ON JAPAN'S GRANT AID PROGRAM

1. Japan's Grant Aid Procedures

- (1) The Japan's Grant Aid Program is executed by the following procedures.
 - · Application (request made by a recipient country)
 - · Study (Preliminary Study / Basic Design Study conducted by JICA)
 - · Appraisal & Approval (Appraisal by the Government of Japan and Approval by the Cabinet of Japan)
 - Determination of Implementation (Exchange of Notes between both Governments)
 - · Implementation (Implementation of the Project)
- (2) Firstly, an application or a request for a project made by the recipient country is examined by the Government of Japan (the Ministry of Foreign Affairs) to see whether or not it is suitable for Japan's grant Aid. If the request is deemed suitable, the Government of Japan entrusts a study on the request to JICA (Japan International Cooperation Agency).

Secondly, JICA conducts the Study (Basic Design Study), using a Japanese consulting firm. If the background and objective of the requested project are not clear, a Preliminary Study is conducted prior to a Basic design Study.

Thirdly, the Government of Japan appraises to see whether or not the Project is suitable for Japan's Grant Aid Program, based on the Basic Design Study report prepared by JICA and the results are then submitted for approval by the Cabinet.

Fourthly, the Project approved by the Cabinet becomes official when pledged by the Exchange of Notes signed by both Governments.

Finally, for the implementation of the Project, JICA assists the recipient country in preparing contracts and so on.

2. Contents of the Study

(1) Contents of the Study

The purpose of the Study (preliminary Study / Basic Design Study) conducted

on a project requested by JICA is to provide a basic document necessary for appraisal of the project by the Japanese Government. The contents of the Study are as follows:

- a) to confirm background, objectives, benefits of the project and also institutional capacity of agencies concerned of the recipient country necessary for project implementation.
- b) to evaluate appropriateness of the Project for the Grant Aid Scheme from a technical, social and economical point of view,
- c) to confirm items agreed on by both parties concerning a basic concept of the project,
- d) to prepare a basic design of the project,
- e) to estimate cost involved in the project.

Final project components are subject to approval by the Government of Japan and therefore may differ from an original request.

Implementing the project, the Government of Japan requests the recipient country to take necessary measures involved which are itemized on Exchange of Notes.

(2) Selecting (a) Consulting Firm(s)

For smooth implementation of the study, JICA uses (a) consulting firm(s) registered. JICA selects (a) firm(s) through proposals submitted by firms which are interested. The firm(s) selected carry(its) out a Basic Design Study and write(s) a report, based upon terms of reference made by JICA.

The consulting firm(s) used for the study is(are) recommended by JICA to a recipient country after Exchange of Notes, in order to maintain technical consistency and also to avoid possible undue delay in implementation caused if a new selection process is repeated.

(3) Status of a Preliminary Study in the grant Aid Program

A Preliminary Study is conducted during the second step of a project formulation & preparation as mentioned above.

A result of the study will be utilized in Japan to decide if the Project is to be suitable for a Basic Design Study.

Based on the result of the Basic Design Study, the Government would proceed to the stage of decision making process (appraisal and approval).

It is important to notice that at the stage of Preliminary Study, no commitment is made by the Japanese side concerning the realization of the Project in the scheme of Grant Aid Program.



3. Japan's Grant Aid Scheme

(1) What is Grant Aid?

The Grant Aid Program provides a recipient country with non reimbursable funds needed to procure facilities, equipment and services for economic and social development of the country under the following principles in accordance with relevant laws and regulations of Japan. The Grant Aid is not in a form of donation or such.

(2) Exchange of Notes (E/N)

The Japan's Grant Aid is extended in accordance with the Exchange of Notes by both Governments, in which the objectives of the Project, period of execution, conditions and amount of the Grant, etc. are confirmed.

- (3) "The period of the Grant Aid" means one Japanese fiscal year which the Cabinet approves the Project for. Within the fiscal year, all procedure such as Exchange of Notes, concluding a contract with (a) consulting firm(s) and (a) contractor(s) and a final payment to them must be completed.
- (4) Under the Grant, in principle, products and services of origins of Japan or the recipient country are to be purchased.
 When the two Governments deem it necessary, the Grant may be used for the purchase of products or services of a third country origin.
 However the prime contractors, namely, consulting, contractor and procurement firms, are limited to "Japanese nationals". (The term "Japanese nationals" means Japanese physical persons or Japanese juridical persons controlled by Japanese physical persons.)

(5) Necessity of the "Verification"

The Government of the recipient country or its designated authority will conclude into contracts in Japanese yen with Japanese nationals. Those contracts shall be verified by the Government of Japan. The "Verification" is deemed necessary to secure accountability to Japanese tax payers.

- (6) Undertakings required to the Government of the recipient country
 In the implementation of the Grant Aid, the recipient country is required to
 undertake necessary measures such as the following!
 - a) to secure land necessary for the sites of the project and to clear and level the land prior to commencement of the construction work,
 - b) to provide facilities for distribution of electricity, water supply and drainage and other incidental facilities in and around the sites,

- c) to secure buildings prior to the installation work in case the Project is providing equipment,
- d) to ensure all expenses and prompt execution for unloading, customs clearance at the port disembarkation and internal transportation of the products purchased under the Grant Aid,
- e) to exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which will be imposed in the recipient country with respect to the supply of the products and services under the Verified Contracts,
- f) to accord Japanese nationals whose services may be required in connection with the supply of the products and services under the Verified Contracts, such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work.

