologic units, such as Hlawga shale, Thadugan sandstone and Besapet alteration. The Pegu group is exposed at the northern portion of Yangon area. Geologic map of the study area is shown in Figure (5.1).

5.2.Irrawaddy Formation (Tertiary)

The continental and marine (?) deposits of the Pliocene belong to the Irrawaddy Formation. This formation includes two litho-stratigraphic units; they are Arzanigone sandstone and Danyingon clay.

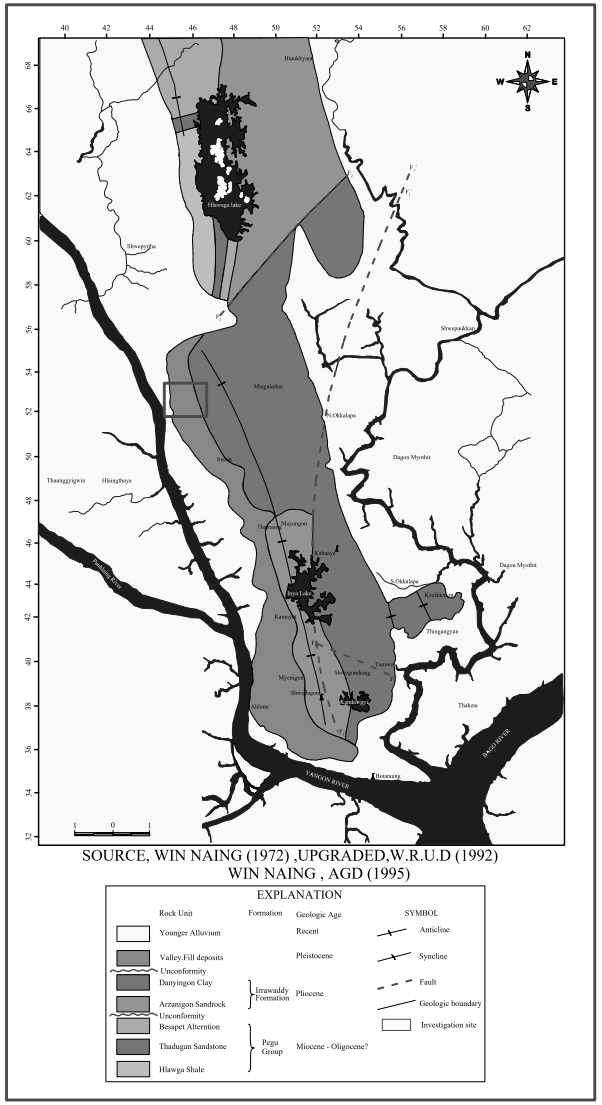
5.3.Arzanigon Sandstone

This formation is loose to very dense, generally unconsolidated to consolidated, sand rocks containing admixtures of silt, clay and fine gravel at various precentages. This formation gives moderate to fairly high yields of water. (Win Naing, 1972)

5.4.Danyingon Clay

This formation is composed of clay with interbedded sand rock, exposed on the west side of Pyay road near Mingalardon Airport and at Mindama road. Well tapping this formation gives low yields because the aquifer is thin and permeability is low due to consolidation and admixture of silt and clay. (Win Naing, 1972)

A125



SOURCE, WIN NAING (1972) ,UPGRADED,W.R.U.D (1992)
WIN NAING , AGD (1995)

Figure (5.1) Regional Geology Map of the Yangon Area

6. Hydrogeologic Characteristics

6.1Valley –Fill Deposite (Quaternary)

Valley-fill deposit occupies the synclinal valley west of Yangon ridge. They were probably deposited in Pleistocene and Sub-recent time as channel deposit. It consists of a thick sequence of loose, highly pervious, inter-bedded sand and fine to very coarse gravels. The Valley-fill deposits along Hlaing-Yangon river valley are the principal aquifer in the area.

Valley-fill deposists mainly consists of sands interbedded with fine to very coarse gravels and some clay and silt. It is a thick sequence of loose, highly pervious sediments.

At-least two water bearing horizons are found. Upper zone I is composed of yellow to light brown colour medium to coarse grained sand and gravel. The lower zone, zone II, is sand, silty sand and clayey sand. Light gray to light blue color clay unit separates these two water bearing horizons. Water bearing horizon depth (160ftto 200 ft or 48.8 m to60.9m).Aquifer thickness is (12.2 m or 40ft).

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6.2. Water Well Design

Collected the sample of the formation penetrated at each 3 meters interval. Describe the detail information were thoroughly checked and the detail logs of the well was presented and water well design of the investigation well is shown in Figure (6.1)

Table (6.1) Summary of Lithological Log ofØ 6" PVC Tube Well No (1)

Depth(ft)		Thickness	Lithology	Remark
From	To			
0	10	10	Overburden, soil, sandy clay, yellow	
10	20	10	Sand, fine, yellow, clayey	
20	40	20	Sand, fine, yellow	
40	60	20	Sand, fine, yellow	
60	80	20	Sand, fine to medium, yellow	
80	100	20	Sand, medium to coarse, yellow	
100	120	20	Sand, coarse,dark yellow	
120	140	20	Sand, coarse, yellow	
140	160	20	Sand, coarse, yellow	
160	180	20	Sand, coarse, fine gravel, yellow	
180	200	20	Sand, coarse, yellow	
200	220	20	Sand, fine, dark yellow	
220	240	20	Sand, fine, dark yellow, bluish	
240	260	20	Sand, fine, dark grey	
260	280	20	Sand, medium, dark grey	
280	300	20	Sand, medium, blue	
300	320	20	Sand, fine, blue ,slaty layer	
320	340	20	Clay, blue, sandy	
340	360	20	Clay, blue, sandy	
360	380	20	Sand, fine, dark blue	
380	400	20	Sand, fine, blue	
400	420	20	Sand, medium, blue	
420	440	20	Sand, medium, blue, slaty layer interbedded	
440	460	20	Sand, medium to coarse, dark blue	
460	480	20	Sand, medium, blue	
480	500	20	Sand, fine, blue,slaty layer interbedded	

6.3. Well Log and Well Design

The well log and well design of investigation well is shown in figure (6.1).Testing well is accommodated 6"Ø PVC casing pipe, 2"Ø PVC raiser pipe and submersible pump.

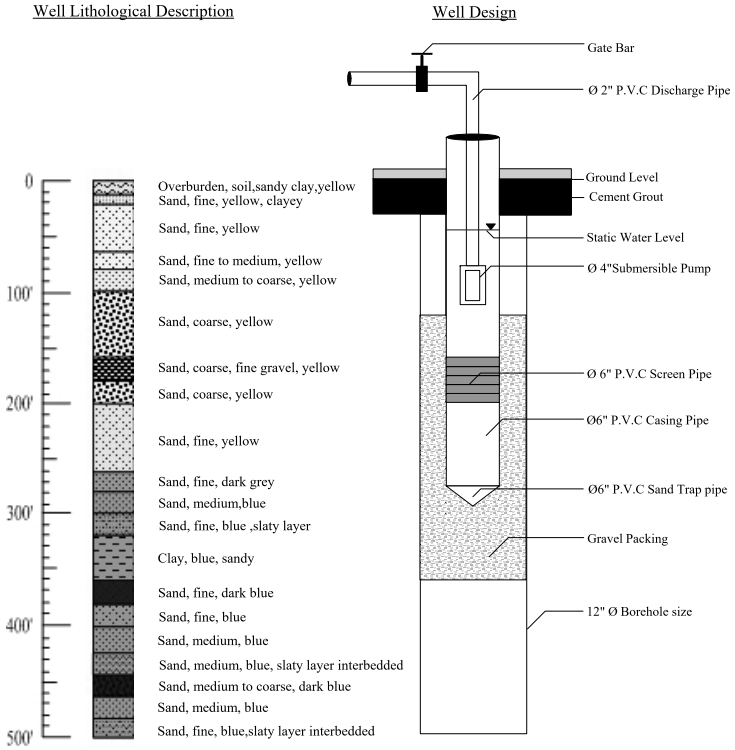

Figure (6.1) Well Log and Well Design of Investigation Site

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7. Hydraulic Characteristics of Aquifer

7.1 Aquifer Test / Well Test or Pumping Test

The principle of a pumping test is that if used pump water from a well and measure the discharge of the well and the drawdown in the well. Constant discharge test has seen done at Ø6" PVCwell by using Ø4" submersible pump, HST, KSB Cora 18/9, 4HP, 18-20mH. During on test, the discharge was measured by 5 gallon capacity open bucket frequently to maintain the constant discharge. After (360minutes or 6hours) since pumping started the steady state condition was observed. After waiting for (18 hours), the pumping was not changed, therefore, after 24 hours pumping test, the pump was stopped and 24 hours recovery measurement test wasdone.It is shown in figure (7.2) and (7.5).

Pumping water level and recovery were already measured by using electric water level indicator. The computed transmissivity and hydraulic conductivity values of constant discharge test and recovery test are following.

