Specific Gravity/1	Void Ratio/1	Moisture Content/3	Density			Shearing Strength	
			γd/4	γt/5	γsat/6	ø/7	C/8
(Gs, lb/cu.ft)	(e)	(M.C.%)	(lb/cu.ft)	(lb/cu.ft)	(lb/cu.ft)	(°)	(lb/sq.in)
164.2	0.5	3.0	109.3	115.5	130.5	42°00'	0
(ton/cu.m)			(ton/cu.m)	(ton/cu.m)			(ton/sq.m)
2.63	0.5	3.0	1.75	1.85	2.09	42°00'	0

NOTE: /1, /2, /3 -- assumed values; /4-- dry density; $\gamma d = Gs/(1 + e)$
/5 -- wet density; $\gamma t = \gamma d(1 + M.C/100)$; /6-- saturated density, $\gamma sat = (Gs + e)/(He)$
/7 -- angle of internal friction; /8 -- cohesion.

Design values of the above-mentioned embankment materials for the main dam are summarized in Table 4D-3.

TABLE 4D-3. SUMMARY OF DESIGN VALUES FOR EMBANKMENT MATERIALS ON MAIN DAM

Zone	Density			Shearing Strength		Permeability Coefficient	Coefficient of Consolidation
	γd	γt	γsat	ø	C		
	(lb/cu.ft)	(lb/cu.ft)	(lb/cu.ft)	(°)	(lb/sq.in)	(ft/yr.)	(sq.in/min.)
Impervious	90.5	108.6	119.2	15°00'	7.11	0.1	1.55×10^{-2}
	(ton/cu.m)	(ton/cu.m)	(ton/cu.m)		(ton/sq.m)	(cm/sec)	(sq.cm/min)
	1.45	1.74	1.91	15°00'	5.0	9×10^{-7}	1.0×10^{-1}
	(lb/cu.ft)	(lb/cu.ft)	(lb/cu.ft)		(lb/sq.in)	(ft/yr)	(sq.in/min)
Random	90.5	108.6	119.2	15°00'	7.11	0.1	1.55×10^{-2}
	(ton/cu.m)	(ton/cu.m)	(ton/cu.m)		(ton/sq.m)	(cm/sec)	(sq.cm/min
	1.45	1.74	1.91	15°00'	5.0	9×10^{-7}	1.0×10^{-1}
	(lb/cu.ft)	(lb/cu.ft)	(lb/cu.ft)		(lb/sq.in)	(ft/yr)	(sq.in/min)
Rock	109.3	115.5	130.5	42°00'	-	-	-
	(ton/cu.m)	(ton/cu.m)	(ton/cum)		(ton/sq.m)	(cm/sec)	(sq.cm/min.)
	1.75	1.85	2.09	42°00	-	-	-

(b) Stability Analysis Against Sliding Failure

Since the shearing strength test was carried out only by direct shear test, the sliding failure analysis for the dam body is made under the following cases in consideration of the pore pressure.

Case and Reservoir Condition	Slope	Pore Pressure
After completion, N.W.S.	Up and downstream	Steady flow
Rapid drawdown, from N.W.S. to D.W.S.	Upstream	Steady flow

Stability analysis is carried out by the slip circle method shown in Figure 4D-15 and the factor of safety is obtained by the following equation.

$$F.S. = \frac{\Sigma[(N-U-Ne).\tan\emptyset + c.l]}{\Sigma(T + Te)}$$

Where, F.S. -- factor of safety.
N -- normal force acting on slip circle of each slice.
U -- pore pressure acting on slip circle of each slice.
Ne -- normal force of earthquake load acting on slip circle of each slice.
Ø -- angle of internal friction of materials on slip circle of each slice.
C -- cohesion of materials on slip circle of each slice.
l -- arc length of slip circle of each slice.
T -- tangetial force acting on slip circle of each slice.
Te -- tangential force of earthquake load acting on slip circle of each slice.

The factor of safety is in conformity with the Design Criteria for Dams established by Japanese National Committee on Large Dams, that is to say, it must not be less than 1.2 in any case. This value comes from the consideration that the dynamic property of the embankment materials in earthquake is not clarified and the limit design system is introduced to calculation process.

The calculation should be repeated for different circles until obtained in the smallest value of factor of safety as above mentioned. This procedure is the work of trial and error, and the electronic computer is advantageously used with the flow chart as shown in Fig. 4D-16.

The results of calculation are presented in Table 4D-4.

TABLE 4D-4. FACTOR OF SAFETY IN EACH CONDITION ON MAIN DAM

Reservoir Condition	K/1	Slope	Factor of Safety	Pore Pressure
After completion with Full water surface (N.W.S.)/2	0.12	Upstream	F.S.=1.225	Steady flow
	0.12	Downstream	F.S.=1.205	Steady flow
Rapid drawdown from N.W.S. to D.W.S./3	0.06	Upstream	F.S.=1.215	Steady flow

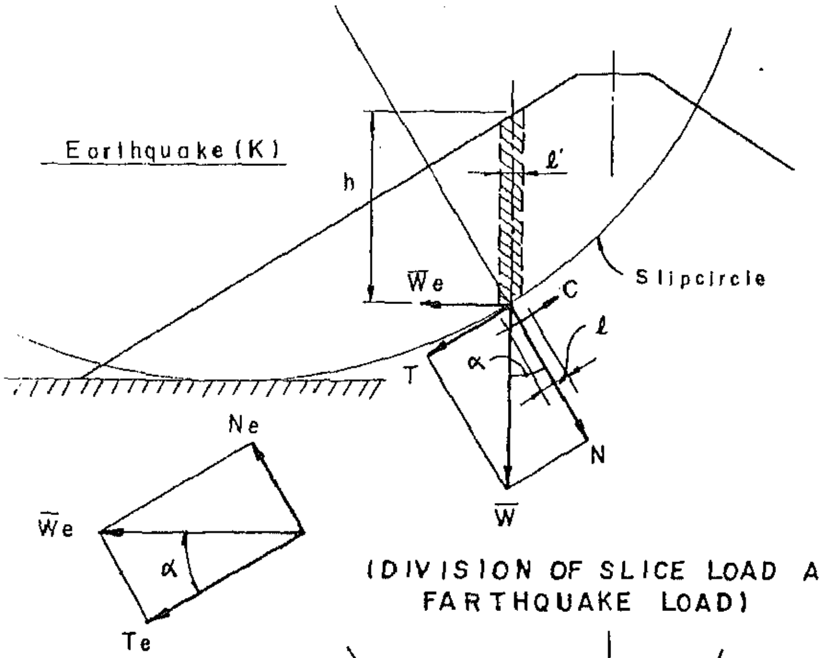
NOTE: /1 -- seismic coefficient, K=0.12 in usual case and K = 0.06 in special case.
/2 -- full water surface elevation is 295 ft.
/3 -- dead water surface elevation is 252 ft.

The above factor of safety is considered reasonable judging from the design of feasibility stage, the quantity and quality of soil tests, and the capacity of test equipment. Besides, the above factor of safety will be increased taking into account that the stabilized fills which are executed by spoil bank at the upstream and downstream slopes of dam body is effective.

It is desirable that the embedded devices such as pore pressure gauges and multi-layer settlement measurements will be installed in the dam body due to control of the embankment speed, management of dam body and foundation in future.

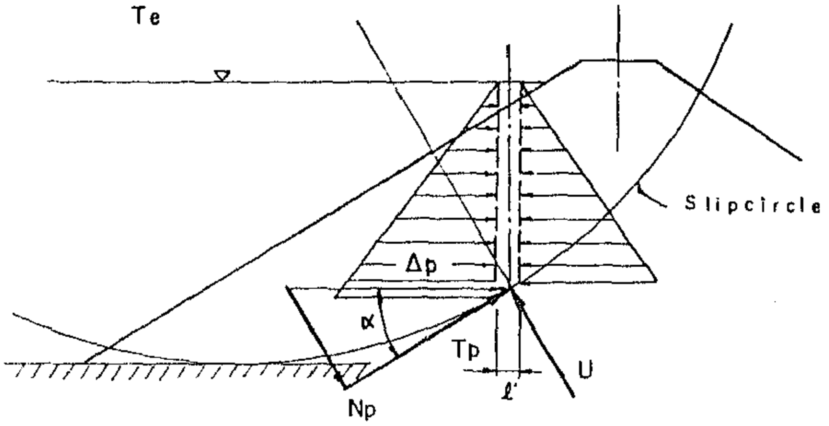
Since the dynamic tests for the embankment materials were limited in quality and quantity, it is recommendable to execute the triaxial compressure tests with U-U and C-U conditions measuring the pore pressure.

FIGURE 15-5, CONCEPTION OF STABITY ANALYSIS WITH SLIPCIRCLE METHOD



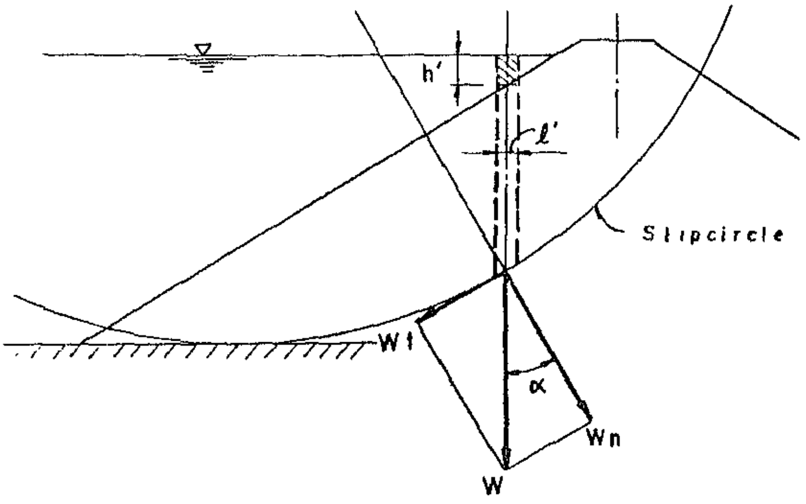
$W = h \cdot \ell' \cdot r$
ℓ ; width of slice
r ; unit weight
$N = \overline{W} \cdot \cos\alpha$
$T = \overline{W} \cdot \sin\alpha$
$\ell = \ell' / \cos\alpha$
$\overline{W}e = \overline{W} \cdot K$
K ; seisinc coefficient
$Ne = \overline{W}e \cdot \sin\alpha$
$Te = \overline{W}e \cdot \cos\alpha$

(DIVISION OF SLICE LOAD AND FARTHQUAKE LOAD)



$Np = \Delta P \cdot \sin\alpha$
$TP = \Delta P \cdot \cos\alpha$
ΔP ; difference of hydrostatic pressure between both Side of slice
ℓ ; Width of slice
U ; Pore pressure

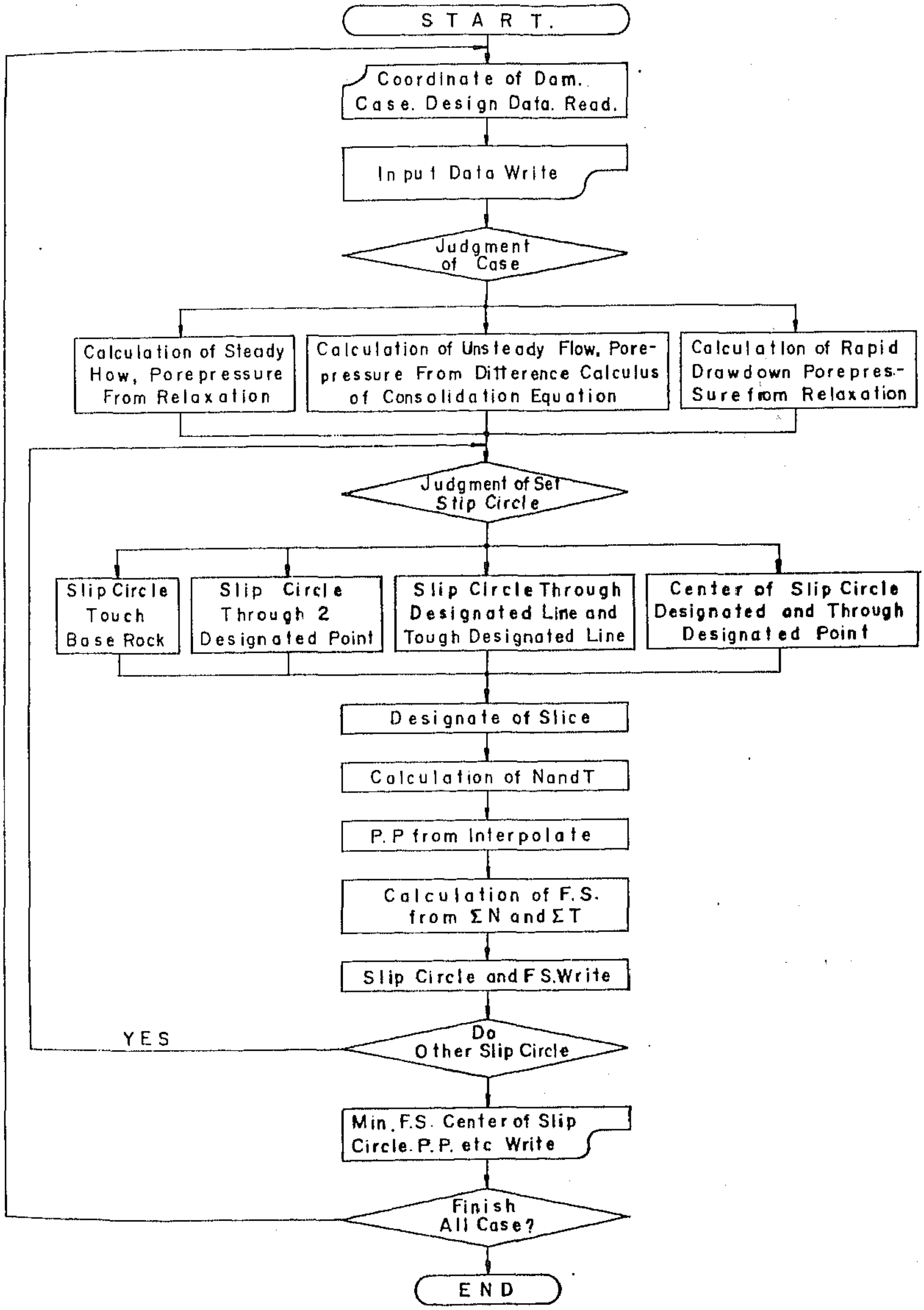
(DIVISION OF HYDROSTATIC LOAD)



$W = h' \cdot \ell' \cdot r'$
ℓ' ; Width of Slice
r' ; unit weight of storage water
$Wn = W \cdot \cos\alpha$
$Wt = W \cdot \sin\alpha$

(DIVISION OF SURCHARGE WATER)

FIGURE 4D-16 FIOWCHART OF STABILITY ANALYSIS BY COMPUTER



4D-8. Spillway of Main Dam

At the proposed main dam site, four routes of spillway have been considered during the early stage of feasibility study in order to minimize the construction costs. After obtaining the data of geological investigations, the route of spillway which situates on a remaining small hillock at the right bank was fixed as the most favorable one taking into account the poor bearing capacity of the bedrock (refer to Fig. 4D-6)and topographical condition).

In general, open-type spillway would be adopted to the fill-type dam in consideration of non-resistance against overtopping from unexpected flood and hydraulic characteristic of itself. The open-type spillway can be classified into two kinds, e.g., ungate and gate types, from the viewpoint of its control method.

From the site conditions, it is considered that the ungate type, e.g., no control type, spillway is more suitable to be adopted than the gate-type spillway in order to reduce the required bearing capacity for the bed rock, avoidance of risk by gate control and elimination of operation and maintenance costs.

In ungate spillway, a Duck-bill's type is distinctly more favorable from the viewpoints of design flood discharge, topograhic and economic features.

(a) Design Flood Discharge for Spillway

For the spillway design purpose, 1000-year probability flood discharge was considered based on the existing custom in Burma and conformity with Design Criteria for Dams in Japan as mentioned in paragraph of "Flood Analysis."

The running discharge through the spillway in peak can be decreased from the design flood discharge due to reservoir routing at the entrance of spillway. The calculation has been carried out by using the following formula considering the relationship between the flow-out capacity of spillway and the reservoir routing provided by the main dam with a 1000-year flood flow into the reservoir.

$$1/2\ (I_1 + I_2)\cdot\Delta t + S_1 - 1/2\cdot O_1\cdot\Delta t = S_2 + 1/2\cdot O_2\cdot\Delta t$$

Where, I_1 -- *inflow discharge at* t_1 *hour in cu.m/sec.*
I_2 -- inflow discharge at t_2 hour in cu.m/sec.
O_1 -- outflow discharge at t_1 hour in cu.m/sec.
O_2 -- Outflow discharge at t_2 hour in cu.m/sec.
S_1 -- Storage volume at t_1 hour in cu.m
S_2 -- Storage volume at t_2 hour in cu.m
$\Delta t = t_2 - t_1,\ (t_2 > t_1)$

A rise of water surface level in the reservoir due to various flow-out capacity of the spillway are shown in the following table in consideration of the reservoir routing.

	Length of Crest at Spillway (in ft)				
	150	200	250	300	350
Water surface elevation (EL. ft)	300.98	300.58	300.27	300.03	299.83
Flow-out discharge (cu.ft/sec)	8,558.87	10,276.71	11,812.26 ≑ 11,810	13,205.41	14,483.96
Over-flow depth (ft)	5.98	5.58	5.27	5.03	4.83

NOTE: Overflow depth = Water surface elevation - 295 (ft)

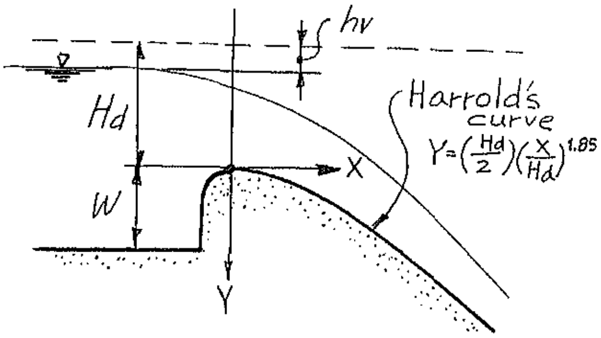
As the length of crest becomes shorter, the over-flow depth becomes deeper, the effect of reservoir routing will become better and the scale of spillway becomes smaller. However, the dam height will become higher contrarily.

From the above table, it seems that the run-off discharge of 11,810 cu.ft/sec is reasonable value as a design flood discharge for the spillway in consideration of the applicability and restriction of topographic feature, geological condition at the dam site.

The estimated run-off hydrograph through the spillway in flow-out discharge of 11,810 cu.mft/sec is shown in Fig. 4D-17.

(b) Hydraulic Dimensions

The dimensions of weir in complete over-flow condition have a close relation with a shape of weir. In case of Harrold's standard type is adopted as the shape of over-flow crest, coefficient of discharge and length of weir can be obtained from the following equations:



$$C = 2.200 - 0.0416\ (Hd/W)^{0.99} = 2.15$$
$$L = Q/C.H^{3/2} = 76.27\ \text{m} \div 250\ \text{ft}$$

Where,
C -- coefficient of discharge
Hd -- overflow depth at crest and adopted by 5.27 ft (1.606 m).
W -- depth of entrance channel and adopted by 5.27 ft.
L -- effective length of weir.
Q -- design flood discharge and adopted by 11,810 cu.ft/sec. (335 cu.m/sec).

The water depth on chute section is roughly estimated in applying the following equation:

$$(1 - \alpha)\ He = d + [Q^2/2gd^2.b^2]$$

Where,
He -- difference elevation between the total head at control point and under consideration section.
α -- coefficient of friction loss and adopted by 0.1-0.15 on fill-type dam usually.
d -- *water depth under consideration section.*
Q -- design flood discharge and adopted by 11,810 cu.ft/sec.
g -- gravitational acceleration.
b -- width of chute section and adopted by 40 ft.

The results of calculation of water depth on the chute section are shown in the following table:

Elevation of Floor (EL. ft)	Water Depth (d, ft)	Velocity[/1] (V, ft/sec)	Froude Number[/2] (Fr)
264.74	13.93	21.20	1.00
227.23	5.07	58.23	4.56
207.56	4.34	68.03	5.76
187.89	3.88	76.10	6.82
175.00	3.65	80.89	7.47

/1 -- $V = Q/b.d$; /2 -- $Fr = V/\sqrt{g.d.}$

The running water through the chute possesses considerably high energy to bring about erosion and scouring at the downstream of spillway. Judging from the velocity and Froude number, intensive hydraulic jump shall be occurred in the energy dissipator, therefore, the USBR (United States Department of Interior, Bureau of Reclamation) type II in providing chute block and end sill in the stilling basin should be adopted. The conjugate depth in the stilling basin d_2 can be obtained by the following formula:

$$d_2 = 1/2d_1.(\sqrt{1 + 8Fr^2} - 1), \quad Fr = V_1/\sqrt{g.d_1}$$

Where, d_2 -- water depth after hydraulic jump
d_1 -- water depth before hydraulic jump
Fr -- Froude number ($Fr = V_1/\sqrt{g.d_1}$)
V_1 -- velocity before hydraulic jump.
g -- acceleration of gravity.

The required length of stilling basin Ls can be obtained from relation curve between Ls/d_2 and Froude number, and adoptedly by Ls/d_2 is 4.2 for type II stilling basin.

The results of calculation for d_2 and Ls are shown in the following table:

Floor Elevation (EL. ft)	d_1 (ft)	Fr	d_2 (ft)	Ls (ft)
175.00	3.65	7.47	36.77	155.00

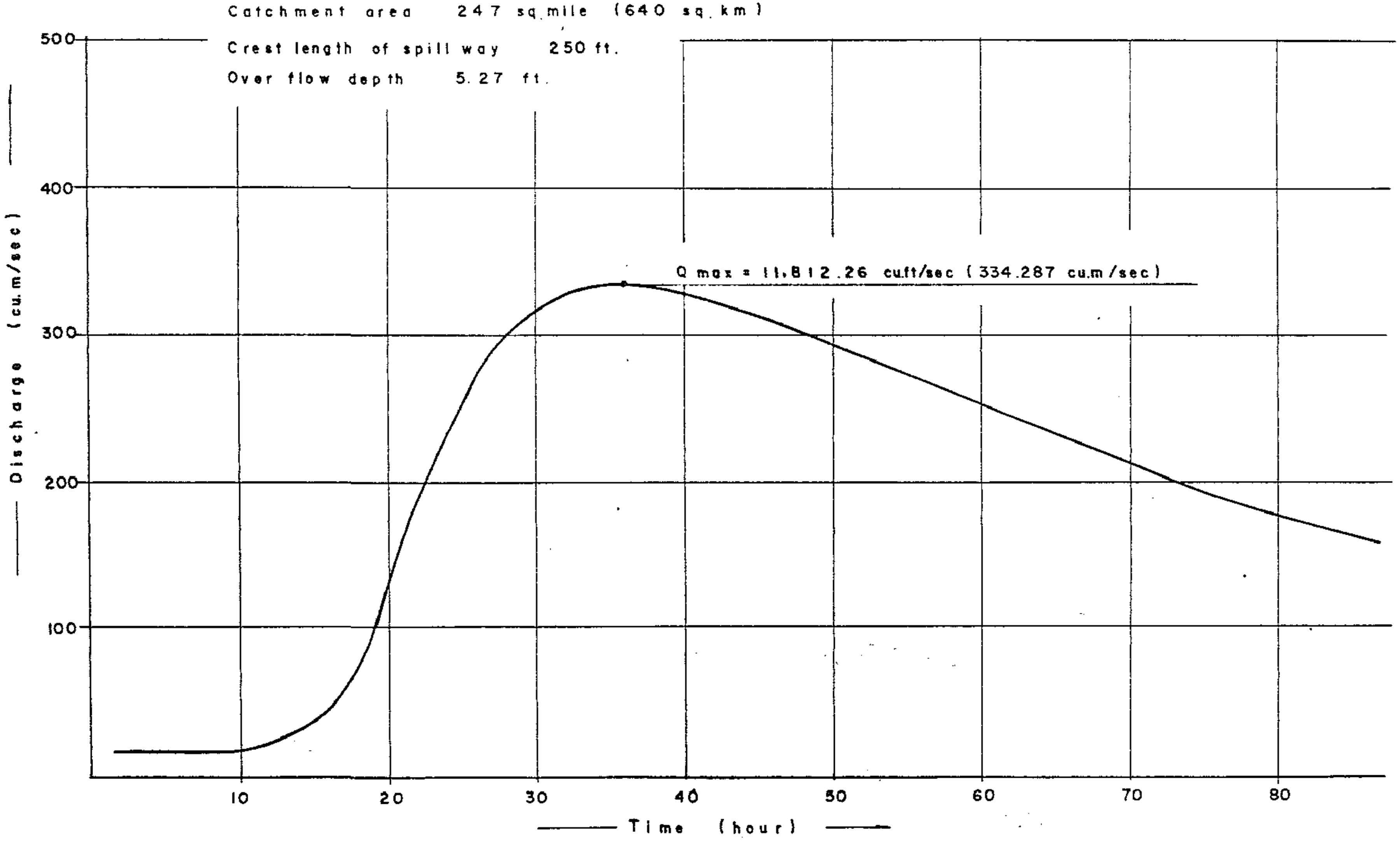
Freeboard of chute and stilling basin can be obtained from the following formulas and the results of calculation are tabulated as follows:

Chute	$Fb = 0.1\ V.d^{1/2}$,	$H = (d + Fb)/\mathrm{Cos}\ \theta$
Stilling basin	$Fb = 0.1\ (V_1+d_2)$,	$H = (d_2 + Fb)$

Where, Fb -- freeboard of chute and stilling basin.
V,d -- velocity and water depth under consideration section.
V_1 -- velocity before hydraulic jump.
d_2 -- water depth after hydraulic jump
H -- vertical height of wall
θ -- slope angle of chute floor

Since the flow condition in Duck-bill's type spillway is very complicated, it is desirable to execute the hydraulic model test for the spillway during the final design stage.

FIGURE 4D-17. HYDROGRAPH THROUGH SPILLWAY IN 11,812.26 cu.ft/sec AT MAIN DAM



4D-9. Irrigation Outlet of Main Dam

The storage water at the main dam is used for irrigation and hydro-electric power purposes, and the water will be released by the outlet facility flows into the existing river. Another role of the outlet facility is to make the rapid drawdown of the water level in the reservoir in case of emergency at after completion of the dam.

The outlet facility will be provided nearby the right bank of the South Nawin river from the viewpoints of effective use of water head for power generation, topographical and geological conditions, construction method and schedule of the dam.

A circular drop inlet type of intake with trash-rack which is located near the upstream toe of dam body and an inner steel lining conveyance conduit with a bifurcation pipe are provided as the outlet facility. For the control equipment of irrigation demand, a corn valve is to be installed as it functions both for discharge control and energy dissipation at the end of irrigation conveyance conduit.

During the operation of the hydro-electric power plant, the water will be diverted through a bifurcation pipe to the plant and this released water will be used for irrigation purpose again.

Regarding the water supply for Paukkaung irrigable area, a steel pipe of two feet diameter will be installed on the left bank as shown in the attached drawing with a discharge control apparatus at the end of pipe.

(a) Outlet Discharge

The outlet discharge from the reservoir varies with the water requirement of irrigation area in seasons. The maximum outlet discharge of 1,031 cu.ft/sec (29.2 cu.m/sec) has occurred near the full water level in the reservoir, however, at around the dead water level, most of outlet discharge may distinctly be less than from the maximum discharge except extreme drought years.

(b) Hydraulic Dimensions

The hydraulic dimension of conveyance conduit with circular shape can roughly be obtained on the basis of the allowable velocity in steel pipe.

Since the allowable maximum velocity in steel pipe is usually limited within 16.4 ft/sec (5.0 m/sec) in ordinary case, the dimension of conduit was decided nine feet of inside diameter with circular shape, when the maximum outlet discharge flows through the outlet facility.

Regarding the dimension of corn valve for irrigation demand, the total loss head through the irrigation outlet can roughly be estimated as follows:

$$H = f \cdot \frac{V^2}{2g} + \left(\frac{Q}{2.945 . D^2}\right)^2$$

Where, H -- total loss head.
f -- coefficient of loss head at screen, entrance, bending, friction, bifurcation and contraction, and assumed by 4.50.
V -- velocity in irrigation conduit and adopted by 16.21 ft/sec (4.94 m/sec).
g -- acceleration of gravity.
Q -- maximum outlet of discharge and adopted by 1,031 cu.ft/sec.
D -- inside diameter of corn valve and assumed by 6.0 ft.

When the downstream water surface elevation is fixed at EL 199.5ft, the effective head of He for irrigation outlet is as follows:

He = EL 252 - EL 199.5 = 52.5 ft (16.01 m)

On the other hand, total loss head of irrigation outlet is equal to 52.5 (16.01 m); therefore, the diameter of corn valve should be 6.0 ft (1.83 m).

In order to repair and maintain hydro-power plant and corn valve for irrigation demand, the emergency gates should be installed in front of those facilities and to close each facilities as required.

4D-10. Diversion Facilities on Main Dam

The diversion facilities are merely constructed for the purpose of bypassing the river run-off during the construction period of the main dam. An open-type with no lining canal and coffer dam are provided as the diversion facilities taking into account the topographic feature, design flood discharge and construction schedule of the dam.

(a) Design Flood Discharge

The design flood discharge for diversion facilities varies case by case and is decided in conformity with the Design Criteria for Dams which was established by Japanese National Committee On Large Dams, that is to say, a flood discharge with a return-period of 10-year is adopted for the fill-type dam. The peak discharge in various return periods are shown in the following table which is quoted from paragraph of "Flood Analysis."

Return Period (Years)	5	10	20	30
Peak discharge (cu.ft/sec)	27,500	32,400	37,200	39,700

(b) Hydraulic Dimensions

The hydraulic calculation for diversion facilities have been carried out to establish the relationship between the run-off discharge through diversion canal and the reservoir routing provided by an upstream coffer dam with a flood discharge of 32,400 cu.ft/sec flow into the reservoir. A rise of water surface level in the reservoir due to various bottom width in the diversion canal with bottom elevation of 220 ft are shown in the following table.

Bottom Width (ft)	50	100	150	200
Water level (EL. ft)	242.98	238.38	234.99	232.87
Run-off discharge (cu.ft/sec)	16,959.75	24,258.12	26,820.97	28,455.51

From the above table, it seems that the bottom width of 100 ft open canal which is provided along a "wadi" on the left bank of the main dam is more suitable taking into account the height of coffer dam, excavation of the open canal and storage volume in the reservoir which will be used for the moisture control of embankment materials and mixing water of concrete.

(c) Crest Elevation of Coffer Dam

The freeboard of coffer dam can be obtained as same estimation method with that of the freeboard on main dam. The result of calculation and adopted crest elevation of coffer dam is presented in the following table.

Fetch (ft)	R/1 (ft)	Freeboard/2 (ft)	Water Level (EL. ft)	Crest Elevation (EL. ft)
4,000	1.60	4.88	238.38	243.26 ÷ 243

/1 -- Wind speed is 44.75 mph and U/S slope of coffer dam is 1 on 3.5 with hand placed riprap, therefore, an intermediate value at the smooth slope and the rock zone slope in Figure 4D-11 was adopted as the height of wave due to wind.

/2 -- Freeboard can be obtained as follows: Fb = R + hs.

A smaller temporary downstream coffer dam is also necessary in order to fully protect the construction site of the dam.

4D-11. *Dam Site and Dam Axis of Diversion Dam*

The diversion dam is planned as it functions both for effective utilization of run-off water through the remaining catchment area at the proposed dam site and a role of afterbay for the hydro-electric power.

Two potential diversion dam sites have been considered during early stage of feasibility study. The one is located on the confluence of South Nawin and Gwegyo rivers near Chaunggwa village and the other is about 0.6 miles far from the above site in downstream direction.

After the basic data has been obtained, the upstream site was proposed to construct the diversion dam from the viewpoints of water surface elevation in the reservoir which ensure to supply the irrigation water to the Project area and topographic condition.

As for the dam alignment, two possible dam axes, A and B, have been considered at the proposed diversion dam site. The axis B is the proposed axis which is selected with linear formation as shown in the attached drawing and the axis A with a curve in a certain portion on the dam axis is located about 350 ft. upstream from the proposed dam axis. At the first glance on this site, the axis A may give a favorable impression as a dam site because the topography presents narrow gorge formation. However, at the remaining hillock of the right bank of this site, there seemed to have a thick terrace deposit layer with high permeability and this site may require high cost for foundation treatment. Moreover, at the left bank of the site, there are many erosions observed at about three feet intervals and forming cliff which will restrain the temporary works in implementation stage.

From the above conditions, the axis B is finally selected as the most suitable dam axis in this site.

4D-12. Geology and Construction Materials on Diversion Dam

The proposed diversion dam site is covered with relatively thick overburdens such as river-bed sand, terrace deposits, talus, etc. No outcrop of bedrock exposes around the site. However, the surrounding circumstances indicate the Irrawaddian sandstone composes the practical bed-rock.

Five boreholes covering totally 625 ft. (190 m) have been drilled along the proposed dam axis. In-situ permeability tests covering the entire depths of borehole and standard penetration test throughout the overburden section have been performed. The location map of bore on diversion dam site, geologic log and penetration resistance of drill holes are shown in Figs. 4D-18 and 4D-19.

The overburden on the dam axis is composed of rather thick soft clay to sand layers. The thickness of the layer varies place to place and the lowest elevation of the bottom is around at 120 ft (36.6 m). Since the river-bed elevation is at 167 ft, the thickness at this portion reaches 47 ft (14.3 m).

The penetration resistance, N-value, of the overburden varies from three to 96 and the lower mean value is defined to be 12.

The permeability of the layers is rather high ranging from 28.8 ft/yr (2.6×10^{-5} cm/sec) to 1,300 ft/yr (1.2×10^{-3} cm/sec).

The bed-rock of the site, the Irrawaddian Formation is slightly cemented, friable fine to medium sandstone as the predominant component, and blue shale.

The sandstone taken by core barrel is seemed to be as just like as river sands. The N-values of the layer, however, show higher category ranging from 50 to 200.

The permeability of the sandstones ranges from 24.7 ft/yr (2.2×10^{-5} cm/sec) to 814 ft/yr (7.3×10^{-4} cm/sec).

As for the embankment earth materials, the top layer on the diversion dam site consists of sandy and clayey soils. Since the bed-rock of the site is composed of slightly cemented sandstone, the top layer around foot-hill is of sandy. While the top layer on the river terraces consists generally of clayey material.

Two test pits, TP1 and TP2, have been dug at the upstream and lower reach of dam axis, respectively. The logs are illustrated in Fig. 4D-20 together with tested logs of field moisture contents. Each bulk sample has been collected from the said pits covering whole depths of pit, and a series of soil mechanical tests covering the same items carried out on the earth materials of the main dam site has been made. The test results are shown in Table 4D-2 and Fig. 4D-11. The mechanical properties of the samples are concluded in Fig. 4D-21.

The unified soil classification of material from TP1 is CL and just same gradation with TP11 material of main dam site. On the other hand, TP2 material belongs to CH class and sandy loam containing 68% of sand particle. The dry density of the material is rather high being 115 lb/cu. ft of maximum dry density by standard proctor compaction. That of TP2 material shows only 96 lb/cu. ft. Reflecting the difference of gradation, the other properties between both material differ to some extent, as seen in the said illustrations.

The distribution of both materials on the site is not clear at the moment. Therefore, selective utilization of materials for dam body may not be decided.

Regarding the other embankment materials such as sand and gravel, rock and coarse concrete aggregate are taken from the same places designated on the main dam.

FIG 4D-18 GEOLOGICAL CONDITION ON DIVERSION DAMSITE

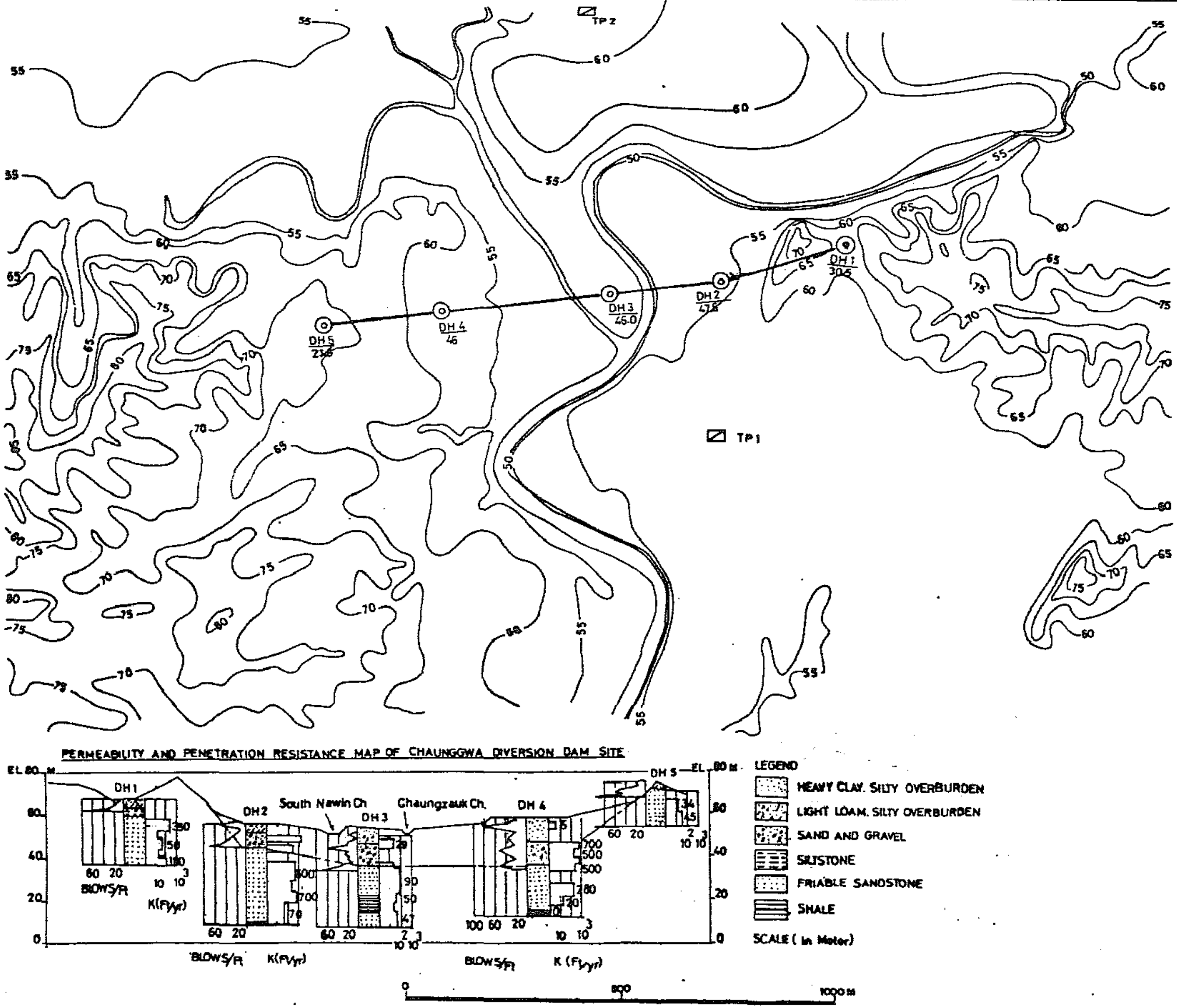


Fig. 4D-19 (1)

GEOLOGIC LOG OF DRILL HOLE

SHEET 1 OF

FEATURE Diversion Weir PROJECT South Nawin Dam Project STATE Pegu Division
HOLE NO. 1 LOCATION South Bank - bank of Phayagyi Taung GROUND ELEV. DIP (ANGLE FROM HORIZ.) 90°
COORDS. N. E.
BEGUN 4.7.79 FINISHED 13.7.79 DEPTH OF OVERBURDEN 12' TOTAL DEPTH 100' BEARING
DEPTH AND ELEV. OF WATER LEVEL AND DATE MEASURED 56'6" (13.7.79) LOGGED BY U Win Tun (A.E.G) LOG REVIEWED BY

NOTES ON WATER LOSSES AND LEVELS, CASING, CEMENTING, CAVING, AND OTHER DRILLING CONDITIONS

Drilling Equipments

(1) S & H Drill No. 12 - trailer - mounted.