(7) Proper Use

The recipient country is required to maintain and use facilities constructed and equipment purchased under the Grant Aid properly and effectively and to assign staff necessary for their operation and maintenance as well as to bear all expenses other than those to be borne by the Grant Aid.

(8) Re-export

The products purchased under the Grant Aid shall not be re-exported from the recipient country.

(9) Banking Arrangement (B/A)

- a)The Government of the recipient country or its designated authority shall open an account in the name of the Government of the recipient country in an authorized foreign exchange bank in Japan (hereinafter referred to as "the Bank"). The Government of Japan will execute the Grant Aid by making payments in Japanese yen to cover the obligations incurred by Government of the recipient country or its designated authority under the contracts verified.
- b) The payments will be made when payment requests are presented by the Bank to the Government of Japan under an Authorization to pay issued by the Government of the recipient country or its designated authority.



NECESSARY MEASURES TO BE TAKEN BY THE GOVERNMENT OF VIETNAM IN CASE JAPAN'S GRANT AID IS EXTENDED

- 1. To provide data and information necessary for the Project.
- 2.To secure the site for the Project.
- 3. To bear two kinds of commissions to the Japanese foreign exchange bank for its banking services based upon the Banking Arrangement (B/A) namely,
 - the advising commission of the "Authorization to Pay (A/P)" and
 - the payment commission.
- 4. To ensure prompt unloading, tax exemption, and customs clearance at the port of disembarkation in Vietnam and prompt internal transportation therein of the materials and equipment for the project purchased under the Grant Aid.
- 5.To exempt Japanese nationals or a staff from a third country engaged in the project from customs duties, internal taxes and other fiscal levies which may be imposed in Vietnam with respect to the supply of the products and services under the verified contracts.
- 6. To accord Japanese nationals or a staff from a third country whose services may be required in connection with supply of the products and services under the verified contracts, such facilities as may be necessary for their entry into Vietnam and stay therein for the performance of their work.
- 7. To provide necessary permissions, licenses, and other authorization for implementing the Project, if necessary.
- 8. To assign appropriate budget and staff members for proper and effective operation and maintenance of the facilities constructed under the Project.
- 9. To maintain and use properly and effectively the facilities constructed and equipment provided under the Project;
- 10. To bear all the expenses other than those to be borne by the Grant Aid within the scope of the Project.



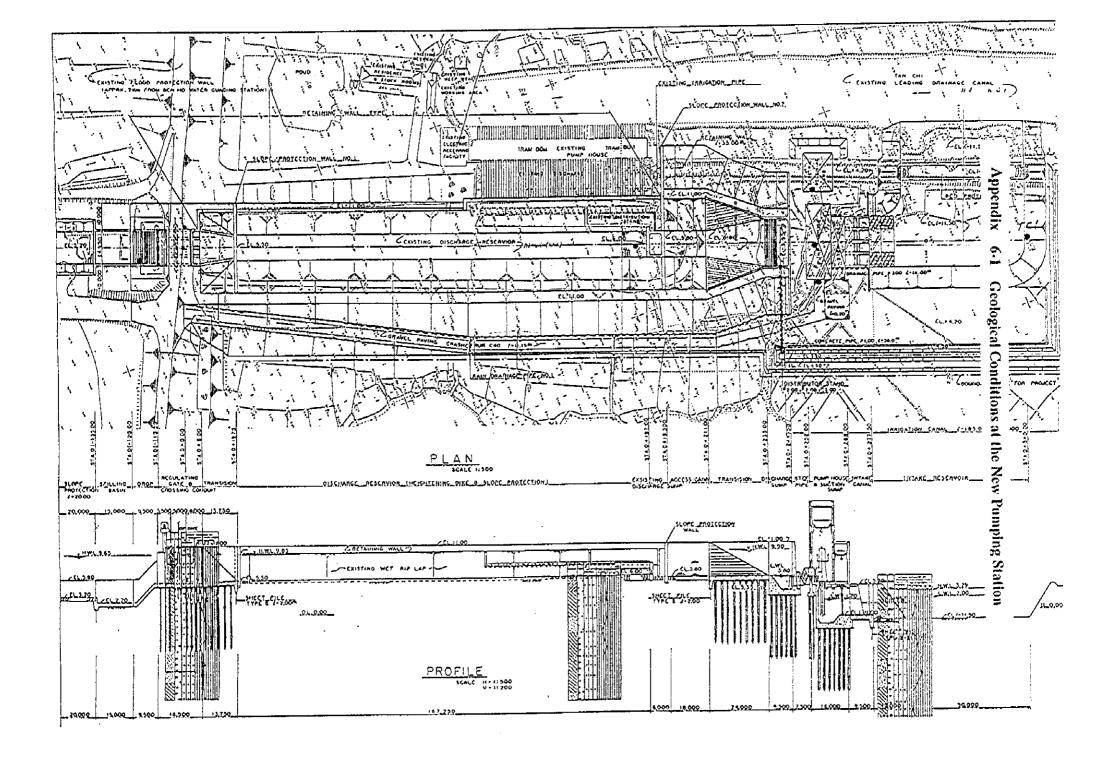
Appendix 5 Cost Estimation Borne by the Receipt Country