7.1.1 Constant –DischargePumpingTest

$$T = KD = \frac{2.3Q}{4\pi\Delta s}$$

Where,

T = Transmissivity (m^2/day)

1330m^2/day

Q = Constant well discharge rate (m^3/day)

654m^3/day

Δs =Drawdown difference per log cycle, (m)

0.09m

K =Permeability or Hydraulic Conductivity (m/d)

109m/day

7.1.2 Constant Discharge Recovery Test

$$T = KD = \frac{2.3Q}{4\pi\Delta s'}$$

Where,

T = Transmissivity (m^2/day)

1662m^2/day

Q = Constant well discharge rate (m^3/day)

654m^3/day

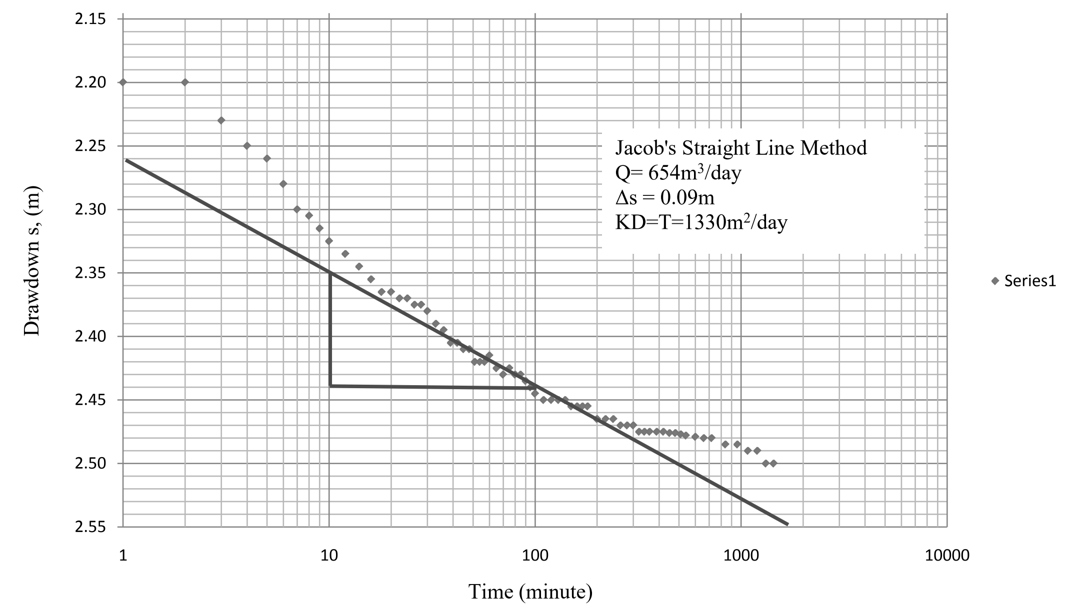
Δs' =Drawdown difference per log cycle, (m)

0.072m

K =Permeability or Hydraulic Conductivity (m/d)

136 m/day

Figure (7.1) Constant Discharge Pumping Test
Ø6'' Well (1), GTHS Compound, Aung San, Insein Township



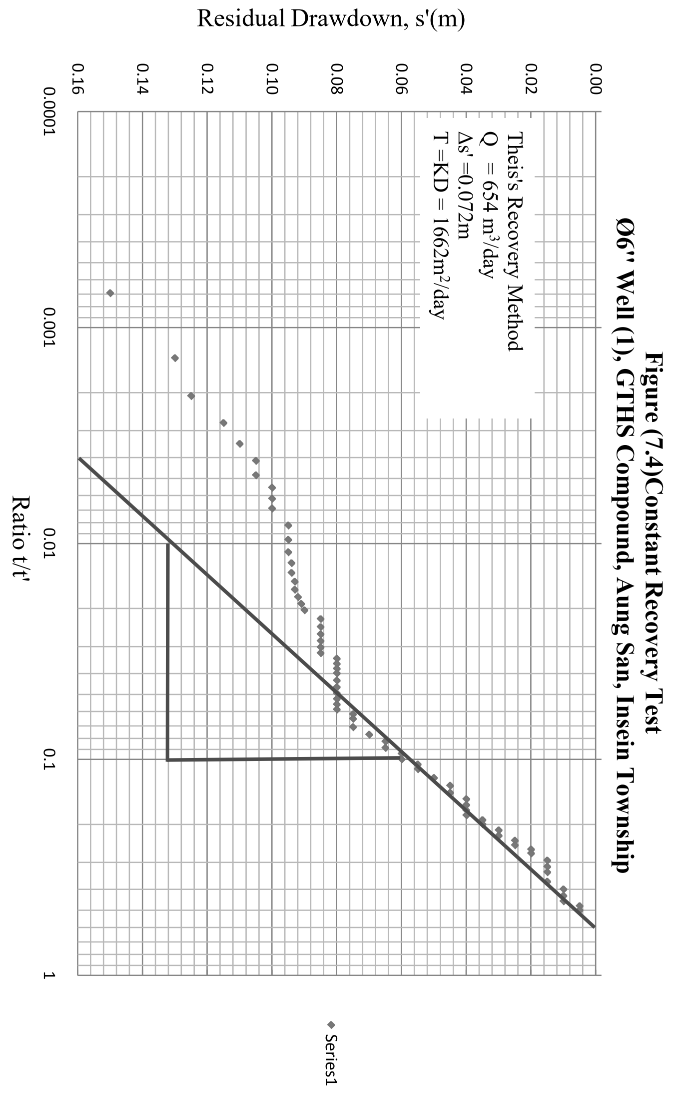


Figure (7.4)Constant Recovery Test
Ø6'' Well (1), GTHS Compound, Aung San, Insein Township

7.2 Step-drawdown Test or Well Performance Test

A step drawdown test is a single well test in which the well is pumped at a low constant discharge rate until the drawdown within the well stabilized. The pumping rate is then increased to a higher constant discharge rate and the well is pumped until the drawdown stabilized one more. This process repeated through at least three steps, which should be of equal duration, say 100 minutes. Drawdown is measured for successively increasing values of discharge such as 50%, 75% and 100% of maximum or 3000 gph, 4500 gph and 6000 gph of maximum.

The drawdown is in pumped well consisting of two components, the aquifer loosed and well loosed. A step drawdown test is conducted to determine these loosed. Excessive loosed are caused by damaging of the aquifer during drilling and completion of the well. This test also shows the information regarding the relation between discharge and drawdown of the well, which is useful for selecting of optimum pump and depth of pumping.During pumping the water level measured by electric water level indicator. Figure (7.9)

Step drawdown test makes it possible to evaluate the parameter B (Aquifer loss) and C (Well loss). The well drawdown can be expressed as

$$Sw= BQ+CQ^2$$

Where,

Sw =Drawdown in well

Q =Well discharge

B =Aquifer loss or Formation loss

C =Well loss

Table (7.1) Specific Drawdown Determined with the Hantush-BierschenkMethod: Step- drawdown Test

Step	Q (m^3/d)	sw(m)	sw/Q
I	327	1.05	$3.2x10^{-3}$
II	490	1.65	$3.4x10^{-3}$
III	654	2.4	$3.7x10^{-3}$

Figure (7.7)Step test Analysis (Q vs s/Q)
Ø6'' Well (1), GTHS Compound, Aung San, Insein Township

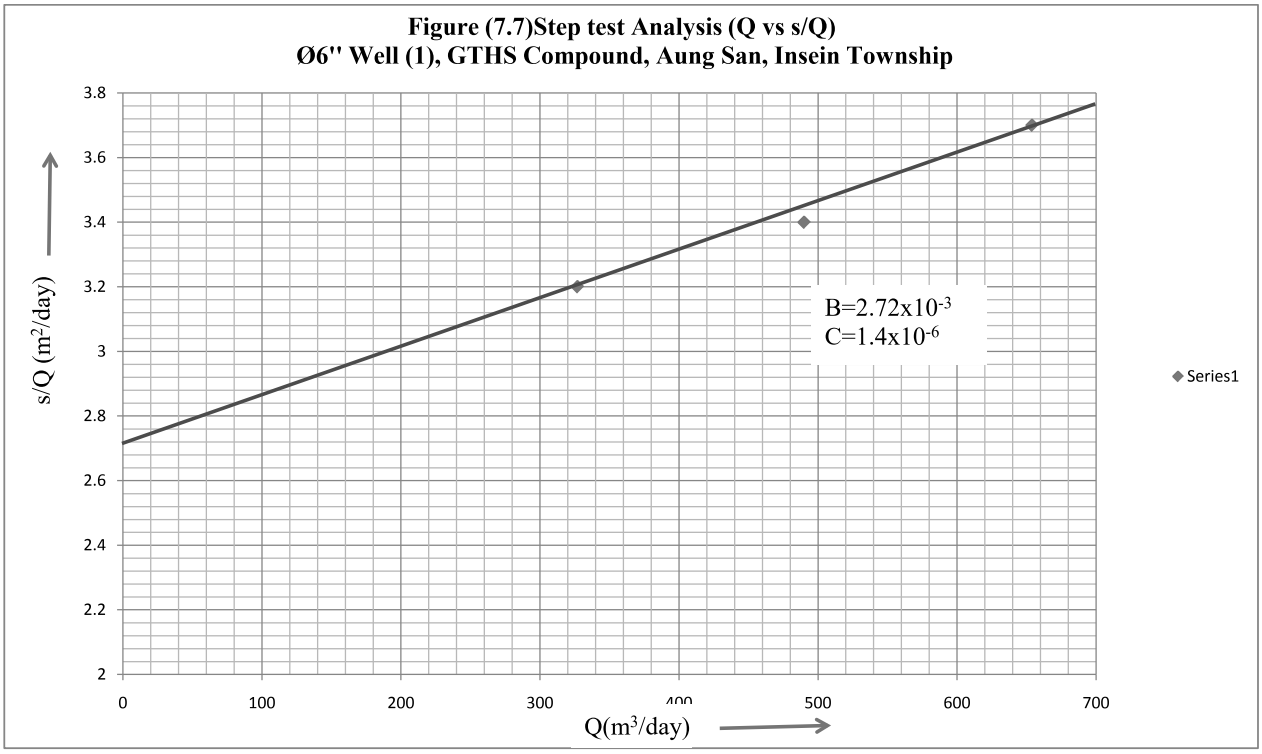
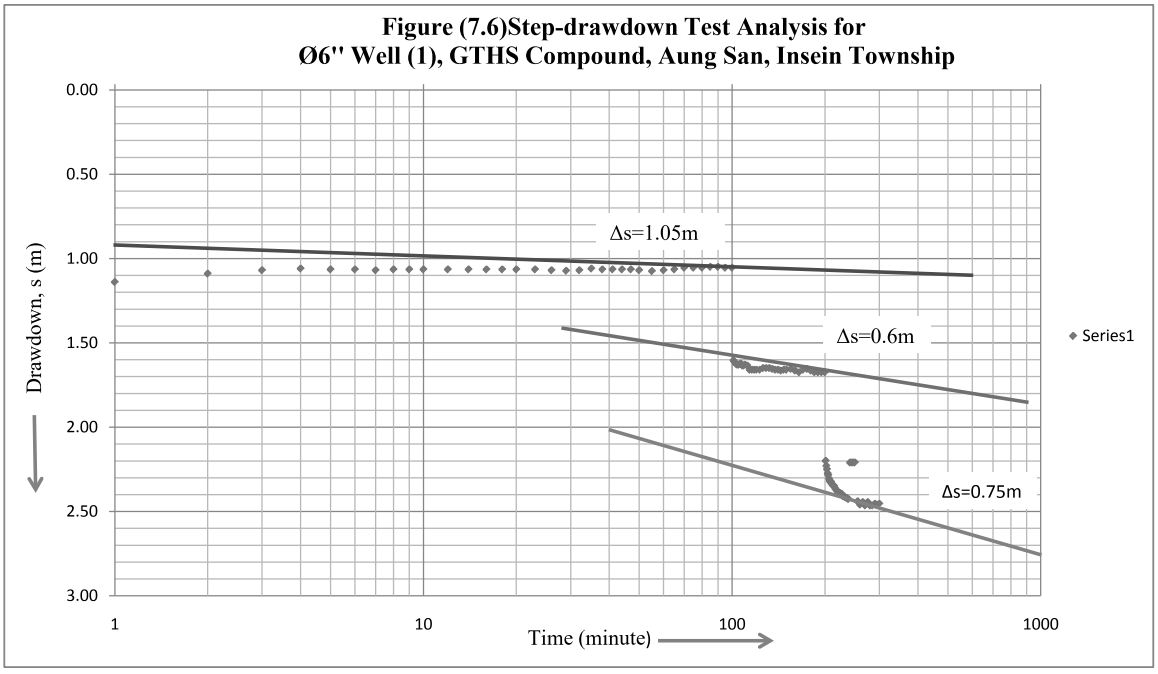