(2) Ford Industrial Pump No. 11

(3) Gorman Rupp Pump No. 18 for supplying.

(4) Standard Percolation test is done down to 15' Depth.

(5) Hydraulic feed Rotary drilling from 15' to 100' depth

(a) Nx M T.C. Bit

(b) 10' NxM Double-tube corebarrel.

▽ G.W.L. 56'6" (13.7.79)

(6) Nx Casing drivers used for casing driving - Nx Casing is driven down to 75' Depth.

Drill Fluid

Tinted Stream Water

Loss of Drill Return water from 20'-30' Depth.

Driller: Tin Soe

TYPE AND SIZE OF HOLE: CORE DRILL HOLE, NX SIZE

CORE RECOVERY (%) AND PERCOLATION TESTS

Core recovery (%)	Depth (feet) From (P, Cm or Ca)	To	Loss (G.P.M.)	Pressure (P.S.I.)	Length of test (min.)
100 100 100 100 100	0' Open	10' End	High Pervious Ground - Water Pressure can not be raised above zero p.s.i. Pump can not fully supply.		
87.8 100 100	10' Open	15' End	High Pervious Ground - Pump can not fully supply above 0 psi.		
0 0	15' single	30' Packer	High Pervious Ground - Water Pressure can not be raised above Zero p.s.i. Pump can not fully supply		
0 10 50	30' single	45' Packer	5.5 7 8.5 Water Pressure can not be raised above 20 p.s.i.	10 20 10	26 10 10
10 0	45' single	60' Packer	0.4 0.2 0.7 0.2 0.2	10 20 30 20 10	30 30 30 20 20
0 0	60' single	75' Packer	1.5 1.8 2.5 1 0.8	20 30 40 30 20	20 20 20 20 30
0 0	75' single	90' Packer	0.6 0.8 0.9 0.7 0.8	20 30 40 30 20	25 20 20 20 20
0	90' single	100' Packer	2.4 4.8 3.1 2.3 2	20 30 40 30 20	30 30 30 20 20

CLASSIFICATION AND PHYSICAL CONDITION

Depth (feet)	Classification and physical condition
0' - 12'	Top Soil with plant roots, Sandy Loam, silty, dark brown coloured, mixed with coarse mica flakes in 20-30%; sometimes ferruginous at some places; very small milky Quartz gravels of 0.1"ø are found between 5-12' Depth slightly moistened, loosely cemented & friable, coarse to finegrained downwards.
12' - 30'	Light to Dark yellowish brown coloured siltstone, mixed with occasional sand layer & coarse mica flakes in 20-30%, loosely cemented & friable, very fine & soft, slightly moistened; some small gravels of 0.3"ø are found at some places.
30' - 100'	Dark yellowish brown coloured Silty sandstone of Irrawaddian Formations, with coarse mica flakes in 30%, coarsegrained, ferruginous at some places, very loosely cemented & friable, fully saturated.

EXPLANATION

□ CORE LOSS
▨ CORE RECOVERY

Type of hole .... D = Diamond, H = Hayetellite, S = Shot, C = Churn
Hole sealed .... P = Packer, Cm = Cemented, Ca = Bottom of casing
Approx. size of hole (X-series) .. Ex = 1-1/2", Ax = 1-7/8", Bx = 2-3/8", Nx = 3"
Approx. size of core (X-series) .. Ex = 7/8", Ax = 1-1/8", Bx = 1-5/8", Nx = 2-1/8"
Outside dia. of casing (X-series). Ex = 1-13/16", Ax = 2-1/4", Bx = 2-7/8", Nx = 3-1/2"
Inside dia. of casing (X-series).. Ex = 1-1/2", Ax = 1-29/32", Bx = 2-3/8", Nx = 3"

FEATURE Diversion Weir PROJECT S. N. D. P. STATE Pegu Div. SHEET 1 OF 1 HOLE NO 1

Fig. 4D-19 (2)

Irrigation Department. GEOLOGIC LOG OF DRILL HOLE SHEET 1 OF 2

FEATURE Diversion - Dam Site PROJECT South Nawin Sub-Dam Project, Pegu Division
HOLE NO. 2 LOCATION Left bank, Dam & Weir GROUND ELEV. DIP (ANGLE FROM HORIZ.) 90°
COORDS. N E
BEGUN 25.5.79 FINISHED 26.5.79 DEPTH OF OVERBURDEN 35' TOTAL DEPTH 155' BEARING
DEPTH AND ELEV. OF WATER LEVEL AND DATE MEASURED 18' (25-5-79) LOGGED BY Min Tin (A.E.G.) LOG REVIEWED BY

NOTES ON WATER LOSSES AND LEVELS, TYPE CASING, CEMENTING, AND CAVING, AND OTHER DRILLING CONDITIONS:

▽ GWL 18' (25-5-79)

Drilling Equipments
(1) S&H Drill No. 12 - trailer-mounted.
(2) Ford Industrial Pump No. 11
(3) Standard Penetration test is done down to bed rock (35' Depth)
(4) Hydraulic feed Rotary drilling from 35' to 155' Depth.
(a) Nx of T.C. Bit
(b) 10' Nx Double-tube core barrel.
(5) Nx casing driveshoe used for casing driving.
- Nx casing is driven down to 135' Depth.

Drill Fluid
Turbid Stream water

Drill Rate of Penetration is fairly & automatically dropped from 74'–77' Depth without Hydraulic pressure.

Loss of Drill Return water at 85.5', 95'–100' Depth

Casing is dropped fairly & automatically down to the depth 75'–90'.

Driller - Tin Soe

TYPE AND SIZE OF HOLE: NXM SIZE CORE DRILL HOLE

CORE RECOVERY (%): 100, 100, 83, 58, 75, 83, 83, 33, 79, 75, 100, 75, 100, 100, 100, 0, 35, 35, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 50

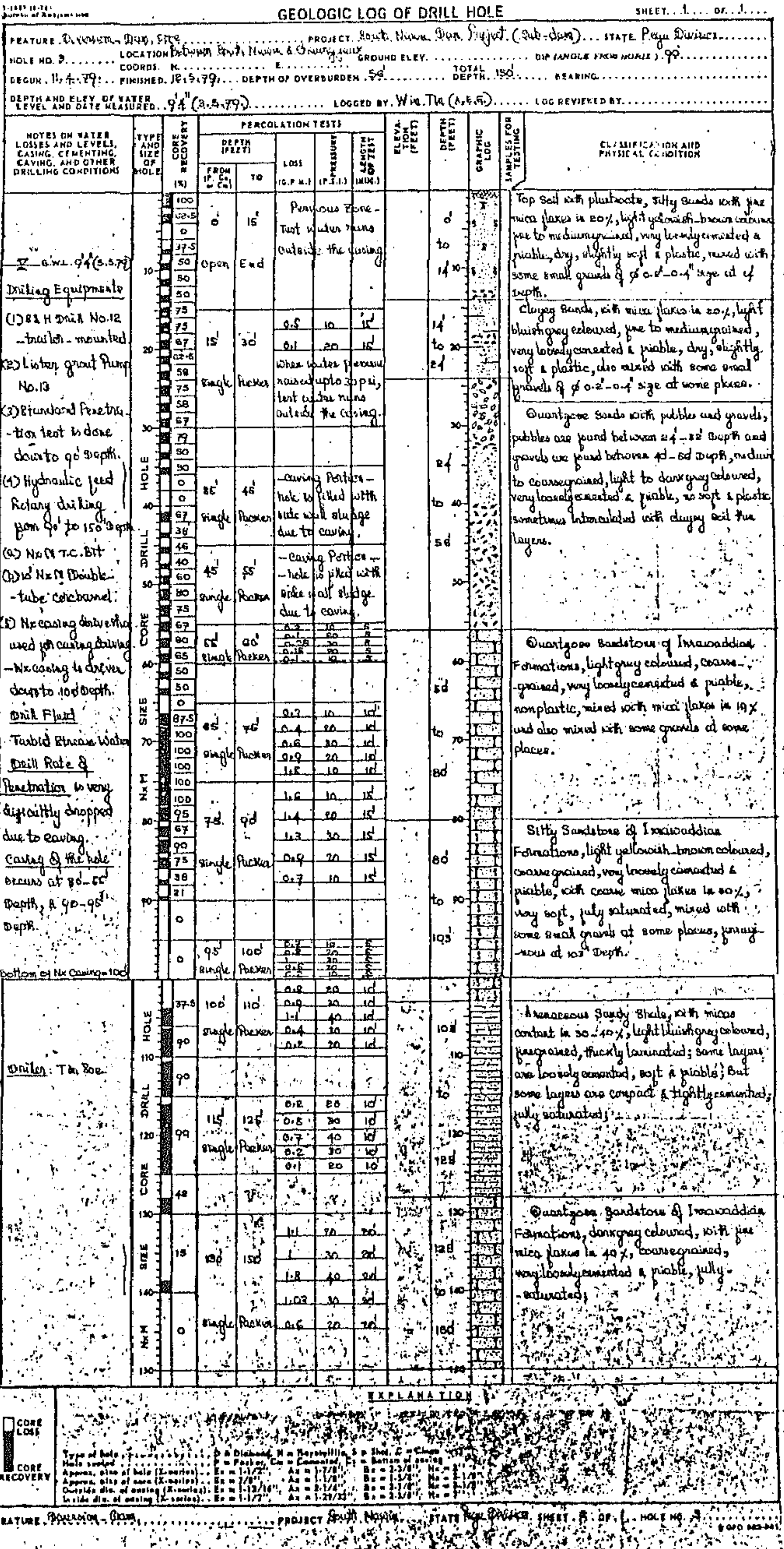
PERCOLATION TESTS

Depth (feet) From (1 Pkr or 2)	To	Loss (G.P.M.)	Pressure (P.S.I.)	Time (Min.)
10' single	20' Packer	>4.8	10	10'
		Highly pervious, water runs outside the casing		
20' single	30' Packer	11.4	10	10
		10.4	20	10
		14	30	10
		13.7	20	10
		13	10	10
35' single	45' Packer	1.4	10	10
		4.5	20	10
		12	30	10
		7	20	10
		4	10	10
45' single	60' Packer	0.4	10	15
		1.3	25	15
		1.5	40	15
		0.4	25	15
		0.3	10	15
60' single	75' Packer	8.1	10	15
		15.5	25	15
		17	40	15
		11.5	25	15
		9.7	10	15
75' single	90' Packer	9	10	15
		11	25	15
		13	40	15
		10.5	25	15
		9	10	15
90' single	105' Packer	10	10	15
		12.5	25	15
		16	40	15
		12.5	25	15
		10	10	15
105' single	120' Packer	10	10	15
		12	25	15
		14	40	15
		12.5	25	15
		9.5	10	15
120' single	135' Packer	1.6	20	15
		2.2	30	15
		2.4	40	15
		1.2	30	15
		0.6	20	15
135' single	150' Packer	1.4	20	15
		1.8	30	15
		2.2	40	15
		1.2	30	15
		0.8	20	15

ELEVATION (FEET)

Depth (feet)	Classification and Physical Condition
0 to 5'	Top soil & plastic clay, heavy clay, dark brownish-grey coloured, hard, compact & tightly cemented, dry, soft & plastic under wet condition.
5' to 18'	Light loam, silty, with fine mica flakes in 20%, dark yellowish brown coloured, very fine-grained, loosely cemented & friable, slightly moistened, soft & slightly plastic.
20' to 35'	Silty sands, light to dark yellowish brown coloured, medium to coarse-grained, very loosely cemented & friable, slightly moistened, But saturated & GWL is encountered at 18' Depth, mixed with slight amount of very small granule & fine mica flakes between 20 – 35' Depth.
35' to 77'	Quartzose Sandstone of Irrawaddian Formations, light to dark grey coloured, coarse-grained, very loosely cemented & friable, fully saturated, nonplastic, also mixed with fine mica flakes in 30% between 45'–77' Depth. Between 60'–77' Depth, sand grains are very fine and equigranular grain-size.
77' to 151'	Silty Sandstone, of Irrawaddian Formations, light to dark yellowish brown coloured, mixed with fine mica flakes in 30–40%, fully saturated, very loosely cemented & friable, nonplastic, fine-grained to coarse-grained.
77' to 151'	Silty Sandstone of Irrawaddian Formations.
151' to 155'	Argillaceous Shale, conchoidal fractured, light bluish grey coloured, very fine & soft, compact & moderately cemented, fully saturated, moderately plastic, massive; laminations are not distinct. But brilliant, smooth & conchoidal fracture planes are distinct. It is broken along the conchoidal fracture planes, some part is calcareous & slightly hard.

Fig. 4D-19 (3)



GEOLOGIC LOG OF DRILL HOLE

SHEET 1 OF 1

FEATURE Diversion Dam Site PROJECT South Nawin Dam Project (Sub-dam) STATE Pegu Division
HOLE NO. 3 LOCATION Between South Nawin & Gravity [illegible] GROUND ELEV. DIP (ANGLE FROM HORIZ.) 90°
COORDS. N. E.
BEGUN 11.4.79 FINISHED 18.5.79 DEPTH OF OVERBURDEN 58' TOTAL DEPTH 150' BEARING
DEPTH AND ELEV. OF WATER LEVEL AND DATE MEASURED 9¼' (3.5.79) LOGGED BY Win Tin (A.E.G.) LOG REVIEWED BY

NOTES ON WATER LOSSES AND LEVELS, CASING, CEMENTING, CAVING, AND OTHER DRILLING CONDITIONS

▽ G.W.L. 9¼'(3.5.79)

Drilling Equipments

(1) B&H Drill No.12 - trailer - mounted

(2) Listor grout Pump No.13

(3) Standard Penetration test is done down to 90' Depth.

(4) Hydraulic feed Rotary drilling from 90' to 150' Depth

(a) NxM T.C. Bit

(b) 10' NxM Double-tube corebarrel.

(5) Nx casing driver are used for casing driving. - Nx casing is driven down to 100' Depth.

Drill Fluid

Turbid Stream Water

Drill Rate & Penetration is very significantly dropped due to caving.

Caving of the hole occurs at 30'-55' Depth, & 90-95' Depth.

Bottom of Nx Casing = 100'

Driller: Tin Soe.

TYPE AND SIZE OF HOLE: NxM SIZE CORE DRILL HOLE

CORE RECOVERY (%): 100, 62.5, 0, 37.5, 50, 50, 50, 75, 75, 67, 62.5, 58, 75, 58, 67, 79, 50, 50, 0, 0, 67, 38, 46, 40, 60, 80, 75, 67, 80, 65, 50, 50, 0, 87.5, 100, 100, 100, 100, 100, 95, 67, 90, 75, 38, 21, 0, 0, 37.5, 90, 90, 99, 42, 15, 0

PERCOLATION TESTS

DEPTH (FEET) FROM (P, Cm or Ca)	TO	LOSS (G.P.M.)	PRESSURE (P.S.I.)	LENGTH OF TEST (MIN.)
0' Open	15' End	Pervious Zone - Test water runs outside the casing		
15' single	30' Packer	0.5	10	15'
		0.1	20	15'
		When water pressure raised upto 30 psi, test water runs outside the casing.		
35' single	45' Packer	- caving Portion - hole is filled with side wall sludge due to caving.		
45' single	55' Packer	- Caving Portion - hole is filled with side wall sludge due to caving.		
55' single	60' Packer	0.2	10	5
		0.1	20	5
		0.28	30	5
		0.18	20	5
		0.1	10	5
65' single	70' Packer	0.3	10	10'
		0.4	20	10'
		0.6	30	10'
		0.9	20	10'
		1.5	10	10'
75' single	90' Packer	1.6	10	15'
		1.4	20	15'
		1.3	30	15'
		0.9	20	15'
		0.7	10	15'
95' single	100' Packer	0.2	10	5
		0.8	20	5
		1	30	5
		0.6	20	5
		0.2	10	5
100' single	110' Packer	0.8	20	10'
		0.9	30	10'
		1.1	40	10'
		0.4	30	10'
		0.2	20	10'
115' single	125' Packer	0.2	20	10'
		0.5	30	10'
		0.7	40	10'
		0.2	30	10'
		0.1	20	10'
130' single	150' Packer	1.1	20	20'
		1	30	20'
		1.8	40	20'
		1.03	30	20'
		0.6	20	20'

DEPTH (FEET)	CLASSIFICATION AND PHYSICAL CONDITION
0' to 14'	Top Soil with plantroots, silty Sands with fine mica flakes in 20%, light yellowish-brown coloured fine to medium-grained, very loosely cemented & friable, dry, slightly soft & plastic, mixed with some small gravels of ∅ 0.2"-0.4" size at 4' depth.
14' to 24'	Clayey Sands, with mica flakes in 20%, light bluish grey coloured, fine to medium-grained, very loosely cemented & friable, dry, slightly soft & plastic, also mixed with some small gravels of ∅ 0.2"-0.4" size at some places.
24' to 58'	Quartzose Sands with pebbles and gravels, pebbles are found between 24'-32' Depth and gravels are found between 40'-50' Depth, medium to coarse-grained, light to dark grey coloured, very loosely cemented & friable, no soft & plastic sometimes intercalated with clayey soil thin layers.
58' to 80'	Quartzose Sandstone of Irrawaddian Formations, light grey coloured, coarse-grained, very loosely cemented & friable, nonplastic, mixed with mica flakes in 19% and also mixed with some gravels at some places.
80' to 103'	Silty Sandstone of Irrawaddian Formations, light yellowish-brown coloured, coarse grained, very loosely cemented & friable, with coarse mica flakes in 30%, very soft, fully saturated, mixed with some small gravels at some places, ferruginous at 103' Depth.
104' to 128'	Arenaceous Sandy Shale, with micas content in 30-40%, light bluish grey coloured, fine grained, thickly laminated; some layers are loosely cemented, soft & friable; But some layers are compact & tightly cemented, fully saturated;
128' to 150'	Quartzose Sandstone of Irrawaddian Formations, dark grey coloured, with fine mica flakes in 40%, coarse grained, very loosely cemented & friable, fully-saturated;

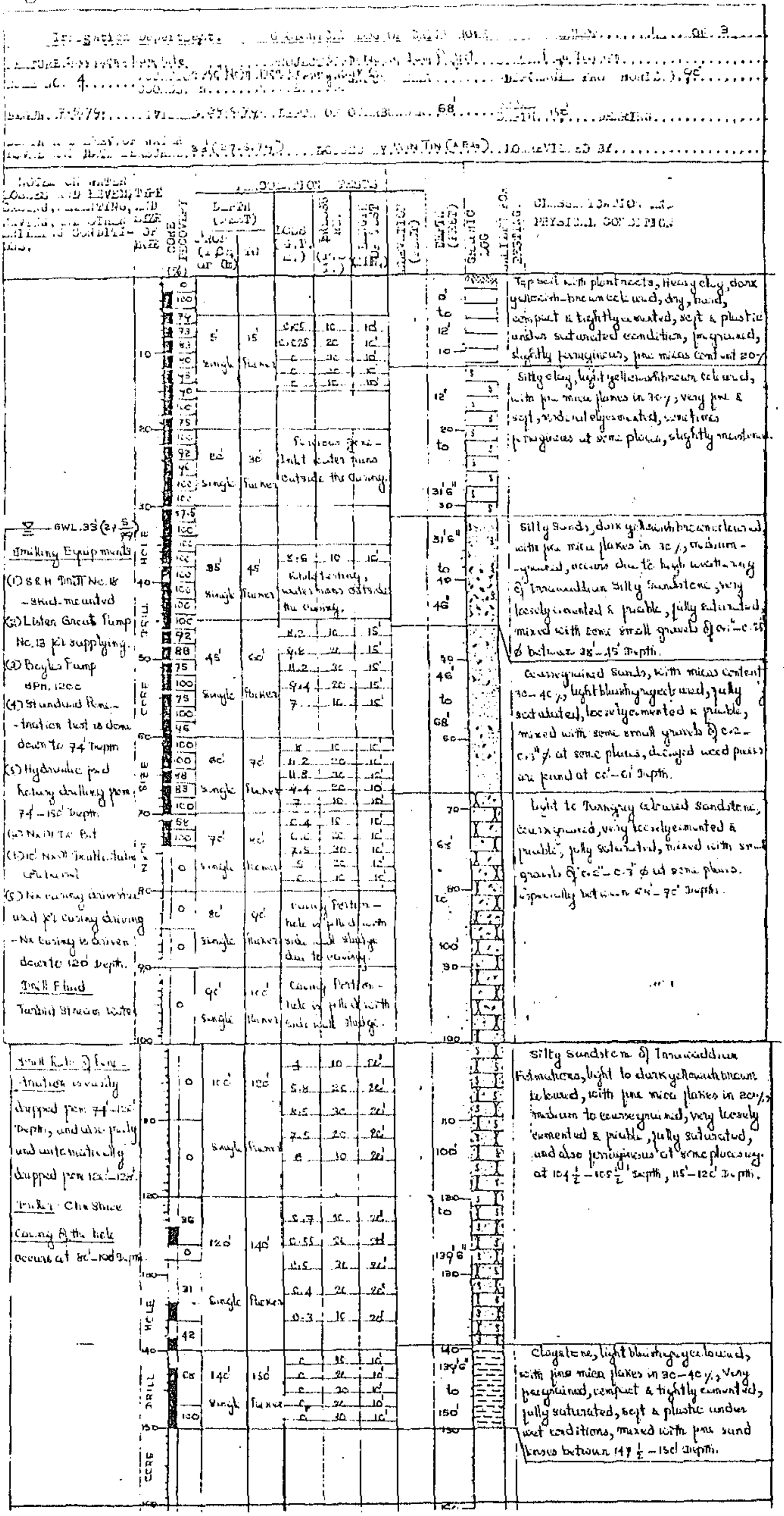
EXPLANATION

☐ CORE LOSS
▨ CORE RECOVERY

Type of hole . . . . D = Diamond, H = Hars[illegible], S = Shot, C = Churn
Hole sealed . . . . P = Packer, Cm = Cemented, Bt = Bottom of casing
Approx. size of hole (X-series) . . Ex = 1-1/2", Ax = 1-7/8", Bx = 2-3/8", Nx = [illegible]
Approx. size of core (X-series) . . Ex = 7/8", Ax = 1-1/8", Bx = 1-5/8", Nx = [illegible]
Outside dia. of casing (X-series) . . Ex = 1-13/16", Ax = 2-1/4", Bx = 2-7/8", Nx = [illegible]
Inside dia. of casing (X-series) . . Ex = 1-1/2", Ax = 1-29/32", Bx = 2-3/8", Nx = [illegible]

FEATURE Diversion - Dam PROJECT South Nawin STATE Pegu Division SHEET 8 OF 1 HOLE NO. 3

Fig. 4D-19 (4)



Irrigation Department . GEOLOGICAL LOG OF DRILL HOLE . . . SHEET 1 OF 3

HOLE NO. 4 . . . [illegible] . . . 98'

DATE 7-5-79 . . . [illegible] 27-5-79 . . . DEPTH OF OVERBURDEN 68' . . . TOTAL DEPTH 150'

[illegible] 33'(27-5-79) . . . LOGGED BY THAN TIN (A.E.O.) . . . [illegible]

NOTES ON WATER LOSSES AND LEVELS, TYPE CASING, CEMENTING, AND CAVING, AND OTHER DRILLING CONDITIONS:

▽ GWL 33' (27-5-79)

Drilling Equipments
(1) S & H Drill No. 18 - skid-mounted
(2) Lister Great Pump No. 13 for supplying.
(3) Boyles Pump GPH. 1200
(4) Standard Penetration test is done down to 74' depth
(5) Hydraulic feed rotary drilling from 74'-150' depth.
(6) NX DT Bit
(7) 10' NX Double tube core barrel
(8) NX casing drive head used for casing driving - NX casing is driven down to 120' depth.

Drill Fluid
Turbid Stream water

Drill Rate of Penetration is easily dropped from 74'-100' depth, and also fully and automatically dropped from 100'-120'.

Trouble - Cave Since
Caving of the hole occurs at 80'-100' depth.

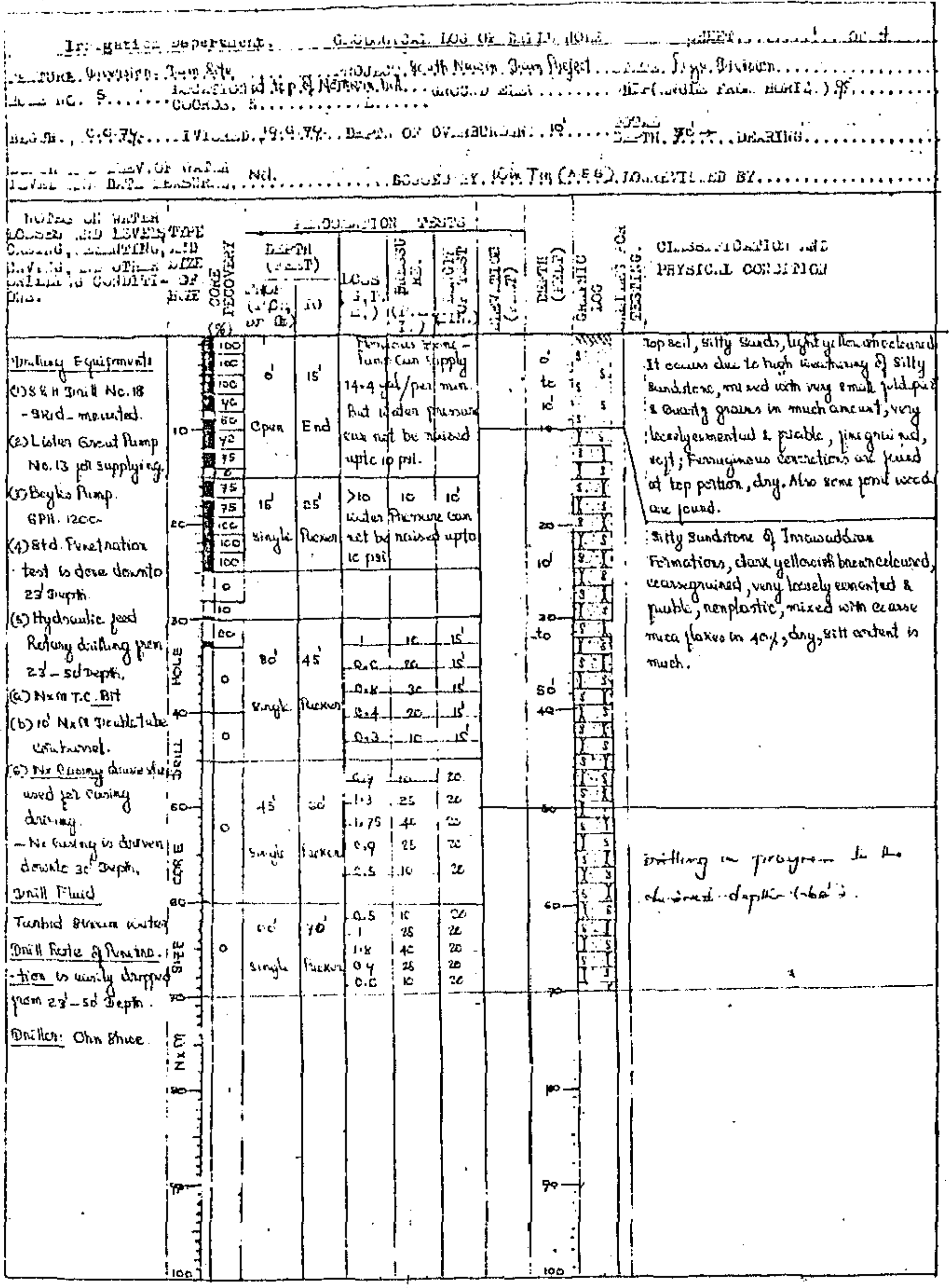
CORE RECOVERY (%): 0, 100, 74, 73, 83, 50, 75, 70, 60, 75, 100, 92, 75, 100, 100, 57.5, 100, 100, 100, 100, 100, 100, 100, 92, 88, 75, 100, 75, 100, 46, 100, 100, 48, 83, 100, 58, 100, 0, 0, 0, 0, 0, 0, 96, 0, 31, 42, 68, 100

PERCOLATION TESTS

Depth (feet) From (top)	To	Loss (G.P.M.)	Pressure (P.S.I.)	Elapsed time (Min.)
5' Single	15' Packer	0.05	10	10
		0.025	20	10
		0	30	10
		0	20	10
		0	10	10
20' Single	30' Packer	Pervious zone - Inlet water runs outside the casing.		
35' Single	45' Packer	5.6	10	10
		Stable testing, water runs outside the casing.		
45' Single	60' Packer	8.2	10	15'
		9.8	20	15'
		11.2	30	15'
		9.4	20	15'
		7	10	15'
60' Single	70' Packer	8	10	10'
		11.2	20	10'
		11.8	30	10'
		4.4	20	10
		3	10	10'
70' Single	80' Packer	0.4	15	10'
		0.6	20	10'
		7.5	20	10'
		5	20	10'
		0	10	10'
80' Single	90' Packer	Casing Portion - hole is filled with side wall sludge due to caving.		
90' Single	100' Packer	Casing Portion - hole is filled with side wall sludge.		
100' Single	120' Packer	4	10	20'
		5.8	20	20'
		8.5	30	20'
		7.5	20	20'
		6	10	20'
120' Single	140' Packer	0.7	10	20'
		0.55	20	20'
		0.5	30	20'
		0.4	20	20'
		0.3	10	20'
140' Single	150' Packer	0	15	10'
		0	20	10'
		0	30	10'
		0	20	10'
		0	10	10'

Depth (feet)	Classification and physical conditions
0' to 12'	Top soil with plant roots, heavy clay, dark yellowish-brown coloured, dry, hard, compact & tightly cemented, soft & plastic under saturated condition, fine grained, slightly ferruginous, fine micas content 20%
12' to 31'6"	Silty clay, light yellowish-brown coloured, with fine mica flakes in 30%, very fine & soft, moderately cemented, sometimes ferruginous at some places, slightly moistured.
31'6" to 46'	Silty Sands, dark yellowish-brown coloured, with fine mica flakes in 30%, medium-grained, occurs due to high weathering of Irrawaddian Silty Sandstone, very loosely cemented & friable, fully saturated, mixed with some small gravels of 0.1"-0.25" ø between 38'-45' depth.
46' to 68'	Coarse-grained Sands, with micas content 30-40%, light bluish-grey coloured, fully saturated, loosely cemented & friable, mixed with some small gravels of 0.2"-0.3" ø at some places, decayed wood pieces are found at 60'-61' depth.
68' to 100'	Light to bluish-grey coloured Sandstone, coarse grained, very loosely cemented & friable, fully saturated, mixed with small gravels of 0.2"-0.3" ø at some places, especially between 68'-70' depth.
100' to 139'6"	Silty Sandstone of Irrawaddian Formations, light to dark yellowish-brown coloured, with fine mica flakes in 20%, medium to coarse-grained, very loosely cemented & friable, fully saturated, and also ferruginous at some places e.g. at 104½-105½' depth, 115'-120' depth.
139'6" to 150'	Claystone, light bluish-grey coloured, with fine mica flakes in 30-40%, very fine grained, compact & tightly cemented, fully saturated, soft & plastic under wet conditions, mixed with fine sand lenses between 147½-150' depth.

Fig. 4D-19 (5)



Irrigation Department. GEOLOGICAL LOG OF DRILL HOLE. SHEET 1 OF 4

FEATURE. Diversion: Dam Site. PROJECT. South Nawin Dam Project. AREA. Irgn. Division.

HOLE NO. 5. LOCATION: N.W. of Nawin Weir. GROUND ELEV. DIP (ANGLE FROM HORIZ.) 90°

COORDS. N .... E ....

BEGUN 9.9.79 FINISHED 19.9.79 DEPTH OF OVERBURDEN 10' TOTAL DEPTH 70' BEARING

DEPTH AND ELEV. OF WATER LEVEL AND DATE MEASURED Nil. LOGGED BY Kin Tin (A.E.G). COMPILED BY

NOTES ON WATER LOSSES AND LEVELS, CASING, CEMENTING, CAVING, AND OTHER DRILLING CONDITIONS	TYPE AND SIZE OF HOLE	CORE RECOVERY (%)	PERCOLATION TESTS: DEPTH (FEET) FROM (L'Pkr or Bt)	TO	LOSS (G.P.M.)	PRESSURE (P.S.I.)	LENGTH OF TEST (MIN.)	ELEVATION (FEET)	DEPTH (FEET)	GRAPHIC LOG	SAMPLES FOR TESTING	CLASSIFICATION AND PHYSICAL CONDITION
Drilling Equipments (1) S & H Drill No.18 - Skid-mounted. (2) Lister Grout Pump No.13 for supplying. (3) Boyles Pump. GPH. 1200 (4) Std. Penetration test is done down to 23' Depth. (5) Hydraulic feed Rotary drilling from 23' - 50' Depth. (a) NxM T.C. Bit (b) 10' NxM Double tube core barrel. (6) Nx Casing drive shoe used for casing driving. - Nx Casing is driven down to 30' Depth. Drill Fluid Turbid Stream water Drill Rate of Penetration is rarely dropped from 23' - 50' Depth. Driller: Ohn Shwe.	DRILL HOLE CORE SIZE NxM	100 100 100 40 60 42 75 0 75 75 100 100 100 0 10 60 0 0 0 0	0' Open	15' End	Pervious zone - Pump can supply 14.4 gal/per min. But water pressure can not be raised upto 10 psi.				0' to 10'			Top soil, silty sands, light yellowish coloured. It occurs due to high weathering of silty sandstone, mixed with very small feldspar & quartz grains in much amount, very loosely cemented & friable, fine grained, soft; Ferruginous concretions are found at top portion, dry. Also some fossil wood are found.
			15' Single	25' Packer	>10 water Pressure can not be raised upto 10 psi	10	10'		10'			Silty Sandstone of Irrawaddian Formations, dark yellowish brown coloured, coarse grained, very loosely cemented & friable, nonplastic, mixed with coarse mica flakes in 40%, dry, silt content is much.
			30' Single	45' Packer	1 0.6 0.8 0.4 0.3	10 20 30 20 10	15' 15' 15' 15' 15'		30' to 50'			
			45' Single	60' Packer	[illegible] 1.3 1.75 0.9 0.5	10 25 40 25 10	20 20 20 20 20					
			60' Single	70' Packer	0.5 1 1.8 0.4 0.6	10 25 40 25 10	20 20 20 20 20					Drilling in progress to the desired depth (70').

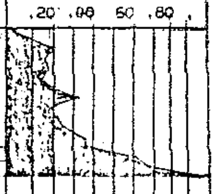
Fig. 4D-19 (6)

SUBSURFACE EXPLORATION - PENTRATION RESISTANCE AND LOG

Feature [illegible] Dam Grd. Elevtn. ______ Hole Number 1
Project South Nawin Project GWL. Elevtn. 56'6" Location South Bank of [illegible] Phongyi Kyaung Taung
District Paukkaung Township Date. GWL gaged 13.7.79. Coordinares ______
Foreman Tin Sw Wt. of hammer 140 lbs. Total depth 100'.
Logged by Win Tin (A.E.S) Ht of drop 2'6" Date begun 4.7.79.
Date completed 13.7.79.

NOTES Type & size of hole Type of bit or spoon. Loss of drill water.	core recovery %	number of blows	moisture %	sample for testing	DESCRIPTION AND CLASSIFICATION OF MATERIAL	depth.	log.
– Standard Penetration test hole, Ax size. – Split-tube Sampler. – Drill Water Nil	100 100 100 100 100 87.5 100 100				Top Soil & plantroots, Sandy Loam, silt, darkbrowncoloured, mixed with coarse mica flakes in 20–30%; sometimes ferruginous at some places; very small milky quartz gravels of 0–1"ø are found between 5'–12' depth; slightly moistured, loosely cemented & friable, coarse to fine grained downwards.	0' to 12'	
					Light to darkyellowishbrowncoloured siltstone, mixed with occasional sand layers & coarse mica flakes in 20–30%, loosely cemented & friable, very fine & soft, slightly moistured; some small gravels of 0.3"ø are found at some place.	12' 15'	
					N.B. Bed Rx at 12' Depth. For detailed Description on log, Permeability, and core Recovery, see attached geological log of Drill Hole No.1.		