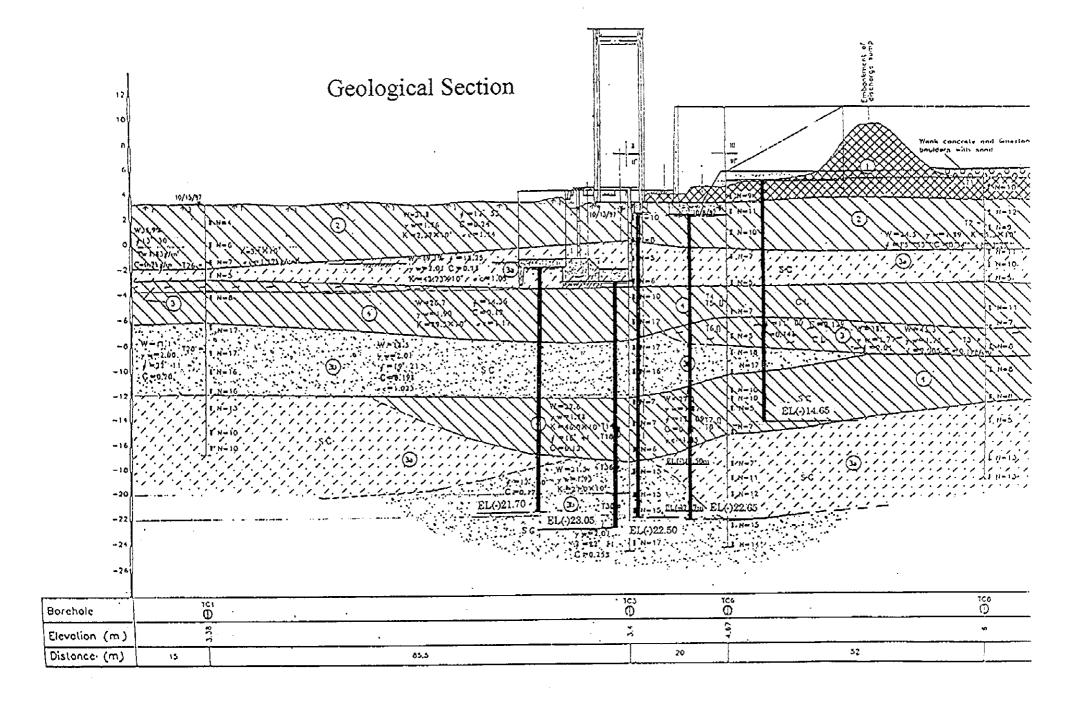
(Unit: million dong)

	Without	the Scot	pe of G.A. Proj	ect	Within t	he Scope	of G.A. Project		Grand
Item	Qnt.	Unit	Unit Price	Price.	Ont	Unit	Unit price	Price	Total
1. Construction Cost		7.6	33,724	33,730	0	L.S.	0	0	33,730
1)Direct Construction Cost	Ţ	LS.		3,620	ő	L.S.	ol	0	3,620
2)Common Temporary Work	1	L.S.	3,620		^	L.S.	ő	ō	13,550
3)Site Expenditure	1	L.S.	13,541	13,550	0	1	0	ŏ	3,380
4)Over Head	1	L.S.	3,372	3,380	O	L.S.		١	54500
Sub Total		<u> </u>		54,280				i	54,280
2. Association Cost								200	
1)Land Acquisition Cost	7.5	Ha	153	1,150	2.5	Ha	153	390	1,540
2)Banking Commission	0	L.S.		0	1	L.S.	İ	120	120
3)Rehabilitation of Electric line to New P.S	Ö	L.S.		0	1	L.S.	[1,410	1,410
3)Rehabilitation of Electric line to New 1.5	ŏ	L.S.		0	1	L.S.		50	4,000
4)Electric Receiving Facilities	l	T .		ň	1	L.S.	i	240	240
5)Access Road to New Pumping Station	0	L.S.		0	1	L.S.		50	50
6) Custom Clearance and Inland Transportation	0	L.S.	1	V		1.0.			
Sub Total				1,150				2,260	3,410
3.Grand Total			 	55,430	1	 		2,260	57,690

Direct Construction Cost (Unit :million dong)

1. Direct Construction Cost	
(1) Crossing Structures of Main Drainage Canal	
DTram Bridge	5,407
②No.6 Elevated Flume	0
3Dong Mai Bridge	2,388
Sub Total	7,795
(2) Crossing Structures of Secondary Canal	
(3) Rehabilitation of Drainage Canal	
①Main Drainage Canal	11,445
②Secondary Canal	13,947
Sub Total	25,392
Total	33,187
2. Direct Temporary Construction Cost	
(1) Crossing Structures of Main Drainage Canal	240
(2) Crossing Structures of Secondary canal	0
(2) Rehabilitation of Drainage Canal	297
Sub Total	537
3. Grand Total	33,724