Figure (7.6)Step-drawdown Test Analysis for
Ø6'' Well (1), GTHS Compound, Aung San, Insein Township



7.2.1Recovery of Step Test

$$T = KD = \frac{2.3Q}{4\pi\Delta s'}$$

Where,

T = Transmissivity (m^2/day)

1794m^2/day

Q = Constant well discharge rate (m^3/day)

490m^3/day

Δs' =Drawdown difference per log cycle, (m)

0.05m

K =Permeability or Hydraulic Conductivity (m/d)

147 m/day

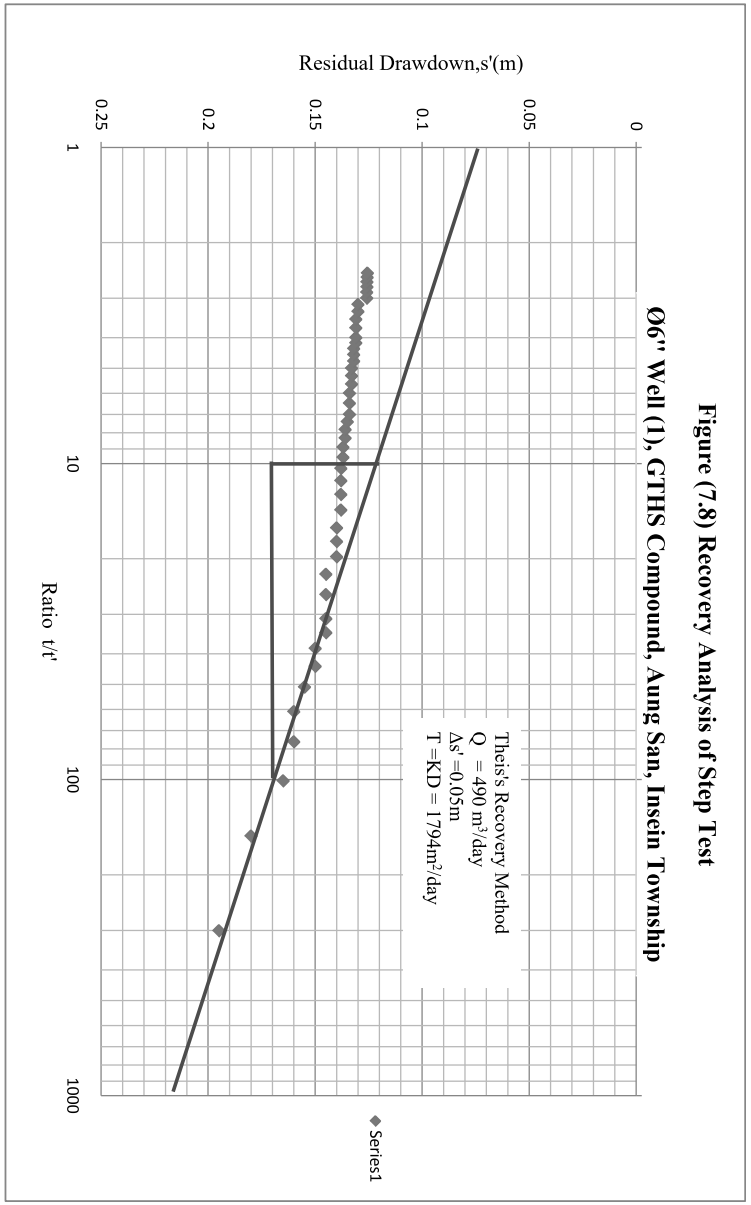


Figure (7.8) Recovery Analysis of Step Test

Ø6'' Well (1), GTHS Compound, Aung San, Insein Township

Figure (7.9) Measurement step-drawdown Test at Investigation Site

7.3 Discharge Rate with Various Step Test

Shown in table (7.2)

Step	Discharge (Q)					
	g/hr	g/day	m^3/hr	m^3/day	L/hr	L/day
I	3000	72000	13	327	13638	327312
II	4500	108000	20	490	20457	490968
III	6000	144000	27	654	27276	654624

7.4 Transmissivity and Permeability Determination from Various Tests.

It is shown in table (7.3) and (7.4).

Table (7.3) TransmissivityDetermination from Various Tests

Step	Q		Δs	T (m^2/day)
	m^3/hr	m^3/d		
I	13	327	1.05	57.02
II	20	490	0.6	149.54
III	27	654	0.75	159.66
Average	20	490	0.8	122.07

Table (7.4) Transmissivity and Permeability Determination from Various Tests

No	Type of test	T (m^2/sec)	K (m/sec)
1	Constant-discharge test	$1.5x10^{-2}$	$1.22x10^{-3}$
2	Recovery test (Constant-discharge)	$1.8x10^{-2}$	$1.57x10^{-3}$
3	Step I	$6.27x10^{-4}$	$5.13x10^{-5}$
	StepII	$1.69x10^{-3}$	$1.38x10^{-4}$
	Step III	$1.83x10^{-3}$	$1.5x10^{-4}$
4	Recovery test (step)	$2.1x10^{-2}$	$1.72x10^{-3}$
	Average	$9.69x10^{-3}$	$4.84x10^{-3}$

$$T=KDK=T/D$$

Where:

T =Transmaissivity(m^2/sec)

K =Permeability (m/sec)

D =Water bearing horizon or aquifer thickness (m)

As a result the representative transmaissivity and permeability ranges are from$6.27x10^{-4}$ m^2/sec to $2.1x10^{-2}m^2$/sec and from $1.22x10^{-3}$m/sec to$5.13x10^{-5}$m/sec respectively. The average value of permeability is $4.84x10^{-3}$m/sec. It is indicated that the aquifer material is coarse sand.(Reference: Domenico and Schwartz 1990).

7.5Well Efficiency

Express the relationship between drawdown and discharge as the specific capacity of a well, Q/sw, which describes the productivity of both the aquifer and the well.The specific capacity is not a constant but decreases as pumping continues (Q) is constant and also decreased with measuring (Q).The well efficiency, Ew, can be expressed as

$$E_w = \frac{BQ}{BQ+CQ^2} \times 100\%$$

E_w= Well efficiency

B=Aquifer loss coefficient

C=Well loss coefficient

Table (7.5) Well Efficiency Determination from Various Steps

Step	Δsw (m)	sw (m)	Q (m^3/d)	sw/Q	BQ	CQ^2	Well Efficiency(%)	Remark
I	1.05	1.05	327	$3.2x10^{-3}$	0.889	0.149	85%	
II	0.6	1.65	490	$3.4x10^{-3}$	1.332	1.336	79%	
III	0.75	2.4	654	$3.7x10^{-3}$	1.778	0.598	74%	
						Average	79%	

Aquifer loss coefficient, B =$2.72x10^{-3}$

Well loss coefficient, C =$1.4x10^{-6}$

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7.6Pump Setting Depth

According to the step test analysis, the pump setting depth and its discharge are shown in the following table.

Table (7.6) Pump Setting Depth

Sr.no	Q		Well drawdown sw=BQ+CQ^2		Pump setting depth P.S.D=sw+S.W.L		Seasonal Fluctuation		Recommended P.S.D (m)
	m^3/hr	m^3/d	m	ft	m	ft	m	ft	
1	13	327	1.039	3.4	13.569	44	10	32	23.569
2	20	490	1.668	5.47	14.198	46	10	32	24.198
3	27	654	2.377	7.79	14.91	48	10	32	24.91
S.W.L=12.53m from TOC				Average	14.23	47			24.22

Pump setting depth should be place (23.569 m or 77ft) depth from ground while the discharge is 327m^3/day or 3000 gph.

8.Chemical Characteristics of Groundwater

Water sample was collected and sent to ISO Tech Laboratory. Lab results were presented as follow:

ISO TECH LABORATORY

Laboratory Technical Consultant: U Saw Christopher Maung
B.Sc Engg: (Civil), Dip S.E (Delft) Lecturer of YIT (Retd), Consultant (Y.C.D.C), LWSE 001.
Former Member (UNICEF, Water quality monitoring & Surveillance Myanmar)

WTL-RE-001
Issue Date - 01-12-2012
Effective Date - 01-12-2012
Issue No - 1.0/Page 1 of 2

W0718 078

WATER QUALITY TEST RESULTS FORM

Client	Geo Friend
Nature of Water	Tube Well Water (6 inches)
Location	GTHS (Insein)
Date and Time of collection	4.7.2018
Date and Time of arrival at Laboratory	4.7.2018
Date and Time of commencing examination	5.7.2018
Date and Time of completing	7.7.2018

Results of Water Analysis			WHO Drinking Water Guideline (Geneva - 1993)
pH	7.1		6.5 - 8.5
Colour (True)	20	TCU	15 TCU
Turbidity	42	NTU	5 NTU
Conductivity		micro S/cm	
Total Hardness	22	mg/l as $CaCO_3$	500 mg/l as $CaCO_3$
Calcium Hardness		mg/l as $CaCO_3$	
Magnesium Hardness		mg/l as $CaCO_3$	
Total Alkalinity		mg/l as $CaCO_3$	
Phenolphthalein Alkalinity		mg/l as $CaCO_3$	
Carbonate ($CaCO_3$)		mg/l as $CaCO_3$	
Bicarbonate (HCO_3)		mg/l as $CaCO_3$	
Iron	0.73	mg/l	0.3 mg/l
Chloride (as CL)	9	mg/l	250 mg/l
Sodium Chloride (as NaCL)		mg/l	
Sulphate (as SO_4)	20	mg/l	200 mg/l
Total Solids		mg/l	1500 mg/l
Suspended Solids		mg/l	
Dissolved Solids	81	mg/l	1000 mg/l
Manganese	Nil	mg/l	0.05 mg/l
Phosphate		mg/l	
Phenolphthalein Acidity		mg/l	
Methyl Orange Acidity		mg/l	
Salinity		ppt	

Remark: This certificate is issued only for the receipt of the test sample.