Penetration resistance Blows / foot.



SUBSURFACE EXPLORATION - PENTRATION RESISTANCE AND LOG

Feature [illegible] Dam Grd. Elevtn. ______ Hole Number 2
Project South Nawin Project GWL. Elevtn. 14'6" Location [illegible] Nawin C.
District Paukkaung Date. GWL gaged 20.6.79. Coordinares ______
Foreman Tin Sw. Wt. of hammer 140 lbs. Total depth 155'
Logged by Win Tin (A.E.S) Ht of drop 2'6" Date begun 25.5.79.
Date completed 26.6.79.

NOTES Type & size of hole Type of bit or spoon. Loss of drill water.	core recovery %	number of blows	moisture %	sample for testing	DESCRIPTION AND CLASSIFICATION OF MATERIAL	depth.	log.
– Standard Penetration test hole, Ax size. – Split-tube Sampler. – Drill Water Nil	100 100 83				Top Soil & plantroots, Heavy Clay, Dark brownish grey coloured, hard, compact & tightly cemented, dry.	0' to 5'	
	58 75 83				Light Loam, silty, & fine mica flakes in 20%, darkyellowishbrowncoloured, very fine grained, loosely cemented & friable, slightly moistured & soft.	5' to 11'	
	83 83 74 75 100 75 100 100 100 60 75 85				Silty Sands, light to darkyellowish brown coloured, medium to coarse-grained, very loosely cemented & friable, slightly moistured; mixed with slight amount of very small gravels & fine mica flakes between 20–35' Depth.	11' to 35'	
					Quartzose Sandstone of Irrawaddian Formations.		
					NB. Bed Rx at 35' Depth. For further information on log, Permeability & core recovery, see attached drill hole log sheet of DH. No. 2.		

Penetration resistance Blows / foot.

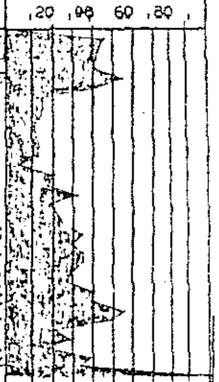
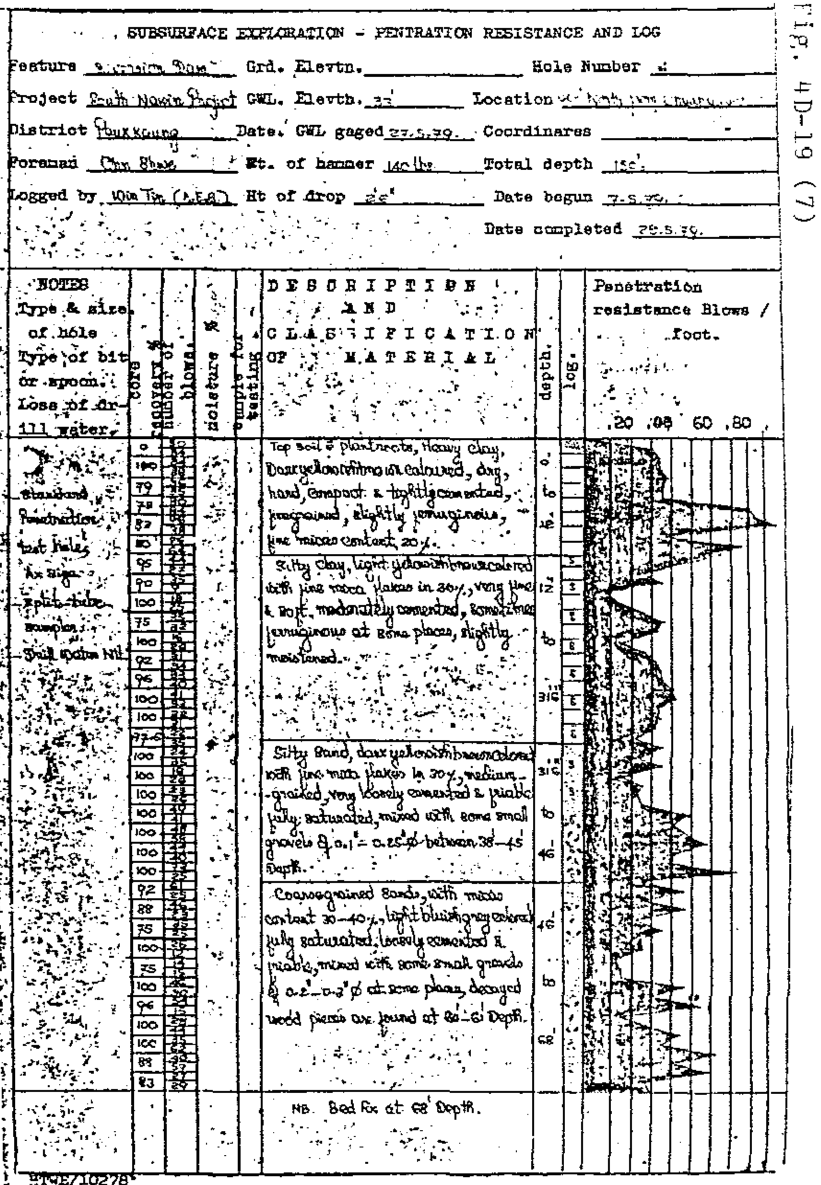


Fig. 4D-19 (7)



SUBSURFACE EXPLORATION - PENTRATION RESISTANCE AND LOG

Feature [illegible] Dam Grd. Elevtn. ______ Hole Number [illegible]
Project South Nawin Project GWL. Elevth. 33' Location [illegible]
District Paukkaung Date. GWL gaged 27.5.79. Coordinares ______
Foreman Chn Shwe Wt. of hammer 140 lbs Total depth 150'.
Logged by Win Tin (A.E.A) Ht of drop 2'6" Date begun 7.5.79.
Date completed 25.5.79.

NOTES Type & size of hole Type of bit or spoon. Loss of drill water.	core recovery %	DESCRIPTION AND CLASSIFICATION OF MATERIAL	depth
Standard Penetration test holes 4" size split-tube sampler. Drill water Nil.	0 100 79 78 87 80	Top soil & plantroots, Heavy clay, Darkyellowish brown coloured, dry, hard, compact & tightly cemented, fine grained, slightly ferruginous, fine micas content, 20%.	0' to 12'
	95 90 100 75 100 92 96 100 100 77.6	Silty Clay, light yellowish brown colored with fine mica flakes in 30%, very fine & soft, moderately cemented, sometimes ferruginous at some places, slightly moistened.	12' to 31'6"
	100 100 100 100 100 100 100	Silty Sand, dark yellowish brown colored with fine mica flakes in 30%, medium-grained, very loosely cemented & friable fully saturated, mixed with some small gravels of 0.1"–0.25"ϕ between 38'–45' Depth.	31'6" to 46'
	92 88 75 100 75 100 96 100 100 88 83	Coarsegrained Sands, with micas content 30–40%, light bluish grey colored fully saturated, loosely cemented & friable, mixed with some small gravels of 0.2"–0.3"ϕ at some places, decayed wood pieces are found at 60'–61' Depth.	46' to 68'
		NB. Bed Rx at 68' Depth.	

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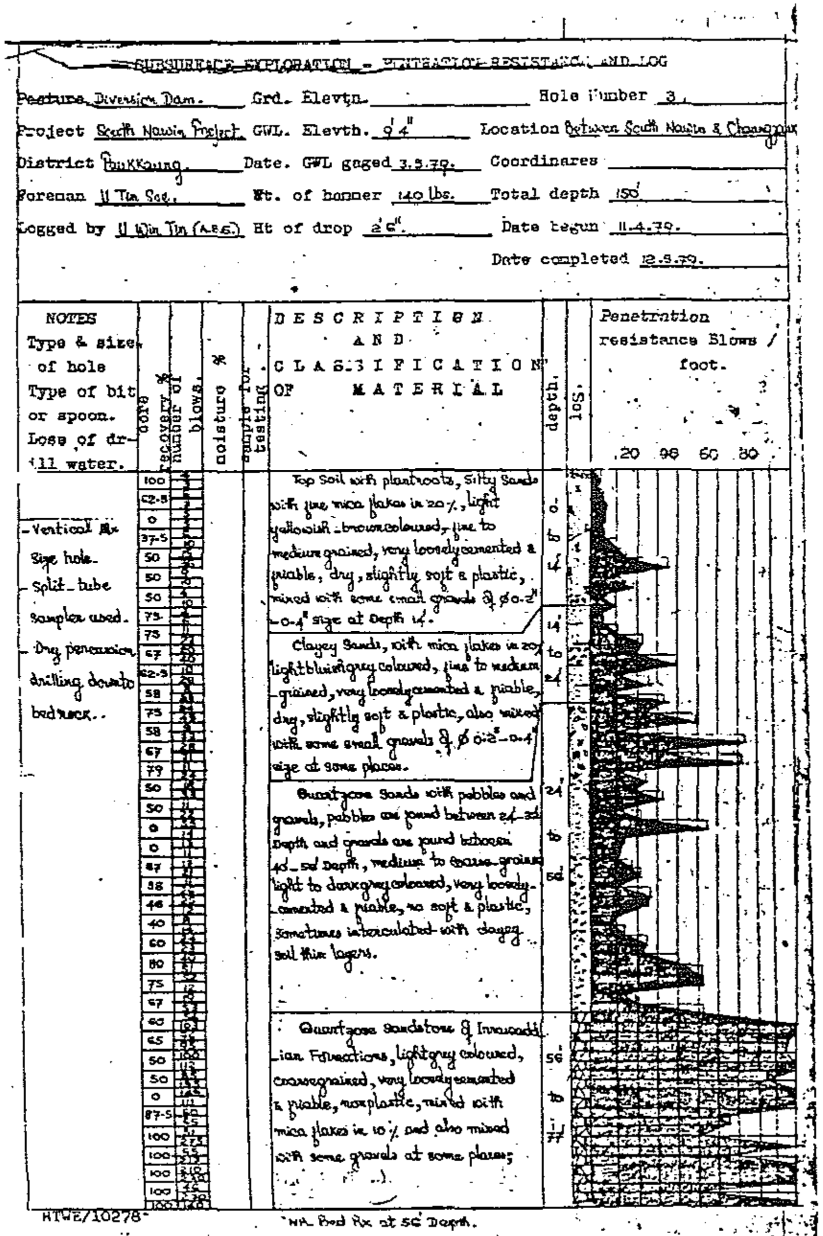


SUBSURFACE EXPLORATION - PENTRATION RESISTANCE AND LOG

Feature Diversion Dam. Grd. Elevtn. ______ Hole Number 3.
Project South Nawin Project GWL. Elevth. 9'4" Location Between South Nawin & Chaungpauk
District Paukkaung. Date. GWL gaged 3.5.79. Coordinares ______
Foreman U Tin Soe. Wt. of hammer 140 lbs. Total depth 150'
Logged by U Win Tin (A.E.A.) Ht of drop 2'6". Date begun 11.4.79.
Date completed 12.5.79.

NOTES Type & size of hole Type of bit or spoon. Loss of drill water.	core recovery %	DESCRIPTION AND CLASSIFICATION OF MATERIAL	depth
Vertical 4" Size hole. Split-tube sampler used. Dry percussion drilling down to bedrock..	100 62.5 0 37.5 50 50 50 75	Top Soil with plantroots, Silty Sands with fine mica flakes in 20%, light yellowish-browncoloured, fine to medium grained, very loosely cemented & friable, dry, slightly soft & plastic, mixed with some small gravels of ϕ 0.2"–0.4" size at Depth 14'.	0' to 14'
	75 67 62.5 58 75 58 67 79	Clayey Sands, with mica flakes in 20% lightbluishgrey coloured, fine to medium grained, very loosely cemented & friable, dry, slightly soft & plastic, also mixed with some small gravels of ϕ 0.2"–0.4" size at some places.	14' to 24'
	50 50 0 0 67 58 46 40 60 80 75 67	Quartzose Sands with pebbles and gravels, pebbles are found between 24–30' Depth and gravels are found between 40–50' Depth, medium to coarse-grained light to darkgrey coloured, very loosely cemented & friable, no soft & plastic, Sometimes intercalated with clayey soil thin layers.	24' to 56'
	60 65 50 50 0 87.5 100 100 100 100 100	Quartzose Sandstone of Irrawaddian Formations, lightgrey coloured, coarsegrained, very loosely cemented & friable, nonplastic, mixed with mica flakes in 10% and also mixed with some gravels at some places;	56' to 77'

HTWE/10278

NB. Bed Rx at 56' Depth.

Fig. 4D-19 (8)

SUBSURFACE EXPLORATION - PENTRATION RESISTANCE AND LOG

Feature [illegible] Grd. Elevtn. ____ Hole Number 5

Project [illegible] GWL. Elevth. nil Location at top of [illegible] Hill

District [illegible] Date. GWL gaged 19.6.74 Coordinares ____

Foreman [illegible] Wt. of hammer 140 lbs Total depth 20'

Logged by [illegible] Ht of drop 30" Date begun 6.6.74

Date completed 16.6.74.

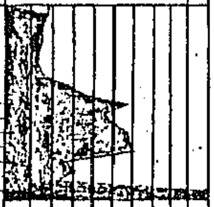
NOTES Type & size of hole Type of bit or spoon. Loss of drill water.	core recovery %	number of blows.	moisture %	sample for testing	DESCRIPTION AND CLASSIFICATION OF MATERIAL	depth.	log.	Penetration resistance Blows / foot. 20 40 60 80
- Standard Penetration test hole, Ax Size. - Split-tube Sampler. - Drill Water Nil.	100 100 100 90 50 92 75 0 75 75 100	[illegible]			Top Soil, Silty Sands, light yellowish coloured, mixed with very small feldspar & Quartz grains in much amount, very loosely cemented & friable, fine grained & soft; Fossil woods & ferruginous concretions are found at top portion. Silty Sandstone of Irrawaddian Formations, dark yellowish brown coloured	0' to 10' 10' to 20'	S S S S S S	
					N.B. Bed Rx at 10' Depth. For further information on log, permeability & core recovery, see attached Drill Hole Log of DH No. 6.			

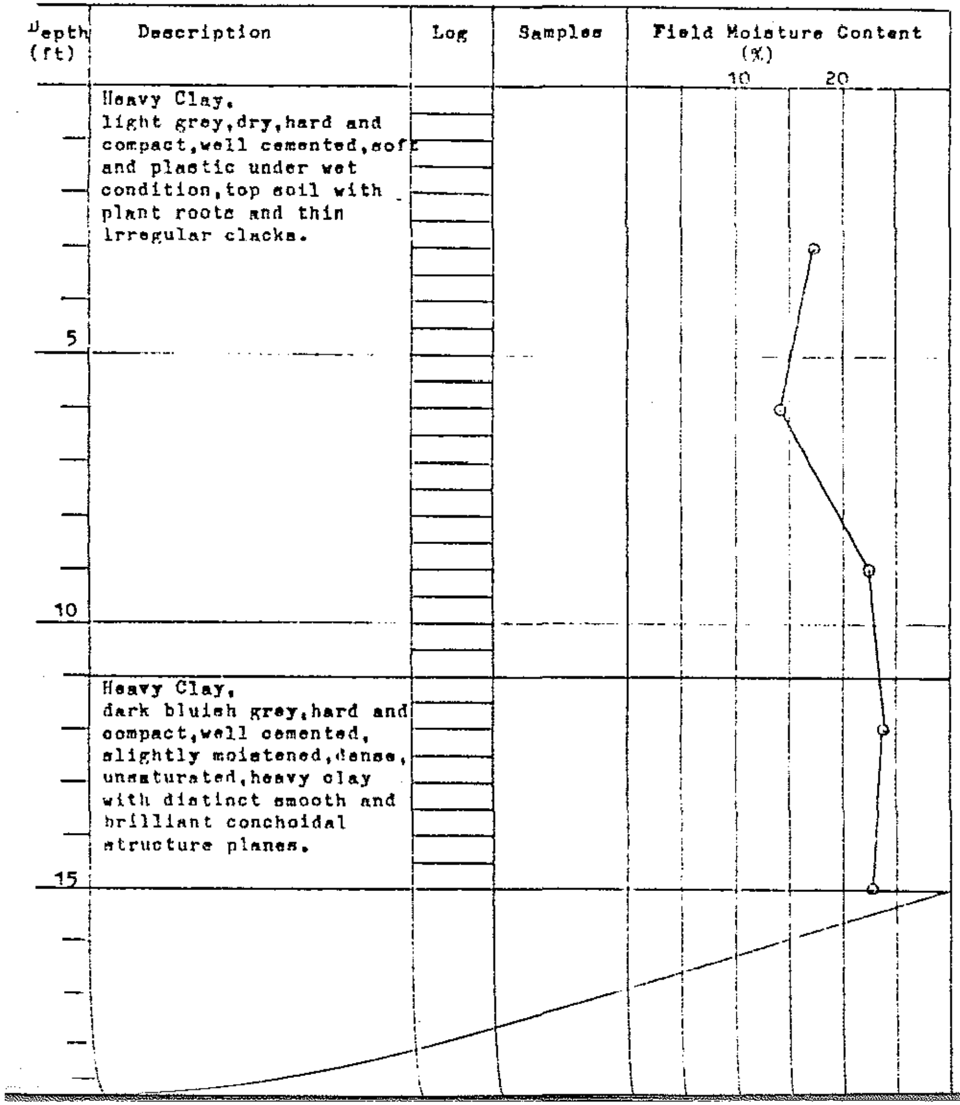
Fig. 4D-29

TEST PIT LOG

South Nawin Irrigation Project   Diversion Dam Site

Test Pit No. TP1

No groundwater was reached



Heavy Clay,
light grey,dry,hard and compact,well cemented,soft and plastic under wet condition,top soil with plant roots and thin irregular clacks.

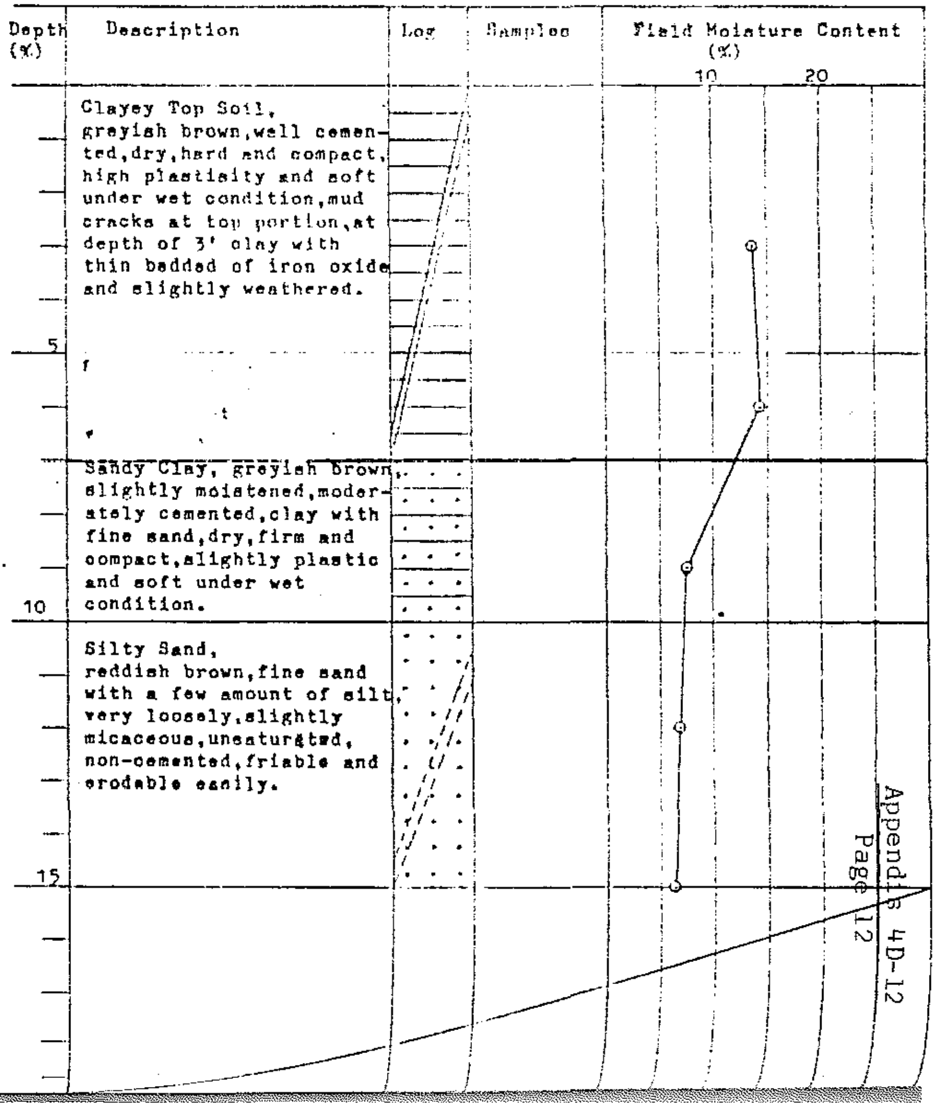
Heavy Clay,
dark bluish grey,hard and compact,well cemented, slightly moistened,dense, unsaturated,heavy clay with distinct smooth and brilliant conchoidal structure planes.

TEST PIT LOG

South Nawin Irrigation Project   Diversion Dam Site

Test Pit No. TP2

No groundwater was reached

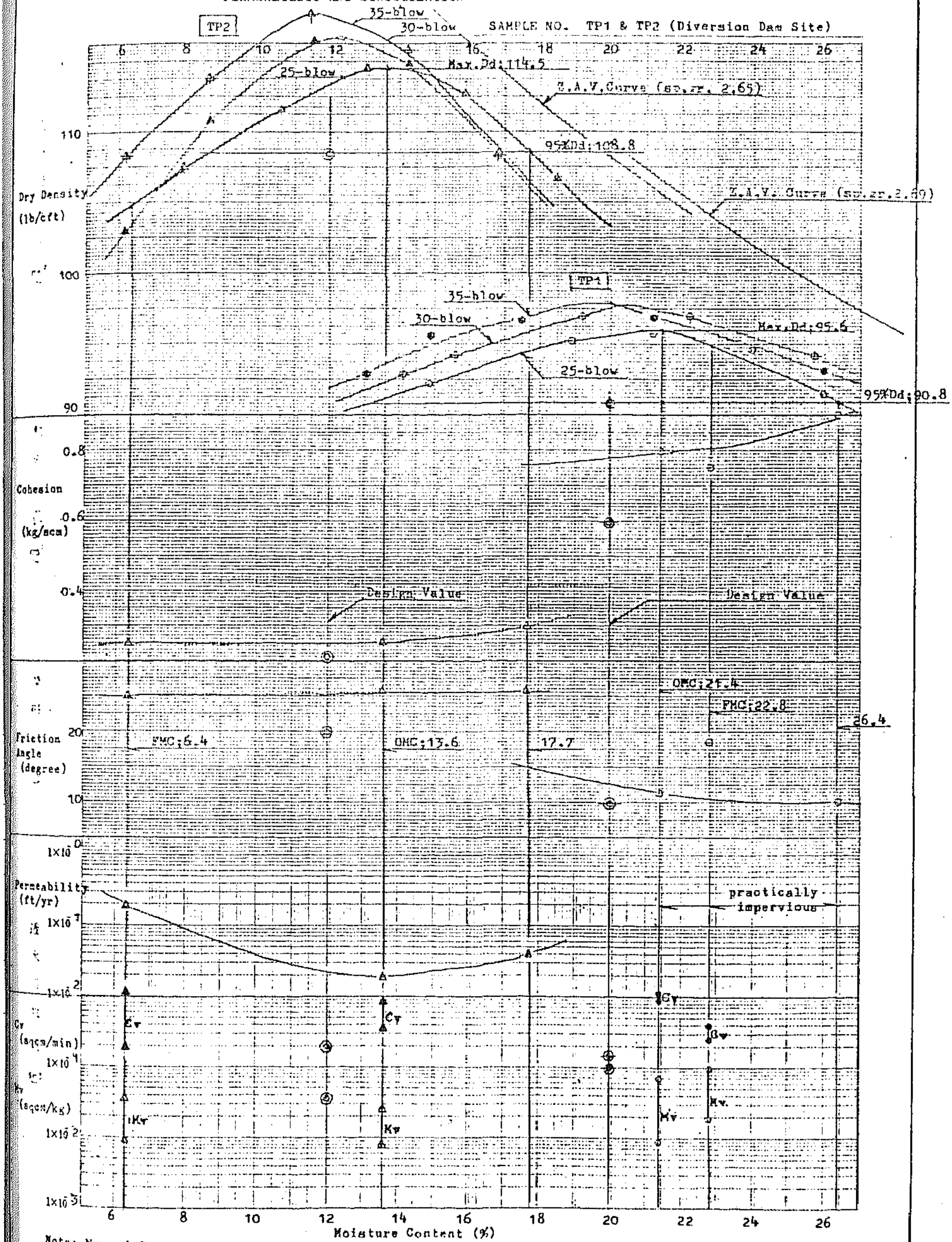


Clayey Top Soil,
greyish brown,well cemented,dry,hard and compact, high plasticity and soft under wet condition,mud cracks at top portion,at depth of 3' clay with thin badded of iron oxide and slightly weathered.

Sandy Clay, greyish brown, slightly moistened,moderately cemented,clay with fine sand,dry,firm and compact,slightly plastic and soft under wet condition.

Silty Sand,
reddish brown,fine sand with a few amount of silt, very loosely,slightly micaceous,unsaturated, non-cemented,friable and erodable easily.

Fig. 4D-21 RELATIONSHIP BETWEEN MOISTURE-CONTENT / DRY DENSITY, COHESION, FRICTION ANGLE, PERMEABILITY AND CONSOLIDATION



Note; Mv and Cv values are shown those at the effective loads of 1.0 to 8.0 kg/sqcm.

4D-13. Dam Type and Dam Crest Elevation on Diversion Dam

Two types of the diversion dam have been considered taking into account the topographical, geological and hydrological conditions at the site. The one is barrage-type with gated sluice way at the river course and earth-fill at the both banks, and the other is dam-type which is composed of fill dam at the river valley and independent spillway at the right abutment.

In order to determine the priority of dam-type, the basic study with crest elevation of 207 ft was carried out on the basis of the comparative design shown in the attached drawings.

A summary of the direct construction cost is presented in the following table:

Items	Barrage-type (x 10^3 Kyat)	Dam-type (x 10^3Kyat)
Foundation treatment	31,567	5,670
Dam body embankment	3,890	25,851
Spillway or sluiceway	44,092	9,830
Outlet facility	2,988	2,988
Total	82,537	44,339

From the above table, a dam-type of diversion dam is recommended as the most suitable type in this site.

At the dam-type of diversion dam, an earth fill type with impervious and random zones is the most favorable one for this site among several fill types taking into account the dam height, the embankment materials available around the site, topographical and geological conditions.

The crest elevation of diversion dam can be obtained the maximum water surface level in the reservoir plus freeboard. The freeboard should be determined as same estimation method of the freeboard on the main dam and the result of calculation is shown in the following table.

Fetch (ft)	R/1 (ft)	Ho/2 (ft)	he/3 (ft)	ht/4 (ft)	hs/5 (ft)	Freeboard/6 (ft)
24,000	4.3	33.5	0.63	0	3.28	7.58 ≑ 7.6

NOTES: /1 - wind speed is 44.75 mph in 10 minutes on an average and upstream slope of diversion dam is 7 on 3.5 with hand placed riprap, therefore, an intermediate value at the smooth slope and the rock zone slope in Fig. 4D-14 was adopted as the height of wave due to wind.

/2 - depth of reservoir.

/3 - height of wave due to earthquake refer to freeboard on main dam.

/4 - rise of water level due to unexpected accident in operating spillway gate.

/5 - addition of allowance according to type and importance of dam.

/6 - freeboard can be obtained as follows: $Fb \geqq (Ro \text{ or } he/2) + ht + hs$

According to the result of spillway studies, a rising height of water surface from the full storage level due to release the design flood discharge at the spillway was decided to 8.8 ft. Therefore, the dam crest elevation without extra-bank can be obtained by adding the freeboard to maximum water surface, as follows:

Dam crest elevation EL 196.5 + 8.8 + 7.6 = EL 212.9 ft ≑ EL 213 ft

This elevation seems to be reasonable value taking into account the applicability and restriction of topographic feature at the dam site, effect of back-water to the Paukkaung Town and trunk road.

4D-14. Stability Analysis on Diversion Dam

Stability analysis of the diversion dam body has been made by the same calculation method on the main dam body considering the difference of soil mechanic properties of embankment materials and zoning in dam body.

(a) Design Values

The earth materials obtained around the dam site are definitely classified into two types such as clayey material for impervious zone and sandy material for random zone, reflecting the difference of gradation and other properties. The design values of those materials should be decided according to the results of soil test executed by Burmese laboratory in 1979. However, additional soil tests for embankment materials should be planned during the final design stage due to lack of physical and dynamic tests in quality and quantity.

(1) Impervious and Random Materials

Since the dry density of impervious and random materials are controlled at about 95 percent of the maximum dry density of compaction test in embankment, the design values of density and shearing strength for impervious and random materials can be obtained from the results of soil tests on TP-1 and TP-2, respectively, and are shown in the following table. However, the values of shearing strength was decided from 80 percent of direct shear test values at the field moisture level considering the mechanism of testing equipment.

Embankment Materials	Density			Shearing Strength		Permeability Coefficient
	γd /1	γt /2	γsat /3	ø /4	C /5	
	(lb/cu.ft)	(lb/cu.ft)	(lb/cu.ft)	(°)	(lb/sq.in)	(ft/year)
Impervious Zone	90.5	108.6	119.2	10°00'	8.53	0.1
	(ton/cu.m)	(ton/cu.m)	(ton/cu.m)		(ton/sq.m)	(cm/sec)
	1.45	1.74	1.91	10°00'	6.0	1×10^{-7}
	(lb/cu.ft)	(lb/cu.ft)	(lb/cu.ft)	(°)	(lb/sq.in)	(ft/year)
Randon Zone	108.6	121.7	130.5	20°00'	2.85	0.2
	(ton/cu.m)	(ton/cu.m)	(ton/cu.m)		(ton/sq.m)	(cm/sec)
	1.74	1.95	2.09	20°00'	2.0	2×10^{-7}

NOTES: /1 -- dry density; /2 -- wet density; /3 -- saturated density; /4 -- angle of internal friction; /5 -- cohesion.

$$\gamma d = \frac{Gs}{(1+e)}, \quad \gamma t = \gamma d\left(1 + \frac{M.C}{100}\right), \quad \gamma sat = \frac{(Gs + e)}{(1 + e)}, \quad e = \frac{Gs - \gamma d}{\gamma d}$$

Gs: specific gravity; e: void ratio; M.C.: moisture content

(2) Foundation Material (Overburden)

Since effective soil test of dam foundation materials on the riverbed has not been executed, the design values were assumed from the testing data of random material and cone penetration resistance (N-value).

As for the design values of density, the same values of random material can be used for the foundation material considering the profile of test pit and situation of testing specimen and are shown in the table below.

According to the results of penetration test, N-value of the foundation material varies from three to 96 in depths and places, and the lower mean value is defined to be 12. The internal friction angle of shearing strength for this material was assumed by applying the Terzaghi-Peak's formula on the basis of the lower mean N-value and the results are shown below.

Density			Shearing Strength		Permeability Coefficient
γd	γt	γsat	ø	C	
(lb/cu.ft)	(lb/cu.ft)	(lb/cu.ft)	(°)	(lb/sq.in)	(ft/year)
108.6	121.7	130.5	30°00'	-	1,241.6
(ton/cu.m)	(ton/cu.m)	(ton/cu.m)		(ton/sq.m)	(cm/sec)
1.74	1.95	2.09	30°00'	-	1.2×10^{-3}

The notes in the table are same as in the paragraph of impervious and random materials.

(3) Rock Material

Since the rock material is taken from the same quarry site on the main dam, the design values of density and shearing strength for the rock material on the main dam can be quoted as the design values for the diversion dam.

Design values of the above-mentioned embankment materials for the diversion dam are summarized in Table 4D-5.

TABLE 4D-5. SUMMARY OF DESIGN VALUES FOR EMBANKMENT MATERIALS ON DIVERSION DAM

Zone	Density			Shearing Strength		Permeability Coefficient	Coefficient of Consolidation
	γd	γt	γsat	ϕ	C		
	(lb/cu.ft)	(lb/cu.ft)	(lb/cu.ft)	($^{\circ}$)	(lb/sq. in.)	(ft/year)	(sq.in/min.)
	90.5	108.6	119.2	$10^{\circ}00'$	8.53	0.1	1.55×10^{-2}
Impervious	(ton/cu.m)	(ton/cu.m)	(ton/cu.m)		(ton/sq.m)	(cm/sec)	(sq.cm/min.)
	1.45	1.74	1.91	$10^{\circ}00'$	6.0	1×10^{-7}	1×10^{-1}
	(lb/cu.ft)	(lb/cu.ft)	(lb/cu.ft)	($^{\circ}$)	(lb/sq.in.)	(ft/year)	(sq. in/min.)
	108.6	121.7	130.5	$20^{\circ}00'$	2.85	0.2	3.10×10^{-2}
Random	(ton/cu.m)	(ton/cu.m)	(ton/cu.m)		(ton/sq.m)	(cm/sec.)	(sq.cm/min.)
	1.74	1.95	2.09	$20^{\circ}00'$	2.0	2×10^{-7}	2×10^{-1}
	(lb/cu.ft)	(lb/cu.ft)	(lb/cu.ft)	($^{\circ}$)	(lb/sq.in.)	(ft/year)	(sq. in/min.)
	109.3	115.5	130.5	$42^{\circ}00'$	-	-	-
Rock	(ton/cu.m)	(ton/cu.m)	(ton/cu.m)		(ton/sq.m)	(cm/sec)	(sq.cm/min.)
	1.75	1.85	2.09	$42^{\circ}00'$	-	-	-
	(lb/cu.ft)	(lb/cu.ft)	(lb/cu.ft)	($^{\circ}$)	(lb/sq.in)	(ft/year)	(sq. in/min.)
Foundation	108.6	121.7	130.5	$30^{\circ}00'$	-	1,241.6	-
	(ton/cu.m)	(ton/cu.m)	(ton/cum.)		(ton/sq. m)	(cm/sec)	(sq.cm/min.)
	1.74	1.95	2.09	$30^{\circ}00'$	-	1.2×10^{-3}	-

(b) *Stability Analysis*

The sliding failure analysis for the diversion dam body is made by the same analysing method on the main dam under the conditions of after completion of dam, taking into account that the shearing strength test was carried out only by direct shear test.

The calculation procedure and equation for factor of safety refer to the paragraph of Stability Analysis on main dam.

The results of analysis for each condition are presented in Table 4D-6.

TABLE 4D-6. FACTOR OF SAFETY IN EACH CONDITION ON DIVERSION DAM

Reservoir Condition	K/1	Slope	Factor of Safety	Pore-pressure
After completion with High Water Surace (H.W.S.)/2	0.12	Upstream	F.S.=1.485	Steady flow
	0.12	Downstream	F.S.=1.333	Steady flow
Rapid drawdown from H.W.S. to L.W.S./3	0.06	Upstream	F.S.=1.753	Steady flow

NOTES: /1 -- seismic coefficient and adopted by 0.12 in usual case, and 0.06 in special case.
/2 -- high water surface elevation and adopted by 205.3 ft.
/3 -- low water surface elevation and adopted by 190.0 ft.

The above factor of safety is considered reasonable judging from the design of feasibility stage, the quantity and quality of soil test, and the capacity of test equipment. Besides, the above factor of safety will be increased taking into account that the stabilized fills which are executed by spoil bank at the upstream and downstream slopes of dam body is effective.

It is desirable that the embedded devices such as pore pressure gauges and multi-layer settlement measurements will be installed in the dam body in order to control the embankment speed and management of dam body and foundation in future.

Since the soil tests for the embankment and foundation materials are very limited in quality and quantity, it is recommendable to execute the physical and dynamic soil tests during the final design stage.

4D-15. Foundation Treatment on Diversion Dam

Around the river bed of the proposed diversion dam site, there are the river deposits of 50-70 ft thick, which consist of sand, silt and clay. The river deposit layers in general are loose and pervious, and the permeability coefficient ranges in n x 10^4 to n x 10^2 ft/year (n x 10^{-2} - n x 10^{-4} cm/sec), in some part fully permeable particularly. The sand layers are composed of very fine grain with poor gradation and being liable to liquefaction.

The bedrocks are friable, slightly cemented so-called Irrawaddian sand stone. The permeability of bedrock is n x 10^2 ft/year (n x 10^{-4}cm/sec).

(a) Method of Foundation Treatment

To take countermeasures for seepage and piping is essential problem for constructing diversion dam on the foundation mentioned above. As countermeasures in foundation treatment, the following four methods were considered as shown in Fig. 4D-22.

- Open cut method -- the river deposit layers are replaced with the impervious materials, and grouting is made for the bedrocks. However, since the ordinary grouting method may be not so effective for these kinds of bedrock, the double tubing method is proposed to adopt.
- Casting underground wall method -- the river deposit layers are treated by reinforced concrete cut off wall with slurry trench and the bedrock is treated by grouting.
- Curtain grouting method -- both of river deposit layers and bedrock are to be treated by curtain grouting of double tubing method. However, the extent to which the river

deposit layers can be improved by cement grout is up to n x 10^2 ft/year (n x 10^{-4} cm/sec) without regard to the original permeability, and a further improvement can be hardly obtained unless a special chemical grout is employed.

o Blanket method -- the earth blanket is provided in front of the dam body to extend the creep length for preventing seepage and piping. Usually, the blanket method is adopted when the coefficient of permeability on dam foundation indicates below n x 10^2 ft/year (n x 10^{-4} cm/sec) order and in case that an impervious layer which can be recognized impermeable is found in rather shallow depth.