INDRAULIC ENGINEERING CONSULTANTS CORPORATION N° I(HEC-1)

BOREHOLE LOG

Project :

IMPROVEMENT OF TAN CHI

. DRAINAGE SYSTEM

Location :

SUCTION SUMP

Borehole :

TC 1

Depth (m): Elevation:

20,00 3.38

Y = 11 920.507

Coordinate X = 33 209,355

Commenced:

Oct 13th, 97

Completed :

Oct 13th , 97 Logged by TRAN HOANG LAN

GWL /date : Appeared :

Checked : GIAP DUC TINH

Stabilized: 3.48 / 10/15/97

Sheet .1 . . of .1. .

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(name , group symbol , colour , consistency, relative density, water content, grading etc.)	Legend 1:100	Depth (m)	,,,,	s of s/10c	m	Nos of blows/30cm 5 10 15 20 25	Core recovery percentage (%	UD.	0 S	O É
op cultivation soil (0.0 - 0.30 m) ean CLAY(CL): Brownish and yellowish to whitish grey, moist, firm, plastic.		1 -	1	1	2					Ø 110
at CLAY (CH): Brownish to whitish grey, vet, soft - firm, highly plastic.		3 -	2	2	2	1			2∂	
Clayey SAND (SC): Fine grained, grey oblackish grey, saturated, loose.		5.1	2	1	1	,	100	ž.		m m
at CLAY (CH): Blackish grey to grey, rarely organic matters; moist, soft, plastic.		8.9	1							9
ean CLAY with sands (CL): Reddish brown o yellowish and bluish grey; moist, firm - stiff, plastic.		8 9 9.4	2	3	3					Drilling with alloy bit
		10	5	6	6			T	28	Drilling ₩
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o brownish grey; saturated, medium dense.	a	13	5	5	6	1	60			
	7.7	15.	5	5	6)				
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with some thin clay lenses; saturated, medium dense.		18	3	3	4	\				
Bottom at 20 m		19 20	3	4	4)				
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cty SANO (SM): Fire grained. Gray is elevated gray, askeraled, medical dered.		1.	•	2	5			-				8	•		
ean CLAY to load CLAY with eard (CL.)			١.	\$	5							8			
indefelt brown and pelicular to exhibit grey. nodel, first - staff, pleedic.			,	2	3		ĺ								
ean (ZAT with sand (Ct.): Reddish brown		720	12	3.	2	-	1	Щ	Ц	H	1		┞	╀	├
nd yallowiah ia whitheh grey; moist, fern, feelic) -	1.	2	,							8		L	ā
Buttom et 22.0 M			{										١		
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						Part and the letter	**************************************								
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			1			100-100-100-100-100-100-100-100-100-100	***************************************								
										P1 P10	**************************************				
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BOREHOLE LOG

HEC

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BOREHOLE LOG

COOLAGE ET STATE SO CONTENENT: CANTAT

YO 11878 TS CONSTANT: CANTAT

GM. Kate: : bosed by Shandolle

Append: Content: Device of Shandolle

Southed: \$30,100057 Sheet, 1, 4, 2,

Products processed objectives conformed in the conformed in the conformed conformed conformed conformed in the conformed confo

. BOALDESCRIPTION Enomel, group extribut, bodour, consideration	Legend	ra pë	1			PE-ET	4 ×>	-37	œ٩		3	n#	4	
halabel density, water burners, granting are \$	122	(m)_			اے	1	10	3 7	9 2	1	3 [4	
			2	,	,									9
MCNFRE-Lean CLAY (CE) to be CLAY CHY Brownish to think gray moint all - in, plants			3	3	4		/					 - -	۱,	
			3	3	3									
		, ,	,	,	,									7 0 9 m
een CLAY; CE): Brown and brownish to blush wy; moist, Brow will, plastic		.,	,	١	•						8			Dietary with alley by to to the
ean DUAYECL IS Grey to black on grey, with larde organic mattern, well, and, highly plantic.	111	,	3	,			ŀ				!			á
een Cl.A.f.(Cl.): Reddish brown morted a krimbh and bridsh gray, raig laterta, moint, 38, plaskic			,	,	,									
		}, <u>.</u>	3	3	ľ)							
eas CLAY with sand (SC); Yellowish to novembring ey; maint, firm - soft, plantic		, ,	; ;	2	,							1	•	
Clayer SAMO (SC): Fine prained, brownish to reflexish grey; saturated, very toose - loose.		15 -	,	ļ,	3									l
Clayer SANO (SC): Fire grained, brownish to reflected graft salvated, locus.				Ì	ĺ		Į,				8		_	
Sity SAND (Site): Medium g afted with same and gramps, potentials g by to gran, tone o nession dente. Lean CLATE lean CLAT with sand (CL.)		1		,		111	`		7		79			6.59
Reddish brown mottled in burish to which a ey, mont, firm - self, plentic. Solton at 25 0 m		,	,	3	١.		/				<u> </u>			L.
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Esmails:	<u></u>		1	1			11			1		L		