Tested by
Signature:
Name: Zaw Hein Oo, B.Sc (Chemistry), St. Chemist, ISO TECH Laboratory

Approved by
Signature:
Name: Soe Thit, B.E (Civil) 1980, Technical Officer, ISO TECH Laboratory

(a division of WEG Co.,Ltd.)
No.18, Lanthit Road, Nanthargone Quarter, Insein Township, Yangon, Myanmar.
Ph: 01-640955, 09-73225175, 09-73242162, Fax: 01-644506, E-mail: isotechlaboratory@gmail.com, Website: weg-myanmar.com

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ISO TECH LABORATORY

Laboratory Technical Consultant: U Saw Christopher Maung
B.Sc Engg: (Civil), Dip S.E (Delft) Lecturer of YIT (Retd), Consultant (Y.C.D.C), LWSE 001.
Former Member (UNICEF, Water quality monitoring & Surveillance Myanmar)

WTL-RE-001
Issue Date - 01-12-2012
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Issue No - 1.0/Page 2 of 2

W0718 078

WATER QUALITY TEST RESULTS FORM

Client	Geo Friend
Nature of Water	Tube Well Water (6 inches)
Location	GTHS (Insein)
Date and Time of collection	4.7.2018
Date and Time of arrival at Laboratory	4.7.2018
Date and Time of commencing examination	5.7.2018
Date and Time of completing	7.7.2018

Results of Water Analysis			WHO Drinking Water Guideline (Geneva - 1993)
Temperature (°C)		°C	
Fluoride (F)	0.4	mg/l	1.5 mg/l
Lead (as Pb)	Nil	mg/l	0.01 mg/l
Arsenic (As)	Nil	mg/l	0.01 mg/l
Nitrate ($N.NO_3$)	0.3	mg/l	50 mg/l
Chlorine (Residual)		mg/l	
Ammonia (NH_3)		mg/l	
Ammonium (NH_4)		mg/l	
Dissolved Oxygen (DO)		mg/l	
Chemical Oxygen Demand (COD)		mg/l	
Biochemical Oxygen Demand (BOD) (5 days at 20 °C)		mg/l	
Cyanide (CN)	Nil	mg/l	0.07 mg/l
Zinc (Zn)	Nil	mg/l	3 mg/l
Copper (Cu)	Nil	mg/l	2 mg/l
Silica (Si)		mg/l	

Remark: This certificate is issued only for the receipt of the test sample.

Tested by
Signature:
Name: Zaw Hein Oo, B.Sc (Chemistry), St. Chemist, ISO TECH Laboratory

Approved by
Signature:
Name: Soe Thit, B.E (Civil) 1980, Technical Officer, ISO TECH Laboratory

(a division of WEG Co.,Ltd.)
No.18, Lanthit Road, Nanthargone Quarter, Insein Township, Yangon, Myanmar.
Ph: 01-640955, 09-73225175, 09-73242162, Fax: 01-644506, E-mail: isotechlaboratory@gmail.com, Website: weg-myanmar.com

8.1.WaterQuality

According to the Laboratory result, water quality of the presumed depth showed good condition for drinking purpose except of iron. The measuring of pH, EC and TDS during the step test period is shown in table (8.1).

Table(8.1)The Measured(pH, EC and TDS) Result in Pumping Period.

Step	EC(µmho/cm)	TDS(mg/l)	pH	Temperature(ºC)
I	150	75	6.8	27
II	94	47	6.8	27
III	75	37	6.8	27

The classification of the water type based upon the chemical analysis of the water from the well. According to the results the major water type is Ca^{2+}-Mg^{2+}Cltype, Ca^{2+}-Mg^{2+}dominant Cl^- type, or Cl^- dominant Ca^{2+}-Mg^{2+}type waters.(Reference: D.K.Chada (1999)).Shown in table (8.2). Compare with Groundwater in the investigation site and W.H.O Drinking Water Quality Standard, (2011) is shown in table (8.3)

Table (8.2) Chemical Analysis Result of Investigation Site

Well	TDS	EC	pH	TH	Major Cations					Major Anions				Unit
					Na	K	Ca	Mg	Fe	Cl	SO_4	HCO_3	CO_3	
Insein	81	40.5	7.1	22	-	-	15.72	10.68	0.73	2.3	19.81	26	ND	ppm
					-	-	0.79	0.89	0.02	0.65	0.41	0.43	ND	Epm

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Table (8.3) Compare with Groundwater in the Investigation Site and W.H.O Drinking Water Quality Standard, (2011)

Characteristics	Guideline Values	The Obtained value of ground water in investigation site
	Max Permissible	
Calcium	200 mg/l	15.72mg/l
Magnesium	200 mg/l	10.68mg/l
Sodium	200 mg/l	-
Potassium	200 mg/l	-
Sulphate	600 mg/l	19.81mg/l
Bicarbonate	600 mg/l	26mg/l
Chloride	600 mg/l	2.3mg/l
Iron	2mg/l	0.73mg/l
pH	6.5-9.2	7.1
Hardness (CaCO3)	500 mg/l	22mg/l
EC	1500 µmhos/cm	40.5 µmhos/cm
TDS	1500 mg/l	81mg/l

9. Monitoring Program

Regular monitoring of table well is conducted with a view o detect any decrease in well performance and pump efficiency.

The follow basic observations have to be made for proper well monitoring.

1. Operating hour

2. Power consumption

3. Discharge rate

4. Static water level

5. Pumping water level

6. Water quality

7. Sand content

This regular monitoring can enhance to a prolonged well life.

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10. Recommendation and Conclusion

If a person need 20 gallons per day of water the daily requirement for the training center, which have 240 peoples may need 4800 gallon per day. Maximum yield of recent well is 6000 gallon per day, when 3 hours pumping is done with the rate of 3000 gallon per day, above the requirement will be fulfilled. Maximum drawdown in the well is occurs 15.03m or 49ft of 24 hours pumping.

As a result the representative transmaissivity and permeability ranges are from $6.27x10^{-4}m^2$/sec to $2.1x10^{-2}m^2$/sec and from $1.22x10^{-3}$ m/sec to $5.13x10^{-5}$m/sec respectively. The average value of permeability is $4.84x10^{-3}$ m/sec. It is indicated that the aquifer material is coarse sand. (Reference: Domenico and Schwartz 1990).

According to the chemical analysis water from valley filled are chemically portable for drinking purpose by slightly high iron content is noticed.

The fluctuation may be due to the influence of pumping of the nearby wells.

Ministry of Education
The Republic of Union of Myanmar

QUALITY IMPROVEMENT IN TVET PROGRAM IN MYANMAR

Japan -Myanmar

(Aung San)

Vocational Training Institute

A137

ENVIRONMENTAL MANAGEMENT PLAN

Yangon, April, 2019

Resource and Environment Myanmar Ltd.
B 702 Delta Plaza, Shwegondaing Rd., Bahan, Yangon, Myanmar
Tel: (959) 73013448; Fax: (951) 552901; admin@enviromyanmar.net

DECLARATIONS

DECLARATION - EIA Experts

Resource & Environment Myanmar Co., Ltd. (REM); a local environmental consultant firm, conducted environmental impact assessment and prepared EMP report for Japan-Myanmar Aung San Vocational Training Institute in compliance with EIA Procedure and other relevant laws/rules and formally submitted to the Environmental Conservation Department (ECD) for final approval.

We do state, to the best of our knowledge at the time of report preparation, that

- To our knowledge, all information contained in this report is accurate and a truthful representation of all findings as relating to the project, and;
- The EMP Report has been prepared in strict compliance with all applicable laws, rules regulations and procedure in force.

We also consulted to Japan-Myanmar Aung San Vocational Training Institute to undertake that;

Japan-Myanmar Aung San Vocational Training Institute in respect of the "***QUALITY IMPROVEMENT IN TVET PROGRAM in Myanmar***" will at all times comply fully with (1) any and all commitments and obligations as set forth in the EMP Report which has been reviewed by Review Team, and (2) any and all plans and the various components thereof, including without limitation, impact avoidance, mitigation, and remediation measures, and with respect to such commitments, obligations, plans and measures related to the development, construction, commissioning, operation and maintenance of the project, and any circumstance in which work done or to be done, or services performed or to be performed, in connection with the project's development.

Signed: (Zaw Naing Oo) Date: 12 -04-2019

Director

For: **Resource & Environment Myanmar Co., Ltd. (REM)**

Japan-Myanmar Aung San Vocational Training Institute, DTVET, Ministry of Educaiton, Myanmar

Date: 12th April, 2019

Director Genearal

Ministry of Natural Resources and Environmental Conservation

Office No. (53), Ottrathiri Township,

Nay Pyi Taw, Myanmar.

We refer to the captioned EMP, which was prepared and finalized by {third party, Resource and Environment Myanmar Company Limited (REM Co., Ltd.) in accordance with the Environmental Conservation Law, Rules and Procedures under the instructions of Ministry of Natural Resources and Environmental Conservation and formally submitted by Environmental Conservation Department to Ministry of Natural Resources and Environmental Conservation.