In order to judge the priority of the above four methods, the roughly economical comparison in unit length was carried out and the results are shown as follows:

Items	Open-cut Method (Kyat)	Casting Under Ground Wall Method (Kyat)	Grout Curtain Method (Kyat)	Blanket Method (Kyat)
Excavation	2,850	-	-	4,655
Embankment	3,810	-	-	6,224
Grouting for River Deposit	-	-	15,750	-
Grouting for Bed Rock	5,250	5,250	5,250	-
Concrete Wall	-	15,750	-	-
Others	660	-	-	-
Total	12,570	21,000	21,000	10,879

Though the blanket method is the cheapest in cost from the above table, the open-cut method is finally selected as the most suitable method of foundation treatment in this site taking into account the following technical considerations.

- o The open-cut method can assure the success for the purpose with safety.
- o The river deposit layers are liable to liquefaction due to earthquake; hence, even if the blanket method is applied to cover layers, the blanket might collapse when liquefaction of sand layers takes place.
- o The estimated length of blanket is required about 1,500 ft, but to provide such a blanket on the site is very difficult in terms of implementation.
- o The earth blanket has not always sufficient resistance against piping in the ground since high permeability is expected to be horizontal direction.

The location of cut-off trench was selected at the center of dam body, where the effect of differential settlement by dam embankment load on river deposit can be eliminated, and economical utilization of coffer dam as a part of main dam.

(b) Excavation and Grouting

The stripping thickness of the entire dam base, in general, will not exceed three feet including the removal of all vegetal soil, roots and trunks. However, a deeper excavation of 30 to 70 ft is designed on the impervious zone base, so as to reach bedrocks foundation and free from the differential settlement.

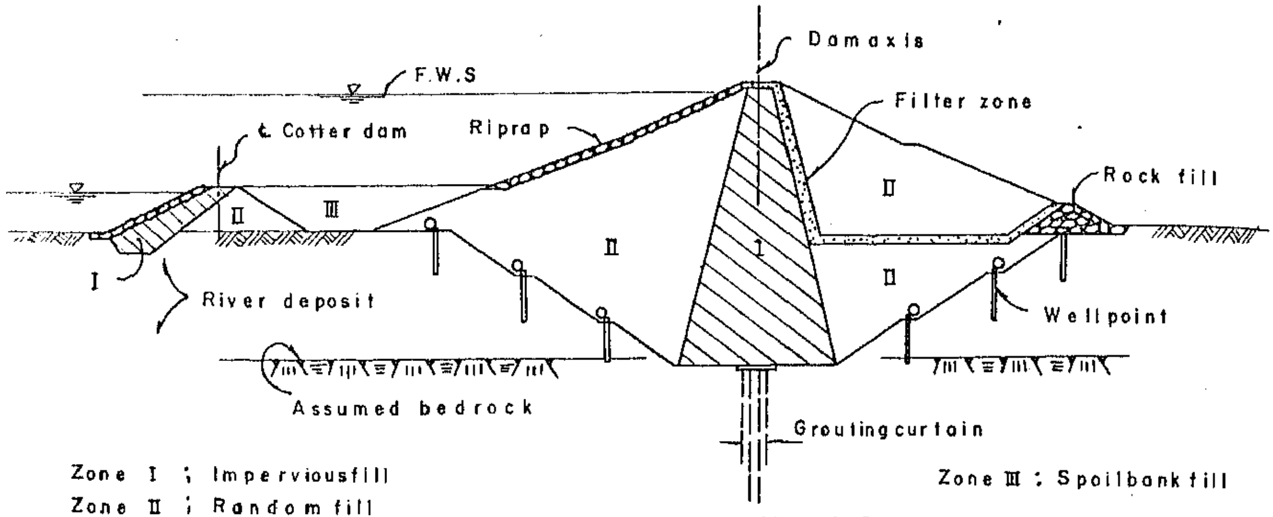
Taking account of the lithic properties of the bedrock formation, the extensive grouting such as dense hole system with four rows blanket and two rows curtain groutings should be considered for the bedrocks. After the excavation of impervious zone base reaches about six feet over the final.excavation line, the excavated base will be treated with blanket grouting in order to improve the bearing capacity with uniformity and make sure the subsequent curtain grouting.

The curtain grouting should be performed with several stages from the excavated base by using the cement milk (suspended liquid of cement and water), so as to obtain an impervious curtain in the dam foundation rocks. Depth of curtain grouting should be reached into sufficient sound rock and joints, fractures are to be sealed.

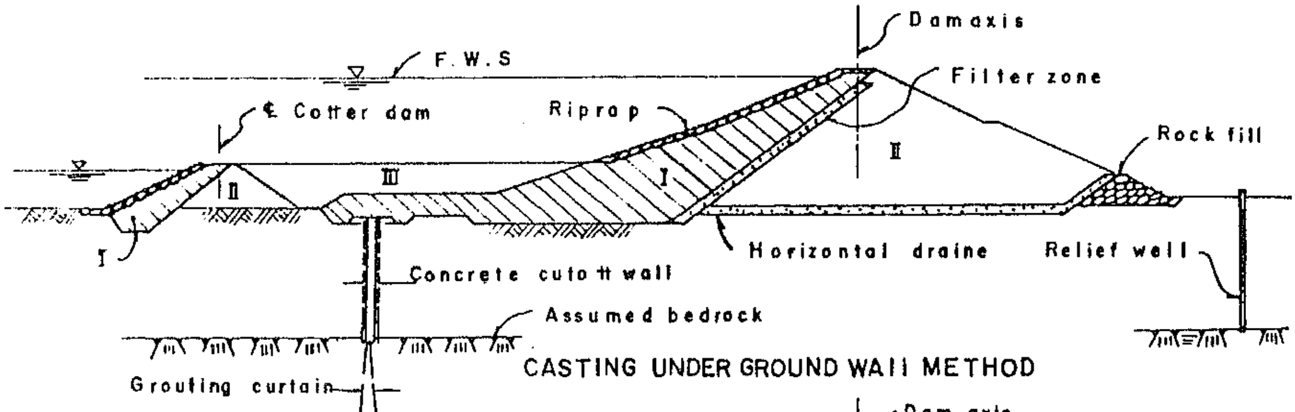
The said six feet layer which has a role of counter weight for grouting and protection for contact surface of impervious zone base should be removed after completion of grouting and embanked with impervious material immediately.

Auxilliary impermeability and consolidation groutings should be performed for the bases of spillway and outlet facility to be connected with the dam curtain.

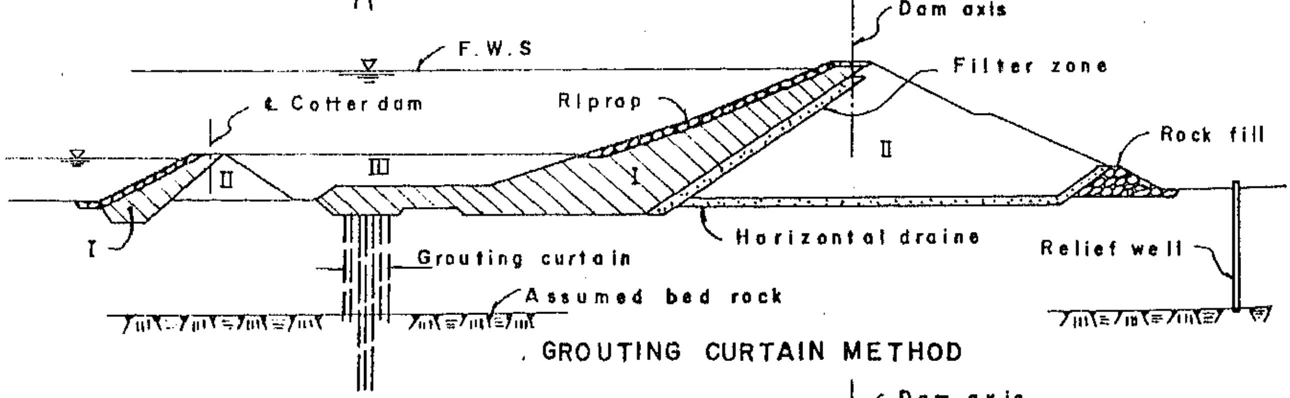
FIGURE 4D-22 METHOD OF FOUNDATION TREATMENT



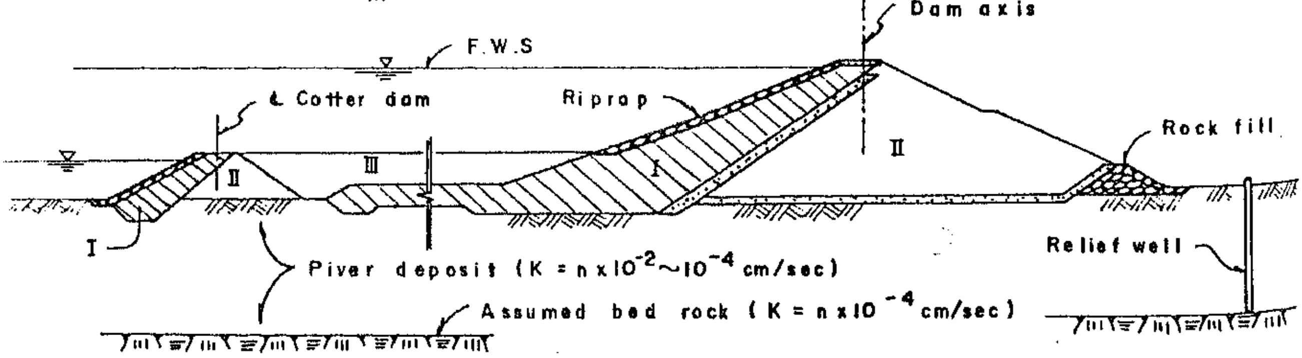
OPEN CUT METHOD



CASTING UNDER GROUND WALL METHOD



GROUTING CURTAIN METHOD



BLANKETING METHOD

4D-16. Spillway of Diversion Dam

The alignment of spillway has been selected on the right abutment independently, considering the applicability of topographical condition and connection of existing river at the downstream of spillway.

According to the results of geological investigation executed along the diversion dam axis, the lithic properties of bedrocks such as bearing capacity and permeability are poor than that of main dam site.

From the above facts, it is reasonable that the ungate type, e.g., no control type, spillway is more suitable to be adopted than the gate type spillway in order to reduce the required bearing capacity for the bedrock, avoidance of risk by gate control and elimination of operation and maintenance costs.

In ungate spillway, a chute type with linear formation is more suitable from the viewpoints of design flood discharge, topographical feature and hydraulic characteristic of itself.

(a) Design Flood Discharge for Spillway

The running discharge through the spillway in peak has been calculated by using the same procedure on main dam considering the relationship between the flow-out capacity of the spillway and reservoir routing provided by the diversion dam with a 1000-year flood flow into the reservoir which was already mentioned in paragraph of "Flood Analysis."

A rise of water surface level in the reservoir due to various flow-out capacity of the spillway are shown in the following table in consideration of the reservoir routing.

	Length of crest at spillway (ft)			
	50	100	150	200
Water surface elevation (EL. ft)	211.66	207.27	205.30	204.14
Flow-out discharge (cu.ft/sec)	11,489.72	13,770.09	15,246.89 ≑ 15,250	16,446.68
Over-flow depth/1 (ft)	15.16	10.77	8.80	7.64

/1 -- Over-flow depth = Water surface elevation - 196.5 (ft)

From the above table, it seems that the run-off discharge of 15,250 cu.ft/sec is reasonable value as a design flood discharge for the spillway in consideration of the applicability and restriction of topographic feature, geological condition at the diversion dam site.

The obtained run-off hydrograph through the spillway in flow-out discharge of 15,250 cu.ft/sec is shown in Fig. 4D-23.

(b) Hydraulic Dimensions

Since a Harrold's standard type is adopted as the shape of over-flow crest, coefficient of discharge and length of weir can be obtained from the following equations:

$$C = 2.200 - 0.0416 \ (Hd/W)^{0.99} = 2.15$$

$$L = Q/CH^{3/2} = 45.80 \text{ m} \fallingdotseq 150 \text{ ft.}$$

Where, C -- coefficient of discharge
Hd -- over-flow depth at crest and adopted by 8.8 ft.
W -- depth of entrance channel and adopted by 8.8 ft.
L -- effective length of weir.
Q -- design flood discharge and adopted by 15,250 cu.ft/sec.

The water depth on chute section is roughly estimated in applying the following equation:

$$(1 - \alpha)He = d + [Q^2/2 \ g.d^2.b^2]$$

Where, He -- difference of elevation between the total head at control point and under consideration section.
α -- coefficient of friction loss and adopted by 0.10-0.15 on fill-type dam usually.

d -- water depth under consideration section
Q -- design flood discharge and adopted by 15,250 cu.ft/sec
g -- gravitational acceleration
b -- width of chute secdtion and adopted by 50 ft.

The calculation results of water depth on the chute section are shown in the following table:

Elevation of Floor (EL. ft)	Water Depth (d, ft)	Velocity/1 (V, ft/sec)	Froude Number/2 (Fr)
186.61	14.23	21.43	1.00
178.53	8.17	37.33	2.30
168.69	6.64	45.93	3.15
158.85	5.78	52.77	3.85
151.00	5.31	57.44	4.39

/1 -- $V = Q/b.d$;   /2 -- $Fr = V/\sqrt{g.d.}$

Judging from the velocity and Froude number at the end of chute, moderate hydraulic jump shall be occurred in the energy dissipator, therefore, the U.S.B.R. type II in providing chute blocks and end sill in the stilling basin should be adopted. The conjugated depth in the stilling basin d_2 can be obtained by the following equation:

$$d_2 = \frac{1}{2} .d_1.(\sqrt{1 + 8Fr^2} - 1), \quad Fr = V_1/\sqrt{g.d_1}$$

Where, d_2 -- water depth after hydraulic jump
d_1 -- water depth before hydraulic jump
Fr -- Froude number
V_1 -- velocity before hydraulic jump
g -- acceleration of gravity

The required length of stilling basin Ls can be obtained from relation curve between Ls/d_2 and Froude number, and adopted by Ls/d_2 is 4.0 for type II stilling basin.

The calculation results of d_2 and Ls are shown in the following table:

Floor Elevation (EL. ft)	d_1 (ft)	Fr	d_2 (ft)	Ls (ft)
151.00	5.31	4.39	30.42	121.68

Freeboard of chute and stilling basin can be obtained by the following equations and the calculated results are tabulated as follows:

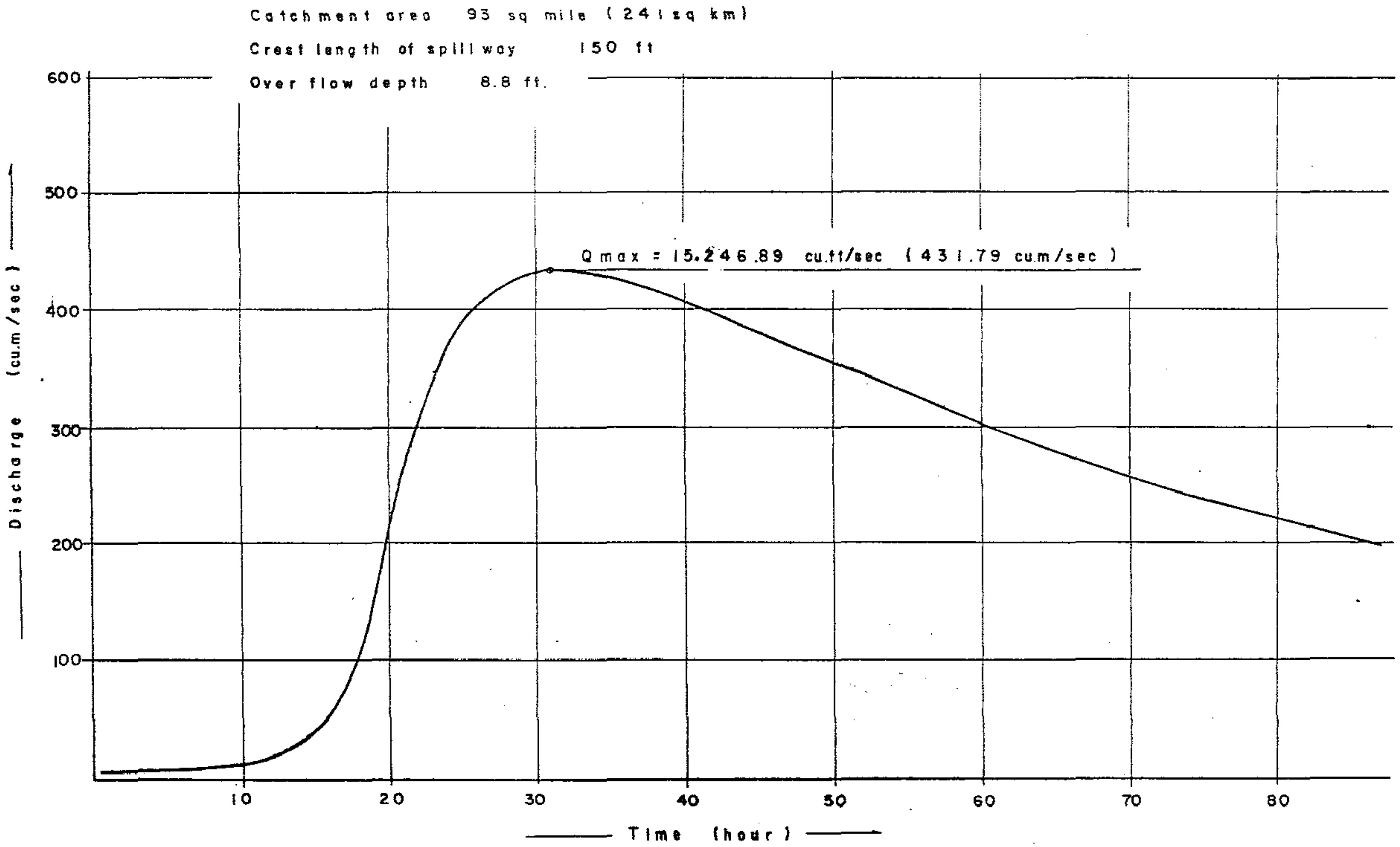
Chute $Fb = 0.1\ V.d^{1/2}$, $H = {}^{(d + Fb)}/\cos\theta$

Stilling basin $Fb = 0.1\ (V_1 + d_2)$, $H = (d_2 + Fb)$

Where, Fb -- freeboard of chute and stilling basin
V, d -- velocity and water depth under consideration section.
V_1 -- velocity before hydraulic jump
d_2 -- water depth after hydraulic jump
H -- vertical height of wall
θ -- slope angle of chute floor

Since the flow condition in chute-type spillway is rather complicated, it is desirable to execute the hydraulic model test for the spillway during the final design stage.

FIGURE 4D-23 HYDROGRAPH THROUGH SPILLWAY IN 15.246.89 cu.ft/sec AT DIVERSION DAM



Catchment area 93 sq mile (241 sq km)
Crest length of spillway 150 ft
Over flow depth 8.8 ft.

Qmax = 15.246.89 cu.ft/sec (431.79 cum/sec)

4D-17. Diversion Facility

The diversion facility which consists of an open-type with no lining canal and coffer dam is constructed for the purpose of bypassing the run-off flow in the river during the construction period of the diversion dam. Since the multiple-stage diversion system is adopted in this site taking into accoun the construction schedule, topographical and geological conditions, the protection works by rock materials should be executed at the river side slope of coffer dam due to the prevention of erosion against run-off flow in rainy seasons.

(a) Design Flood Discharge

Since the reservoir capacity provided by a coffer dam is very small, the reservoir routing with a 10 percent probability flood flows into reservoir cannot be expected. Therefore, the design flood discharge for the diversion facility should be adopted with a 10 percent probability flood discharge in peak of 37,100 cu. ft/sec. which is stated in the paragraph of "Flood Analysis."

(b) Crest Elevation of Coffer Dam

On the assumption that the bottom width and side slope in the open canal is 200 ft and 1 on 1.5 respectively, the hydraulic head at the entrance of canal can be estimated at elevation of 179.8 ft.

The freeboard of coffer dam can be obtained as same estimation method of the freeboard on diversion dam. The result of calculation and adopted crest elevation of coffer dam is shown in the following table:

Fetch (ft)	R/1 (ft)	Freeboard/2 (ft)	Water Level (EL. ft)	Crest Elevation (EL. ft)
6,500	2.1	5.38	179.8	185.18 ≑ 185

/1 -- wind speed is 44.75 mph in 10 minutes on an average and upstream slope of coffer dam is 1 on 3.5 with hand placed riprap, therefore, an intermediate value at the smooth slope and rock zone slope in Fig. 4D-14 was adopted as the height of wave due to wind.

/2 -- freeboard can be obtained as follows: Fb = R + 3.28

4D-18. Sediment Storage in Reservoir

The sediment load which is transported by water stream, consists of wash load and bed material load. The wash load contains a considerable amount of sediment to the total sediment yield despite of the gradient is steep or not, and is mainly generated outside of river channel such as eroded area and gully, etc. On the other hand, the bed material load is divided into suspended load and bed load, and is controlled by the stream intensity and the bed material at the given section.

Though the study on the sediment hydraulic is very developed in today, there still remains many problems to be solved. At present, an accurate prediction of the sediment yield in catchment area is impossible without actual measurement of the sediment yield.

(a) Wash Load and Suspended Load

(1) Rating Curve for Sediment Transport

The proposed main dam site is located in the middle of South Nawin river basin and the gradient of river bed around the dam site is comparatively gentle as indicated at about 5.6×10^{-4}.

A total of 26 water samples were carried out for sediment transport at Yatthit discharge gauge station by Irrigation Department in the rainy seasons of 1978 and 1979, and the measurement was made by means of one point sampling method at about 60 percent of water depth with 10 to 12 sampling points in river channel. The observed sediment concentration with respect to measured water discharge is shown in Table 4D-7.

When the observed data for river discharge and sediment concentration are plotted on double logarithmic paper, it is generally found that a simple linear regression of the following formula which can be used to describe the relationship.

$$Qs = \alpha . Qw^{n}$$

Where, Qs -- sediment concentration in kg/sec.
Qw -- river discharge in cu.m/sec.
α, n -- constants for the particular location

All the available discharge and sediment concentration data are plotted in Fig. 4D-24. From the figure, it is apparent that the correlation between flow discharge and sediment concentration is comparatively high and the correlation coefficient of the logarithms of the two variables is found to be 0.945. And the following exponential equation was obtained as a rating curve for sediment transport at the dam site by the method of least square.

$$Qs = 0.02369.Qw^{2.132} \quad (kg/sec)$$

Where, Qs and Qw are the same quantities as in the previous equation.

From the above equation, the data of one point sampling have a tendency to be somewhat large and it seems that the sediment of the one point sampling data consist of the sum of wash load and suspended load.

For reference, the constants of above equation in other places are shown in the following table:

α	n	River	Country	Remark
1.57×10^{-3}	1.93	Sittang	Burma	Suspended load
2.76×10^{-1}	1.56	Yenwe	Burma	Suspended load
8.26×10^{-2}	1.56	Dayemi	Burma	Suspended load
1.6×10^{-6}	2.20	Chaungmagyi	Burma	Wash & Suspended load
2.369×10^{-2}	2.132	South Nawin	Burma	Wash & Suspended load
3.05×10^{-5}	2.05	Pemali	Indonesia	Wash load
2.0×10^{-5}	2.00	Comal	Indonesia	Wash load
3.0×10^{-7}	2.16	Missouri	U.S.A.	Suspended load
9.5×10^{-6}	2.063	Red	U.S.A.	Suspended load

From the above table, the constants in sediment rating curve at the main dam site seem to range within a reasonable extent.

(2) Sediment Transport Yield

The flow-duration curve and a sediment rating curve have been usually adopted for the estimation of sediment yield, however, the observation period of river discharge at Yatthit station was limited within five years. The daily streamflow records of the year 1977 is used as a flow-duration curve for the estimation of sediment transport such as wash load and suspended load, taking into account an annual total rainfall of the year 1977, 1,143.4 mm/year, is closed to that of 50 percent probability, 1,295.9 mm/year.

The calculation results of the year 1977 are shown in Figure 4D-25 and Table 4D-8. From the results, it is concluded that the average annual sediment transport yield of the year 1977 at the dam site is equal to 8,653.39 kg/sec. And to this value, 1,154.36 kg/sec was added, in consideration of a rate 1,295.9/1,143.4 = 1.1334, to obtain the average annual sediment transport of 50 percent probability. The total average annual sediment transport yield is therefore fixed at 9,807.75 kg/sec.

(b) Bed Load

For the bed load, it is better to take bed load samples directly, however, actual measurement at the dam site, especially in the flood duration is difficult in general, and there is no available data for bed load sample at present. Therefore, the bed load transport in the river is presumed by the empirical formula considering the sediment grains in the river bed.

(1) Estimation of Bed Load for Each Discharge

There are a number of formulas available for estimating the bed load; however, in this case, the estimation has been carried out by using Sato-KitusKawa-Ashida's formula (1958, Japan).

The Sato-KitsuKawa-Ashida's formula is expressed as follows:

$$q_B \cdot \frac{(\delta/\rho - 1).g}{(\tau_o/\rho)^{3/2}} = F(\tau_o/\tau_c).\phi$$

Where, q_B -- bed load in volume per unit width of stream.

δ, ρ -- density of sediment particle and water, respectively.

g -- gravitational acceleration

τ_o -- tractive force

τ_c -- critical tractive force

F -- function of τ_o/τ_c and is shown in Fig. 4D-27.

ϕ -- function of coefficient of roughness in Manning's formula and is proposed as follows:

$n > 0.025 \quad \phi = 0.623$

$n < 0.025 \quad \phi = 0.623\ (40\ n)^{-3.5}$

The grain size distribution of five samples of the bed material are shown in Fig. 4D-26. From the figure, it is found that the bed materials are classified into sand and sandy loam in the Triangular Diagram and having an average mean diameter (D50) of 1.17×10^{-2}cm.

The critical tractive force can be obtained by Iwagaki's formula (1956, Japan) as expressed below:

$$\tau_c/\rho = f(\chi) \cdot \frac{\delta - \rho}{\rho} .g.D50$$

Where, τ_c, δ, ρ, and g are the same quantities as in previous formula.

D50 -- mean diameter of bed material

f -- function of χ and is shown in Fig. 4D-28.

The density of bed material (δ) has been presumed at 2.64 gr/cu.cm based on the results of soil tests and the value of $f(\chi)$ is read to be 9.2×10^{-2} from Fig. 4D-28.

Substituting of these values into Iwagaki's formula, the critical tractive force is found to be 1.73 sq. cm/sq. sec.

On the basis of measured water level data and discharge rating curve at Yatthit gauging station, the hydraulic radius (R), mean velocity (Vm) and width of stream (W) for each measured discharge were estimated and the results are shown in Table 4D-9. From the above table, the coefficient of roughness in Manning's formula (n) for measured discharge can be estimated with the assumption that an energy slope is equal to a river bed slope of 5.6×10^{-4} due to the observation data of water surface slope are not available and the results are shown in Table 4D-9.

Since the value of n in the above table are more than that of 0.025, the function ϕ in Sato-KitsuKawa-Ashida's formula is fixed at 0.623.

The tractive forces for each measured discharge can be calculated by applying the following equation and the results are shown in Table 4D-9.

$$\tau_o = \rho . g . R . I$$

Where, τ_o -- tractive force
g -- gravitational acceleration
R -- hydraulic radius
I -- energy slope and replaced by river bed slope of 5.6×10^{-4}.

From the estimation results of critical tractive force (τc) and tractive force (τo), the values of function $F(\tau c/\tau o)$ for measured discharge can be read from Fig. 4D-27.

Substituting of these values into Sato-KitsuKawa-Ashida's formula, the bed load per unit width of stream for each measured discharge were estimated and are tabulated in Table 4D-9.

The bed load for measured water discharge are obtained by multiplying the width of stream to the above values and are converted into the weight unit with assumption that the density of bed material is 2.64 gr/cu. cm, and the results are shown in Table 4D-9.

(2) Sediment Rating Curve for Bed Load

On the assumption that the bed load is expressed as a function of water discharge in the following form, the calculated bed loads for measured discharge in Table 4D-9 were plotted on double logarithmic paper of Figure 4D-29.

$$Qb = \beta . Qw^{m}$$

Where, Qb -- bed load in kg/sec.
Qw -- water discharge in cu.m/sec.
β, m -- constants

From the figure, the constants β and m can be estimated by applying the method of least square as already mentioned. Then, the following exponential equation was obtained as a sediment rating curve for bed load at the dam site.

$$Qb = 0.2985 . Qw^{0.5868} \text{ (kg/sec)}$$

Where, Qb and Qw are the same quantites as in the previous equation.

(3) Bed Load Yield

In order to estimate the average annual bed load yield, the daily stream flow records of the Year 1977 is used as a flow-duration curve taking into account an annual total rainfall of the Year 1977 is closed to that of 50 percent probability. The calculated daily sediment yield for bed load of the Year 1977 are shown in Figure 4D-25 and Table 4D-10. From the table, the average annual bed load yield of the Year 1977 at the dam site is found to be 310.22 kg/sec. And on this value, some 41.38 kg/sec was added taking into account a previous rate of 1.1334, the average annual bed load yield of 50 percent probability is fixed at 351.60 kg/sec.

The bed load yield at the dam site is about 3.6 percent of the sediment transport yield which consists of wash load and suspended load. And this percentage seems to be comparatively small than that of the other similar projects in Burma.

(c) Sediment Storage

The total amount of sediment transport at the dam site can be estimated in adding bed load to wash load and suspended load. The estimated average annual sediment transport yield is 10,159.35 kg/sec (9,807.75 + 351.60), corresponding to about 1,071.49 cu.m/sq.km/year of specific sediment amount in volume with assumption that the bulk density of wet bottom sediments is equal to 1.28 ton/cu.m.

For the design purpose, specific sediment amount of 2.25 ac-ft/sq. mile/year (1,072.4 cu.m/sq. km/year) was assumed considering the result of analysis of North Nawin Project (1,350 cu.m/sq.km/year/*).

Regarding each reservoir lives, the sediment storage and corresponding elevation in the reservoir of main dam and diversion dam can be fixed as shown in the following table.

Reservoir Life	Main Dam		Diversion Dam	
	Sediment Storage	Corresponding Elevation	Sediment Storage	Corresponding Elevation
(Yr)	(ac-ft)	(EL. ft)	(ac-ft)	(EL. ft)
100	55,575	262	20,925	196.4
50	27,787.5	252	10,462.5	190.0
30	16,672.5	246	6,277.5	185.6

Since reservoir life of 50 years is adopted for the economical analysis, the sediment storage of main dam and diversion dam is fixed at 27.79 x 10^3 ac-ft and 10.46 x 10^3 ac-ft, respectively, and corresponding to about 252 ft of water level in the reservoir at main dam and about 190 ft at diversion dam.

/* -- Result of analysis of sediment storage for North Nawin Project: The transport of suspended load was measured in 1963 and 1964 during which 50 measurements were carried out in total at North Nawin river near Lebe. On the basis of these measurements, the ratio between the discharge and the transport of suspended load was established with a linear function and the specific sediment amount of 1,350 cu.m/sq. km/year was calculated with the assumption that the bed load amount to 10 percent of the suspended load and the bulk density of wet bottom sediments is equal to 1.0 ton/cu.m.

TABLE 4D-7. SEDIMENT CONCENTRATION WITH RESPECT TO MEASURED WATER DISCHARGE FROM OBSERVATION DATA

No.	Date	Water Discharge (cu.m/sec)	Sediment Concentration (kg/sec.)
1	12.10.'78	10.172	69.329
2	12.10.'78	9.516	55.117
3	13.10.'78	38.485	397.673
4	13.10.'78	12.786	103.815
5	15.10.'78	7.113	9.291
6	17.10.'78	3.216	1.874
7	20.10.'78	11.539	43.417
8	22.10.'78	5.011	3.919
9	23.10.'78	2.702	0.676
10	25.10.'78	4.620	2.484
11	30.6.'79	23.176	291.838
12	1.7.'79	6.127	35.044
13	1.7.'79	11.597	97.243
14	2.7.'79	26.850	150.785
15	9.7.'79	24.671	208.491
16	9.7.'79	8.489	38.921
17	31.7.'79	19.934	204.623
18	1.8.'79	1.643	1.140
19	2.8.'79	13.937	115.644
20	6.8.'79	15.844	52.073
21	6.8.'79	11.183	27.139
22	14.8.'79	9.944	39.864
23	16.8.'79	16.395	142.617
24	20.8.'79	7.322	10.310
25	22.8.'79	45.459	428.888
26	22.8.'79	40.405	372.397

FIGURE 4D-24 SEDIMENT RATING CURVE FOR WASH LOAD AND SUSPENDED LOAD (AT. MAIN DAM SITE)

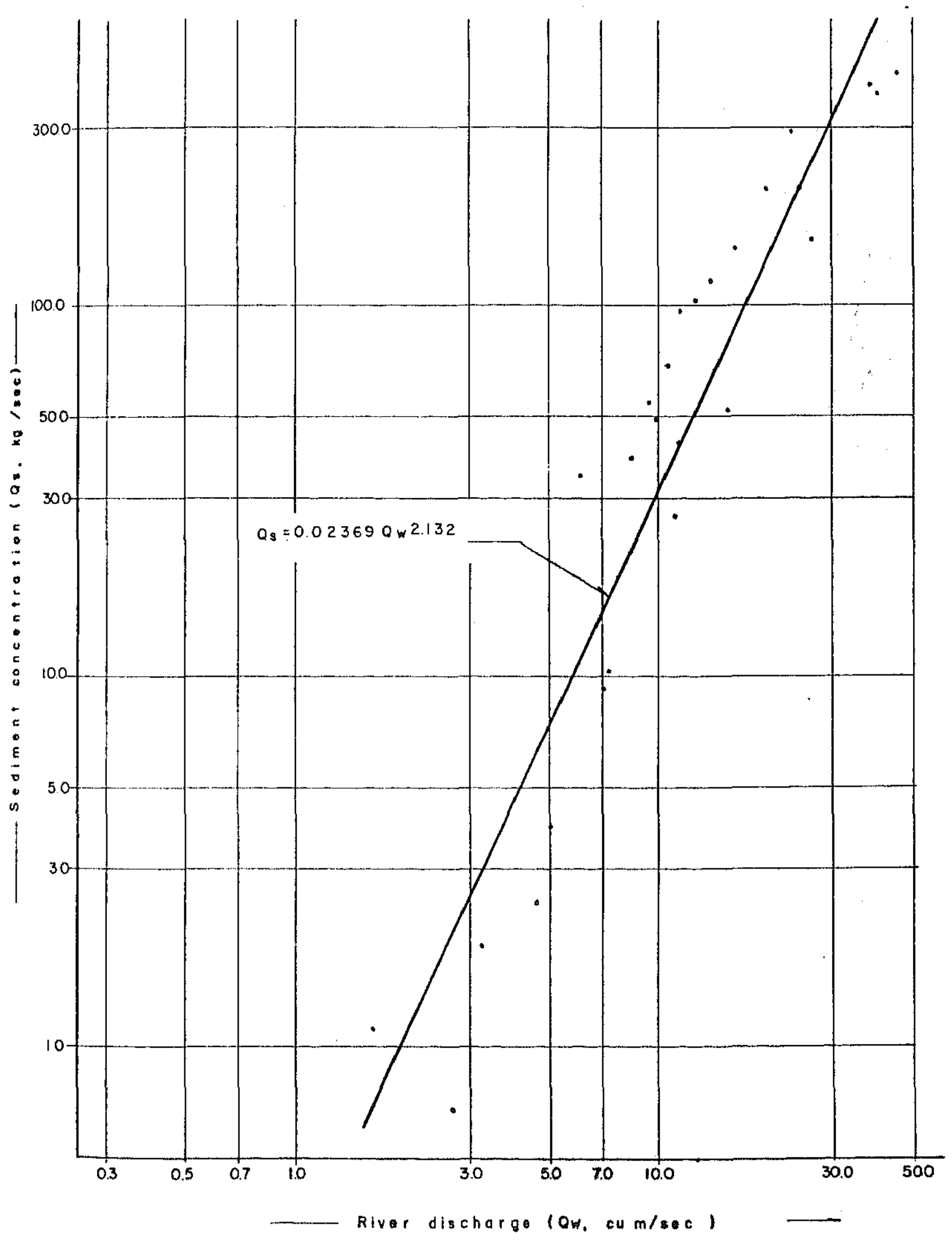


FIGURE 4D-25 MONTHLY AVERAGE SEDIMENT DISCHA RGE AT MAIN DAM SITE (1977)