SOU DESCRIPTION	المحمدا		!	-) P	, -		_			-4	16	1	114	l	11
{name, group symbol, colour, consistency, nations density, mater contest, grading etc.]	Lagens		*		-	**	34 3	367 0 1			25		T.	T.	ĺ	Ş
LACASTEL - Lean CLATE(CL): Brownigh to placesish gray mosts from astif, plants.		<u>(m)</u>	3	>	,	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,							3			0,10
esh CLAY (CL) to be CLAY (CH) Bown nd Sounder to Which perf, noise, firm a self, sect			3	2	,		1					8				Contact with entry bit it is in min
But a popular manura, model and, planeto.		,,	3	,	4		1				1	-		[Confirma
can Olatho han Olat with sand (CL): Paddish bown mored pricewal and bluis pay, rare lateria, moist, firm - soft, pizabo		13	5	•	8	400000000000000000000000000000000000000							0			
Clayey SANO (SC): Yellowish to brownish g ag eaturaised, boses - medium dense	77	13	2	1	Ì					1						
Cagey SAND (SC & Yellowish to brownish gray, saturaled, loose,	\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	,	3	3	ľ							ę		Ī	اً	- L
Lean CLAY (CL & Reddish bows morded yakuwiah tu wholeh grey, moist, stif, plantic		24	ļ,	1	4				-		***************************************	901				ģ
6ocon at 25 € m								A CONTRACTOR OF THE PARTY OF THE PROPERTY OF THE PARTY OF	THE PROPERTY OF THE PROPERTY O	**************************************	Anderson and the second and the seco					

HYCANAUC EVGINEERING CONSULTANTS CORNORATION OF (1940-1)

BOREHOLE LOG

Project : IMPROVEMENT OF TAN ON

DANNISE SYSTEM ENDANDIT YC 12 25.00 Location : Borehole : Depth (m) :

Coordinate X = 32.692.000 Commenced: Oct.17*, 97
Y = 11.801.350 Completed : Oct.16*, 97
GWL Idate: : togged by TRANDOM UN
Appeared : Checked : GW DUCTH
Stabilized : 5.12, 10/19/97 Sheet, 1, of, 2.

son pescalamon (name, group symbol, colour, consistency,	Legend	Οσρι		e of		Her of Hows/300m	Amore so	1777		2000 Tabboo
relative density, water contant, grading etc.)			***	110 -	~	5 10 15 20	-5 §			n E
		(m) 1						Joe I	<u> </u>	9 30
ACKFILL - Lean CEAY (CL.) to fot CEAY CH.); Brownish to yellowish grey, moist, stiff, estic.		2 3 4 5 8.2	3	2	4			¥ 4		
ean CLAY (CL) to fit CLAY (CH): Brown to rownish grey, moist, stiff, plastic.		8 .	3	5	3 5		001	T 47	,	Drilling with alloy bit. © 91 mm
ean CLAY (Ct.), in place dayey SAND with terile; reddish brown motiled yellowish and tuish grey, moist, stiff - firm, plastic.		12	4	5	5	· · · · · · · · · · · · · · · · · · ·	***************************************	Ţ	(3	. .
Clayey SAND (SC): Fine grained, Gray, ellowish gray, saturated, loose - medium lense.		16 17 18 19	2 2	3	3		41.44.44.44.44.44.44.44.44.44.44.44.44.4			
Clayey SARO (SC) : Fine grained, Grey, , , , , , , , , , , , , , , , , , ,		21 22 22	3	3	4	11:1/::::::::::::::::::::::::::::::::::	8	>		⊕ 91 mm
Lean CLAY to lean CLAY with eand (CL): Reddish brown mottled yellowish to whitish grey; moist, firm - stiff, plastic.		24	1	3	2		10	0		_
·										

HYDRAULIC ENGINEERING CONSULTANTS CORPORATION Nº1(HEC-1)

BOREHOLE LOG

Project :

IMPROVEMENT OF TAN CHI

Coordinate X = 32.869.950Y = 11 813,000 Commenced:

Oct . 21th , 97

Location:

DRAINAGE SYSTEM **EMBANKMENT**

E 02

Completed : Oct . 22th ,97 Logged by TRAN HOANG LAN

Borehole:

Checked ; GIAP DUC TINH

Depth (m): Elevation (m):

TC 13 20.00 Appeared: Stabilized : 5.32 / 10/23/97

GWL /date:

Sheet .1 . . of . 1. .