Intending to be legally bound hereby and financially liable to the Ministry of Natural Resources and Environmental Conservation hereunder, we;

a) Endorse and confirm to Ministry of Natural Resources and Environmental Conservation the accuracy and completeness of the EMP.

b) Confirm and undertake to Ministry of Natural Resources and Environmental Conservation that the EMP has been prepared in strict compliance with applicable Environmental Conservation Law, Rules and Procedures and

c) Confirm and undertake to Ministry of Natural Resources and Environmental Conservation that the project in established the (Japan-Myanmar Aung San Vocational Training Institute) in respect of the (Quality Improvement in TVET Program in Myanmar) shall at all times comply fully with: (i) any and all commitments and obligations as set forth in the EMP, and (ii) any and all plans and the various components thereof, including without limitation, impact avoidance, mitigation, and remediation measures, and with respect to both (i) and (ii), including but not limited to such commitments, obligations, plans and maintenance of the project, and any circumstance in which work done or to be done, or mine development, operation and closure of the project, and any circumstance in which work done or to be done, or services performed or to be performed, in connection with the project's development, operation and closure is carried out or intended or required to be carried out or intended or required to be carried out by any contractor, subcontractor or other party.

Japan-Myanmar Aung San Vocational Training Institute, DTVET, Ministry of Educaiton, Myanmar

The issuance of this confirmation and undertaking has been duly authorized by all necessary corporate actions and a copy of the resolution of the Project Management Institution authorizing it and the power of attorney explicitly granting signing authorization to the individual who has signed below are attached as schedules hereto.

Dr. Yan Naing Tun

Principal

Japan-Myanmar Aung San Vocational Training Institute

DTVET, Ministry of Education (MOE), Myanmar

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EXCUTIVE SUMMARY

This EMP report was prepared for the establishment of Japan-Myanmar Aung San Vocational Training Institute JMASVTI project by Resource and Environment Myanmar (REM) consultant firm for the preparatory management plans of environmental and social impacts which can be emerged along with the construction and operation period.

The Japan International Cooperation Agency (JICA) has signed an agreement with the government to establish and fund the Japan-Myanmar Aung San Vocational Training Institute in December 2018 which will be operated under the operation of Department of Technical and Vocational Education and Training.

Figure 1-1: Present Aung San Technical High School

1.1 Project Structure

This project is planned to operate the 3 Years AGTI Diploma courses:

1. Automobile Technology (Maintenance)

2. Electrical Engineering (Industrial)

The overall project will include**;**

a) Pre-Designation

b) Submission of Layout Plan and Internal Approval

c) Bidding of Demolition work

d) EMP

e) UXO Detection and Clearance Work

f) Building Permit

g) Relocation of Buildings

1.2 Project Proponent

Department of Technical and Vocational Education and Training, Ministry of Education, the Republic of the Union of Myanmar.

Contact Person:	Dr. Yan Naing Tun
Designation	Principal, Aung San Vocational Training Institute
Telephone:	09799993363
Email:	jmvti2018@gmail.com
Address:	Aung San Technical High School, Lower Mingalardon Road, Insein Township, Yangon, Myanmar

1.3 Consultant Profile

Name	:	Resource & Environment Myanmar Co., Ltd.
Address	:	No. 702 B, Delta Plaza, Shwegonedaing Road, Bahan, Yangon, Myanmar.
Telephone	:	959-73013448
Facsimile	:	01-552901
Email	:	service@enviromyanmar.net
Contact Person	:	Mr. Thura Aung
Designation	:	General Manager

EMP Team Members

The EMP study team comprises members who have been involved in numerous environmental related studies. The personnel are well trained and qualified in their respective field. Please refer to Table 1.3-1 for details on members in the study team.

Table 1.3-1: EMP Consultant Team

No.	Name	Position	Responsibility
1.	U Zaw Naing Oo	Principal Consultant	Environmental Management Plan
2.	U Thura Aung	Principal Consultant	Physical Environment
3.	Daw Lai Lai Win	Environmental Consultant	Ecology, Environmental and Social Impact Assessment and Reporting
4.	U Kyaw Zin Win	Principal Consultant	GIS
5.	Daw Phyu Phyu Shein	Social Consultant	Socioeconomic
6.	Myat Ko Ko Hein	Junior Consultant	Ecology
7.	De Hlaing Zaw	Environmental Technician	Physical Environment

1.4 Project Layout

1) Establishing a model TVET institute
2) Opening of new diploma courses of Automobile Technology (Maintenance) and Electrical Engineering (Industrial)

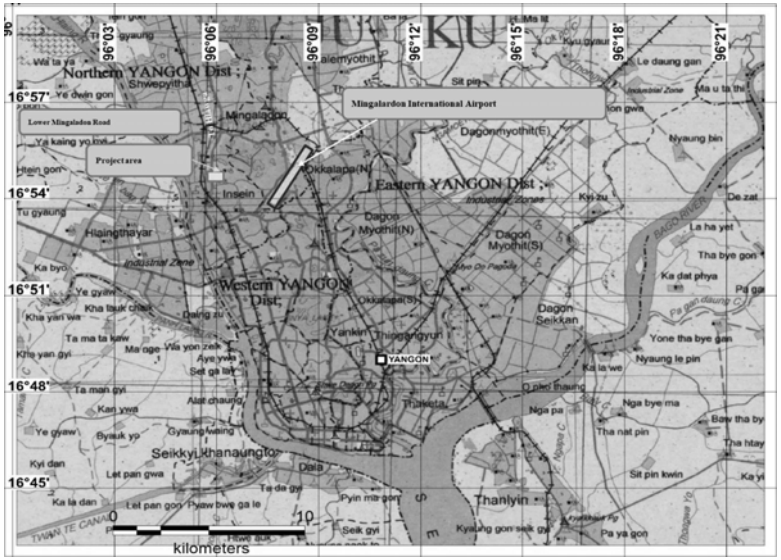


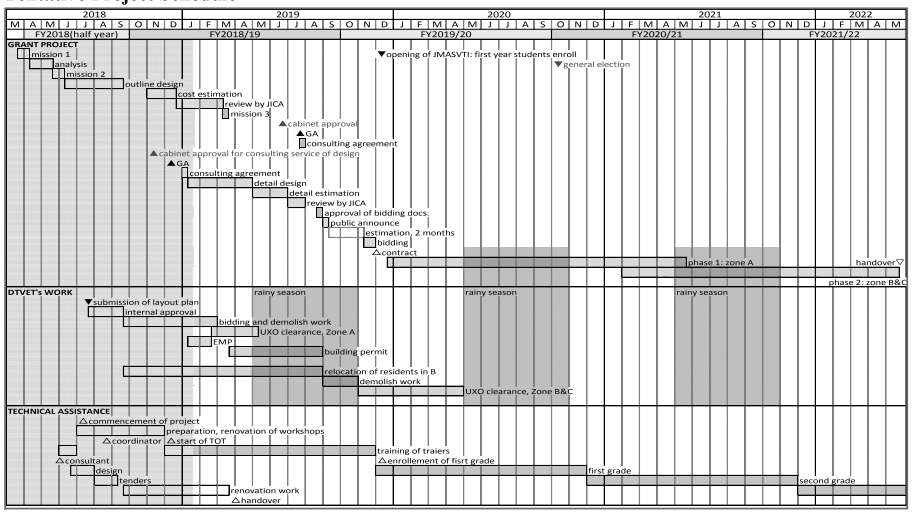
Figure 1.4-1: Location Map of the Project Area

The Japan-Myanmar Aung San Vocational Training Institute (JMASVTI) will be established on the area of 57121 m^2 (14.115 Acres) with the construction of institutional buildings and hostel for students. The institute is planned to operate with about the existing 240 students from the 1st, 2nd and 3rd academic years and 30 for teachers and administrative staffs. The total floor area is 9620 m^2 (103,548.8 ft^2) in the building area of 6974 m^2. The tentative project construction period is December 2019 to May 2022. The project is a Japan-Myanmar collaborative program and will be funded by the Japan International Cooperation Agency (JICA).

A number of buildings will be constructed at the proposed area as the followings;

Building	Components	Story Type	Area (m^2)
A	Main Entrance, Administration, Electrical Workshop, Class Room	2 story Building	2,953
B	Assembly Hall, Administration, Library, Class room	2 story Building	2,020
C	Automobile Workshop	1 story Building	1,848
D	Male Hostel (80 persons)	2 story Building	678
E	Female Hostel (40 persons)	2 story Building	1,146
F	Canteen	1 story Building	654
G	Guard Room	1 story Building	20
H	Machine Room (Electrical)	1 story Building	143
I	Water Tower 1	1 story Building	69
J	Water Tower 2	1 story Building	79
K	Machine Room (for septic tank)	1 story Building	10
Other	Septic Tank	-	2 units

Tentative Project Schedule



1.5 Baseline Studies

Physical and ecological baseline surveys were conducted in February 2019.

1.5.1 Physical Environmental Survey: Ambient Air Quality

Ambient air quality and noise survey was conducted in two points in Aung San Technological High School.

Air Quality & Meteorology	Parameter	1) Nitrogen dioxide, 2) CO, 3) particulate Matter PM_{10}, 4) Particulate Matter $PM_{2.5}$) Sulfur Dioxide, 6) Relative Humidity, 7) Temperature, 8) Wind Speed, and 9) Wind Direction
	Period	Two points within 24 hours continuous
	Location	Aung San Technical High School
Noise Level	Parameter	LAeq (A-weighted loudness equivalent)
	Period	One time at one location within one day
	Location	Within Aung San Technical High School

The survey results for ambient air quality were presented in the following table.