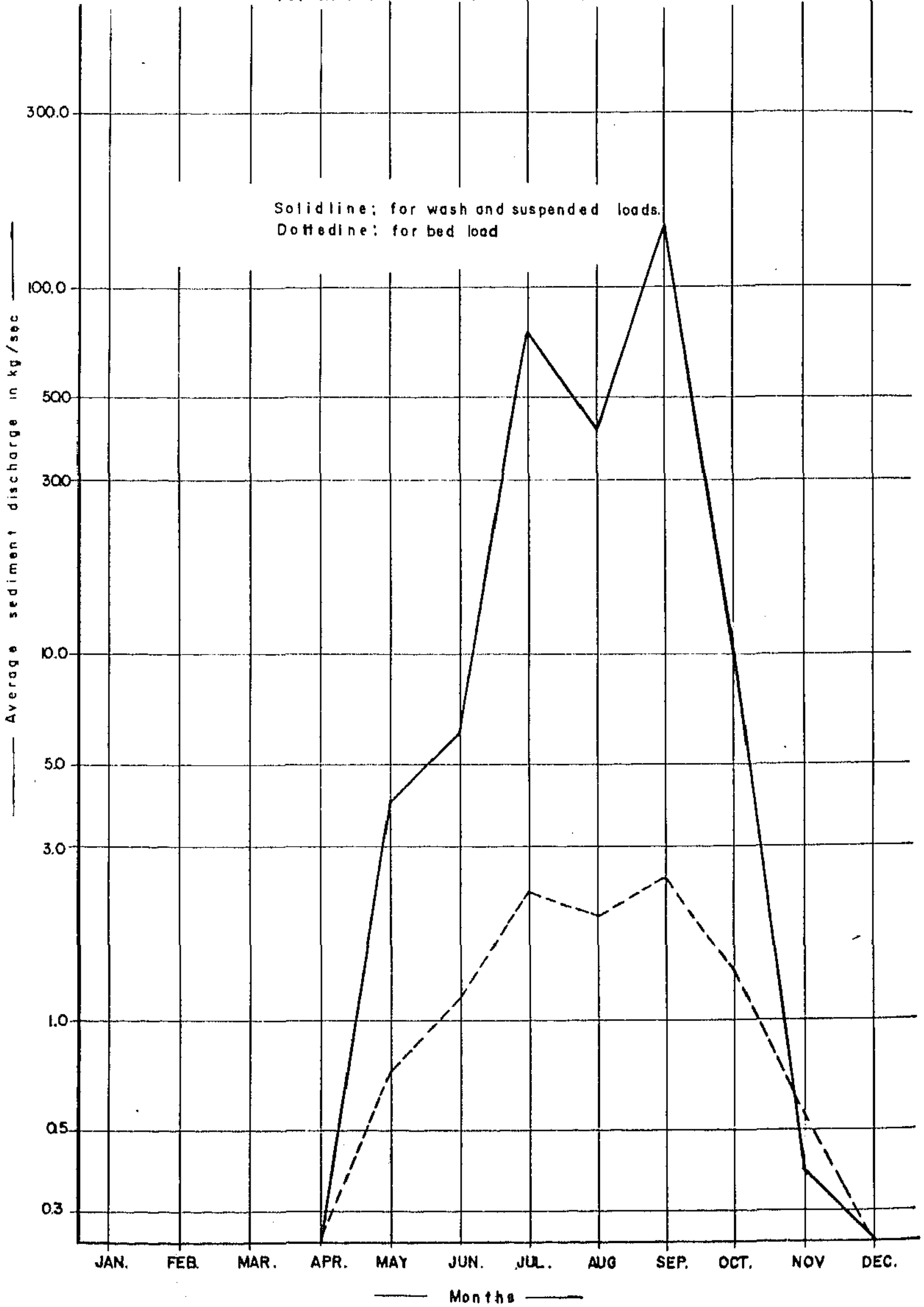
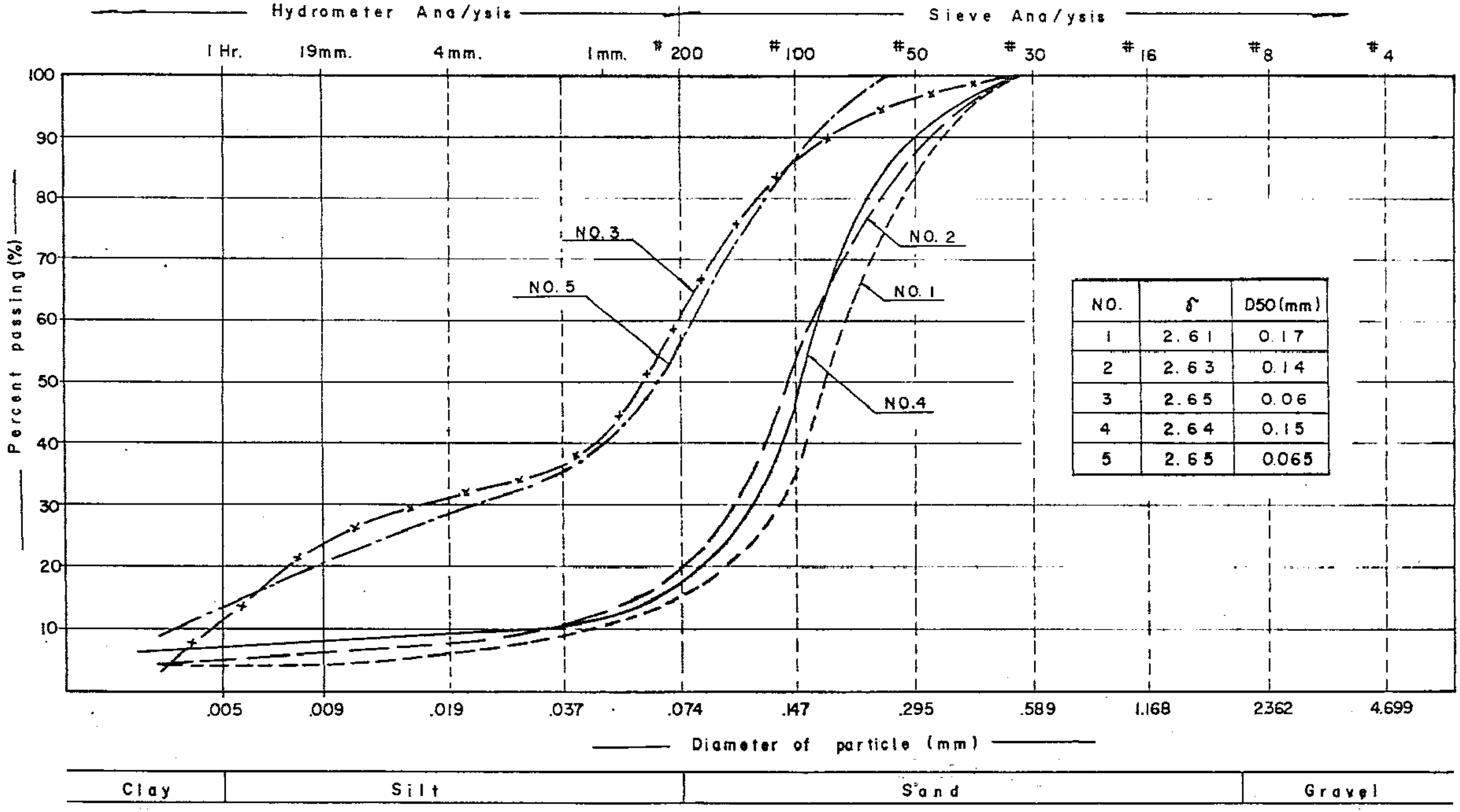


FIGURE 4D-26 GRADATION ANALYSIS CURVE OF RIVER BED MATERIALS AT MAIN DAM SITE



NO.	δ	D50(mm)
1	2.61	0.17
2	2.63	0.14
3	2.65	0.06
4	2.64	0.15
5	2.65	0.065

FIGURE 4D-27 COEFFICIENT OF BED LOAD IN SATO-KITSUKAWA-ASHIDA'S FORMULA

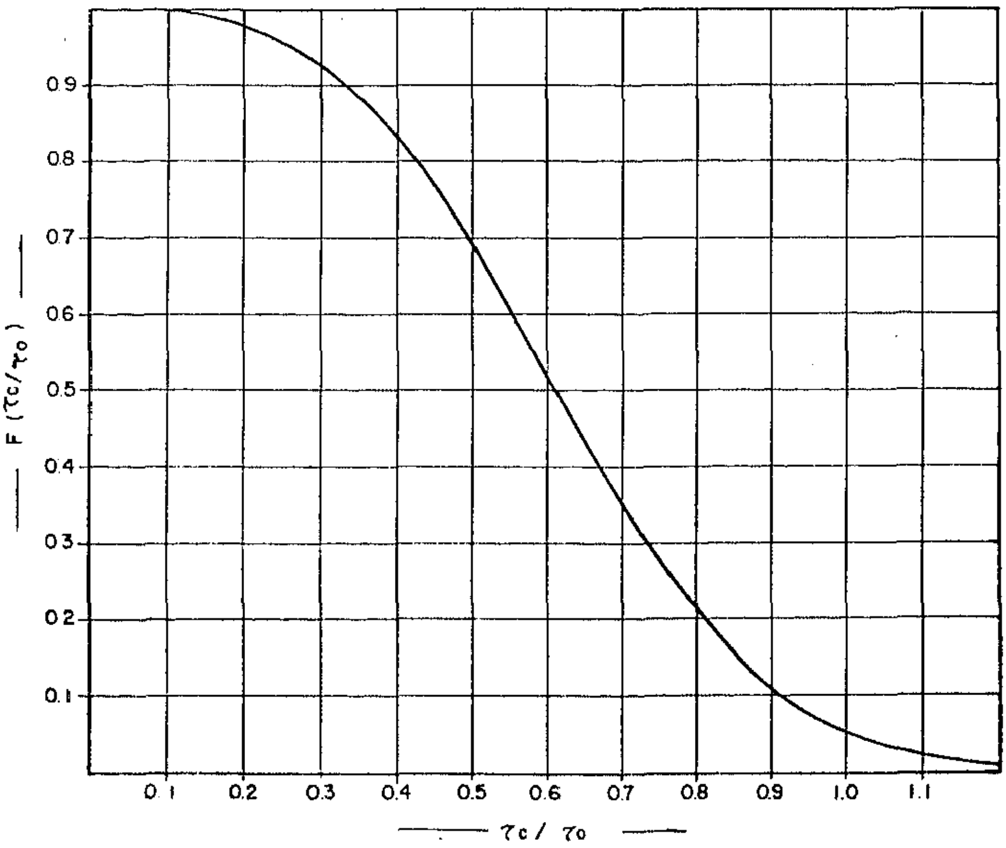


FIGURE 4D-28 COEFFICIENT OF CRITICAL TRACTIVE FORCE IN IWAGAKI'S FORMULA

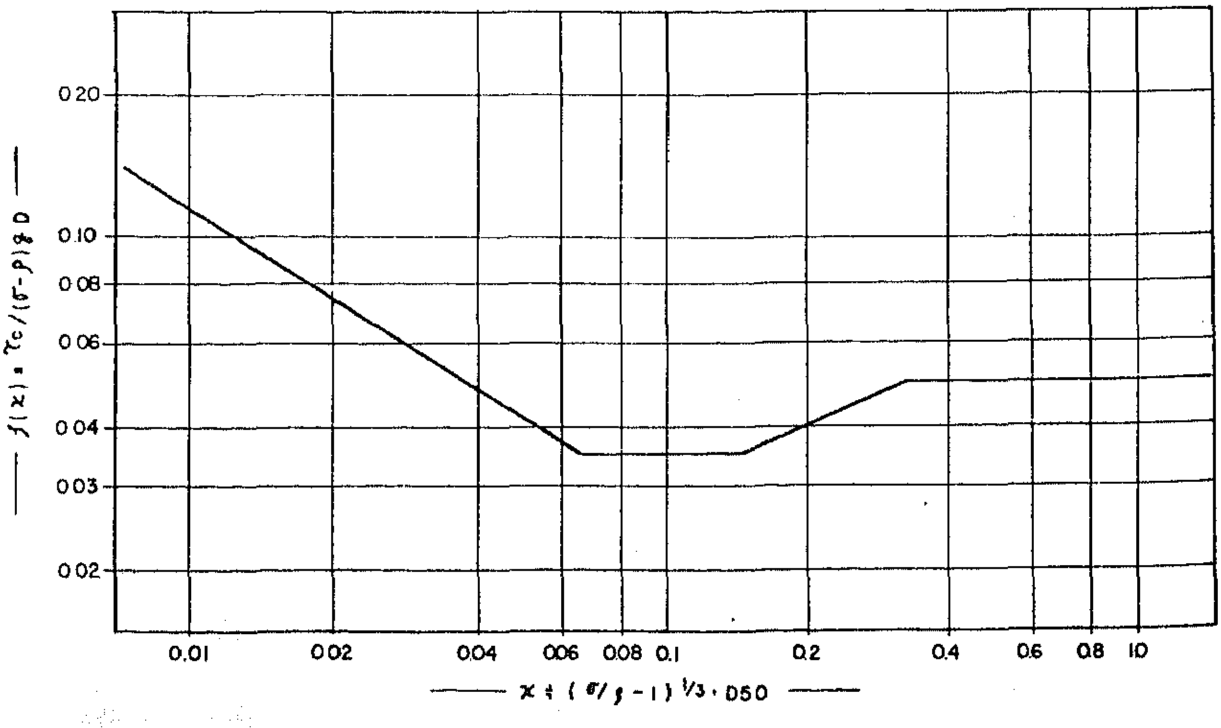


TABLE 4D-8 ESTIMATED SEDIMENT TRANSPORT OF WASH LOAD AND SUSPENDED LOAD IN 1977.

(Unit: Kg/sec.)

Day	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1.	-	-	-	-	-	1.265	0.976	36.965	18.106	36.965	1.265	0.011
2.	-	-	-	-	-	1.603	1.603	26.305	13.848	23.326	0.976	0.011
3.	-	-	-	-	-	13.848	23.326	13.848	2.032	23.326	1.603	0.005
4.	-	-	-	-	-	2.516	8.909	41.141	1.603	15.870	1.265	0.005
5.	-	-	-	-	-	0.394	67.751	67.751	1.265	3.775	0.976	0.005
6.	-	-	-	-	-	0.277	61.649	482.574	672.130	2.032	0.976	0.005
7.	-	-	-	-	-	0.125	33.119	33.119	1,006.065	1.603	0.736	0.005
8.	-	-	-	-	-	0.277	45.696	20.574	259.321	1.265	0.736	0.005
9.	-	-	-	-	-	0.125	182.607	18.106	41.141	2.032	0.547	0.005
10.	-	-	-	-	-	0.076	20.574	9.229	55.914	26.305	0.547	0.002
11.	-	-	-	-	-	0.046	20.574	12.027	145.739	55.914	0.394	0.002
12.	-	-	-	-	-	8.909	4.552	41.141	50.595	36.965	0.277	0.002
13.	-	-	-	-	-	2.032	124.422	41.141	33.119	29.541	0.277	0.002
14.	-	-	-	-	-	2.516	36.965	10.368	8.909	10.368	0.191	0.002
15.	-	-	-	-	-	0.736	210.888	3.775	242.223	3.775	0.191	0.002
16.	-	-	-	-	-	18.106	29.541	23.326	169.639	2.032	0.191	0.002
17.	-	-	-	-	-	7.631	912.926	3.775	81.332	2.032	0.125	0.002
18.	-	-	-	-	-	4.552	55.914	3.095	13.848	8.909	0.125	0.002
19.	-	-	-	-	2.032	0.736	26.305	29.541	8.909	5.434	0.076	0.002
20.	-	-	-	-	0.005	1.265	10.368	5.434	5.434	2.032	0.076	0.000
21.	-	-	-	-	0.000	18.106	45.696	2.516	3.095	3.095	0.076	0.000
22.	-	-	-	-	0.000	3.775	18.106	88.857	105.540	2.032	0.046	0.000
23.	-	-	-	-	0.000	18.106	3.775	33.119	55.914	2.032	0.046	0.000
24.	-	-	-	-	0.394	20.574	6.459	18.106	8.909	2.032	0.046	0.000
25.	-	-	-	-	0.125	10.368	12.027	7.631	3.775	1.603	0.025	0.000
26.	-	-	-	-	0.011	15.870	5.434	2.032	3.095	1.265	0.025	0.000
27.	-	-	-	-	4.552	20.574	124.422	13.848	1,213.689	0.976	0.025	0.000
28.	-	-	-	-	3.775	4.552	15.870	157.286	36.965	0.976	0.025	0.000
29.	-	-	-	-	10.368	1.603	157.286	13.848	145.739	3.775	0.011	0.000
30.	-	-	-	-	29.541	0.976	36.965	7.631	55.914	8.909	0.011	0.000
31.	-	-	-	-	0.277	-	45.696	3.775	-	2.516	-	0.000
Total	-	-	-	-	51.080	181.539	2,350.401	1,271.884	4,463.807	322.712	11.886	0.077
AVG.	-	-	-	-	3.929	6.051	75.819	41.029	148.794	10.410	0.396	0.002

Average annual sediment transport of wash load and suspended load is 8,653.386 Kg/sec.

TABLE 4D-9. CALCULATED BED LOAD BY SATO-KITSUKAWA-ASHIDA'S FORMULA

No.	Date	Water discharge (Q,cu.m/s)	Width of Stream (W, m)	Hydraulic Radius (R. m)	Mean Velocity (Vm,m/s)	Coefficient of roughness (n)	Tractive Force (τ_0/sq.cm/	Bed Load per Unit Width (q_B.cu.cm/ cm/sec)	Bed Load (kg/sec)
1	12.10.78	10.172	37.304	0.918	0.308	0.073	50.376	0.1386	1.3649
2	12.10.78	9.516	36.865	0.782	0.325	0.062	42.938	0.1091	1.0614
3	13.10.78	38.485	38.357	1.235	0.795	0.034	67.769	0.2163	2.1899
4	13.10.78	12.786	37.245	0.900	0.375	0.059	49.391	0.1346	1.3230
5	15.10.78	7.113	36.631	0.690	0.278	0.066	37.862	0.0903	0.8733
6	17.10.78	3.216	34.667	0.423	0.218	0.061	23.224	0.0434	0.3970
7	20.10.78	11.539	37.157	0.873	0.350	0.062	47.911	0.1285	1.2610
8	22.10.78	5.011	36.338	0.617	0.221	0.078	33.852	0.0763	0.7324
9	23.10.78	2.702	35.619	0.480	0.157	0.093	26.351	0.0524	0.4931
10	25.10.78	4.620	36.192	0.571	0.222	0.073	31.342	0.0680	0.6499
11	30.6.79	23.176	37.830	1.078	0.558	0.045	59.152	0.1763	1.7612
12	1.7.79	6.127	37.157	0.873	0.186	0.116	47.911	0.1285	1.2610
13	1.7.79	11.597	37.245	0.900	0.341	0.065	49.391	0.1346	1.3230
14	2.7.79	26.850	38.181	1.177	0.585	0.045	64.614	0.2013	2.0294
15	9.7.79	24.671	38.181	1.183	0.535	0.049	64.915	0.2027	2.0435
16	9.7.79	8.489	36.719	0.737	0.310	0.062	40.432	0.0997	0.9660
17	31.7.79	19.934	37.830	1.078	0.480	0.052	59.152	0.1763	1.7612
18	1.8.79	1.643	35.482	0.472	0.097	0.147	25.909	0.0511	0.4789
19	2.8.79	13.937	37.421	0.954	0.384	0.060	52.341	0.1468	1.4501
20	6.8.79	15.844	37.625	0.988	0.371	0.063	54.229	0.1548	1.5376
21	6.8.79	11.183	37.625	0.918	0.321	0.070	50.376	0.1386	1.3767
22	14.8.79	9.944	37.128	0.864	0.305	0.070	47.416	0.1266	1.2405
23	16.8.79	16.395	37.508	0.980	0.438	0.053	53.808	0.1530	1.5150
24	20.8.79	7.322	36.836	0.773	0.254	0.079	42.438	0.1072	1.0421
25	22.8.79	45.459	39.205	1.482	0.762	0.040	81.341	0.2844	2.9432
26	22.8.79	40.405	38.679	1.329	0.767	0.037	72.960	0.2416	2.4668

FIGURE 4D-29 SEDIMENT RATINGCURVE FOR BED LOAD (AT MAIN DAM SITE)

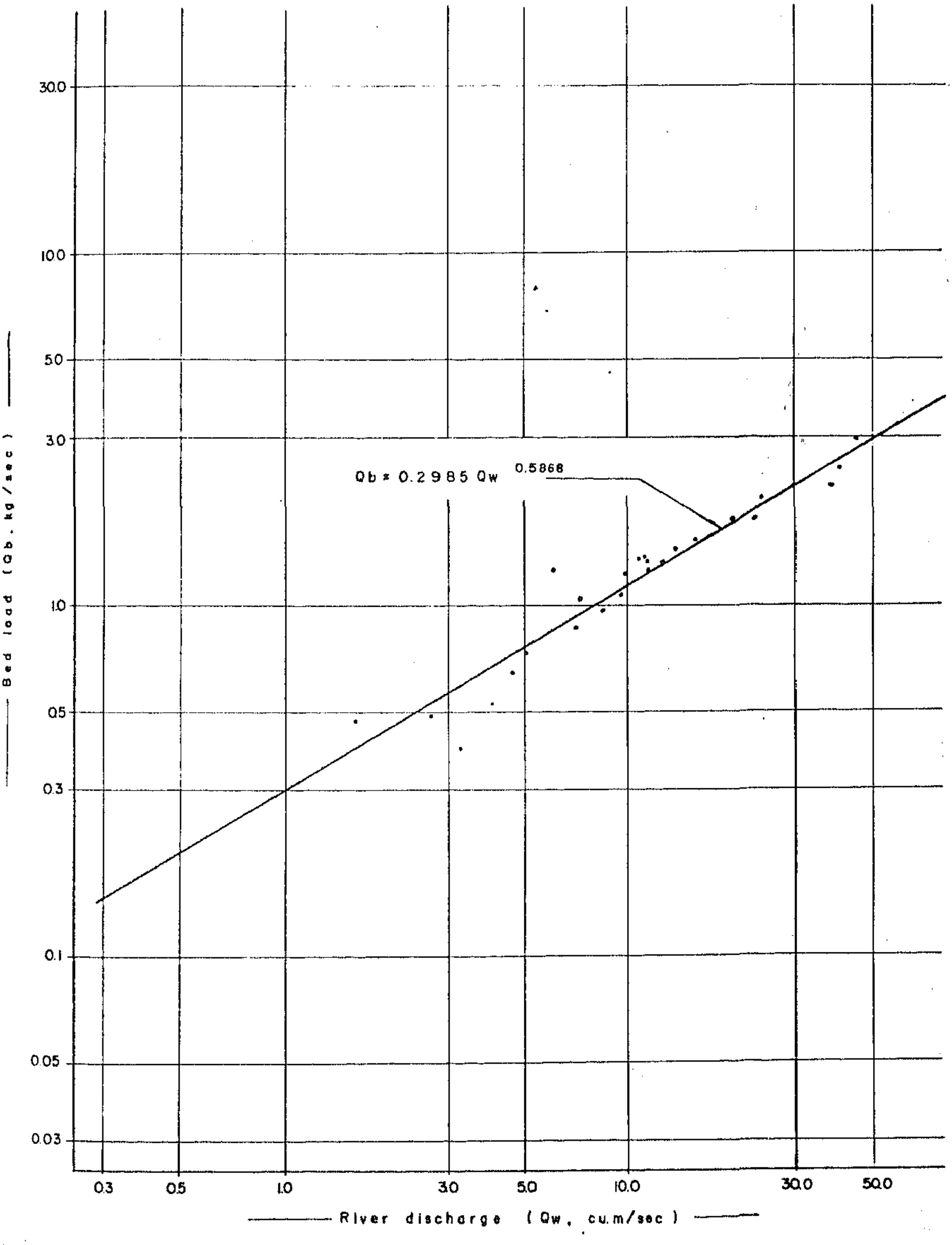


TABLE 4D-10 ESTIMATED SEDIMENT TRANSPORT OF BED LOAD in 1977

(Unit: kg/sec.)

Day	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
1.	-	-	-	-	-	0.892	0.831	2.259	1.856	2.259	0.892	0.244
2.	-	-	-	-	-	0.952	0.952	2.057	1.724	1.99	0.831	0.244
3.	-	-	-	-	-	1.724	1.99	1.724	1.016	1.99	0.952	0.194
4.	-	-	-	-	-	1.078	1.527	2.326	0.952	1.79	0.892	0.194
5.	-	-	-	-	-	0.647	2.668	2.668	0.892	1.205	0.831	0.194
6.	-	-	-	-	-	0.587	2.6	4.581	5.018	1.016	0.831	0.194
7.	-	-	-	-	-	0.472	2.191	2.191	5.607	0.952	0.768	0.194
8.	-	-	-	-	-	0.587	2.394	1.922	3.861	0.892	0.768	0.194
9.	-	-	-	-	-	0.472	3.506	1.856	2.326	1.016	0.708	0.194
10.	-	-	-	-	-	0.412	1.922	1.542	2.531	2.057	0.708	0.141
11.	-	-	-	-	-	0.358	1.922	1.658	3.295	2.531	0.647	0.141
12.	-	-	-	-	-	1.527	1.269	2.326	2.462	2.259	0.587	0.141
13.	-	-	-	-	-	1.016	3.154	2.326	2.191	2.123	0.587	0.141
14.	-	-	-	-	-	1.078	2.259	1.592	1.527	1.592	0.53	0.141
15.	-	-	-	-	-	0.768	3.647	1.205	3.789	1.205	0.53	0.141
16.	-	-	-	-	-	1.856	2.123	1.99	3.435	1.016	0.53	0.141
17.	-	-	-	-	-	1.463	5.459	1.205	2.806	1.016	0.472	0.141
18.	-	-	-	-	-	1.269	2.531	1.141	1.724	1.527	0.472	0.141
19.	-	-	-	-	1.016	0.768	2.057	2.123	1.527	1.332	0.412	0.141
20.	-	-	-	-	0.194	0.892	1.592	1.332	1.332	1.016	0.412	0.082
21.	-	-	-	-	0.038	1.856	2.394	1.078	1.141	1.141	0.412	0.082
22.	-	-	-	-	0.038	1.205	1.856	2.875	3.015	1.016	0.358	0.082
23.	-	-	-	-	0.038	1.856	1.205	2.191	2.531	1.016	0.358	0.082
24.	-	-	-	-	0.647	1.922	1.397	1.856	1.527	1.016	0.358	0.082
25.	-	-	-	-	0.472	1.592	1.658	1.463	1.205	0.952	0.302	0.082
26.	-	-	-	-	0.244	1.79	1.332	1.016	1.141	0.892	0.302	0.082
27.	-	-	-	-	1.269	1.922	3.154	1.724	5.904	0.831	0.302	0.082
28.	-	-	-	-	1.205	1.269	1.79	3.365	2.259	0.831	0.302	0.082
29.	-	-	-	-	1.592	0.952	3.365	1.724	3.295	1.205	0.244	0.038
30.	-	-	-	-	2.123	0.831	2.259	1.463	2.531	1.527	0.244	0.038
31.	-	-	-	-	0.587	-	2.394	1.205	-	1.078	-	0.038
TOTAL					9.463	34.013	69.398	59.984	74.420	42.289	16.542	4.108
AVERAGE					0.728	1.134	2.239	1.935	2.481	1.364	0.551	0.133

Average annual sediment transport of bed load is 310.217 kg/sec.

4D-19. Seismicity

Since the Union of Burma is located on the east end of the Eurasia Earthquak Zone, it is usually required to give a careful consideration on the effect of earthquake to the dam and other structures.

According to the data collected by the Meteorological and Hydrological Department during the period 1762-1978, the nearest recorded major earthquake with magnitude seven of M. Richter scale occurred about 46.6 miles from the dam site in Pyinmana area on 8 August 1928. And also, a great earthquake of nine modified Mercalli scale has occurred some 35 miles north-west of Prome on 24 August 1858. However, there were no significant epicenter around the dam site.

Based on the Seismic Intensity Zonation Map by G.P. Gorshkov shown in Fig. 4D-30, the value of expected horizontal seismic coefficient in maximum atound the dam site fall in the range from 0.102 to 0.255.

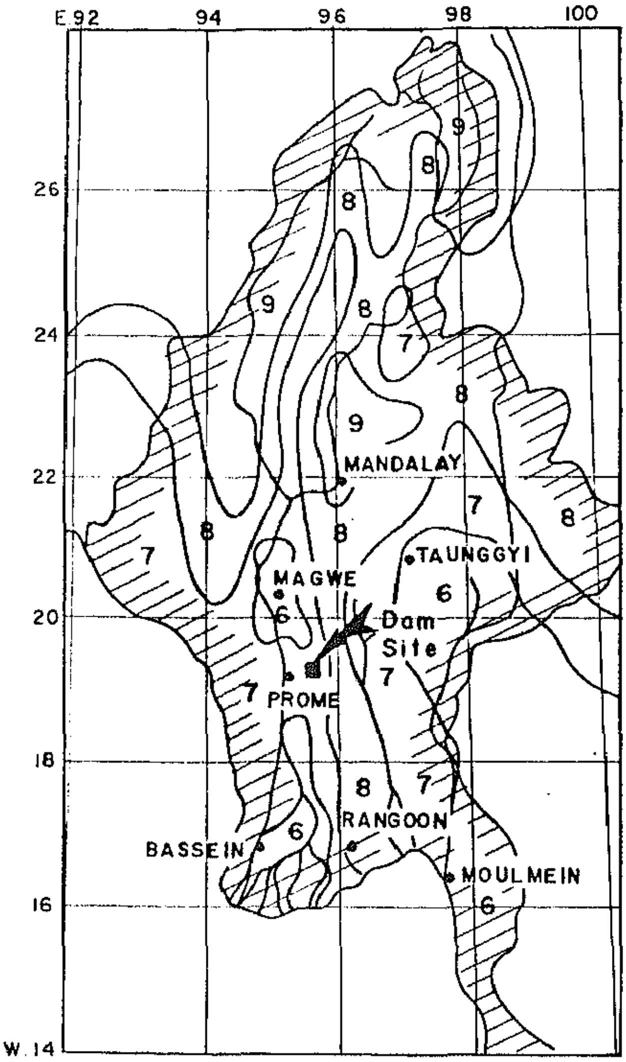
The location of observed epicenters of severe earthquake in Burma during the period 1762 to 1978 are shown in Fig. 4D-31.

Based on the observed data of earthquake by attenuation of the seismic waves over those distances from the epicenters to the dam site, the zonation map of seismic intensity, the seismic coefficient used in the design of other large dams in Burma and the geological condition at the dam foundation, it seems reasonable that the number of 0.12 will be adopted as a coefficient of horizontal seismic force in designing the dam body and other related structures.

FIGURE 4D-30 ZONATION MAP OF SEISMIC INTENSITY

ZONATION MAP

(SCALE 1:12,000,000)



(According to G.P. Gorshkov)

INTENSITY RELATIONSHIP

R-F Scale	M.M Scale	Equi. Accel.
1	1	< 25 (cm/sec²)
1 ~ 2	2	2.5 ~ 5.0
3	3	5 ~ 10
4 ~ 5	4	10 ~ 25
5 ~ 6	5	25 ~ 50
6 ~ 7	6	50 ~ 100
8	7	100 ~ 250
8 ~ 9	8	250 ~ 500
9	9	500 ~ 1000
10	10	1000 ~ 2500
10	11	2500 ~ 5000
10	12	5000 ~ 10000

TABLE OF EPICENTER AND INTENSITY OF SIGNIFICANT EARTHQUAKE IN BURMA

Date	Depth	Epicenter		Magnitude [1]	Intensity [2]
		Lat. N.	Long. E.		
1762. Apr.2		Northof Arakan			Above 10
1839. Mar. 23		21.7	96.0		9-10MM
1858. Aug. 24		19.3	94.8		9 MM
1874. — · —		Southern Shan State			Seyeve
1906. Aug. 31	100km	27.0	97.0	7.0	
1908. Dec. 12		26.5	97.0	7.5	
1912. May. 23		21.0	97.0	8.0	9R-F
1913. Mar. 6		17.4	96.5		8-9 R-F
1917 Jul. 5		17.4	96.5		8-9 R-F
1923 Jun. 22		22.75	98.75	7.3	
1925 Mar. 16	60	25.5	100.25	7.1	
1929 Jan. 19		25.9	98.5		9 R-F
1929 Aug 8		19.25	96.25	7.0	
1929 Dec. 16		25.9	98.5		9 R-F
1930 May. 5		17.0	96.5	7.3	9 R-F
1930 Dec. 3		18.0	96.5	7.3	9-10R-F
1931 Jan. 27		25.6	96.8	7.6	9 R-F
1932. Aug 14	120	26.0	95.5	7.0	
1938 Aug. 16	60	23.5	94.25	7.2	
1941 May. 16	60	24.0	99.0	6.9	
1941 Dec. 26		21.5	99.0	7.0	
1946 Sep. 12		23.5	96.0	7.5	9 MM
1950 Feb. 2		22.0	100.0	7.0	
1950 Aug. 15		28.5	96.5	8.6	12 MM
1954 Mar. 21	150	24.6	95.2	7.0	6 MM
1956 Jul. 16	100	22.0	96.0	7.0	8-9MM
1975 Jul. 8		Pagan/Nyangu		6.8	8 MM
1978. Sep. 30		South of Dedaye		5.3	8 MM

[1] Richter Scale

[2] Approximate Values near Origin

R-F ; Rossi-Forel Scale

MM ; Modified Mercalli Scale

Equi. Accel. ; Equivalent Acceleration
(980 cm / Sq. sec)

Source of Relation ship ;
Hand Book of Disaster Prevention Engineering (Japan)

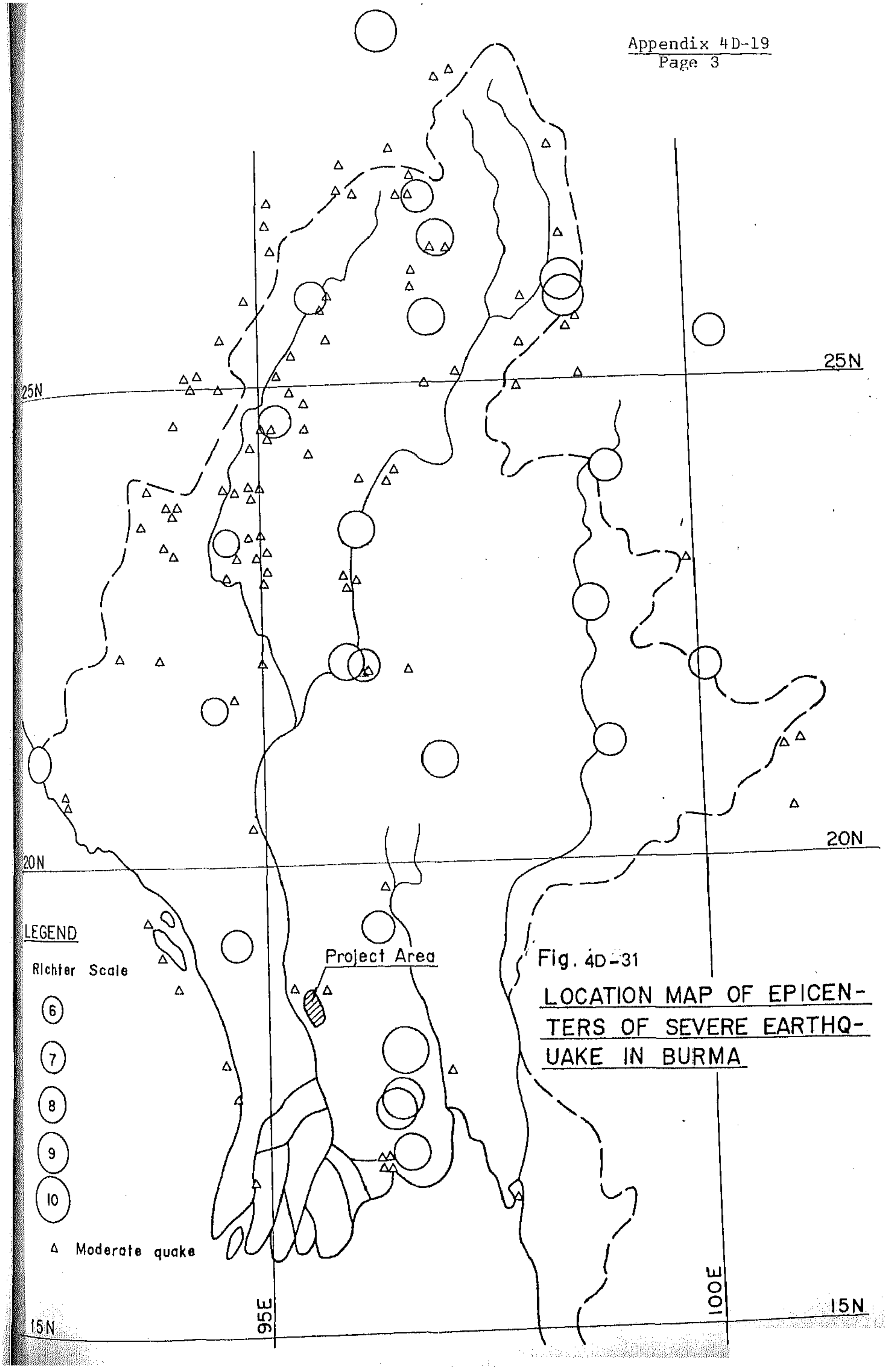


Fig. 4D-31

LOCATION MAP OF EPICENTERS OF SEVERE EARTHQUAKE IN BURMA

4D-20. Flood Analysis

In order to decide the hydraulic capacity of the spillway and diversion facility for the main dam and diversion dam, the flood peak discharge should be estimated on the basis of the simultaneous observation of flood hydrography and hourly rainfall data recorded in a long term. However, such available data could not be obtained near the dam sites and in its basin at present.

Therefore, the design flood discharge for the spillway and diversion facility is presumed by the precipitation data at Prome and Paukkaung observatories with statistical treatment.

(a) Probability Analysis of Precipitation

Two available observatories at Prome and Paukkaung have been operated around the project area. The period of record at each station is shown in Table 4D-11.

Prome station is located at the confluence of Irrawaddy and Nawin river, in Prome Town, being about 24 miles west of the dam site. The station started observation from 1947 and continued up to now, and almost complete data are available.

The observation of Paukkaung station which is located about two miles north-west at downstream of the dam site was started from 1966 and has been continued up to now, however, the data are included about a half of unusable one.

(1) Correlation between Prome and Paukkaung Stations

According to the available data at Prome and Paukkaung stations, the overlapped period of observation has been taken into consideration for anlysing the rainfall correlation between both the stations on the basis of annual maximum daily rainfall. The calculation result was shown in the following equation which indicates the regression line of linear correlation.

$$Y = 0.690\ X + 10.620$$

Where, Y -- annual maximum daily rainfall at Paukkaung station in mm.
X -- annual maximum daily rainfall at Prome station in mm.

As seen from the above equation, the correlation between Prome and Paukkaung stations is comparatively poor and correlation coefficient is found to be 0.701.

Since the observation period of Paukkaung station was limited within seven years, the blank part of Paukkaung rainfall data on annual maximum daily basis has been supplemented from the Prome rainfall data by using the above-mentioned equation and are shown in Table 4D-11.

(2) Maximum Daily Rainfall Analysis

In order to estimate the probability of maximum daily rainfall, the calculation has been carried out for the Prome and Paukkaung stations by using Iwai's method. The calculation results of probability analysis for the two stations are shown in Table 4D-12 and Fig. 4D-32.