SOIL DESCRIPTION				STANI	DARC	D PENETRATION TEST	8.5	SAMI	E	ရှိ ဒို
(name, group symbol, colour, consistency, relative density, water content, grading etc.)	Legend	Depth (m)	110	s of s/10c	m	Nos of blows/30cm 5 10 15 20 25	Core recovery percemage (%)	UD	- 1	Oritting
Stones separated by very weak mortar.	०्ट्रस्य	.4					70			0110
Lean CLAY(CL): brownish and yellowish grey; moist, firm, plastic.		2 -	1	2	2	Ò				ē
Fat CLAY (CH): Grey to blackish grey, wet, soft, highly plastic.		3 .9 .5	2	2	2	3		T 4		
Lean CLAY (CL): Brownish grey to brown; moist, soft - firm, plastic.		4 .4. 5 _	2	3	4	\ \ 		TE		
Lean CLAY to lean CLAY with sand (CL): Reddish brown mottled yellowish to bluish grey,		6 -	2	3	4			T :	ŀ	
moist, stiff, plastic.		8 .	3	4	5		8			Ε
		9 .8	2	2	2					by bit \$91 mm
Clayey SAND (SC): Fine grained, Brownish and yellowish grey, saturated, loose - medium dense.		112	2	2	3					Orilling with alloy bit
		13 .	2	3	4	1				Q
	1	15 .	3	4	4	1		-		
Silty SAND (SM): Fine to medium grained, yellowish and brownish grey, saturated, medium dense.		16 .	4	4	5	, l				
		.5 18	4	7	5)				
Lean CLAY with sand (SC): Reddish brown mottled bluish grey; moist, firm - stiff, plastic.		19.	3	3	4	1				
Bottom at 20 m		20	2	3	3					

HYDRAULIC ENGINEERING CONSULTANTS CORPORATION N°1 (HEC-1)

BOREHOLE LOG

Oct. 16th, 97

Project :

IMPROVEMENT OF TAN CHI

DRAINAGE SYSTEM

Location :

EMBANKMENT

Borehole:

TC 14

Depth (m): 20,00 Coordinate X = .32 877,000

Y = 11 797.050

Commenced: Completed:

Oct , 18th ,97

GWL /date: Appeared:

Logged by TRAN HOANG LAN Checked : GIAP DUG TINH

Stabilized: 6.07, 10/18/97

Sheet .1 . . of . 1. .

SOIL DESCRIPTION				TANE	ARO	PENETRATION TEST	% over 2	SAM		5 2
(name , group symbol , colour , consistency, relative density, water content, grading etc.)	Legend	Depth (m)	114	s of s/10ca	m	Nos of blows/30cm 5 10 15 20 2	Core recovery	บอ	DS	Drilling
ean CLAY - accumulative soil; Brown; mols, soft.		.8					100)		Ø110
Separated by very weak mortar		2-					60)		θ
ean CLAY (CL.): Brownish and yellowish, noist, soft, plastic.		3.	1	1	1			Т	53	
Lean CLAY (CL) to fat CLAY (CH): Grey to blackish grey; wet, firm, highly plastic.		4 .	2	2	1			1		
		6	3	4	5		8			
		7 .	3	4	4	\ \ \				
Lean CLAY (CL): Reddish brown mottled yellowish to bluish grey; moist, stiff - firm, plastic.		9 .	4	4	5	\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\				Ф 91 mm
		10	3	4	4	 				
Clayey SAND (SC): Yellowish to brownish		12	2	2	3		60			Drilling with alloy bit
grey, saturated, loose.		13	2	2	2		10	0 T	54	Orillin
		14	1	2	2	4				
Clayey SAND (SC): Fine grained. Grey and brownish grey; saturated, toose.		. 16	2	2	3	\ 0	8			
		17	2	3	2	1				
Silty SAND(SM): Medium grained with some small gravels, grey to yellowish grey, saturated, loose.		118	3	3	3					
Bottom at 20 m Remark:	<u> </u>	: 20	13	13	13	1:::3::::	<u>. </u>			-1