Sampling. No	Time	CO	NO	PM_{10}	$PM_{2.5}$	RH	SO_2	Temp.
	hours	µg/m³	µg/m³	µg/m³	µg/m³	%	µg/m³	Deg. C
AQN-1	24hrs	671.42	0.00	8.75	2.93	60.54	30.34	25.15
AQN-2	24hrs	641.40	0.00	8.29	2.55	62.18	24.11	25.97
WHO 24-hour (Interim Target 1)	24hrs	-	-	150	75		125	
NEQG Standard (Myanmar)		-	-	50	25	-	20	-

Hourly Nitrogen Dioxide Concentration

AQN-1	AQN-2	unit	NEQG Myanmar Standard (1 Hour)
141.85	3.76	µg/m³	200
182.84	3.76	µg/m³	
28.66	3.76	µg/m³	
43.37	14.61	µg/m³	
17.47	38.69	µg/m³	
47.94	77.95	µg/m³	
82.84	97.93	µg/m³	
85.98	95.73	µg/m³	
82.50	106.17	µg/m³	
76.98	104.39	µg/m³	
74.75	106.39	µg/m³	
74.88	107.40	µg/m³	
83.00	108.40	µg/m³	
73.94	103.60	µg/m³	
76.60	110.44	µg/m³	
80.55	96.80	µg/m³	
79.90	102.60	µg/m³	
77.67	105.11	µg/m³	
76.76	90.49	µg/m³	
69.14	14.80	µg/m³	
40.39	3.86	µg/m³	
3.76	3.76	µg/m³	
3.76	3.76	µg/m³	
3.76	3.76	µg/m³	

According to the survey results, the SO_2 level (24-hr) is slightly higher than the national emission guideline, NEQG. The reasons of higher SO_2 level would be associated with vehicular emissions due to the sampling points are closed to Lower Mingalardon road, which was fully operated with numerous vehicles all the time.

1.5.2 Physical Environmental Survey: Noise

Ambient noise survey was also conducted at the same points of ambient air quality survey during day-time (7:00 – 22:00 hrs) and night-time (22:00 – 7:00 hrs). The following table showed the results of noise levels at the sampling points.

Table 1.5-1: A-Weighted Loudness Equivalent Noise Level

Sampling Points	N-1		N-2	
Result	Day time	Night time	Day time	Night time
	67	57	59	53
NEQG standard (Residential and institutional area)	55	45	55	45
WHO for specific environment, Industrial, commercial, shopping and traffic area, indoor and outdoor	70			

According to the survey results, the noise levels from both points are also above the national emission standard values of residential area. The proposed project area in current situation is likely as the industrial, commercial, shopping and traffic area, including with indoor and outdoor activities. World Health Organization (WHO) guideline value for community noise in specific environments is 70 dB for such kind of area with those activities.

1.5.3 Water Resources

The temporary disposal area might be impacted to the ground water quality nearby (a tube well), which was located at 16°55'05.16" N and 96° 05'55.74" E.

According to the water quality results as shown in the following table (seen in Annex 5-1: Water Analysis Results), the tube well water is not suitable for drinking due to its high concentration of iron, color and turbidity, but suitable for general construction works.

Table 1.5-2: Groundwater Quality Results

Characteristics	WHO Guideline Values (Drinking Water)	Tube Well Water
Sulphate	200 mg/l	20 mg/l
Chloride	250 mg/l	9 mg/l
Iron	0.3 mg/l	0.73mg/l
Manganese	0.05 mg/l	Nil mg/l
pH	6.5-8.5	7.1
Total Hardness (CaCO3)	500 mg/l	22mg/l
EC	1500 µmhos/cm	40.5 µmhos/cm
TDS	1500 mg/l	81mg/l
Cyanide (Cn)	0.07 mg/l	Nil mg/l
Copper (Cu)	2 mg/l	Nil mg/l
Zinc (Zn)	3 mg/l	Nil mg/l
Lead	0.01 mg/l	Nil mg/l
Arsenic	0.01 mg/l	Nil mg/l
Dissolved solid	1000 mg/l	81 mg/l
Turbidity	5 NTU	42 NTU
Color	15 TCU	20 TCU
Fluoride	1.5 mg/l	0.4 mg/l
Nitrate	50 mg/l	0.3 mg/l

1.5.4 Ecological Baseline Survey

A targeted site reconnaissance and baseline data collection were conducted during February 2019. Aerial imagery was used to build a more complete spatial understanding of the pattern of vegetation communities and human uses on the site, and to map access routes and internal tracks.

A total of 37 plant species near fence (Northern and Southern Section), 39 plant species in the Area-A and 51 plant species in the Area-C, 4 species of Mammals, 4 species of Herpet, 17 species of Birds and 8 species of Butterflies were recorded during the survey period. In this survey, one Bird species

recorded as endemic species only. During the survey period, species of herpetofauna and mammal were observed fewer than bird and butterfly species.

1.6 Impact Assessment and Mitigation Measures

The proposed project activities will be categorized into 3 main phases;
Phase-1(P1): Pre-construction
Phase-2(P2): Construction
Phase-3(P3): Operation
For the categorization of qualitative impact assessments, the impacts are classified as;

A^- : Significant
B : Low
C : Insignificant
D : Negligible

				material transport routes, especially, the poor buildings which could be destroyed by vibration. - Long-term noise exposure will reduce hearing and labor productivity, and will cause fatigue, stress, and insomnia.	in action - Maintain machinery and equipment in good conditions - Maintain an active community consultation and positive relations with residents that will assist in alleviating concerns that might arise and resolve any potential noise complaints - Post warning signs within the vicinity of the impact and all personnel shall be provided with personal protective equipment. For example, workers operating equipment that generates noise should be equipped with the appropriate noise protection gear; and - Restrict the construction activities that will generate disturbing sounds to normal working hours
Water Resources and quality	**C**	**C**	**B**	- Degradation of water quality due to inappropriate management of construction wastes and domestic waste from camp site. -Impacts on groundwater quality as a result of construction activities such as deep foundation and piling works, and discharges. -Wastewater discharge from workshop activities during operation phase.	- No storage for fuel and lubricants/oil - regular maintenance and checking of all vehicles and machinery to minimize the risk of fuel or lubricant leakages - As construction activities typically generate disturbed soil, concrete fines, oils and other waste, on-site collection and settling of storm water, prohibition of equipment wash downs, and prevention of soil loss and toxic releases from the construction site are necessary to minimize water pollution; and - Training and equipping relevant staff in protected storage and handling practices, and rapid spill response and clean up techniques - Preparing proper sewage system/Use portable toilet for construction workers
Soil	**B**	**B**	**D**	-Clearance of Trees and UXO detection might affect soil erosion. -The accidental spillage of oil from vehicles used for transportation of construction material and accidental spillage from the building material used for construction purposes are also considered as soil contamination sources.	- Prevent soil contamination by oil or grease spills, leakages or releases, all manipulations of oil derivate in the process of construction and provision of fuel to the machines should be performed with maximum attention - Leak proof containers should be used for storage and transportation of oil/grease and wash off from the oil/grease handling area shall be drained through drains and treated properly before disposal - Construction waste and debris shall be collected on a regular basis,

Table 1.6-1: Impact Assessment and Mitigations

Impact Parameter	Evaluation of Impacts			Impacts/Sources	Mitigation Measures
	P1	**P2**	**P3**		
Air Quality ▪ **PM_{10}** ▪ **$PM_{2.5}$** ▪ **SO_2** ▪ **NO_2**	**C**	**B**	**B**	-Increases in air pollutants caused by fugitive dust from foundation work, site excavation, and emissions from operation of vehicles and trucks and heavy construction equipment. -Occupational health concern for construction workers and community health lived in the closed surroundings of the construction site are expected.	- Contract with the license contractors for compliance of environmental management consistence with the concerned government authorized department - Sprinkling of water on dust generating areas - Restricting the speed limits of vehicles during movement on unpaved roads - Covering of vehicles carrying loose soil/construction material - Applying preventive maintenance system - Checking vehicle and equipment inspection daily - Stopping dust generating activities in high wind - Applying good site practice and housekeeping - Turning off the engine while not in use - Optimizing construction schedule to minimize time that vehicles are in operation - Covering load-carrying platform properly when carrying earth/sand - Vehicle engines and other machinery will be kept turned on only if necessary, avoiding any unnecessary emission - Activities will be conducted trying to use the minimum required number of means at the same time - Electric small-scale mechanization and technical tools will be used when available and feasible; and - Repair and maintenance of construction equipment and vehicles will be performed outside of the construction site by at specialized enterprises
Noise and Vibration	**C**	**A^-**	**B**	- Increase ambient noise level at the construction site, and communities near the	- Select adequate equipment (fit with noise mufflers) - Minimize machinery and equipment unused conditions with engines

					the clearing boundaries in the project site - Unnecessary cleaning the trees is to avoid - Environmental awareness training to be given to all workers for the preservation of local biodiversity species and induct the nature of the sensitivity of project area - Works areas in temporarily affected areas shall be reinstated with tree/shrub/ grass upon completion of the works
Traffic loads	**D**	**B**	**C**	-Heavy vehicle movements during construction phase are highly expected to transport construction machinery.	- Definition of speed limits and make sure that they are respected by Project drivers (including contractors) - Adopt a Traffic Management Plan to ensure traffic safety, which should foresee safe drive trainings, regular alcohol and drug tests for drivers and driving restrictions during rush hours (especially close to schools)
Aesthetic view	**A-**	**B**	**D**	- Clearance of Trees and demolition Activities during preconstruction phase and new buildings during construction phase can be unfamiliar and affect loss of aesthetic view to the surrounding community.	- No introduce the vertical structures which can be overseen from various parts of the region - Adopt the control measures during the detailed design of the project such as building design, and growing vegetation, etc. - Color for project facilities should be carefully selected. Lighter color can be utilized to complement the surrounding areas. Where technically feasible, to decrease the visibility of facilities, plantation around the building should be planned
Occupational Health and Risk	**C**	**B**	**D**	- UXO detection works during pre-construction phase. - The construction dust and noise emissions will be affected to the construction workers.	- Adopting and training all personnel (including contractor workers) in the use of Personal Protective Equipment (PPE) and chemical handling - Training in recognition of hazard symbols - Adoption of work site hazards signage in Myanmar language - Training of all personnel in health and safety risk prevention and protection - Regular noise surveys to ensure the on-site maximum levels are not exceeded