TABLE 4D-12. PROBABILITY OF MAXIMUM DAILY RAINFALL (in mm)

Observation Station	Return Period						
	10-Year	20-Year	50-Year	100-Year	200-Year	500-Year	1000-Year
Prome	124.7	140.1	159.8	174.5	189.1	208.5	223.4
Paukkaung	98.7	110.2	125.0	136.1	147.2	161.9	173.2
Average Value	111.7	125.2	142.4	155.3	168.2	185.2	198.3

In comparing the probability rainfall at the Paukkaung with that at Prome, the Prome value is about 28 percent higher than the one at Paukkaung. Accordingly, the average values of probability analysis at the Prome and Paukkaung stations have been adopted as the basic value for the flood analysis at the main dam and diversion dam, considering the lack of the observation data at the Paukkaung station, comparatively poor correlation and safety reason.

(b) Flood Discahrge for Main Dam

Since the peak flood discharge has not been observed at the South Nawin river, the flood discharge at the main dam site should be estimated by the above-mentioned probability rainfall. The following three different methods were adopted and the obtained values were compared:

Unit hydrograph method by Nakayasu's formula
Rational method
Creager's method

(1) Unit Hydrograph Method

The available observed data of continuous run-off cannot be obtained at the South Nawin river near the dam site and also there is no hourly rainfall data available in the catchment area of the dam site.

Accordingly, the hydrograph has been estimated by using the following formula:

Hourly rainfall: assumed by Talbot formula
Effective rainfall: assumed by Horton formula
Unit hydrograph: assumed by Nakayasu formula

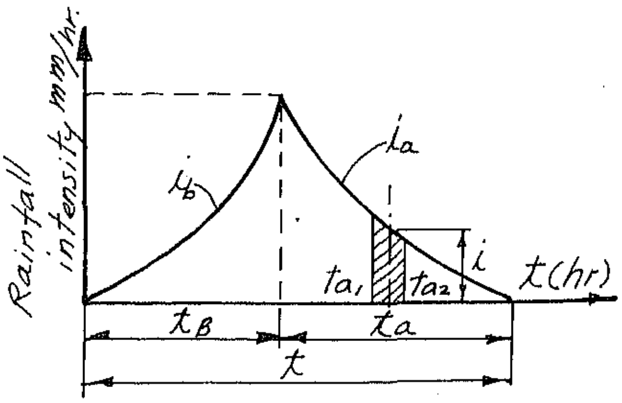
o Estimation of Hourly Rainfall

Since the hourly rainfall data in the catchment area as well as Paukkaung station are not available, it was estimated by using the hyetograph based on the probability analysis of precipitation.
The equation to calculate the hyetograph was based on the following equation:

$$ia = \frac{a.b}{[ta/(1 - r)+b]^2}$$

$$ib = \frac{a.b.}{[(tb/r)+b]^2}$$

$$ta = (1 - r)t; \quad tb= r.t;$$
$$t = ta + tb$$



Where, ia -- hyetograph after peak rainfall intensity.
ib -- hyetograph before peak rainfall intensity.
ta -- rainfall hour after peak rainfall intensity.
tb -- rainfall hour before peak rainfall intensity.
a, b -- constants; these values were estimated by using the Talbot formula of rainfall intensity.

o Effective Rainfall

In order to obtain the effective rainfall, the following equation has been adopted considering the water loss estimated by using the intake rate equation of Horton.

$$ER = TR - WL = TR - [fc.t + \frac{fo - fc}{K} (1 - e^{-k.t})]$$

Where, ER -- effective rainfall in mm.
TR -- total rainfall in mm.
WL -- water loss such as evapotranspiration, percolation and surface retention, etc. in mm.
fc -- intake rate of end point in mm/hour and adopted by 0.3.
fo -- intake rate of beginning point in mm/hour
t -- time in hour
K -- constants; depend upon the soil type in the catchment area and adopted by 0.15
e -- base of natural logarithms.

On the assumption that the total water loss is 80 mm for 12 hours, the intake rate of beginning point "fo" can be obtained from the above equation and is found to be 14.0 mm.

The water loss in unit time is expressed by the following equation:

$$fp = fc + (fo - fc) \cdot e^{-k \cdot t}$$

where, fp -- water loss in unit time in mm.
fc, fo, e, K and t are the same quantities as in the previous equation.

Substituting the values of fo, fc, and K into the above equation, the water loss in unit time can be written as follows:

$$fp = 0.3 + 13.73\ e^{-0.15.t}$$

o Unit Hydrograph

There are a number of formula available for estimating the unit hydrograph, however, in this case, the estimation has been carried out by using the Nakayasu's method due to the lack of observation data of continuous run-off. The equation is as follows:

$$Qp = 0.2778.A.Ro/(0.3\ tp + tK)$$

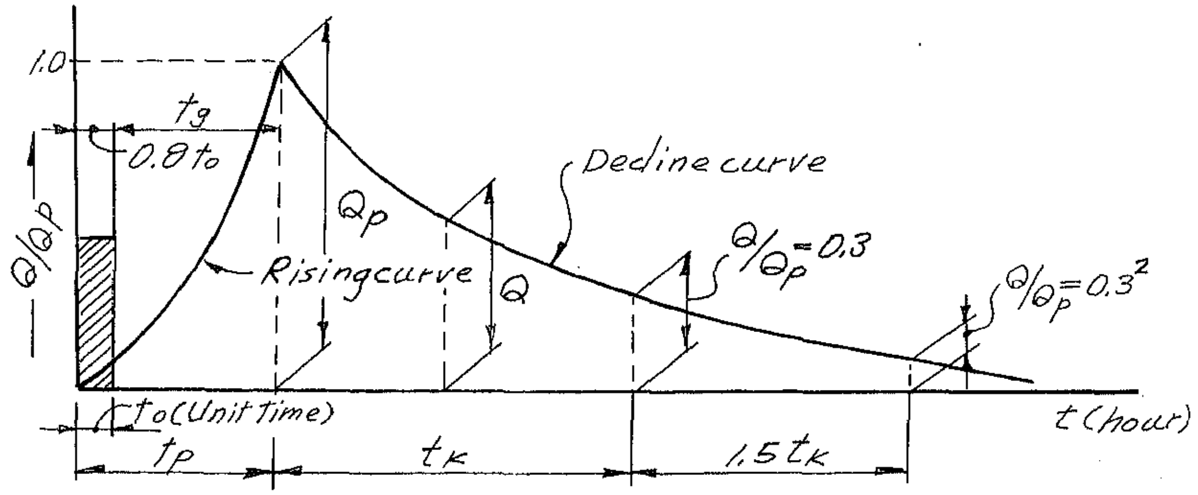
$$\text{Raising curve} \quad \frac{Q}{Qp} = \left(\frac{t}{tp}\right)^{2.4}$$

$$\text{Decline curve} \quad 1 \geqq \frac{Q}{Qp} \geqq 0.3; \quad \frac{Q}{Qp} = 0.3^{\frac{t - tp}{tk}}$$

$$0.3 \geqq \frac{Q}{Qp} \geqq 0.3^2; \quad \frac{Q}{0.3Qp} = 0.3^{\frac{t - (tp + tk)}{1.5\ tk}}$$

$$0.3^2 \geqq \frac{Q}{Qp}; \quad \frac{Q}{0.3^2Qp} = 0.3^{\frac{t-(tp + tk + 1.5tk)}{2.0\ tk}}$$

Where, Qp -- peak discharge in cu.m/sec.
A -- catchment area and adopted by 640 sq. km.
Ro -- peak effective rainfall intensity in mm/hour
tp -- time from beginning run-off to peak discharge point in hour.
tk -- time from peak discharge poin to Q/Qp = 0.3 point in hour
Q -- discharge of each time in cu.m/sec.
t -- each time in hour



Since there is no available run-off hydrograph around the dam site, the annual average dialy discharge of 16.2 cu.m/sec. at Yatthit gauging station was adopted as the base flow of the South Nawin river at the dam site.

The hydrograph of the river at each return-period has been established based on the effective rainfall and unit hydrograph, and the results of hydrograph in 0.1, 1.0 and 10 percent probability flood are shown in Fig. 4D-33. The peak discharge which was picked up from the hydrograph are shown in Table 4D-13 and Fig. 4D-34.

TABLE 4D-13. PEAK DISCHARGE AT EACH RETURN-PERIOD

	Return Period (Year)						
Discharge	1,000	500	200	100	50	20	10
Qmax./1	1,783.37	1,654.48	1,483.21	1,351.09	1,222.25	1,052.82	918.26
q /2	2.787	2.585	2.318	2.111	1.910	1.645	1.435

NOTE: /1 -- Peak discharge in cu.m/sec.
/2 -- Specific discharge in cu.m/sec/sq. km.

The peak discharge at the main dam site in 0.1 percent probability flood is 1,783.37 cu.m/sec occurring in 20 hours, corresponding to about 2.787 cu.m/sec/sq.km in the specific discharge.

(2) Rational Method

This method can be obtained from the following formula by applying the assumptions of coefficient of run-off, arrival time of flood and mean intensity of precipitation.

$$Q = 0.2778.f.\gamma t.A$$

Where, Q -- peak flood discharge in cu.m/sec.
f -- coefficient of run-off and adopted by 0.8
γt -- mean intensity of precipitation within arrival time of flood and expressed as follows: $\gamma t=(R24/24)\cdot(24/t)^n$.
R24 -- probable maximum daily rainfall and adopted by 198.3 mm in 0.1 percent probability.
n -- exponential coefficient and adopted by 0.5.
t -- arrival time of flood and expressed as follows:
$t = L/20.(H/L)^{0.6}$
L -- length of maximum elevation point in the basin to dam site along the run-off path and adopted by 38,500 m.
H -- difference of elevation between maximum elevation point and dam site, and adopted by 250 m.
A -- catchment area and adopted by 640 sq. km.

Substituting of numerical values into the above formula, the peak discharge in 0.1 percent probability can be obtained about 1,738 cu.m/sec, corresponding to about 2.72 cu.m/sec/sq.km in the specific discharge. And this value is considered nearly equal to the above mentioned value which was obtained by the unit hydrograph method.

(3) Creager's Method

A specific discharge in 0.1 percent probability at the dam site can be obtained by using an exponential function of catchment area such as the following Creager's formula:

$$q = 46.C.A^{(0.894A^{-0.048})-1}$$

Where, q -- specific discharge in cu.ft/sec/sq. mile.
c -- coefficient and varied from 20 to 90.
A -- catchment area and adopted by 247 sq. mile

Since the coefficient C varies in wide range, the value obtained from the neighboring North Nawin and Pyinmana Projects was adopted for the calculation and the results of calculation for the specific discharge at the dam site are shown in the following table and Fig. 4D-35.

Specific Discharge	Quoted from North Nawin Project (C=33.02)	Quoted from Pyinmana Project (C=26.25)
q (cu.ft/sec/sq.mile)	269.68	214.39
q (cu.m/sec/sq.km)	2.95	2.34

The values which were found from the previous calculation methods are intermediately located on the above obtained values.

(c) Design Flood Discharge for Main Dam

Design flood discharge for the spillway and diversion facility at the main dam site was presumed based on the above-mentioned three methods with consideration on the following items such as a precedent in Burma and the Design Criteria for Dams which was established by Japanese National Committee on Large Dams.

- According to the collected data in Burma, the design flood discharge for the spillway has been adopted by 0.1 percent probability flood in most of dam.
- In conformity with Design Criteria for Dams, the design flood discharge for the spillway should be estimated by 20 percent more than that in 0.5 percent probability flood at the fill-type dam and this value is almost similar to 0.1 percent probability value.
- Since there is no accurate standard for the diversion facility in Burma, design flood discharge for this facility was considered reasonable to adopt the Design Criteria for Dams and decided the value of 10 percent probability flood.

Consequently, the design flood discharge in peak for the spillway and diversion facility was decided by 0.1 and 10 percent probability flood, respectively, and are shown as follows:

	Spillway	Diversion Facility
Design flood discharge -		
Q_D (cu.ft/sec)	63,016.60	32,447.35
Q_D (cu.m/sec)	1,783.37	918.26
Specific discharge -		
q_D (cu.ft./sec/sq.mile)	254.885	129.718
q_D (cu.m/sec/sq.km)	2.787	1.435

The specific discharge of 254.885 cu.ft/sec/sq. mile is a little smaller than the North Nawin Project value of 269.68 cu.ft/sec/sq.mile, however, considering the fact that the specific discharge has a tendency to decrease in inverse to increase in catchment area, this value seems to range with a reasonable extent.

(d) Design Flood Discharge for Diversion Dam

In order to obtain the design flood discharge for the diversion dam, it is presumed that the construction of diversion dam has been executed during the construction period of main dam. And also, the return period of design flood for the spillway and diversion facility was adopted as same as the criteria of main dam.

Regarding the design flood discharge, the calculation should be made to combine the run-off hydrograph through the spillway and diversion facility at the main dam with that of the remaining catchment area at the diversion dam site.

The hydrograph through the spillway and diversion facility at the main dam was quoted from the paragraph of "Spillway and Diversion Facility" of this report. As for the hydrograph of the remaining catchment area at the diversion dam site, the calculation has been carried out to apply the same procedure at the main dam in consideration of the hydraulic conditions in its basin.

The combined hydrograph in 0.1 percent probability flood are shown in Fig. 4D-36. The peak discharges for the spillway and diversion facility at the diversion dam site are shown in the following table.

	Design Flood Discharge	Peak in Hour
Spillway	26,000 cu.ft/sec, (736.24 cu.m/sec)	19.0
Diversion Facility	37,100 cu.ft/sec, (1,050.91. cu.m/sec)	20.0

TABLE 4D-11. ANNUAL MAXIMUM DAILY RAINFALL AT PROME AND PAUKKAUNG STATIONS (Millimeter)

Year	Prome Station	Paukkahwaung Station
1947	47.8	43.6
1948	65.8	56.0
1949	-	-
1950	-	-
1951	116.1	90.7
1952	98.0	78.2
1953	138.7	106.3
1954	117.9	92.0
1955	95.3	76.4
1956	84.6	67.0
1957	60.5	52.4
1958	62.0	53.4
1959	55.9	49.2
1960	83.8	68.4
1961	112.5	88.2
1962	107.9	85.1
1963	68.8	58.1
1964	84.6	69.0
1965	99.1	79.0
1966	63.0	40.9*
1967	63.0	54.1
1968	64.0	82.0*
1969	115.1	72.4*
1970	59.9	52.0
1971	93.0	55.0*
1972	56.0	49.0*
(cont'd.) Year	Prome Station	Paukkhwaung Station
1973	126.0	121.0*
1974	131.0	101.0
1975	120.0	93.4
1976	107.0	84.5
1977	61.0	52.7
1978	60.0	56.8*
Mean Value	87.3	70.9

NOTE: The figures with asterisk are shown in the observation value.

FIGURE 4D-32 RELATION CURVE BETWEEN RETURN PERIOD AND MAXIMUM DAILY RAINFALL (in mm.)

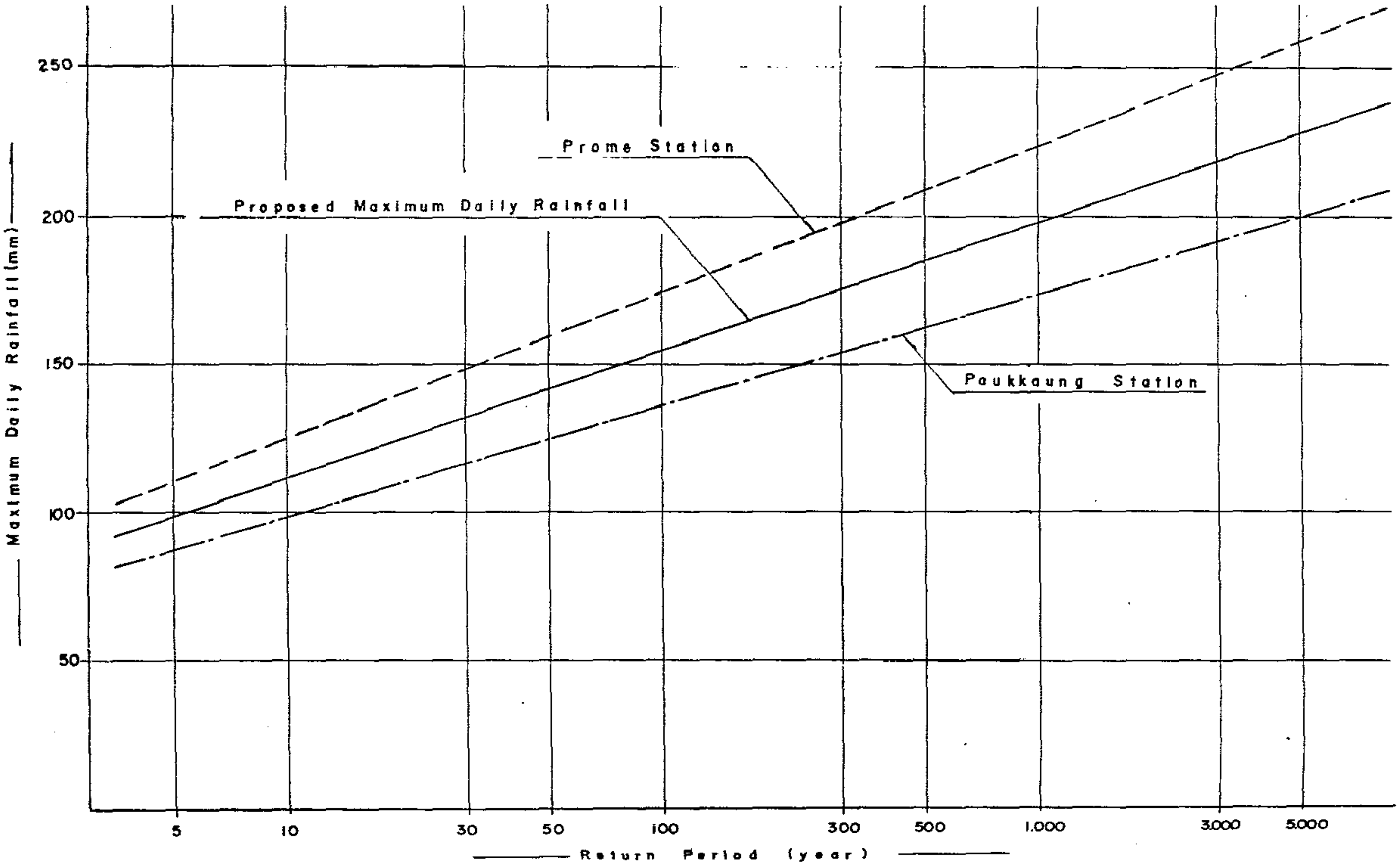


FIGURE 4D-33 HYDROGRAPH AT MAIN DAM SITE IN 0.1, 1.0, AND 10.0 PERCENT PROBABILITY FLOOD

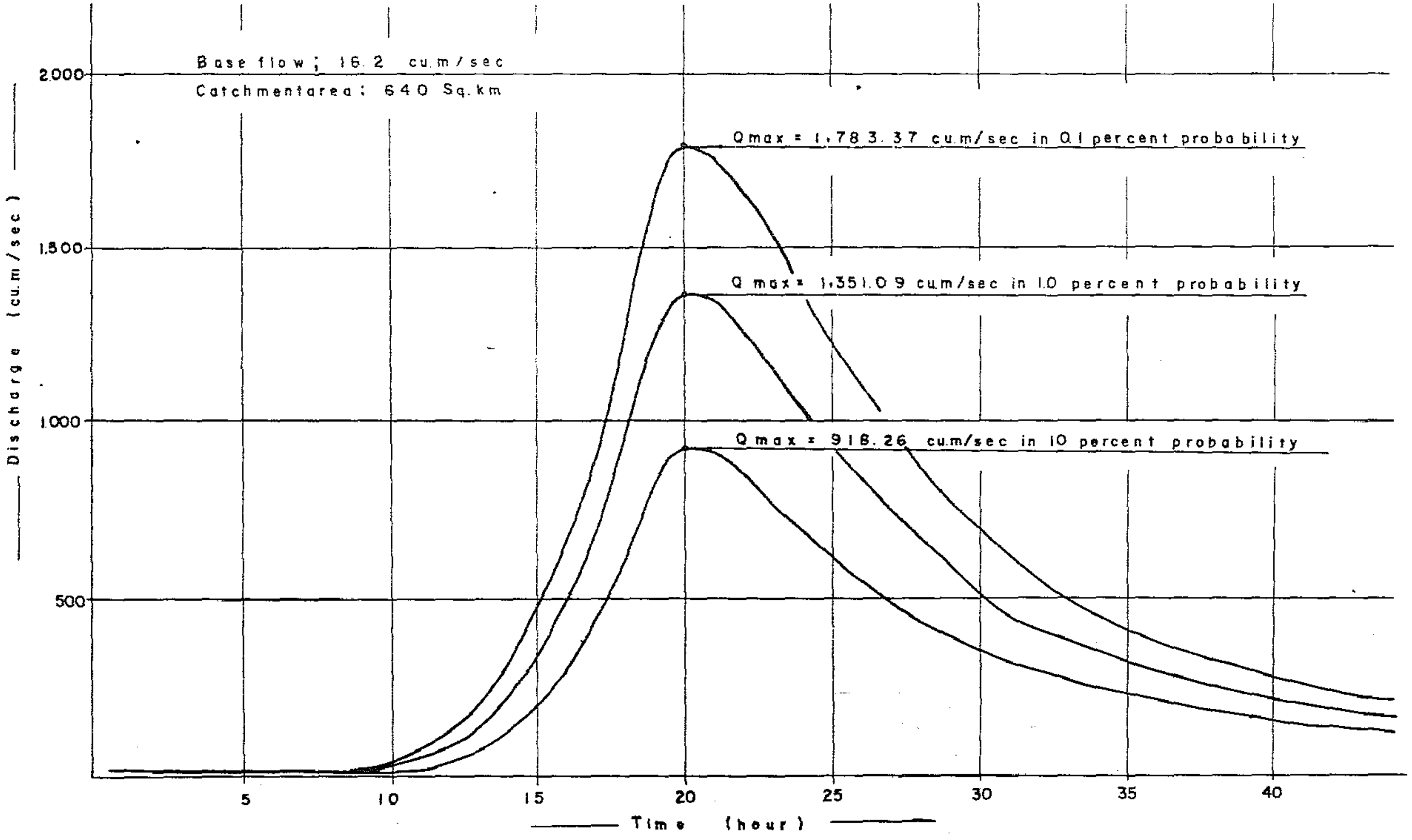


FIGURE 4D-34 RELATION CURVE BETWEEN RETURN PERIOD AND PEAK DISCHARGE, SPECIFIC DISCHARGE AT MAIN DAM

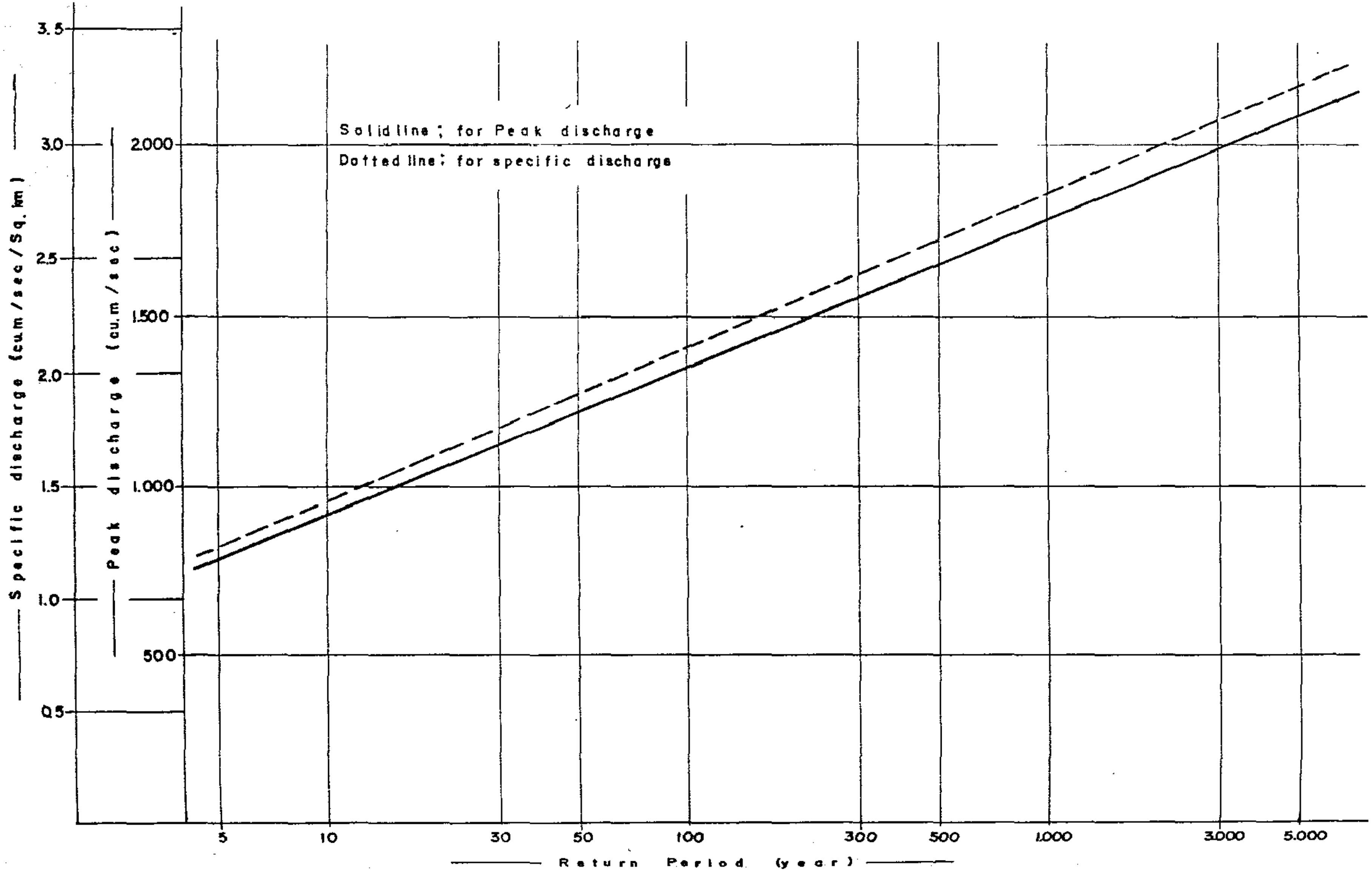


FIGURE 4D-35 RELATION CURVE BETWEEN CATCHMENT AREA AND SPECIFIC DISCHARGE IN O. I PERCENT PROBABILITY FLOOD (AT MAIN DAM)

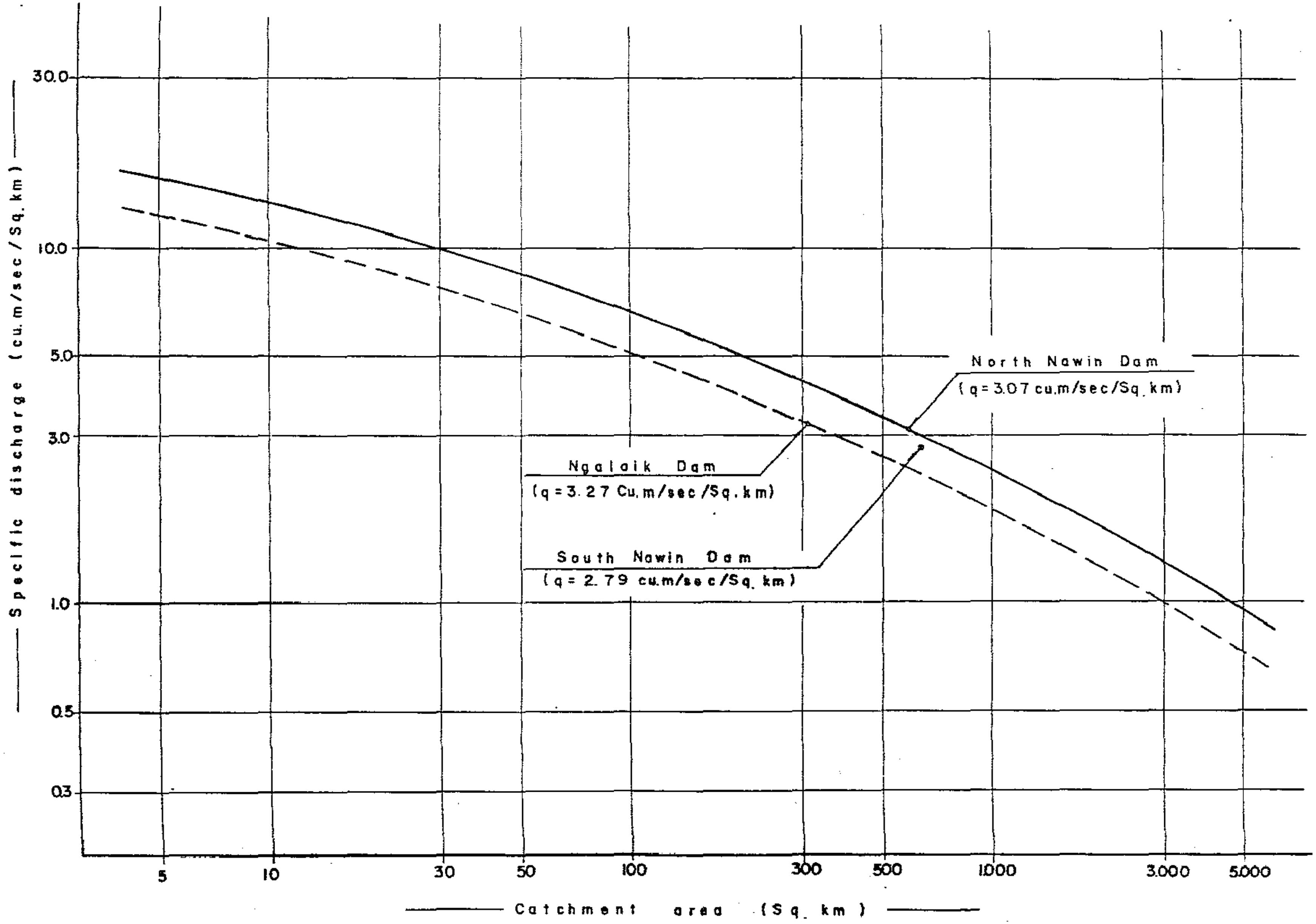


FIGURE 4D-36 HYDROGRAPH AT DIVERSION DAM SITE IN 0.1 PERCENT PROBABILITY FLOOD

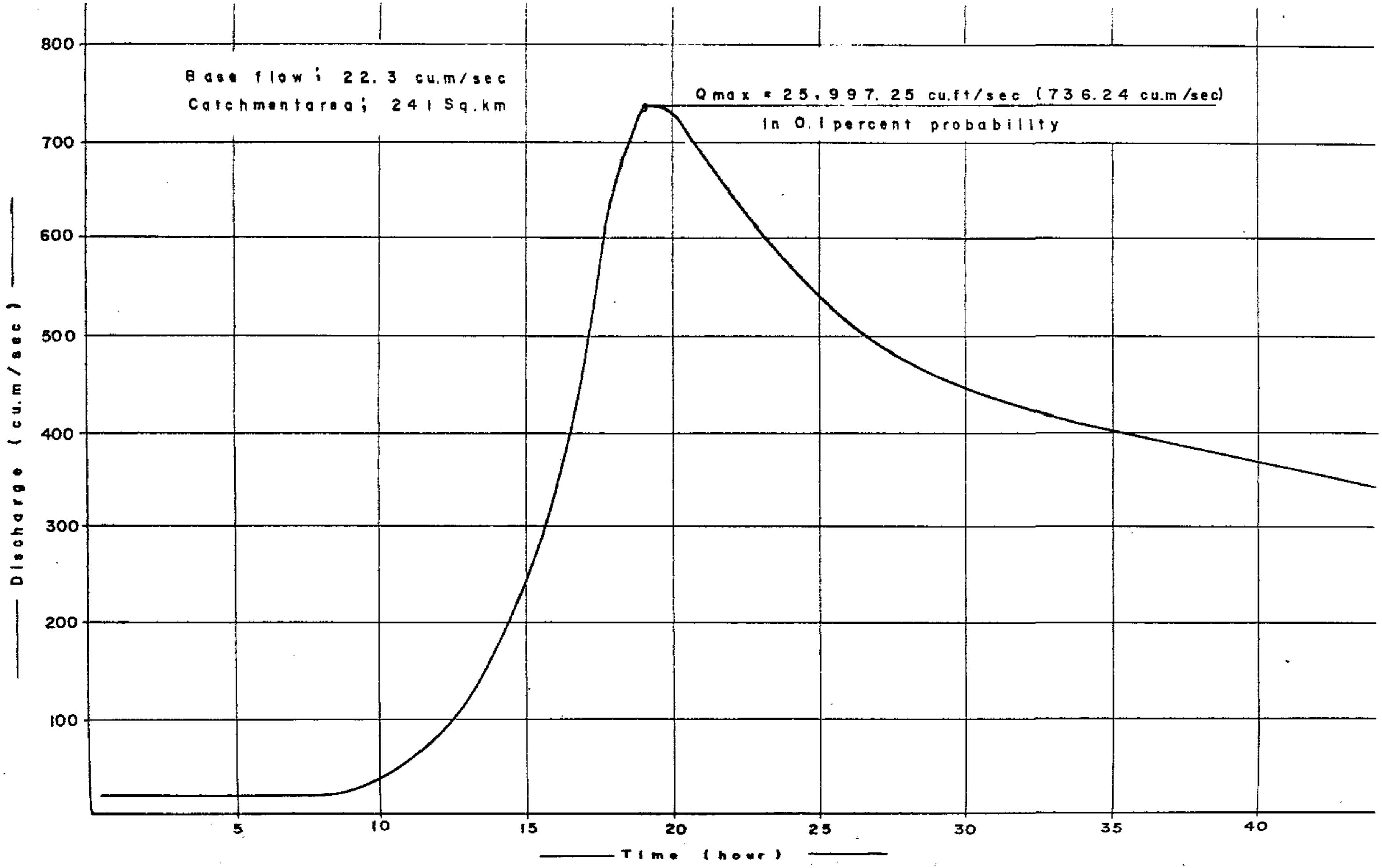


Table 4E-1 Land Statistics of the Pilot Scheme Area

Name of Village Tract	Kwin No.	In the Project (%)	Gross Area	Occupied Area	Fallow Land	Net Sown Area	Cultivable Land	Un-cultivable Land			
								Water logging	Forest	Urban Area	Total
KANNASINT	987-A	100	362	358	-	358	-	-	-	4	4
LAUNG GYI	987-B	100	53	45	-	45	-	8	-	-	8
	986	100	734	708	-	708	2	3	-	21	24
YWA THIT	977-A	100	530	520	-	520	1	-	-	9	9
	976-A	100	783	763	-	763	4	1	-	15	16
KYWE GAUNG	976-B	100	315	300	1	299	2	-	-	13	13
NGET TAWMEE	962	100	1,014	965	5	960	-	9	-	40	49
	963	40	463	337	24	313	38	60	-	28	88
YAT THA	975	100	169	165	-	165	-	-	-	4	4
	964	90	884	840	-	840	-	13	3	28	44
	975-A	100	682	584	-	584	16	-	59	23	82
GYOBINTHA	981-A	100	457	437	-	437	-	9	-	11	20
Net Estimated Pilot Scheme Area			3,461			3,550					111
(%)			(100.0)			(96.8)					(3.2)

Source: Land Record Office at Thegon

Table 4E-2 Land Use on the Pilot Scheme Area

Name of V.T.	Kwin No.	In the Area (%)	Occupied Area					Forest	Cultivable Waste	Non-cultivable	Total
			Le (Paddy Land)	Kaing (Seasonal Alvial Land)	Ya (Upland field)	Uyin (Garden)	Total				
KANNASINT	987-A	100	356	-	-	2	358	-	1	3	362
LAUNG GYI	987-B	100	38	-	-	7	45	-	-	8	53
	986	100	622	-	-	47	699	-	1	64	734
YWA THIT	977-A	100	498	-	-	13	511	-	-	19	530
	976-A	100	726	-	-	29	755	-	-	28	783
KYWE GAUNG	976-B	100	253	-	-	34	287	-	-	28	315
NGET TAWMEE	962	100	901	-	-	19	920	-	5	89	1,014
	963	40	335	-	-	-	335	-	38	90	463
YAT THA	975	100	161	-	-	1	162	-	1	6	169
	964	90	835	-	-	5	840	3	14	27	884
	975-A	100	555	-	-	13	568	59	13	42	682
GYOBINTHA	981-A	100					N.A.*				N.A.
Total			5,280	-	-	170	5,450	62	73	404	5,989
(%)			(96.9)			(3.1)	(100.0)				

* N.A. = Net available

Source: Land Record Office at Thegon.