LAYER 1: BACKFILL - Lean to fat CLAY

					71	T39	T41	T45	T46		·
Lab.					T1	139	141	143	149		Ì
	ole No				TC8	TC9	TC10	TC12	TC12	SUM	AVERAGE
ŀ	hole No)			0.80	2.33	3.55	2.78	3.10	SUM	MATINAGE
Depti	n (m)		from			2.55	4.00	3.00	3.60		
		T	to	Γ	1,00	2.55	4.00	3,00	3.00		}
	Ē		BS	ASTM	22.0	55.0	31.0	41.0	37.0	196.0	39.2
HI	i më-	Clay	<0.002	<0.005	32.0	55.0 16.0	28.0	26.0	29.0	113.0	22,6
SIZE	%	Sitt	.002063	9	14.0	27.0	36.0	28.0	27.0	160.0	32,0
tii	, 1 Z	04	00000	.050075	42.0	1.0	4.0	3.0	3.0	21.0	4,2
ซ	ဋ	Sand	.063-2.0	.075425	10.0	{	1.0	2.0	4.0	9.0	1,8
F	5			.425 - 2.0	1.0	1.0	!	2.0	7.0	1.0	
A C	DISTRIBUTION	01		2.0 - 4.75	1.0						0.2
	وَيَ	Gravel	2.0-63.0	4.75-20.0							.
ĺ	Ω			20.0-75.0				••••••			.
		Cobble	>63.0	75.0-300.0				00.0	60.6	290,1	
α.	. v	Liquid Limit			41.5	64.7	54.1	66.3	63.5		58.0
ü]	Plastic Limi			22.5	32.7	28.1	32.4	30.5	146.2	29.2
Į į	CIMITS	Plasticity in			19.0	32.0	26.0	33.9	33.0	143.9	28.8
		Liquidity ind			0.326	0.075	0.019	0.006	0.018	0.408	0.082
		Water Cont		W	28.7	35.1	28.6	32.6	29.9	154.9	31.0
	ഗ	Wel Densit		Υw	1.91	1.83	1.85	1.80	1.88	9.27	1.85
4	PROPERTIES	Dry Density		Υc	1,48	1,35	1.44	1.36	1.45	7.08	1.42
l G) iX	Specific Gr	avity	Δ	2.74	2,73	2.76	2.74	2.76	13.73	2.75
Ì	<u>.</u>	Void Ratio		ε	0.846	1.015	0.919	1.018	0.907	4.705	0.941
ū	ĕ	Porosity (%)	ก	45.8	50.4	47.9	50.5	47.6	242.2	48.4
		Degree of S			92.7	94.4	86.0	87.9	91.1	452.1	90.4
L		Coeff. of Pe	ermeab. (cri	√s) ×10 ⁻⁷		0.35		3.50		3.85	1.93
N	SHE	EARING		Deg)	13 26	11°18		13 ⁶ 29	ļ	38°13	12544
Ω	STR	ENGTH	C(K	G/cm²)	0.270	0.210		0.27	.	0,75	0.25
กก	PARA	METERS	φ'(Deg)			12°55		12°44	25°39	12°49
D			1	G/cm²)			0.333		0,362	0,695	0.348
	UN. C	COM,		n (%)							
	STRE	NGTH	4	/ cm²)							.
	PROCTOR Optimum Moisture %								[
		CTION	1 -	Dens. g/cm³				,	1		
		ONE-DIME							T		
<u> </u>				0-0.125	·····	1					
		र्षे ≻-		-0.250	}·····	1	}		Ī		
	- t	ž (6		-0.500	0.043	0.048		0.087		0.178	0.059
	Coefficent of	Compressionity (cm²/KG)		-1.000	0.032	0.037		0.045	† • • • • • • • • • • • • • • • • • • •	0.114	0.038
	eff	C J		-2.000	0.030	0.030	· · · · · · · · · · · · · · · · · · ·	0.028	† · · · · · · · · · · · · · · · · · · ·	0.088	0.029
1	ပိ	E O		-4.000 -4.000	0.021	0.030	·········	0.015	f	0.055	0.018
	Ć	ĭ	ļ	-8.000		1	·····	}¥:X.!X			1
Prec	ons, Pre		L	-8.000 KG/cm³	1.19	1.25	} · · · · · · · · · · · · · · · · · · ·	0.98	f	3,42	1.14
1.50	OINS, PR	c > > .	ac	KOICIB.	<u>i. 13</u>	11	· · · · · · · · · · · · · · · · · · ·	}	f		1
		SOIL CLASS	NEICATION	,						[· ·····
	•	SOIL CLASS		ſ	·····	{		······	ł·····		· ····
		(AS	HAL T		ļ	CH	CLI	CH	сн	ļ·····	· ·····
					CL	СН	CH	СН	ļ <u>УП</u>		·[······
1								}			-
1					ļ		ļ	 	†	1	1
<u> </u>					1	٠	<u> </u>	L	<u> </u>		