				- Soil erosion during the construction phase is expected that can indirectly impact to natural landscape values.	covered by roof and disposed of at designated landfills - Prohibit to operate with equipment and vehicles outside the designated work areas and roads - Training and equipment will be in place to minimize the potential environmental impact in the case of accidents (for example using spill kits)
Solid wastes	**B**	**B**	**B**	-Demolition wastes and plant wastes from clearance of trees are expected at pre-construction phase. -Various types of construction solid wastes are likely to occur during the implementation stage of the project construction. -Domestic solid wastes, office wastes, workshop wastes are expected during operation phase.	- A waste management plan shall be developed including requirements for separation, handling and disposal of all waste generated - All hazardous materials shall be stored in clearly labeled containers - Storage and handling of hazardous materials should be in accordance with national and local regulations appropriate to their hazard characteristics - Waste shall be separated on site and waste storage areas shall be roofed and bounded to prevent potential cross-contamination - Spent oils (including transformer oil) shall be recycled - Fire prevention systems and secondary containment shall be provided for storage facilities, where necessary, to prevent fires or releases of hazardous materials - All waste shall be disposed of in line with local requirements at a suitable and licensed waste disposal facility; and - Suitable disposal sites shall be identified with capacities for disposal for general and hazardous waste prior to the operation phase
Vegetation And Terrestrial fauna	**A-**	**C**	**D**	- A removal of the tree and bushes in the construction area will be done so potential impact on vegetation was expected. - The regional fauna species are also expected to face loss of their habitats due to clearance of vegetation.	- Routine checking of trenches (if any) and escape routes to minimize, if not prevent, entrapment of fauna - Reporting of any violation relating to hunting birds, snakes and trading activities - Implementing good housekeeping practices on the field and implementing good Solid Waste Management Plan in order to eliminate any source of hazard to the native fauna - Minimize vegetation clearance and habitat disturbance by demarcating

					- Development of inspection, testing and maintenance programs for machinery and equipment - Accident recording and investigation and prevention initiatives - Development of training in site emergency response plans both for the construction phase; and - Compliance to all international, national or local health safety standards that may exist
Community Health	**D**	**B**	**D**	- The construction dust and noise emissions and fugitive emission by heavy transportation will be affected to the construction workers.	- Guarantee proper vehicle maintenance to reduce noise and accidents - Maintain the Project roads to reduce the possibility of accidents, including clearing of vegetation on to improve sight distance and visibility - A series of traffic measures should be also considered: dust suppression measures, as vehicle speed restrictions, wheel washing area installed at all site access points, containment for dusty materials, and frequent watering or covering of exposed areas of ground, and prompt site restoration; installation of appropriate temporary road sign points on the roads used by Project traffic at bends, junctions, schools and populated areas - Engage with local communities through traffic safety awareness campaigns

1.7 Scope of EMP Work

The EMP framework was Prepared by Resource and Environment Myanmar (REM) in compliance with the Environmental Management Plan in Section 63 (subsection: 8.0) of Environmental Impact Assessment Procedure 2015.

The Environmental Management Plan consists of two parts.

1) Environmental mitigation plan: An EMP will be conducted in order to minimize and/or avoid negative impacts, and to strengthen positive impacts.

2) Environmental monitoring plan: An environmental monitoring plan will be carried out in order to determine the environmental condition, to ensure that the mitigation plan is effectively functioning and to specify adverse impacts before their expanding.

1.7.1 Institutional Arrangement for EMP Implementation

Environmental Management Responsibilities during Construction

The project proponent (DTVET) and JMASVTI will outsource a contractor to implement the detailed design and construction during the pre-construction and construction phases. The outsourced contractor will establish a project office to undertake the implementation of the detailed design and construction works together with the environmental mitigation and management plan and the environmental monitoring, while the project proponent will supervise their works.

Regular Operation Stages

The implementation organization of the monitoring tasks during operation phase will be JMASVTI. During regular operation stage, DTVET shall implement environmental mitigation measures and submission of monitoring report biannually in accordance with the submitted EMP and shall receive the first inspection after 6 months from the start of vocational training school operation and additional inspection after the first inspection as necessary.

1.8.1 Construction Phase: Air Quality Management Plan

Objectives	This EMP relates principally to the control of dust emissions from demolition works, loading/unloading of construction materials and bulk materials transported by truck vehicles.
Legal Requirements	National Environmental Quality (Emission) Guidelines, 2015 Yangon City Development Committee Law, 2018
Implementation Schedule	Construction phase of the project
Management Action	▪ Keeping construction equipment and generators in good operating condition ▪ Keeping vehicles under good condition, with regular checking of vehicle condition to ensure compliance with national standards ▪ Adopt machine and equipment that energy saving and create less pollution ▪ Proper storage including covering of sand, gravel and other materials which are easily spread into the atmosphere ▪ Watering unpaved /dusty roads (at least twice a day) ▪ Sprinkling and covering stockpiles ▪ Cleaning of construction sites, especially near site entrance ▪ Covering top of trucks carrying materials to the site and carrying construction debris away from the site ▪ Protection of all works and materials by installing green net or other measures that

	will prevent dust from spreading around ▪ Dust mask will be provided to the construction workers working in dusty areas
Responsibilities	Staff of Contractor's HSE Department under the guidance of DTVET

1.8.2 Construction Phase: Noise & Vibration Management Plan

Objectives	Activities have minimal adverse noise and vibration effects on surrounding environment and project site. To control the noise from operation of construction machinery will increase the level of noise generated, affecting household and sensitivity receptors (e.g. schools, hospitals and monastery)
Legal Requirements	National Environmental Quality (Emission) Guidelines, 2015 Yangon City Development Committee Law, 2018
Implementation Schedule	Construction phase of the project
Management Action	▪ Routine maintenance of vehicles and construction equipment ▪ Scheduling of deliveries during non-school hours and after regular working hours ▪ Installation of barrier fences during construction to reduce noise disturbance, especially near sensitive receptors (e.g. park and staff house) ▪ Development of working rules so as to, for example, avoid unnecessary use of air-horns, keep to the speed limit, turn off engines when not in operation and train drivers and operators to follow the rules ▪ Scheduling to avoid much equipment operating at the same time near sensitive receptors (e.g. park and staff house) ▪ Avoiding, as much as possible, construction equipment producing excessive noise during school hours ▪ Avoiding prolonged exposure to noise (produced by equipment) by workers ▪ Supply construction workers who will be operating noisy equipment with appropriate personal noise protection gear (e.g. ear muffs, ear plugs, etc.)
Responsibilities	Staff of Contractor's HSE Department under the guidance of DTVET

1.8.3 Construction Phase: Soil Erosion and Drainage Management Plan

Objectives	To control and prevent surface water quality in case of soil erosion To prevent flash flooding in construction site during heavy rain
Legal Requirements	Environmental Conservation Law, 2012 Yangon City Development Committee Law, 2018
Implementation Schedule	Construction phase of the project
Management Action	▪ Ensure that the existing protected trees will not be damaged during the progress of construction works ▪ Adequate temporary drainage channels will be constructed to help facilitate the outflow of onsite runoff to existing drainage facilites. These temporary drainage channels will be constructed in such a manner that they, (a) feed into existing, offsite, natural/engineered drains and (b) do not result in compromise and overtopping of existing offsite drainage features ▪ Storm water should be controlled (channeled), before it enters the site, to ensure that the processing plant is not jeopardized during heavy rains.

Responsibilities	Staff of Contractor's HSE Department under the guidance of DTVET

1.8.4 Construction Phase: Solid Waste Management Plan

Objectives	Solid waste will increase by civil works such as large volume of sand waste especially the foundation works. To control and prevent groundwater quality in case of dumping of solid waste.
Legal Requirements	Environmental Conservation Law, 2012 Yangon City Development Committee Law, 2018
Implementation Schedule	Construction phase of the project
Management Action	▪ Complying with waste management rule under township development committee for disposing waste at disposal site. ▪ Preparation of a temporary waste dumping site during storage ▪ Installation of a signboard to prohibit waste dumping in inappropriate areas ▪ Collection of residues of oils, including lubricating oil ▪ Prohibition of placing materials (e.g. soil, gravel, and sand) on roadside or any other areas outside the project site ▪ Reuse of sand materials for road improvement and others ▪ Arrange garbage bin for general waste and hazardous waste separately ▪ General waste will be clean out once per week and hazardous waste will be clean out once per month
Responsibilities	Staff of Contractor's HSE Department under the guidance of DTVET

1.8.5 Construction Phase: Domestic Wastewater Management Plan

Objectives	Domestic especially sanitary water
Legal Requirements	Environmental Conservation Law, 2012 Yangon City Development Committee Law, 2018
Implementation Schedule	Construction phase of the project
Management Action	▪ Regular maintenance and checking of all vehicles and machinery to minimize the risk of fuel or lubricant leakages ▪ As construction activities typically generate disturbed soil, concrete fines, oils and other waste, on-site collection and settling of storm water, prohibition of equipment wash downs, and prevention of soil loss and toxic releases from the construction site are necessary to minimize water pollution; and ▪ Training and equipping relevant staff in protected storage and handling practices, and rapid spill response and clean up techniques ▪ Preparing proper sewage system of existing toilets ▪ The contractor will procure portable toilets and locate them at the construction site if the existing toilets may not enough for construction workers ▪ Waste water generated from washing of concrete mixer and machines will be stored in the special storage (e.g. fiber drum) and send to the designated treated place after discussion with YCDC
Responsibilities	Staff of Contractor's HSE Department under the guidance of DTVET

1.8.6 Construction Phase: Traffic Safety Plan

Objectives	This Traffic Safety Plan relates principally to the road transport of materials and supplies to the Project site To control the project traffic to prevent traffic jam/disturb traffic flow in front of the school due to mobilization and loading/unloading of equipment and materials for civil works and the construction activities
Legal Requirements	NA
Implementation Schedule	Construction Phase
Management Action	▪ To install traffic signs and warnings at the entrance and exit gates for vehicles and heavy equipment ▪ To provide adequate parking lots at the construction site and to forbid parking vehicles on the roadside ▪ To appoint a staff in charge of traffic control, especially lower Mingaladon Road in front of school ▪ To arrange a schedule of mobilization of equipment to avoid increasing traffic congestion and to avoid busy hours ▪ To coordinate with the traffic police to manage the traffic when traffic congestion period ▪ Speed reduction to 10 km per hour within the school zones
Responsibilities	Contractor (Monitoring by HSE section and/or third party)