Table 4E-3 Present Total Labour Input (Pilot Scheme Area)

Unit: man-day

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
I. Labour Input (man-day/ac)													
a. Paddy	1.5				1.5	6.5	10.5	2.0	1.5	1.5	2.0	5.0	32.0
b. Sesame (Late)									6.0	2.5	2.5	18.0	29.0
c. G'nuts (Monsoon)					2.5	7.5	5.0	22.0	22.0				59.0
d. G'nuts (Dry)		22.0	22.0							2.5	7.5	5.0	59.0
e. Beans (Gram)			6.0								1.0		7.0
II. Total Labour													
a. Paddy (3,100ac)	4,650				4,650	20,150	32,550	6,200	4,650	4,650	6,200	15,500	99,200
b. Sesame (100)									600	250	250	1,800	2,900
c. G'nuts (250)					625	1,875	1,250	5,500	5,500				14,750
d. G'nuts (100)		2,200	2,200							250	750	500	5,900
e. Gram (50)			300								50		350
Total (man/day)	4,650	2,200	2,500		5,275	22,025	33,800	11,700	10,750	5,150	7,250	17,800	123,100
III. Cattle Operator*	2,325	200	500		6,900	19,300	9,300	500	1,700	900	3,225	7,850	52,700
IV. Total Labour Input	6,975	2,400	3,000		12,175	41,325	43,100 (57.4%)	12,200	12,450	6,050	10,475	25,650	175,800 (19.5%)
V. Labour Forces (2.780) 27 working days/month	75,060	75,060	75,060	75,060	75,060	75,060	75,060 (100.0)	75,060	75,060	75,060	75,060	75,060	900,720 (100.0)
VI. Balance (V - IV)	68,085	72,660	72,060	75,060	62,885	33,735	31,960	62,860	62,610	69,010	64,585	49,410	724,920

Table 4E-4 Distribution of Present Labour Input (Pilot Scheme Area)

Unit: man-day/ac

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
a. Paddy (L.V.)													
1. Nursery					0.5	0.5							1.0
2. Land Preparation					0.5	2.0	1.5						4.0
3. Transplanting						2.0	7.0						9.0
4. Caring					0.5	2.0	2.0	2.0	1.5	1.5	0.5		10.0
5. Harvesting	1.5										1.5	5.0	8.0
Total	1.5				1.5	6.5	10.5	2.0	1.5	1.5	2.0	5.0	32.0
b. Sesame (Late)													
1. Land Preparation									1.0				1.0
2. Sowing									5.0				5.0
3. Caring										2.5	2.5		5.0
4. Harvesting												17.0	17.0
5. Transportation												1.[illegible]	1.0
Total									6.0	2.5	2.5	18.0	29.0
c. G'nuts (Monsoon)													
1. Land Preparation					0.5	0.5							1.0
2. Sowing					2.0	2.0							4.0
3. Caring						5.0	5.0						10.0
4. Harvesting								22.0	22.0				44.0
Total					2.5	7.5	5.0	22.0	22.0				59.0
d. G'nuts (Dry)													
1. Land Preparation										0.5	0.5		1.0
2. Sowing										2.0	2.0		4.0
3. Caring											5.0	5.0	10.0
4. Harvesting		22.0	22.0										44.0
Total		22.0	22.0							2.5	7.5	5.0	59.0
e. Beans (Gram)													
1. Sowing											1.0		1.0
2. Harvesting			6.0										6.0
Total			6.0								1.0		7.0

Table 4E-5 Present Total Cattle Input (Pilot Scheme Area)

Unit: Cattle-day

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
I. Cattle Input													
a. Paddy	1.5				3.0	11.0	6.0				1.5	5.0	28.0
b. Sesame (Late)									24.0			2.0	26.0
c. G'nuts (Monsoon)					18.0	18.0		4.0	4.0				44.0
d. G'nuts (Dry)		4.0	4.0							18.0	18.0		44.0
e. Beans (Gram)			12.0										12.0
II. Total Cattle													
a. Paddy (3,100ac)	4,650				9,300	34,100	18,600				4,650	15,500	86,800
b. Sesame (100)									2,400			200	2,600
c. G'nuts (250)					4,500	4,500		1,000	1,000				11,000
d. G'nuts (100)		400	400							1,800	1,800		4,400
e. Gram (50)			600										600
Total (Cattle/day)	4,650	400	1,000		13,800	38,600 (100.0)	18,600	1,000	3,400	1,800	6,450	15,700	105,400 (31.0%)
III. Total Cattle Operator	2,325	200	500		6,900	19,300	9,300	500	1,700	900	3,225	7,850	52,700
IV. Cattle Power (1,050) 27 working days/month	28,350	28,350	28,350	28,350	28,350	28,350 (73.4%)	28,350	28,350	28,350	28,350	28,350	28,350	340,200 (100.0)
V. Balance (IV - II)	23,700	27,950	27,350	28,350	14,500	-10,250	9,750	27,350	24,950	26,550	21,900	12,650	234,800

Table 4E-6 Distribution of Present Cattle Input (Pilot Scheme Area)

Unit: cattle-day*/ac

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
a. Paddy (L.V.)													
1. Nursery					1.0	1.0							2.0
2. Land Preparation					2.0	10.0	6.0						18.0
3. Harvesting	1.5										1.5	5.0	8.0
Total	1.5				3.0	11.0	6.0				1.5	5.0	28.0
b. Sesame (Late)													
1. Land Preparation									22.0				22.0
2. Sowing									2.0				2.0
3. Transportation												2.0	2.0
Total									24.0			2.0	26.0
c. G'nuts (Monsoon)													
1. Land Preparation					16.0	16.0							32.0
2. Sowing					2.0	2.0							4.0
3. Harvesting								4.0	4.0				8.0
Total					18.0	18.0		4.0	4.0				44.0
d. G'nuts (Dry)													
1. Land Preparation										16.0	16.0		32.0
2. Sowing										2.0	2.0		4.0
3. Harvesting		4.0	4.0										8.0
Total		4.0	4.0							18.0	18.0		44.0
e. Gram													
Harvesting			12.0										12.0

* One cattle day = net working 4 hours per day

Table 4E-7 Total Distribution of Labour Requirement, with Project (Pilot Scheme Area)

Unit: man-day

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
I. Man-day/ac*													
a. Paddy (HYV) Mechanized						4.0	12.0	7.0	3.0	2.0	7.0	2.0	37.0
b. " Non-Mech.						4.0	12.0	7.0	3.0	3.0	12.0	5.0	46.0
c. " (LIV) Mechanized					1.6	9.0	10.4	2.0	2.0	2.0	10.0	4.0	41.0
d. " Non-Mech.					1.6	9.0	10.4	2.0	2.0	2.0	10.0	4.0	41.0
e. G'nuts (Monsoon) Mech.					9.0	6.0	4.0	66.0					85.0
f. Sunflower	9.0	66.0									10.0	9.0	94.0
g. Gram	4.0	6.0	4.0							1.0	2.0	4.0	21.0
h. Sesame (Dry) Mech.		8.0	6.0	6.0	32.0								52.0
i. " Non-Mech.		8.0	6.0	6.0	32.0								52.0
j. G'nuts (Dry) Mech.	5.0	5.0	66.0								6.0	5.0	87.0
k. Cotton (L.S.) Mech.	8.0	8.0	4.0	4.0						5.0	8.0	8.0	45.0
II. Total Labour													
a. 1,500 ac						6,000	18,000	10,500	4,500	3,000	10,500	7,500	58,500
b. 500						2,000	6,000	3,500	1,500	1,000	3,500	1,000	23,000
c. 300					480	2,700	3,120	600	600	600	3,000	1,200	12,300
d. 700					1,120	6,300	7,280	1,400	1,400	1,400	7,000	2,800	28,700
e. 100					900	600	400	6,600					8,500
f. 300	2,700	19,800									3,000	2,700	28,200
g. 650	2,600	3,900	2,600							650	1,300	2,600	13,650
h. 1,000		8,000	6,000	6,000	32,000								52,000
i. 400		3,200	2,400	2,400	12,800								20,800
j. 500	2,500	2,500	33,000								3,000	2,500	43,500
k. 100	800	800	400	400						500	800	800	4,500
Total (man-day)	8,600	38,200	44,400	8,800	47,300	17,600	34,800	22,600	8,000	7,150	32,100	13,800	293,650
III. Cattle Operator**	3,950	10,100	5,650	50	3,450	9,300	7,650	600		50	13,200	5,950	56,400
IV. Machinery Operator***	250	1,300	450	400	230	1,300	1,270	380	360	460	1,000	550	7,950
V. Grand Total (II+III+IV)	12,800	49,600	50,500	9,250	50,980	28,200	43,720 (42.3%)	23,580	8,360	7,660	46,300	20,300	358,000 (28.9%)
VI. Labour Resource (3,824) 27 working days/month	103,248	103,248	103,248	103,248	103,248	103,248	103,248 (100.0)	103,248	103,248	103,248	103,248	103,248	1,238,976 (100.0)
VII. Balance	90,448	53,648	52,748	93,998	52,268	75,048	59,528	79,668	94,888	95,588	56,948	82,948	880,976

* See Table 23. ** See Table 24. *** See Table 25.

Table 4E-8-a Distribution of Labour Requirement, with Project (Pilot Scheme Area and Other Project Area)

Unit: man-day/ac

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
a. Paddy (HYV) Mechanized													
1. Nursery						0.5	0.5						1.0
2. Land Preparation						3.0	4.0	1.0					8.0
3. Transplanting							7.0	3.0					10.0
4. Caring						0.5	0.5	3.0	3.0	2.0	2.0		11.0
5. Harvesting											5.0	2.0	7.0
Total						4.0	12.0	7.0	3.0	2.0	7.0	2.0	37.0
b. Paddy (HYV) Non-Mech.													
1. Nursery						0.5	0.5						1.0
2. Land Preparation						3.0	4.0	1.0					8.0
3. Transplanting							7.0	3.0					10.0
4. Caring						0.5	0.5	3.0	3.0	3.0	2.0		12.0
5. harvesting											10.0	5.0	15.0
Total						4.0	12.0	7.0	3.0	3.0	12.0	5.0	46.0
c. Paddy (LIV) Mechanized													
1. Nursery					0.1	0.5	0.4						1.0
2. Land Preparation					1.0	4.0	3.0						8.0
3. Transplanting						4.0	5.0						9.0
4. Caring					0.5	0.5	2.0	2.0	2.0	2.0	2.0		11.0
5. Harvesting											8.0	4.0	12.0
Total					1.6	9.0	10.4	2.0	2.0	2.0	10.0	4.0	41.0
d. Paddy (LIV) Non-Mech.													
1. Nursery					0.1	0.5	0.4						1.0
2. Land Preparation					1.0	4.0	3.0						8.0
3. Transportation						4.0	5.0						9.0
4. Caring					0.5	0.5	2.0	2.0	2.0	2.0	2.0		11.0
5. Harvesting											8.0	4.0	12.0
Total					1.6	9.0	10.4	2.0	2.0	2.0	10.0	4.0	41.0

Table 4E-8-b

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
e. G'nuts (Monsoon) Mech.													
1. Land Preparation					1.0								1.0
2. Sowing					4.0								4.0
3. Caring					4.0	6.0	4.0						14.0
4. harvesting								66.0					66.0
Total					9.0	6.0	4.0	66.0					85.0
f. Sunflower													
1. Sowing											10.0		10.0
2. Caring	9.0											9.0	18.0
3. Harvesting		66.0											66.0
Total	9.0	66.0									10.0	9.0	94.0
g. Gram													
1. Sowing										1.0			1.0
2. Caring	4.0	2.0									2.0	4.0	12.0
3. Harvesting		4.0	4.0										8.0
Total	4.0	6.0	4.0							1.0	2.0	4.0	21.0
h. Sesame (Dry) Mechanized													
1. Land Preparation		1.0											1.0
2. Sowing		7.0											7.0
3. Caring			6.0	6.0									12.0
4. harvesting					32.0								32.0
Total		8.0	6.0	6.0	32.0								52.0
i. Sesam (Dry)Non-mech.													
1. Land Preparation		1.0											1.0
2. Sowing		7.0											7.0
3. Caring			6.0	6.0	32.0								12.0
4. Harvesting													32.0
Total		8.0	6.0	6.0	32.0								52.0
j. G'nuts (Dry) Mechanized											2.0		2.0
1. Land Preparation											4.0		4.0
2. Sowing												5.0	15.0
3. Caring	5.0	5.0											66.0
4. Harvesting			66.0								6.0	5.0	87.0
Total	5.0	5.0	66.0										

Table 4E-8-c

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
k. G'nuts (Dry) Non-mech.													
1. Land Preparation											2.0		2.0
2. Sowing											4.0		4.0
3. Caring	5.0	5.0										5.0	15.0
4. Harvesting			66.0										66.0
Total	5.0	5.0	66.0								6.0	5.0	87.0
l. Cotton (L.S.) Mechanized													
1. Land Preparation										1.0			1.0
2. Sowing										4.0			4.0
3. Caring	8.0	8.0									8.0	8.0	32.0
4. Harvesting			4.0	4.0									8.0
Total	8.0	8.0	4.0	4.0						5.0	8.0	8.0	45.0
m. G'nuts (Monsoon) Non-Mech.													
1. Land Preparation					1.0								1.0
2. Sowing					4.0								4.0
3. Caring					4.0	6.0	4.0						14.0
4. Harvesting								66.0					66.0
Total					9.0	6.0	4.0	66.0					85.0

Table 4E-9 Total Distribution of Cattle Requirement, with Project (Pilot Scheme Area)

Unit: Cattle-day

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
I. Cattle-day/ac*													
a. Paddy (HYV) Mechanized	3.0					3.0	3.0				5.0	4.0	18.0
b. " Non-Mech.	3.0					11.0	11.0				5.0	4.0	18.0
c. " (LIV) Mechanized	1.0				1.2	3.0	1.8				4.0	3.0	14.0
d. " Non-Mech.	1.0				4.2	11.0	6.8				4.0	3.0	30.0
e. G'nuts (Monsoon) Mech.					8.0			12.0					20.0
f. Sunflower	3.0	2.0									28.0	3.0	36.0
g. Gram		8.0	8.0										16.0
h. Sesame (Dry) Mech.		4.0			2.0								6.0
i. " Non-Mech.			26.0			2.0							28.0
j. G'nuts (Dry) Mech.			12.0								8.0		20.0
k. Cotton (L.S.) Mech.			1.0	1.0						1.0			12.0
II. Total Cattle													
a. 1,500 ac	4,500					4,500	4,500				7,500	6,000	27,000
b. 500	1,500					5,500	5,500				2,500	2,000	9,000
c. 300	300				360	900	540				1,200	900	4,200
d. 700	700				2,940	7,700	4,760				2,800	2,100	21,000
e. 100					900			1,200					2,000
f. 300	900	600									8,400	900	10,800
g. 650		5,200	5,200										10,400
h. 1,000		4,000			2,000								6,000
i. 400		10,400			800								11,200
j. 500			6,000								4,000		10,000
k. 100			100	100						100			1,200
Total (cattle-day)	7,900	20,200	11,300	100	6,900	18,600	15,300	1,200		100	26,400 (93.1%)	11,900	112,800 (33.2%)
III. Cattle Operator (Man-day)	3,950	10,100	5,650	50	3,450	9,300	7,650	600		50	13,200	5,950	56,400
IV. Cattle Resource (1,050) 27 working day/month	28,350	28,350	28,350	28,350	28,350	28,350	28,350	28,350	28,350	28,350	28,350 (100.0)	28,350	340,200 (100.0)
V. Balance	20,450	8,150	17,050	28,250	21,450	9,750	13,050	27,150	28,350	28,250	1,950	16,450	227,400

* See Table 25.

Table 4E-10 Distribution of Cattle Requirement, with Project

Unit: Cattle-day/ac

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
a. Paddy (HYV) Mechanized													
1. Nursery						1.0	1.0						2.0
2. Land Preparation						2.0	2.0						4.0
3. Harvesting	3.0										5.0	4.0	12.0
Total	3.0					3.0	3.0				5.0	4.0	18.0
b. Paddy (HYV) Non-Mech.													
1. Nursery						1.0	1.0						2.0
2. Land Preparation						10.0	10.0						20.0
3. Harvesting	3.0										5.0	4.0	12.0
Total	3.0					11.0	11.0				5.0	4.0	34.0
c. Paddy (LIV) Mechanized													
1. Nursery					0.2	1.0	0.8						2.0
2. Land Preparation					1.0	2.0	1.0						4.0
3. Harvesting	1.0										4.0	3.0	8.0
Total	1.0				1.2	3.0	1.8				4.0	3.0	14.0
d. Paddy (LIV) Non-Mech.													
1. Nursery					0.2	1.0	0.8						2.0
2. Land Preparation					4.0	10.0	6.0						20.0
3. Harvesting	1.0										4.0	3.0	8.0
Total	1.0				4.2	11.0	6.8				4.0	3.0	30.0
e. G'nuts (Monsoon) Mech.													
1. Land Preparation					4.0								4.0
2. Sowing					4.0								4.0
3. Harvesting								12.0					12.0
Total					8.0			12.0					20.0
f. G'nuts (Monsoon) Non-mech.													
1. Land Preparation					34.0								34.0
2. Sowing					4.0								4.0
3. Harvesting								12.0					12.0
Total					38.0			12.0					50.0

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
g. Sunflower													
1. Land Preparation											28.0		28.0
2. Caring	3.0											3.0	6.0
3. Harvesting		2.0											2.0
Total	3.0	2.0									28.0	3.0	36.0
h. Gram													
Harvesting		8.0	8.0										16.0
i. Sesame (Dry) Mechanized													
1. Land Preparation		2.0											2.0
2. Sowing		2.0											2.0
3. Harvesting					2.0								2.0
Total		4.0			2.0								6.0
j. Sesame (Dry) Non-Mech.													
1. Land Preparation		24.0											24.0
2. Sowing		2.0											2.0
3. Harvesting					2.0								2.0
Total		26.0			2.0								28.0
k. G'nuts (Dry) Mechanized													
1. Land Preparation											4.0		4.0
2. Sowing											4.0		4.0
3. Harvesting			12.0										12.0
Total			12.0								8.0		20.0
l. G'nuts (Dry) Non-Mech.													
1. Land Preparation											26.0		26.0
2. Sowing											4.0		4.0
3. Harvesting			12.0										12.0
Total			12.0								30.0		42.0
m. Cotton (L.S.) Mech.													
1. Land Preparation										8.0			8.0
2. Sowing										2.0			2.0
3. Harvesting			1.0	1.0									2.0
Total			1.0	1.0						10.0			12.0

Table 4E-11 Total Machinery Operator Requirement, with Project (Pilot Scheme Area)

Unit: man-day

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
I. Man-day/ac*													
a. Paddy (HYV) Mech						0.7	0.7	0.2	0.2	0.2	0.3	0.2	2.5
b. Paddy (LIV) "					0.1	0.7	0.6	0.2	0.2	0.2			2.0
c. G'nuts (Monsoon) "					1.0	0.4	0.4	0.2					2.0
d. Sesame (Dry) "		1.1	0.4	0.4	0.1								2.0
e. G'nuts (Dry) "	0.3	0.3	0.1								1.0	0.3	2.0
f. Cotton (L.S.) "	1.0	0.5								1.0	0.5	1.0	4.0
II. Total Operator													
a. 1,500 ac						1,050	1,050	300	300	300	450	300	3,750
b. 300					30	210	180	60	60	60			600
c. 100					100	40	40	20					200
d. 1,000		1,000	400	400	100								2,000
e. 500	150	150	50								500	150	1,000
f. 100	100	50								100	50	100	400
Total (man-day)	250	1,300	450	400	230	1,300	1,270	380	360	460	1,000	550	7,950

* See Table 26.

Table 4E-12 Distribution of Machinery Operator Requirement, with Project (Pilot Scheme Area and the Project Area)

Unit: man-day/ac

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
a. Paddy (HYV) Mech.													
1. Land Preparation						0.5	0.5						1.0
2. Caring						0.2	0.2	0.2	0.2	0.2			1.0
3. Harvesting											0.3	0.2	0.5
Total						0.7	0.7	0.2	0.2	0.2	0.3	0.2	2.5
b. Paddy (LIV) Mech.													
1. Land Preparation					0.1	0.5	0.4						1.0
2. Caring						0.2	0.2	0.2	0.2	0.2			1.0
Total					1.0	0.7	0.6	0.2	0.2	0.2			2.0
c. G'nuts (Monsoon) Mech.													
1. Land Preparation					1.0								1.0
2. Caring						0.4	0.4	0.2					1.0
Total					1.0	0.4	0.4	0.2					2.0
d. Sesame (Dry) Mech.													
1. Land Preparation		1.0											1.0
2. Caring		0.1	0.4	0.4	0.1								1.0
Total		1.1	0.4	0.4	0.1								2.0
e. G'nuts (Dry) Mech.													
1. Land Preparation											1.0		1.0
2. Caring	0.3	0.3	0.1									0.3	1.0
Total	0.3	0.3	0.1								1.0	0.3	2.0
f. Cotton (L.S.) Mech.													
1. Land Preparation										1.0			1.0
2. Caring	1.0	0.5									0.5	1.0	3.0
Total	1.0	0.5								1.0	0.5	1.0	4.0
Total (Man-day)	1.3	1.9	0.5	0.4	1.2	1.8	1.7	0.6	0.4	1.4	1.8	1.5	14.5

Table 4E-13 Requirement of Seeds (Pilot)

	Required Quantity		Annual Requirement		Unit Cot	Total Cost
	(ton)	(Bkts)	(ton)	(Bkts)	(kats)	(kats)
Paddy	93.9	4,500	31.3	1,500	9.0	13,500
G'nuts	40.8	3,600	13.6	1,200	60	72,000
Sesame	4.1	168	1.4	56	100	5,600
Gram	20.3	650	6.8	217	30	6,510
Sunflower	0.7	75	0.23	25	40	29,000
L.S. Cotton	2.4	1,500(viss)	0.8	500	0.6	300

Table 4E-14 Requirement of Fertilizers (Pilot)

Crops	Acreage	Urea		T.S.P.		Potash		Organic	
	(ac)	(lb/ac)	(ton)	(lb/ac)	(ton)	(lb/ac)	(ton)	(lb/ac)	(ton)
Paddy (L.I.V.)	1,000	56	25	28	13	0	0	2	2,000
Paddy (H.Y.V.)	2,000	112	102	84	76	28	25	6	12,000
G'nuts	600	28	8	28	8	0	0	4	2,400
Sesame	1,400	28	18	28	18	0	0	4	5,600
Gram	650	28	8	28	8	0	0	0	0
Sunflower	300	84	11	56	8	28	4	4	1,200
L.S. Cotton	100	84	4	56	3	28	1	4	400
Total			176		134		30		23,600
Unit Cost (@)		25kg/bag = K.9		50kg/bag = K.62.2		50kg/bag = K.30		K 10/ton	
Total cost (K)		63,360		166,696		18,000		236,000	

Table 4E-15 Requirement of Agro-Chemicals (Pilot)

Crops	Acreage (ac)	Unit (kg/ac)	Total (ton)	Unit Price* K/kg	Total Cost (K)	Remarks
Paddy	3,000	24	72.0	2.75	198,000	Lindane P065, P130 etc.
G'nuts	600	25	15.0	3.08	46,200	Lindane P065, P130, Aldrin 2.5%
Sesame	1,400	2	2.8	38.0	106,400	Lindane L20
Gram	650	25	16.3	2.72	44,200	Aldrin 2.5%, Lindane P065 etc.
Sunflower	300	2	0.6	38.0	22,800	Lindane L20
L.S. Cotton	100	20	2.0	2.75	9,500	Sevin, Thimet etc.
	6,050		108.7			

* Average price of insecticides and pesticides.

Table 4E-16

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WATER REQUIREMENT ON PUMP IRRIGATION AREA
=========================================

*--------------------------------------------------------------------------------*
                         JAN                 FEB                 MAR                 APR
                      1     2     3     4     5     6     7     8     9    10    11    12
*--------------------------------------------------------------------------------*

 PILOT SCHEME P.I.P. 3200AC (1295HA)

 W.R.       1000 M**3  348   388   452   434   414   330   389   513   547   544   582   536
 DISCHARGE M**3/SEC 0.41  0.45  0.53  0.51  0.48  0.39  0.46  0.60  0.54  0.63  0.68  0.63
 PUMP OPERATION  HR  205   228   266   255   244   194   229   302   322   320   342   315
*--------------------------------------------------------------------------------*
                         MAY                 JUN                 JUL                 AUG
                     13    14    15    16    17    18    19    20    21    22    23    24
*--------------------------------------------------------------------------------*

 PILOT SCHEME P.I.P. 3200AC (1295HA)

 W.R.       1000 M**3  245   140     0   403     0  1071     0  1215   903     0     0   389
 DISCHARGE M**3/SEC 0.29  0.17  0.00  0.47  0.00  1.24  0.00  1.41  1.05  0.00  0.00  0.46
 PUMP OPERATION  HR  144    83     0   237     0   629     0   714   531     0     0   229
*--------------------------------------------------------------------------------*
                         SEP                 OCT                 NOV                 DEC
                     25    26    27    28 .  29    30    31    32    33    34    35    36
*--------------------------------------------------------------------------------*

 PILOT SCHEME P.I.P. 3200AC (1295HA)

 W.R.       1000 M**3  924   126     0   437   213  1158   550   544   294    92   274   360
 DISCHARGE M**3/SEC 1.07  0.15  0.00  0.51  0.25  1.35  0.64  0.63  0.35  0.11  0.32  0.42
 PUMP OPERATION  HR  543    74     0   257   126   681   323   320   173    55   161   212
*--------------------------------------------------------------------------------*
                     TOTAL PUMP OPERATION HOUR
                     PILOT SCHEME P.I.P. 3200AC (1295HA)        8716
```

4E-3. Agricultures Mechanization (Pilot Scheme Area)

A. Selection of Farm Machinery

The selection of farm machinery to be used in the Area has been made in due consideration of the local climate and soil conditions in the Project Area, the proposed works and those practices, furthermore, the experiences of prevailing farm mechanization in Burma and other countries.

1. Tractors and Power tillers

Four wheel tractors of 50 HP class and two wheel power tillers of 8 HP are selected as the main power in this programme. This type of tractors and power tillers are most popularly introducing in the country at present in spite of high population of farm labours. This tendency is as same as would trend due to the requirement of high efficiency of higher horsepower machinery and suplemental work of insufficient cattle power. From the repair and maintenance point of view, present assembling of this type of tractors and power tillers in Burma would be helpful for mechanization.

The paddy cultivation practices such as ploughing, puddling, levelling, etc. are usually implemented in the muddy wet field. However, mechanical operation under said conditions in the Project Area will be low efficiency and/or difficult due to the soil characteristics, comparatively uneffective drainage and small plot of field under non-land consolidations, except very limited area. The other hand, land preparations for upland crops such as harrowing, drawing of sowing lines etc. should be carried out more carefully in the project compared to traditional method.

In those area, two wheel power tillers will be required to the supplementary operations of four wheel tractors and cattle power.

2. Attachments

As for the elementary attachments to the tractors and power tillers, the following type and size are selected on the basis of the experiences in Burma.

For ploughing:	Disc plough having 3 discs of 26".
For harrowing:	Offset disc harrow which consist of two gangs. Each gang will be equiped with 8 discs 24".

In addition to the above, rotarrator is proposed for final soil preparations by power tillers. The rotary harrowing is not popularly practiced in Burma at present, but it will be much applicable for preparation of good seed bed for paddy and upland crops.

3. Reapers

The harvester is broadly classified into three types by the mechanical difference. The combine harvester will be the most effective harvesting machinery, however, it will be required the drying facilities and high cost. Secondary, reaper binders will be usefull, however, the binding strings will be costly and requires foreign currency for import of strings every year.

Finaly, in the consideration of relatively low cost and high efficiency of machinery, the reapers which is removed binding apparatus, will be applicable for paddy harvesting.

The harvesting will be usually carried out after 10 or 15 days from the drainage operation. The traficability of the reapears will be satisfied.

4. Plant Protection Equipment

Very high efficiency plant protection equipment such as tractor driven power sprayers, boom sprayers, air blast sprayers, etc. would not use in the project area, because there are no farm road with non-land-consolidation. Therefore, plant protection machinery are selected by those limitted factors.

Knapsack type machinery will be usefull in the project area for spraying liquid chemicals, powder dust and/or granules.

B. Required Numbers of Farm Machinery

The number of farm machinery are studied on the basis of the operation programme, cropping patterns, workability specified in each machinery and workable days to be estimated hereinunder.

(1) Estimation of Workable Days and Working Hours a Day

The weather conditions were checked in connection with the workable days on the field operations. However, land preparation for paddy field and paddy transplanting works are able to carried out in the rain. Other farming practices are mostly arranged in the dry season. Therefore, the influence of rainfall are not so important in the consideration of workable days. The real net holidays including national holidays, Sunday, heavy rainfall days, religious holidays will be estimated in average at 3 or 5 day per month. Therefore, the workable days in each month are estimated at 26 days in average after the project.

It is assumed that the daily working hours of farm machinery are estimated at 8 hours in the normal conditions.

However, the draft cattles in the field operations will be 4 hours only per day as usual.

(2) Working Capacity and Efficiency in Each Machinery

Actual field working capacity and its efficiency in each practices of tractors such as land preparations are directly estimated on the basis of the results of various experiences made by Agricultural Mechanization Department (AMD). However, owing to limited experience on other machinery and equipment such as power tillers, reapers, and power sprayers, the efficiency are estimated by the references available in case of paddy cultivation in Japan and other Asian Countries.

(3) Total Coverage of Farm Machinery

In order to determine the most appropriate and economical number of machinery to be used in the project, a study was made on the cropping pattern and working conditions of farm machinery as mentioned before.

Land preparations;

The most critical part of land preparations will be graund nuts in November. It will be carried out 500 ac within half month (13 net working day). Mechanized land preparations should be covered by 100 percent, namely 500 ac, because cattle power would not be able to cover in this season.

The land preparations consists of ploughing and first harrowing by tractors, and second harrowing by power tillers.

This mechanized power of land preparations will also be utilized for 1,000 ac of sesame in February, 100 ac of ground nuts in May, 300 ac of paddy (L.I.V.) in May, 1,000 ac of paddy in June, 500 ac of paddy in July and 100 ac of cotton in October. Therefore, 3,500 ac of land preparation will be carried out per annum. It is about 57.9 percent of total cropping area in the Pilot Scheme Area.

Harvesting:

Another critical practice will be harvesting in the beginning of November due to the land preparation of 500 ac ground nuts. According to the cropping pattern, about 500 ac of high yielding varieties should be harvested within half month in November. Therefore, this portion should be mechanized by reapers.

This mechanized power of harvesting will be used by other part of paddy harvesting, namely latter half of November and first half of December. It will be able to cover 1,000 ac of paddy field. In other w$\overset{o}{}$rds, totaly 1,500 ac or 50 percent of paddy field will be covered by mechanized harvesting.

Plant Protection & Fertilization

Proposed work of the plant protection and fertilization will be undertaken by traditional ground spraying or dusting method. In this connection, power knapsack type sprayers equiped with long application pipe for powdery or granular type of agro-chemicals and fertilizers are selected in due consideration of the field conditions to be mostly under non-land-consolidation and small plot.

The utilization of power sprayers will be many times, for example, three times of additional fertilization and two times of agro-chemicals for paddy rice, eight times of agro-chemicals and one time fertilizer applications for cotton. Therefore, 3,000 ac should be covered within 10 days for one time application.

According to these considerations, actual required number and total coverage of farm machinery are as shown in the following table 1 & 2.

C. Ownership of Farm Machinery

According to the agricultural development plan, farm machinery will be introduced to villagetract cooperatives. In this case, utilization of farm machinery such as cordination of working programme, procedures of rental arrangement, short distance from pooling base to working farm field, would be very convinience compared to direct contract services by the Tractor Station, because the village-tract cooperatives have small teritories and good communications among member farmers.

However, rental charge of farm machinery will become higher than Tractor Stations' tractors. Therefore, the Government should be set up a low interest loan and/or subsidy system towards introduced farm machinery.

Table 4E-17 Actual Required Number of Farm Machinery

	Covering Acreage (ac)	Working Bags (day)	Covering Acreage/day	Actual Efficiency/Unit	Required Number	Standby	Total Unit
Plough (Ploughing)	500*	13	38.5	4ac/8hr	10	-	10
Harrow (Harrowing)	500	13	38.5	8 /8	5	-	5
Tractor (Primover)	-	-	-	-	-	-	15
Tiller (Harrowing)	500	13	38.5	2 /8	20	-	20
Reaper (Harvesting)	500**	13	38.5	2 /8	20	-	20
Sprayer (Application)	3,000***	10	3.00	50 /8	6	-	6

* Acreage of dry season groundnuts in November.
** Acreage of paddy (HYV) in November for land preparation of groundnuts in November.
*** Application acreage for chemicals or fertilizers or one operation in the paddy field.

Table 4E-18 Actual Coverage by Machinery

Operation / Crops	Paddy (L.I.V.)	Paddy (HYV)	G'nuts (Monsoon)	Sesame (Dry)	G'nuts (Dry)	L.S. Cotton	Sunflower	Gram	Total (ac)
Land Preparations	300	1,500	100	1,000	500	100	-	-	3,500
Harvesting	-	1,500	-	-	-	-	-	-	1,500
Plant Protection	3,000	6,000	200	2,800	1,000	800	300	650	14,750
Fertilizer Application	2,000	4,000	100	1,400	500	100	300	650	9,050

1. Investment Cost

Machinery	Unit No.	Cost per Unit* ($)	Total Cost* ($)	Remarks
Tractor	15	8,100	121,500	**
Disc Plough	10	560	5,600	
Disc Harrow	5	830	4,150	
Power Tiller	20	2,300	46,000	**
Reaper	20	1,730	34,600	
Power Sprayer	6	300	1,800	

* Market Price ** Made in Burma

2. Fixed Cost

Machinery	Purchasing Price ($)	Durable Period	Fixed Cost* Ratio (%)	Fixed Cost/Unit ($/year)	Coverage per unit (ac)	Total Cost per ac ($)	Remarks (Total coverage)
Tractor	8,100	8	20	1,620	467**	3.5	3,500
Disc Plough	560	5	24	134	350	0.38	3,500
Disc Harrow	830	5	24	199	700	0.28	3,500
Power Tiller	2,300	5	22	506	175	2.9	3,500
Reaper	1,730	5	22	381	75	5.1	1,500
Power Sprayer	300	5	20	60	3,967	0.015	23,800

* Includes depreciation ratio, repare cost ratio, garage cost ratio, tax & others ratio.

** Average between 10 unit of tractors for 350 ac per unit and 5 unit of tractors for 700 ac per unit.

3. Variable Cost

	Operation	Machinery	Ope. hour per ac	Fuel Consumption/hr (ℓ)	Fuel/ac (ℓ)	Unit Cost ($)	Fuel Cost ($)	Oil*** Cost ($)	Variable Cost/ac ($)
1.	Ploughing	Tractor + Plough	2	5.0*	10	0.15	1.5	0.45	1.95
2.	Harrowing	Tractor + Harrow	1	4.0*	4	0.15	0.6	0. 8	0.78
3.	Harrowing	Power Tiller	4	2.0*	8	0.15	1.2	0.36	1.56
4.	Harvesting	Reaper	4	1.5**	6	0.2	1.2	0.36	1.56
5.	Application	Power duster	0.2	1.0**	0.2	0.2	0.4	0.12	0.52

4. Total Variable Cost

Operation	Variable Cost/ac ($)	Total Coverage (ac)	Total variable Amount ($)
Ploughing	1.95	3,500	6,825
Harrowing (Tractor)	0.78	3,500	2,730
Harrowing (Power Tiller)	1.56	3,500	5,460
Harvesting	1.56	1,500	2,340
Application	0.52	23,800	12,376

5. Rental Charge

Machinery & Equipment	Fixed Cost ($)	Clerical Charge/ac ($)	Rental Fee/ac ($)
Tractor	3.5	0.2	3.7
Plough	0.38	0.1	0.48
Harrow	0.28	0.1	0.38
Power Tiller	2.9	0.2	3.1
Reaper	5.1	0.2	5.3
Power Sprayer	0.015	0.015	0.03

4E-4. Facilities and Personnel of Supporting Services (Pilot Scheme Area)

1. List of Equipment

A. Equipment for Extension & Training	($)
Audio-visual Divices	5,000
Office Equipment	32,000
Laboratory Equipment	36,000
Soil Testing Equipment	13,000
Farm Machinery for Applied Research	92,000
Farm Machinery for Training	182,000
Sub-total	360,000

B. Workshop Equipment for Farm Machinery	
Engine Service Equipment	3,360
Chassis Service Equipment	2,130
Electrical Testing Equipment	1,650
Meter Testing Equipment	1,040
General Facilities	4,900
Machine Shop Equipment	4,920
Furnance for Foundry & Accessories	10,000
Service Car	25,000
Office Equipment	10,000
Sub-total	63,000

C. Equipment for Seed Multiplication	
Farm Machinery for Seed Maltiplication	25,000
Storage Equipment	15,000
Office Equipment	10,000
Sub-total	50,000

D. Equipment for Applied Research	
Laboratory Equipment	50,000
Soil Testing Equipment	10,000
Office Equipment	40,000
Sub-total	100,000
Total	573,000

II. Vehicles

			($)
A. For Extension & Training			
Land Lover	3		
Motorcycles	2		
Bicycles	7		
		Sub-total	33,000
B. For Farm Mechanization			
Land Lover	3		
		Sub-total	30,000
C. For Seed Multiplication			
Land Lover	3		
		Sub-total	30,000
D. Applied Research			
Land Lover	6		
		Sub-total	60,000
		Total (II)	153,000

III. Salary & Wages

	No.	@ (K)	Annual Rate (K)	Amount (K)
A. Extension & Training				
Chief Extension Officer	1	500	6,000	6,000
Extension Officer	2	400	4,800	9,600
Ass. Extension Officer	2	350	4,200	8,400
V.T. Extension Agent	7	300	3,600	25,200
Driver	3	300	3,600	10,800
Sub-total				60,000
B. Farm Mechanization				
Project Head (PH)	1	500	6,000	6,000
Deputy PH	2	400	4,800	9,600
Workshop Staff	15	300	3,600	54,000
Mechanics	33	300	3,600	118,800
Driver	3	300	3,600	10,800
Sub-total				199,200

	No.	@ (K)	Annual Rate (K)	Amount (K)
C. Seed Multiplication				
Chief Seed Multiplication Officer	1	500	6,000	6,000
Seed Multiplication Officer	2	400	4,800	9,600
Dirver	3	300	3,600	10,800
Sub-total				26,400
D. Applied Research				
Plant Pathologist	1	500	6,000	6,000
Entomologist	1	500	6,000	6,000
Soil Chemist	1	500	6,000	6,000
Agronomist	1	500	6,000	6,000
Expert of Animal Husbandry	1	500	6,000	6,000
Expert of Farm Management	1	500	6,000	6,000
Driver	6	300	3,600	21,600
Sub-total				57,600
Total (III)				343,200

VI. Buildings & Housing (K 1,000)

A. Offices		
Project Office	(448 m^2)	
Guest House	(416 m^2)	
Staff Court	(122 m^2 x 6)	
Applied Research Centre	(256 m^2)	
Extension & Training Centre	(384 m^2)	
Dormitory	(240 m^2)	
Quarters	(90 m^2)	
Sub-total	2,656 m^2	2,922
B. Warehouse		
Warehouse	(150 m^2 x 3)	
Motor Pool	(675 m^2)	
Farm Machinery Workshop	(875 m^2)	
Sub-total	2,000 m^2	1,600

V. Operating Expenses

A. Extension & Training		($)
Heat & Light		6,000
Fuel & Lubricant		6,000
Others		5,000
	Sub-total	18,000
B. Farm Mechanization		
Heat & Light		10,000
Fuel & Lubricant		10,000
Others		5,000
	Sub-total	25,000
C. Seed Multiplication		
Heat & Light		4,000
Fuel & Lubricant		3,000
Others		3,000
	Sub-total	10,000
D. Apllied Research		
Heat & Light		4,000
Fuel & Lubricant		5,000
Others		5,000
	Sub-total	14,000
	Total	67,000

($1 = K6.45)

Table 4F-I Project Cost Estimate

Exchange Rate 1 US$ = 6.44 Kyats

Description	Total		Foreign Currency		Local Currency	
	$ '000	K '000	$ '000	K '000	$ '000	K '000
I. Pilot Scheme						
11. Civil Works						
11-1. Irrigation and Drainage Facilities	2,348	15,120	1,430	9,210	918	5,910
11-2. Land Consolidation	109	700	16	100	93	600
Sub-total	2,457	15,820	1,446	9,310	1,011	6,510
12. Construction Equipment	491	3,160	481	3,100	10	60
13. Agriculture Development	795	5,120	637	4,100	158	1,020
14. Operation and Maintenance	290	1,870	73	470	217	1,400
15. Project Facilities	750	4,830	92	590	658	4,240
16. Expert Service	776	5,000	652	4,200	124	800
17. Consulting Services	569	3,660	509	3,280	60	380
Sub-total	6,128	39,460	3,890	25,050	2,238	14,410
18. Contingency	622	3,940	388	2,500	224	1,440
Sub-total	6,750	43,400	4,278	27,550	2,462	15,850
19. Price Escalation	1,150	7,370	730	4,680	420	2,690
Total of Pilot Scheme	7,890	50,770	5,008	32,230	2,882	18,540
II. Final Design						
21. Irrigation & Drainate	552	3,556	495	3,187	57	369
22. Hydro Power	148	952	133	854	15	98
Total of Final Design	700	4,508	628	4,041	72	467
III. First Phase Implementation						
31. Civil Works						
31-1. Preparation	689	4,439	-	-	689	4,439
31-2. Diversion Dam	3,265	21,027	928	5,974	2,337	15,053
31-3. Irrigation Draiange	3,606	23,225	1,252	8,066	2,354	15,159
31-4. On-farm	568	3,662	78	507	490	3,155
31-5. Pre-engineering	129	832	41	263	88	569
Sub-total	8,257	53,185	2,299	14,810	5,958	38,375
32. Compensation	-	-	-	-	-	-
33. Construction Equipment	10,523 (7,692)	67,770 (49,536)	10,419 (7,692)	67,098 (49,536)	104 (-)	672 (-)
34. Agriculture Development	151	970	-	-	151	970
35. Operation & Maintenance	248	1,600	248	1,600	-	-
36. Project Facilities	287	1,848	31	200	256	1,648
37. Project Administration	1,056	6,800	-	-	1,056	6,800
38. Consulting Services	370	2,382	332	2,136	38	246
Sub-total	20,892	134,555	13,329	85,844	7,563	48,711
39. Contingency	3,134	20,183	2,000	12,877	1,134	7,306
Sub-total	24,026	154,738	15,329	98,721	8,697	56,017
40. Price Escalation	8,414	54,162	5,371	34,579	3,043	19,583
Total of First Phase	32,440	208,900	20,700	133,300	11,740	75,600

Description	Total		Foreign Currency		Local Currency	
	$ '000	K '000	$ '000	K '000	$ '000	K '000
IV. Second Phase Implementation						
A. Irrigation						
41. Civil Works						
41-1. Preparation	689	4,438	-	-	689	4,438
41-2. Main Dam	9,018	58,077	1,833	11,802	7,185	46,275
41-3. Paukkaung Area	76	488	33	215	43	273
41-4. Irrigation Drainage	3,607	23,226	1,253	8,067	2,354	15,159
41-5. On-farm	569	3,662	79	508	490	3,154
41-6. Pre-engineering	130	833	41	263	89	570
Sub-total	14,089	90,724	3,239	20,855	10,850	69,869
42. Compensation	224	1,445	-	-	224	1,445
43. Construction Equipment	9,480 (6,930)	61,050 (44,631)	9,387 (6,930)	60,452 (44,631)	93 (-)	598 (-)
44. Agriculture Development	152	980			152	980
45. Operation & Maintenance	109	700	-	-	109	700
46. Project Facilities	288	1,852	31	200	257	1,652
47. Project Administration	1,559	10,040	-	-	1,559	10,040
48. Consulting Services	405	2,607	363	2,336	42	271
Sub-total	26,306	169,398	13,020	83,843	13,286	85,555
49. Contingency	4,029	25,948	2,027	13,059	2,002	12,889
Sub-total	30,335	195,346	15,047	96,902	15,288	98,444
50. Price Escalation	10,803	69,608	5,432	35,001	5,371	34,607
Total	41,138	264,954	20,479	131,903	20,659	133,051
B. Hydro Power Scheme						
51. Civil Works						
51-1. Water-way & Penstock	158	1,019	121	780	37	239
51-2. Power House	468	3,012	216	1,393	252	1,619
51-3. Tail Race	152	977	80	515	72	462
51-4. Machine & Equipment	2,026	13,050	2,006	12,920	20	130
51-5. Transmission Line	350	2,250	305	1,965	45	285
Sub-total	3,154	20,308	2,728	17,573	426	2,735
52. Administration	379	2,437	-	-	379	2,437
53. Consulting Services	209	1,347	187	1,208	22	139
Sub-total	3,742	24,092	2,915	18,781	827	5,311
54. Contingency	540	3,486	456	2,935	84	551
Sub-total	4,282	27,578	3,371	21,716	911	5,862
55. Price Escalation	1,550	9,980	1,227	7,900	323	2,080
Total	5,832	37,558	4,598	29,616	1,234	7,942
Total of Second Phase	46,970	302,512	25,077	161,519	21,893	140,993
Grand Total	88,000	566,690	51,413	331,090	36,587	235,600

Table 4F-2 Breakdown of Construction Cost

						Foreign Currency			Local Currency		
Item	Description	Quantity	Unit	Rate (Kyat)	Total Cost (K '000)	Depreciation (K '000)	Material (K '000)	Total (K '000)	Fuel, Repair & Material (K '000)	Labor (K '000)	Total (K '000)
I	Pilot Scheme										
11	Civil Works										
11-1	Irrigation & Drainage Facilities										
	Pumping Station 450mmx3		set		6,423	40	5,900	5,940	13	470	483
	Pipe Line	1,500	m		2,177	60	2,100	2,160	1	16	17
	Check weir civil works				670	-	-	-	70	600	670
	Gate				950	50	900	950	-	-	-
	Irrigation canal & structure				1,742	15	145	160	140	1,542	1,582
	On farm & structure				2,807	-	-	-	-	2,807	2,807
	Drainage facilities				351	-	-	-	-	351	351
					15,120			9,210			5,910
11-2	Land Consolidation										
	Land Leveling	170	ha		253	30	-	30	13	210	223
	Field ditch	34,000	m		123	-	-	-	-	123	123
	Field drainage Ditch	34,000	m		75	-	-	-	-	75	75
	Structure	1	L.S.		249	-	70	70	9	170	179
					700			100			600
	Sub-total				15,820			9,310			6,510
12.	Construction Equipment	1	L.S.		3,160	3,100	-	3,100	-	60	60
13.	Agricultural Development	1	L.S.		5,120	-	4,100	4,100	620	400	1,020
14.	Operation & maintanance	1	L.S.		1,870	-	470	470	-	1,400	1,400
15.	Project Facilities	1	L.S.		4,830	-	590	590	3,950	290	4,240
16.	Expert Service	1	L.S.		5,000	-	4,200	4,200	200	600	800
17.	Consulting Service	1	L.S.		3,660	-	3,280	3,280	-	380	380
	Sub-total				39,460			25,050			14,410
18.	Contingency	(10%)			3,940			2,500			1,440
	Sub-total				43,400			27,550			15,850
19.	Price Escalation	(17%)			7,370			4,680			2,690
	Total of Pilot Scheme				50,770			32,230			18,540
II.	Final Design										
21.	Irrigation Drainage	1	L.S.		3,556	-	3,187	3,187	-	369	369
22.	Hydro-power	1	L.S.		952			854			98
	Total of Final Design				4,508			4,041			467
III.	First Phase Implementation										
31.	Civil Works										
31-1	Preparation										
	Temporary canal	1	L.S.		2,510				1,510	1,000	2,510
	Access road	1	L.S.		1,610				910	700	1,610
	Irrigation & Drainage	1	L.S.		319				151	168	319
					4,439				2,571	1,868	4,439

Item	Description	Quantity	Unit	Rate (Kyat)	Total Cost (K '000)	Foreign Currency			Local Currency		
						Depre-ciation (K '000)	Material (K '000)	Total (K '000)	Fuel, Re-pair & Material (K '000)	Labor (K '000)	Total (K '000)
31-2	Diversion Dam										
31-2-1	Dam Works										
	Stripping	116,840	cu.yd	5.48	640.3	464.9	-	464.9	44.7	130.7	175.4
	Common Excavation	843,080	"	5.75	4,847.7	3,160.5	-	3,160.5	322.5	1,364.7	1,687.2
	Soft Rock Excavation	93,840	"	8.43	791.1	415.9	-	415.9	43.0	332.0	375.2
	Coffer Dam	35,070	"	12.95	454.2	324.3	-	324.3	40.2	89.7	129.9
	Embankment Zone I	281,420	"	12.95	3,644.4	2,531.1	-	2,531.1	345.2	768.1	1,113.3
	" Zone II, II'	777,440	"	11.81	9,181.6	6,538.4	-	6,538.4	832.2	1,811	2,643.2
	" Zone II, II'	202,640	"	2.96	599.8	417.7	-	417.7	61.9	120.2	182.1
	" Zone III	3,000	"	38.64	116.1	33.6	-	33.6	5.5	77	82.5
	Riprap	30,880	"	40.55	1,252.3	306.8	-	306.8	56.6	888.9	945.5
	Filter	9,410	"	55.43	521.7	301.7	-	301.7	51.1	168.9	220.0
	Instruments for observation		set		167.4	-	152.2	152.2	-	15.2	15.2
	Miscellaneous		-		323.4	0.1	0.8	0.9	90.1	232.4	322.5
	Sub-total				22,540	14,495	153	14,648	1,893	5,999	7,892
31-2-2	Grout Works										
	Drilling of Grout hole	44,260	ft	25.89	1,145.9	942.3	-	942.3	123.1	80.5	203.6
	Grouting	44,260	"	100.70	4,457.1	2,430.0	-	2,430.0	1,637.5	389.6	2,027.1
	Miscellaneous				224.0	0.7	-	0.7	176.4	46.9	223.3
	Sub-total				5,827	3,373	-	3,373	1,937	517	2,454
31-2-3	Spillway Works										
	Common Excavation	324,120	cu.yd	7.24	2,346.6	1,634.2		1,634.2	198.1	514.3	712.4
	Soft Rock Excavation	81,010	"	10.07	815.8	532.3		532.3	61.9	221.6	283.5
	Backfill	45,530	"	5.28	240.4	135.7		135.7	17.4	87.3	104.7
	Reinforced Concrete	349,200	cu.ft	6.49	2,266.3	277.2		277.2	1,925.6	63.5	1,989.1
	Formwork	159,850	sq.ft	3.40	543.5	-		-	271.7	271.8	543.5
	Reinforcement bar	495	ton	6,645.2	3,289.4	-	3,252.2	3,252.2	-	37.2	37.2
	Riprap	1,410	cu.yd	40.63	57.1	14.3		14.3	2.6	40.2	42.8
	Miscellaneous				208.9	0.3	0.8	1.1	123.7	84.1	207.8
	Sub-total				9,768	2,594	3,253	5,847	2,601	1,320	3,921
31-2-4	Intake Works										
	Excavation (a)	27,240	cu.yd	1.7	46.3	30.9		30.9	4.2	11.2	15.4
	" (b)	6,800	"	5.18	35.2	23.5		23.5	2.6	9.1	11.7
	" (c)	7,060	"	1.70	12.0	8.0		8.0	1.1	2.9	4.0
	" (d)	4,690	"	5.18	24.3	16.1		16.1	1.8	6.4	8.2
	Backfill	5,600	"	2.82	15.8	10.6		10.6	1.3	3.9	5.2
	Reinforced concrete	73,000	cu.ft	6.49	473.8	-	-	-	-	26.4	473.8
	Formwork	64,030	sq.ft	3.40	217.7	-	-	-	108.8	108.9	217.7
	Reinforcing bar	163	ton	6,645.2	1,083.1	-	1,070.9	1,070.9	-	12.2	12.2
	Screen	5.5	ton	5,000	27.5	-	27.5	27.5	-	-	-
	Gate	21.6	"	68,000	1,468.8	-	1,468.8	1,468.8	-	-	-
	Miscellaneous				39.5	0.9	0.8	1.7	5.2	32.6	37.8
	Sub-total				3,444 (3,354)	90 (-)	2,568 (2,568)	2,758 (2,568)	125 (125)	661 (661)	786 (786)

						Foreign Currency			Local Currency		
Item	Description	Quantity	Unit	Rate (Kyat)	Total Cost (K '000)	Depreciation (K '000)	Material (K '000)	Total (K '000)	Fuel, Repair & Material (K '000)	Labor (K '000)	Total (K '000)
	Total of Diversion Dam				41,578	20,552	5,974	26,526	6,557	8,497	15,053
	- do - Excluding Depreciation Cost				21,027						
31-3.	Irrigation & Drainage										
	Irrigation Facilities	11,695	ha		25,351	2,126	8,066	10,192	219	14,940	15,159
	Drainage Facilities	-	"		-	-	-	-	-	-	-
	Road Facilities	-	"		-	-	-	-	-	-	-
	Total				25,351	2,126	8,066	10,192	219	14,940	15,159
	Excluding Depraciation cost				23,225						
31-4	On-farm										
	Main water course	11,695	m		459	4	43	47	83	329	412
	Supplemental water course	654,920	"		2,563	21	237	258	461	1,844	2,305
	Drainage Ditch	133,323	"		201	12	132	144	11	46	57
	Diversion Box	2,573	ps.		412	-	84	84	66	261	327
	Off take	11,695	"		12	-	-	-	3	9	12
	Enc Check	327	"		52	-	11	11	8	34	42
	Total				3,699	37	507	544	632	2,523	3,155
	Excluding Depreciation cost				3,662						
31-5	Pre-Engineering										
31-5-1	Survey works										
	Topographical survey										
	Main Dam Site	63	ac					0.340			0.565
	Diversion Dam Site	167	"					0.900			1.500
	Pilot Scheme	1,600	"					8.640			14.400
	Profile survey										
	Main Dam										
	Dam Axis	1,000	ft					0.030			0.060
	Spillway	2,250	"					0.005			0.015
	Intake	1,000	"					0.005			0.005
	Diversion canal	1,000	"					0.005			0.005
	Access road	41,000						0.125			0.245
	Diversion Dam										
	Dam Axis	2,150	"					0.005			0.010
	Spillway	1,350	"					0.005			0.010
	Intake	350	"					0			0
	Access road	28,000	"					0.080			0.170
	Irrigation and drainage canal	692,000	"					2.075			4.150
	Cross Section										
	Main Dam										
	Dam Axis	15,000	"					0.045			0.090
	Spillway	5,600	"					0.015			0.035
	Intake	1,500	"					0.065			0.010
	Diversion Canal	1,500	"					0.005			0.010
	Access road	10,250	"					0.030			0.060

						Foreign Currency			Local Currency		
Item	Description	Quantity	Unit	Rate (Kyat)	Total Cost (K '000)	Depreciation (K '000)	Material (K '000)	Total (K '000)	Fuel, Repair & Material (K '000)	Labor (K '000)	Total (K '000)
	Diversion Dam										
	Dam Axis	10,750	ft.					0.030			0.065
	Spillway	2,800	"					0.010			0.015
	Intake	1,400	"					0.005			0.010
	Access road	700	"					0			0.005
	Irrigation and drainage canal	461,500	"					1.385			2.770
	Sub-total							13.745			24.205
31-5-2	Geological Investigation										
	Main Dam										
	Seismic exploration	18,000	"								
	Bore hole drilling										
	Dam site	280	"					8.400			14.000
	Spillway	70	"					2.100			3.500
	Intake	75	"					2.250			3.750
	Quarry site	200	"					6.000			10.000
	Diversion Dam										
	Seismic exploration										
	Dam axis	3,150	"					6.300			126.000
	Spillway	1,300	"					2.600			5.200
	Bore hole drilling										
	Dam site	250						75.000			125.000
	Spill Way	70						21.000			3.500
	Intake	35						1.050			1.750
	Irrigation and drainage canal										
	Bore hole drilling	2,755	"					82.65			165.3
	Site transportation	1	L.S.					12.805			0.145
	Sub-total							220.155			458.145
31-5-3	Material Investigation										
	Main Dam										
	Aggregate pipe	1	L.S.								11.400
	Insitu test	1	L.S.					1.000			2.000
	Laboratory test	1	L.S.					16.500			33.000
	Diversion Dam										
	Aggregate pite	1	L.S.					-			7.600
	Insitu test	1	L.S.					0.750			1.250
	Laboratory test	1	L.S.					11.000			22.000
	Sub-total							29.250			77.250
31-5-4	Soil Survey	1	L.S.					—			9.401
	Total							263			569
	Total of 31				53,185			14,810			38,375
32	Compensation	-	-	-	-	-	-	-	-	-	-
33	Construction equipment (Please see the Breakdown)	1	L.S.		67,770	-	-	67,098	-	-	672
34.	Agriculture Development										
34-1.	Cadastral survey	1	L.S.		250				125	125	250
34-2.	Working Station	1.5	House	150	220				150	70	220

						Foreign Currency			Local Currency		
Item	Description	Quantity	Unit	Rate (Kyat)	Total Cost (K '000)	Depre-ciation (K '000)	Material (K '000)	Total (K '000)	Fuel, Repair & Material (K '000)	Labor (K '000)	Total (K '000)
34-3	Wages for 4 years	2	years	250	500				-	500	500
	Total				970				275	695	970
35.	Operation & Maintenance										
35-1	Equipments	1	L.S.		1,600	-	1,600	1,600			
	Total				1,600		1,600	1,600			
36.	Project Facilities										
36-1	Building of Office	1	L.S.		1,000	-	-	-	1,000	-	1,000
36-2	Office furniture	1	L.S.		148	-	-	-	148	-	148
36-3	Office equipment	1	L.S.		350	-	100	100	250	-	250
36-4	Office, the other equipments and parts	1	L.S.		350	-	100	100	250	-	250
	Total				1,848			200	1,648		1,648
37.	Project Administration										
37-1	Project Administration	1	L.S.		6,800	-	-	-	-	-	6,800
38.	Consulting Service										
38-1	Consulting Service	1	L.S.		2,382	-	2,136	2,136	-	246	246
	Sub-total				134,555			85,844			48,711
39.	Contingency										
39-1	Contingency (15%)				20,183	-	-	12,877	-	-	7,306
	Sub-total				154,738			98,721			56,017
40.	Price Escalation										
40-1	Price Escalation (35%)				54,162	-	-	34,579	-	-	19,583
	Total of First Phase				208,900			133,300			75,600
IV.	Second Phase Implementation										
A.	Irrigation										
41.	Civil Works										
41-1	Preparation										
	Main dam										
	Temporary canal	1	L.S.		730			-	430	300	730
	Water Supply facilities	1	L.S.		50			-	35	15	50
	Drainage Facilities	1	L.S.		140			-	100	40	140
	Scaffold	1	L.S.		110			-	50	60	110
	Miscellaneous Works	1	L.S.		710			-	410	300	710
	Sub-total								1,025	715	1,740
41-2	Diversion dam Temporary canal	1	L.S.		620			-	420	200	620
	Water Supply Facilities	1	L.S.		40			-	20	20	40
	Drainage Facilities	1	L.S.		900			-	500	400	900
	Scaffold	1	L.S.		70			-	28	42	70
	Miscellaneous Works	1	L.S.		650			-	350	300	650
	Sub-total								1,318	962	2,280
41-3	Paukkaung Area	1	L.S.		5			-	2	3	5
41-4	Irrigation & Drainage facilities	1	L.S.		606			-	135	152	287
41-5	On-farm	1	L.S.		126			-	66	60	126
	Sub-total								203	215	418
	Total				4,438				2,546	1,892	4,438

Item	Description	Quantity	Unit	Rate (Kyat)	Total Cost (K '000)	Foreign Currency			Local Currency		
						Depreciation (K '000)	Material (K '000)	Total (K '000)	Fuel, Repair & Material (K '000)	Labor (K '000)	Total (K '000)
41-2	Main Dam										
41-2-1	Dam Works										
	Stripping	457,430	cu.yd	5.48	2,506.7	1,820.0		1,820.0	175.0	511.7	686.7
	Common Excavation	104,550	"	5.75	601.7	392.0	-	392.0	40.0	169.2	209.2
	Soft Rock Excavation	26,190	"	8.43	220.8	116.0	-	116.0	12.0	92.8	104.8
	Coffer Dam	65,400	"	12.95	947.0	605.0	-	605.0	75.0	167.0	242.0
	Embankment Zone I	1,386,510	"	12.95	17,955.3	12,826.0	-	12,826.0	1,590.0	3,539.3	5,129.3
	" Zone II, II'	4,256,300	"	11.81	50,266.9	35,796.2	-	35,796.2	4,555.9	9,194.8	14,470.7
	" Zone II, II'	557,740	"	2.96	1,650.9	1,149.7	-	1,149.7	170.3	330.9	501.2
	" Zone III	26,200	"	38.64	1,012.5	292.0	-	292.0	48.0	672.5	720.5
	Riprap	235,340	"	40.55	9,543.2	2,340.0	-	2,340.0	432.0	6,771.2	7,203.2
	Filter	143,900	cu.yd	55.43	7,976.3	4,609.0	-	4,609.0	781.0	2,586.3	3,367.3
	Instruments for observation		No		167.4	-	152.2	152.2	-	15.2	15.2
	Miscellaneous		-		1,407.8	0.1	0.8	0.9	393.8	1,013.1	1,406.9
	Sub-total				94,156 (34,210)	59,946 (-)	153 (153)	60,099 (153)	8,273 (8,273)	25,784 (25,784)	34,057 (34,057)
41-2-2	Grout Works										
	Drilling of Grout hole	78,690	ft.	25.89	2,037.2	1,675.2	-	1,675.2	219.0	143.0	362.0
	Grouting	78,690	"	15.82	1,244.9	379.2	-	379.2	634.8	230.9	865.7
	Miscellaneous		set		123.9	0.6	-	0.6	85.2	38.1	123.3
	Sub-total				3,406 (1,351)	2,055 (-)	- (-)	2,055 (-)	939 (939)	412 (412)	1,351 (1,351)
41-2-3	Spillway Works										
	Common Excavation	901,780	cu.yd	7.24	6,528.9	4,546.7	-	4,546.7	551.1	1,431.1	1,982.2
	Soft Rock Excavation	212,910	"	10.07	2,144.0	1,399.2	-	1,399.2	162.7	582.1	744.8
	Backfill	67,630	"	5.28	357.1	201.6	-	201.6	25.9	129.6	155.5
	Reinforced concrete	581,990	cu.ft	6.49	3,777.1	462.0	-	462	3,209.3	105.8	3,315.1
	Formwork	266,410	sq.ft	3.40	905.8	-	-	-	452.9	452.9	905.8
	Reinforcing bar	825	ton	6,645.2	5,482.3	-	5,420.3	5,420.3	-	62.0	62.0
	Riprap	640	cu.yd	40.63	26.0	6.4	-	6.4	18.4	1.2	19.6
	Miscellaneous		-		408.8	0.1	0.7	0.8	221.7	186.3	408.0
	Sub-total				19,630 (13,014)	6,616 (-)	5,421 (5,421)	12,037 (5,421)	4,642 (4,642)	2,951 (2,951)	7,539 (7,593)
41-2-4	Intake works										
(1)	Main Intake										
	Common Excavation	44,940	cu.yd	5.51	247.6	157.8	-	157.8	17.2	72.6	89.8
	Soft Rock Excavation	11,210	"	7.05	79.0	49.9	-	49.9	5.2	23.9	29.1
	Backfill	43,330	"	8.24	357.0	105.9	-	105.9	19.9	231.2	251.1
	Reinforced concrete	261,020	cu.ft	6.49	1,694.0	207.2	-	207.2	1,439.4	47.4	1,486.8
	Formwork	100,320	sq.ft	3.40	341.1	-	-	-	170.5	170.6	341.1
	Reinforcing bar	298	ton	6,645.2	1,980.3	-	1,957.9	1,957.9	-	22.4	22.4

						Foreign Currency			Local Currency		
Item	Description	Quantity	Unit	Rate (Kyat)	Total Cost (K '000)	Depre-ciation (K '000)	Material (K '000)	Total (K '000)	Fuel, Re-pair & Material (K '000)	Labor (K '000)	Total (K '000)
	Steel pipe (Dia 9.00 ft)	680	ft	3,261.2	2,217.6	-	1,865.0	1,865.0	-	352.6	352.6
	Steel pipe (Dia 6.00 ft)	110	"	1,603.6	176.4	-	149.6	149.6	-	26.8	26.8
	Sluice valve (Dia 6.00 ft)		No		430.0	-	387.0	387	-	43.0	43.0
	Jet Flow Gate (Dia 6.00 ft)		set		1,205.0	-	1,000.0	1,000	-	205.0	205.0
	Miscellaneous		-		155.0	0.2	0.5	0.7	82.8	71.5	154.3
	Sub-total				8,883 (8,362)	521 (-)	5,360 (5,360)	5,881 (5,360)	1,735 (1,735)	1,267 (1,267)	3,002 (3,002)
(2)	Second Intake										
	Common Excavation	15,990	cu.yd	5.51	88.1	56.1	-	56.1	6.1	25.9	32.0
	Soft Rock Excavation	3,900	"	7.05	27.5	17.4	-	17.4	1.8	8.3	10.1
	Backfill	17,800	"	5.76	102.5	59.8	-	59.8	8.2	34.5	42.7
	Reinforced concrete	11,630	cu.ft	6.49	75.5	9.2	-	9.2	64.2	2.1	66.3
	Formwork	6,350	sq.ft	3.40	21.6	-	-	-	10.8	10.8	21.6
	Reinforcing bar	14	ton	6,645.2	93.1	-	92.0	92	-	1.1	1.1
	Steel pipe (Dia 2.00 ft)	470	ft	287.2	135.0	-	122.1	122.1	-	12.9	12.9
	Sluice value (Dia 2.00 ft)		No		40.3	-	36.3	36.3	-	4.0	4.0
	Jet Flow Gate (Dia 2.00 ft)		set		685.0	-	617.0	617.0	-	68.0	68.0
	Miscellaneous		-		14.4	0.5	0.6	1.1	4.9	8.4	13.3
	Sub-total				1,283 (1,140)	143 (-)	868 (868)	1,011 (868)	96 (96)	176 (176)	272 (272)
	Total of Main Dam				127,358	69,281	11,802	81,083	15,685	30,590	46,275
	-do- Excluding Depreciation Cost				58,077						
41-3	Paukkaung Area										
	On-farm	620	ha		200	4	31	35	34	131	165
	Irrigation & Drainage facilities	1,130	m		296	4	184	188	43	65	108
	Total				496	8	215	223	77	196	273
	Excluding Depresiation Cost				488						
41-4	Irrigation & Drainage										
	Irrigation Facilities	11,695	ha		23,155	1,956	7,422	9,378	377	13,400	13,777
	Drainage Facilities	23,390	"		1,192	170	645	815	-	377	377
	Road Facilities	23,390	"		1,005	-	-	-	805	200	1,005
	Total				25,352	2,126	8,067	10,193	1,182	13,977	15,159
	Excluding Depreciation Cost				23,226						
41-5	On-farm										
	Main water course	11,695	m		459	4	43	47	83	329	412
	Supplemental water course	654,920	m		2,563	21	237	258	461	1,844	2,305
	Drainage ditch	133,323	m		201	12	132	144	11	46	57
	Division box	2,573	ps		411	-	84	84	66	261	327

						Foreign Currency			Local Currency		
Item	Description	Quantity	Unit	Rate (Kyat)	Total Cost (K '000)	Depreciation (K '000)	Material (K '000)	Total (K '000)	Fuel, Repair & Material (K '000)	Labor (K '000)	Total (K '000)
	Off take	11,695	ps		12	-	-	-	3	9	12
	End check	327	"		53	-	12	12	7	34	41
	Total				3,699	37	508	545	631	2,523	3,154
	Excluding Depreciation cost				3,662						
41-6	Pre-Engineering										
41-6-1	Survey works										
	Topographical survey										
	Main Dam Site	63	ac					0.340			0.565
	Diversion Dam Site	167	"					0.900			1.500
	Pilot Scheme	1,600	"					8.640			14.400
	Profile survey										
	Main Dam										
	Dam Axis	1,000	ft					0.030			0.060
	Spillway	2,250	"					0.005			0.015
	Intake	1,000	"					0.005			0.005
	Diversion canal	1,000	"					0.005			0.005
	Access road	41,000						0.125			0.245
	Diversion Dam										
	Dam Axis	2,150	ft					0.005			0.010
	Spillway	1,350	"					0.005			0.010
	Intake	350	"					0			0
	Access road	26,000	"					0.080			0.170
	Irrigation and drainage canal	692,000						2.075			4.150
	Cross Section										
	Main Dam										
	Dam Axis	15,000	ft					0.045			0.090
	Spillway	5,600	"					0.015			0.035
	Intake	1,500	"					0.065			0.010
	Diversion Canal	1,500	"					0.005			0.010
	Access road	10,250	"					0.030			0.060
	Diversion Dam										
	Dam Axis	10,750	"					0.030			0.065
	Spillway	2,800	"					0.010			0.015
	Intake	1,400	"					0.005			0.010
	Access road	700	"					0			0.005
	Irrigation and drainage canal	461,500						1.385			2.770
	Sub-total							13.745			24.205
41-6-2	Geological Investigation										
	Main Dam										
	Seismic exploration	18,000	ft								
	Bore hole drilling										
	Dam site	280	"					8.400			14.000
	Spillway	70	"					2.100			3.500
	Intake	75	"					2.250			3.750

						Foreign Currency			Local Currency		
Item	Description	Quantity	Unit	Rate (Kyat)	Total Cost (K '000)	Depreciation (K '000)	Material (K '000)	Total (K '000)	Fuel, Repair & Material (K '000)	Labor (K '000)	Total (K '000)
	Quarry site	200	ft					6.000			10.000
	Diversion Dam										
	Seismic exploration										
	Dam axis	3,150	"					6.300			126.000
	Spillway	1,300	"					2.600			5.200
	Bore hole drilling										
	Dam site	250	"					75.00			125.000
	Spillway	70	"					21.000			3.500
	Intake	35	"					1.050			1.750
	Irrigation and Drainage canal										
	Bore hole drilling	2,755	ft					82.65			165.3
	Site transportation	1	L.S.					12.805			0.145
	Sub-total							220.155			458.145
41-6-3	Material Investigation										
	Main Dam										
	Aggregate pipe	1	L.S.								11.400
	Insitu test	1	L.S.					1.000			2.000
	Laboratory test	1	L.S.					16.500			33.000
	Diversion Dam										
	Aggregate pite	1	L.S.								7.600
	Insitu test	1	L.S.					0.750			1.250
	Laboratory test	1	L.S.					11.000			22.000
	Sub-total							29.250			77.250
41-6-4	Soil Survey	1	L.S.								10.400
	Total				833			263			570
	Sub-total				90,724			20,855			69,869
42.	Compensation										
	Transportation of house shefting	1	L.S.		240				120	120	240
	Preparation of house Area	1	L.S.		675				423	252	675
	Facilities of housing	1	L.S.		240				240	-	240
	Electric & Water Facilities	1	L.S.		143				143	-	143
	Compensation	200	house	500	100				100	-	100
	Miscellaneous	1	L.S.		47				-	47	47
	Total				1,445				1,026	419	1,445
43	Construction Equipment										
43-1	Construction Equipment	1	L.S.		61,050			60,452			598
	Total				61,050			60,452			598
44	Agriculture Development										
44-1	Agricultural Development										
44-2	Cadastral survey	1	L.S.		250				125	125	250
44-3	Working Station	1.5	house	150	230				150	80	230
44-4	Wages for 4 years	2	years	250	500					500	500
	Total				980				275	705	980

Item	Description	Quantity	Unit	Rate (Kyat)	Total Cost (K '000)	Foreign Currency			Local Currency		
						Depreciation (K '000)	Material (K '000)	Total (K '000)	Fuel, Repair & Material (K '000)	Labor (K '000)	Total (K '000)
45	Operation & Maintenance										
45-1	Salary & Wages	1	L.S.		300					300	300
45-2	Equipment Operator	1	L.S.		200					200	200
45-3	Material	1	L.S.		100				100	-	100
45-4	Administration	1	L.S.		100				-	100	100
	Total				700				100	600	700
46	Project Facilities										
46-1	Building of Office	1	L.S.		1,000	-	-	-	1,000	-	1,000
46-2	Office furniture	1	L.S.		152	-	-	-	152	-	152
46-3	Office equipment	1	L.S.		350	-	100	100	250	-	250
46-4	Office, the other equipments and parts	1	L.S.		350	-	100	100	250	-	250
	Total				1,852	-		200	1,652	-	1,652
47	Project Administration										
47-1	Project Administration	1	L.S.		10,040	-	-	-	-	-	10,040
48	Consulting Service	1	L.S.		2,607	-	2,336	2,336	-	271	271
	Sub-total				169,398	-	-	83,843	-	-	85,555
49	Contingency										
49-1	Contingency (15%)				25,948	-	-	13,059	-	-	12,889
	Sub-total				195,346	-	-	96,902	-	-	98,444
50	Price Escalation										
50-1	Price Escalation 35%)				69,608	-	-	35,001	-	-	34,607
	Total				264,954	-	-	131,903	-	-	133,051
B.	Hydro Power Scheme										
51	Civil Works										
51-1	Water way & Penstock	1	L.S.		1,019	-	780	780	100	139	239
51-2	Power House	1	house		3,012	-	1,393	1,393	1,039	580	1,619
51-3	Tail Race	1	set		977	-	515	515	326	136	462
51-4	Machine equipment	1	L.S.		13,050	-	12,920	12,920	-	130	130
51-5	Transmission	1	L.S.		2,250	-	1,965	1,965	150	135	285
	Sub-total				20,308			17,573			2,735
52	Administration										
52-1	Administration				2,437	-	-	-	-	-	2,437
53	Consulting Service										
53-1	Consulting Service				1,347	-	-	1,208	-	-	139
	Sub-total				24,092	-	-	18,781	-	-	5,311
54	Contingency										
54-1	Contingency (15%)				3,486	-	-	2,935	-	-	551
	Sub-total				27,578	-	-	21,716	-	-	5,862
55	Price Escalation (35%)				9,980	-	-	7,900	-	-	2,080
	Total				37,558	-	-	29,616	-	-	7,942
	Total of Second Phase				302,512	-	-	161,519	-	-	140,993
	Grand Total				566,690			331,090			235,600

Table 4F-3 Cost Estimate for Consulting Services

Unit: Kyats '000
1 US$ = 6.44 Kyats

Item		Pilot Scheme		First Phase		Second Phase		Hydro Power	
I. Final Design									
1. Foreign Currency									
Engineers		22 M-M	1,430	45 M-M	2,925		-	12 M-M	780
International Travel		6 Travels	48	9 Travels	72		-	3 Travels	24
Miscellaneous		L.S.	92	L.S.	190		-	L.S.	50
Sub-total	(K '000)		1,570		3,187		-		854
	($ '000)		244		495		-		133
2. Local Currency									
Per diem & Other		L.S.	180	L.S.	369		-	L.S.	98
Sub-total	(K '000)		180		369		-		98
	($ '000)		28		57		-		15
Total	(K '000)		1,750		3,556		-		952
	($ '000)		272		552		-		148
II. Construction Supervision									
1. Foreign Currency									
Engineers		24 M-M	1,560	30 M-M	1,950	33 M-M	2,145	17 M-M	1,105
International Travel		6 Travels	48	7 Travels	56	7 Travels	56	4 Travels	32
Miscellaneous		L.S.	101	L.S.	130	L.S.	135	L.S.	71
Sub-total	(K '000)		1,709		2,136		2,336		1,208
	($ '000)		265		332		363		187
2. Local Currency									
Per diem & others		L.S.	197	L.S.	246	L.S.	271	L.S.	139
Sub-total	(K '000)		197		246		271		139
	($ '000)		31		38		42		22
Total	(K '000)		1,906		2,382		2,607		1,347
	($ '000)		296		370		405		209
Grand Total	(K '000)		3,656		5,938		2,607		2,299
	($ '000)		568		922		405		357

Table 4F-4
Construction Equipments for Phasing

Description	No.	Unit Price	Total Amount 000K	Construction Equipment for the 1st Phase Implementation		Construction Equipment for the 2nd Phase Implementation	
				No.	Amount 000K	No.	Amount 000K
Bulldozer 18ton	5	494	2,470	5	2,470	-	-
" 21	23	650	14,950	23	14,950	0	
" 32	10	1,120	11,200	10	11,200	0	
Motor scraper 11 m^3	15	1,560	23,400	4	6,240	11	17,160
Scrape-dozer 6.4 m^3	18	900	16,200	9	8,100	9	8,100
Wheel Loader 21 m^3	7	450	3,150	2	900	5	2,250
Backhoe	3	500	1,500	2	1,000	1	500
Dragline 0.6 m^3	2	660	1,320	1	660	1	660
Froted Loader 1.8 m^3	3	420	1,260	1	420	2	840
Dumptruck 11 ton	50	240	12,000	8	1,920	42	10,080
Tamping roller 17.5 t	3	890	2,670	1	890	2	1,780
Crawler crane 16 t	2	700	1,400	1	700	1	700
Motor-Grader 3.1 m	1	331	331	1	300	-	-
" 3.7 m	2	370	740	1	370	-	370
Agitator truck 3.2 m^3	4	200	800	2	400	2	400
" 1.6 m^3	2	130	260	1	130	1	130
Tire roller 30 t	17	290	4,930	5	1,450	12	3,480
Crawller drill	1	200	200	0.5	100	0.5	100
Borring machine 7.5 pH	17	62	1,054	8	496	9	558