1.8.7 Operation Phase: Domestic Solid Waste Management Plan

Objectives	Domestic solid waste will increase by consumption of hostels, office and students and prevent groundwater quality in case of dumping of solid waste.
Legal Requirements	Environmental Conservation Law, 2012 Yangon City Development Committee Law, 2018
Implementation Schedule	Operation phase of the project
Management Action	▪ Yangon City Development Committee (YCDC) has responsibility for solid waste management in Insein Township ▪ YCDC is planning to introduce a separation collection system of solid waste. Therefore, JMASVTI will be requested to co-operate separation discharge of its solid waste as part of environmental education ▪ Collect waste from hostel by separating different types of garbage bins such as vegetable waste, food waste, living garbage etc. ▪ Collect waste from office, class room, electrical training workshop, automobile workshop by separating different types of garbage bins ▪ General waste will be clean out once per week and hazardous waste will be clean out once per month ▪ MOE will be allocated a budget for collection of solid waste management by YCDC services.
Responsibilities	DTVET and Township Development Committee

1.8.8 Rehabilitation Plan

Objectives	Clearance of trees for construction of new buildings for office main buildings, hostels, workshops and other training facilities are defined and rehabilitation plan for the green area shall be developed. The flora species should be suitable for institutional area. The national flowering plants, Padauk (Myanmar) and Sakura (Japan) where possible, and seasonal flowering plants, Wild Himalayan Cherry (*Prunus wallichii*), Ceylon ironwood (*Mesua ferrea*), Peacock flower (*Caesalpinia pulcherrima*), Golden shower (*Caesalpinia pulcherrima*) etc. shall be planted along with the fence area.
Legal Requirements	Environmental Conservation Law, 2012
Implementation Schedule	Operation phase of the project
Management Action	▪ Areas of exposed soil should be replanted with grass, as soon as possible, after site preparation and construction to help mitigate against flash flooding and soil erosion ▪ Yangon City Development Committee (relevant department associated with park area) has responsibility for regrowth of trees in Insein Township ▪ Therefore, JMASVTI will be requested to co-operate with playgrounds, parks & gardens department for plant seedlings and replantation activities as part of ecological management.
Responsibilities	DTVET and Township playgrounds, parks & gardens department

1.9 Environmental Monitoring Plan

Table 1.9-1: Environmental Monitoring Plan (Construction Phase)

Environmental Monitoring Plan (Construction Phase)					
Category	**Item**	**Location**	**Frequency**	**Responsible Organization**	**Target Value**
Air emission (mainly dust)	- Dust emissions during foundation works - Water spray to limit dust from vehicle movements. - Record of sprinkle water implementation	Construction site (Within the school compound) and main gate	Daily	Contractor's Environmental Team (HSE)	National Regulation; Air and Water Quality
Noise	- Loud Noise by visual observation - Complaint from nearby communities	Construction site (Within the school compound)	Daily	Contractor's Environmental Team (HSE)	Community perception
Solid Waste	- Amount of solid waste - Nonhazardous waste (office waste) - Hazardous waste (used lubricants) - - Site observation, Examination of records of type and volume of waste/ Proportion of recycling/reuse	Construction Site	Daily/Weekly	- Contractor's Environmental Team (HSE)	YCDC Rules and Guidelines
Traffic congestion and incident	Site observation Installation of traffic signals, compliance with traffic routes etc.) hearing with the community	In front of the JMASVTI	Weekly	Contractor's Environmental Team (HSE)	YCDC Rules and Guidelines
Occupational Health and Safety	OHS training records for all contractors and employees	Construction site	Once a month	Contractor's Environmental Team (HSE)	IFC EHS standards
Community Health and Safety	Training record and number of accidents,	Construction site	Twice a year	Contractor's Environmental Team (HSE)	IFC EHS standards

Table 1.9-3: Environment Monitoring Plan (Operation Phase)

Environment Monitoring Plan (Operation Phase)					
Category	**Item**	**Location**	**Frequency**	**Responsible Organization**	**Target Value**
Waste water	Proper functioning of the water supply and sanitary sewage facilities to ensure full hygienic practices	Designated location	Once a month	Engineer from JMASVTI	YCDC Rules and Guidelines
Strict commitment to EHS requirements	Proper functioning of automobile workshop and electrical workshop	Designated location	Once a month	Engineer from JMASVTI	As required
Solid Waste	Nonhazardous waste (office waste) Hazardous waste (used lubricants)	Main office Storage area	Monthly Twice / year.	- Engineer from JMASVTI - YCDC	YCDC Guidelines
Hazardous and Chemical Substances	Fuel storage, new and used lubricants area	Storage area	Monthly	- Engineer from JMASVTI	Community perception
Occupational Health and Safety	Training record for staff, loss time injury, and number of accidents	Entire boundary	Twice/year	- Engineer from JMASVTI	Community perception
Community Health and Safety	Training record and number of accidents	Surrounding	Twice/year	- Engineer from JMASVTI	Community perception

1.10 Public Consultation Meeting and Disclosure of EMP

Public consultation meeting was conducted to disclose the project information, the baseline study results and the estimation of potential impacts to the surrounding communities and the relevant government departments.

Total 26 participants were recorded in meeting attendant list, who are representatives of JMASVTI itself, the surrounding institutes of JMASVTI, relevant government officers from planning and ECD and consultant organizations. The following table shows the summary of Public Consultation Meeting and Disclosure of EMP. Detailed Public Consultation Meeting and Disclosure of EMP is provided in Chapter 10.

Date and Time	29-03-2019 10:00 – 11:30
Venue	Government Technical Institute (Insein)
Consultation Method	• Presentation • Questions and Answers • Face to Face Discussion
Participants	• JMASVTI • Consultant (MICT) • REM Consultants • ECD (Yangon Region) • Planning Department (Yangon Region) • UHC Insein • THS (Ywar-Ma)
Meeting Organizers	• Principal, JMASVTI • REM Consultant

Outlines of Presentation	• Objectives of Public Consultation Meeting • Project Description • Aim and Objectives of the Project • Location and Project Components • building Layout Plan • Project Implementation Schedule • Environmental Baseline Results (Physical and Ecological Environments) (Water, Wind Direction, Air, Flora, Fauna) • Impact Assessments • Mitigation Measures • Institutional Arrangement of EMP Implementation Team • EMP for Construction Phase and Operation Phase
Meeting Results	• Clarification of project components • Baseline surveys • Electricity and water usage during construction and operation period • Wastewater and solid treatment units • Protection barrier for atmospheric and noise emissions • Rehabilitation of plant species which were cleared during preconstruction phase • Potential replantation plan during the operation period

1.11 Conclusion and Recommendations

The Resource & Environment Myanmar Ltd. has been invited as the consultant to support and prepare the EMP report by Developer.

In support and approval of this EMP report, the Resource & Environment Myanmar Ltd. had collected and analyzed physical, biological and social data such as people's perceptions, concern, opinion, and expectation on the project for the approval of clean environment and guiltless society during and after the development of the project.

The proposed project is aimed to:

- develop qualified human resources through the graduates of JMASVTI, contributing their skill and knowledge that make fulfilling in the field of Automobile Technology (Maintenance) and Electrical Engineering (Industrial).
- establish a system based on local market needs in Automobile Technology (Maintenance) and Electrical Engineering (Industrial) field which in turn fulfill the education gaps.

Although the project involves some inevitable negative environmental impacts, such impacts as clearance of vegetation and demolition activities, are not served as to not undertake the project. Mitigation measures have been proposed to adequately minimize the significant impacts. Hence, the project is justifiable in the light of the socioeconomic conditions and anticipated benefits from the project which clearly and absolutely outweigh the negative environmental impacts upon completion.

1.0: INTRODUCTION

The Environmental Management Plan (EMP) of Japan-Myanmar Aung San Vocational Training Institute (JMASVTI) project is prepared by Resource & Environment Myanmar Company Ltd. The Environmental management plan deals with environmental protection measures, environmental management system and environmental monitoring during project construction and operation period, to ensure environmental protection measures and monitoring requirements can be effectively executed in subsequent stages of the project.

This environmental management plan is worked out during the preparation of project, all kinds of conditions and expected objectives for the project are put forward in the plan.

Once construction and operation schemes are finalized during the implementation of project, this environmental management plan shall be revised accordingly.

1.1 Scope of EMP

The project is expected to provide direct financing to "Project for Quality Improvement in TVET Program" to establish and fund the Japan-Myanmar Aung San Vocational Training Institute. The Japan International Cooperation Agency has pledged to provide financial and technical support for the establishment of the Japan-Myanmar Aung San Vocational Training Institute in Yangon.

This EMP is developed by Ministry of Education (MOE) based on the EIA Procedures 2015 to address potential impacts arising from project implementation and operation and in line with the relevant National and International Legislation.

The EMP lists the obligations and responsibilities of each party involved in the project, stipulates methods and procedures that will be followed, and outlines the environmental and social management actions that will be implemented.

1.2 Purpose and Objectives of the EMP

The present EMP has been prepared according to the letter dated on 27 June 2018 of Ministry of Natural Resources and Environmental Conservation.

This environmental management plan includes the following contents:

1) Executive Summary

2) Introduction

3) Project Description

4) Environmental institutional, policies and legislative framework applicable to the project

5) Environmental and Ecological Baseline

6) Role and Responsibility of Environmental Management

7) Summary of Impacts and Mitigation Measures

8) Environmental Management Plan

9) Environmental supervision and monitoring plan

10) Cost for Mitigation Measures and Monitoring

11) Public Consultation Meeting and Disclosure of EMP

12) Conclusion

1.3 Project Proponent

Department of Technical and Vocational Education and Training, Ministry of Education, the Republic of the Union of Myanmar.

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1.4 Consultant Profile

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Contact Person	:	Mr. Thura Aung
Designation	:	General Manager

EMP Team Members

The EMP study team comprises members who have been involved in numerous environmental related studies. The personnel are well trained and qualified in their respective field. Please refer to Table 1.3-1 for details on members in the study team.

Table 1.3-1: EMP Consultant Team

No.	Name	Position	Responsibility
1.	U Zaw Naing Oo	Principal Consultant	Environmental Management Plan
2.	U Thura Aung	Principal Consultant	Physical Environment
3.	Daw Lai Lai Win	Environmental Consultant	Ecology, Environmental and Social Impact Assessment and Reporting
4.	U Kyaw Zin Win	Principal Consultant	GIS
5.	Daw Phyu Phyu Shein	Social Consultant	Socioeconomic
6.	Myat Ko Ko Hein	Junior Consultant	Ecology
7.	De Hlaing Zaw	Environmental Technician	Physical Environment