LAYER 2: Lean to fat CLAY

ab. No		_			Т2	T26	T29	T43	T47	T50		
ample l	No			j					7040	TC13	SUM	AVERAGE
ore hol	le No)		}	TC8	TC1	TC2	TC11	TC12		SOM	Average
epth (n	n)		from		4,30	4.70	4.00	8.50	8.50	3.50		
			lo		4.52	4.92	4.22	8.70	9.00	3.72		
	. 1		BS	ASTM							245.0	40.0
ÉÉ		Clay	<0.002	<0.005	34.0	32.0	30.0	48.0	51.0	50.0	245.0	40.8
SIZE %		Sitt	.002063	.005020	11.0	18.0	17.0	20.0	18.0	19.0	103.0	17.2
N S	ı			.050075	31.0	43.0	46.0	29.0	30.0	30.0	209.0	34.8
PARTICLE DISTRIBUTION	;	Sand	.063-2.0	.075425	24.0	5.0	7.0	2.0	1.0	1.0	40.0	6.7
ΒĔ				.425 - 2.0		1.0		1.0	ļ		2.0	0.3
<u> </u>	į			2.0 - 4.75		1.0			<u>.</u>		1.0	D.2
_ & @	-	Gravel	2.0-63.0	4.75-20.0					<u> </u>			ļ
<u> </u>	?			20.0-75.0				<u> </u>	<u> </u>			
•	•	Cobble	>63.0	75.0-300.0					Į. 			ļ
		Liquid Limit		<u> </u>	43.5	52.9	45.6	63.7	65,7	41.3	312.7	52.1
ης 1	2	Plastic Limit	-		23.0	29.1	25.0	30.6	30.8	24.1	162.6	27.1
ATTERB	i ki	Plasticity inc			20.5	23.8	20.6	33.1	35.0	17.2	150.2	25.0
⋖ -	J	Elquidity ind			0.073	0.286	0.515	-0.027	0.026	0.535	1.408	0.235
		Water Cont		W	24.5	35.9	35.6	29.7	31.7	33.3	190.7	31.8
		Wet Density		 Υ ν	1.89	1,83	1.83	1.88	1.88	1.84	11.15	1.86
PHYSICAL	Ŋ				1.52	1.35	1.35	1.45	1.43	1.38	8,48	1,41
₹₹	=	Dry Density		γc Δ	2.73	2.74	2.74	2.75	2.75	2.69	16.40	2.73
တ္တြင့်	Į	Specific Gr	avity		0.798	1.035	1.030	0.897	0.926	0.949	5.635	0.939
Ĭ. (ģ	Vold Ratio		3	44.4	50.9	50.7	47.3	48.1	48.7	290.1	48.4
α. α	J K	Porosity (%		n	1	95.1	94.7	91.1	94.3	94.4	553.5	92.3
		Degree of S	Saturation	(%) G	83.9	1	1.90	0.42	0.63		11.35	2 27
		Coeff, of Pe	ermeab. (c	m/s) × 10 ⁻⁷	5.3 15 53	3.10 13°30	15°16	11°08		9°16	64°37	12°55
Š		EARING	1	(Deg)			0.160	0.38		0.14	1.22	0.24
<u></u>		RENGTH		KG/cm')	0.340	0.200	1.0.100		11°38		11°38	11°38
nn	PA	RAMETERS		(Deg)					0.381		0.381	0.381
			+	KG/cm²)	-				.1.9.39.1			
ŧ	UN.	сом.		ain (%)								
S	TRE	NGTH		G/cm²)	_							
1	PRO	CTOR	1 '	n Molsture %	1					·		
C	OMP	ACTION		y Dens. g/cm³	_[.		.		
		ONE-DIME			_		.]	.}		.	-	•
		ર્જ	σn	=0-0.125					. 	.		
	ŏ	ž·		-0.250		.					0.396	0.03
	Ĕ	: (9)		-0.500	0.050		.,	0.048		0.089	-1	0.05
	ည်	355 137/		-1,000	0.037	0.058			• • • • • • • • • • • • • • • • • • • •	0.059	0.245	
İ	Coefficent of	Compressibility (cm²/KG)		-2.000	0.031	0.044				0.038	. 1	0.04
	Q	E		-4.000	0.020	0.028	0.028	0.015	<u>). </u>	0.023	0.114	0.02
		U		-8.000	<u> </u>							
Preco	ns. F	ress.	αc	KG/cm²	1.25	1.17	1.21	1.10		0.99	5.72	1.14
		•										
]		SOIL CLAS		ON								
		(AS	STM)							CL	··[······	
1					CL.	CH.	CL.	CH	CH.	<u></u>	[······	
									{			}
						.						
1											1	_L

LAYER 3: Lean to fat CLAY

Lab, No				T16	T17	120	T21	T6	13	T49	T53	 	
Sample No			,			<u> </u>							
Bore hote N				TC4	TC4	TC5	TC5	TC6	TC8	TC13	TC14	SUM	AVERAGE
Depth (m)		from		11.10	11.60	11.28	11.50	11,10	13,60	3.0	3.58	20141	
Departing		to		11.55	11.80	11.50	12.00	11.60	13.82	3.5	3.8		
	1		ACTH	11.55	11.00	11	12.00	1.00	15.02				·
-am	Cin	8S <0.002	ASTM	07.0	210	17.0	100	23.0	51.0	47.0	36.0	240.0	30.0
n Ę	Ciay		<0.005	27.0	21.0		18.0	22.0	24.0	17.0	33.0	187.0	23,4
Size	Sitt	.002053	.005020	24.0	24.0	23.0	20.0			35.0		346.0	
01.2			.050075	47.0	50.0	55.0	55.0	50.0	24.0		30.0	*********	43,2
PARTICLE : DISTRIBUTION	Sand	.063-2.0	.075425	2.0	5.0	5.0	7.0	5.0	1.0	1.0	1.0	27.0	3,4
ž5	ļ		.425 - 2.0	********	*********								• • • • • • • • • • • • • • • • • • • •
% E		į	2.0 - 4.75	· · · · · · · · · · · · · · · · · · ·									• • • • • • • • • • • • • • • • • • • •
ST	Gravel	2.0-53.0	4.75-20.0					• · · · • · • · · • · ·			••••••		
ជ			20.0-75.0			!							• • • • • • • • • • • • • • • • • • • •
	Cobble	>63.0	75.0-300.0]	ļ						
ω ₍₀	Liquid Limit			48.1	36.2	42.5	42.2	42.6	62.4	55.0	52.8	381,8	47.7
戸青	Plastic Limit	(%)		26.3	21.1	24.8	24.3	24.1	32.7	28.3	27.8	209.4	26.2
ATTERB LIMITS	Plasticity Inc			21.8	15.1	17.7	17.9	18.5	29.7	26,7	25.0	172.4	21.5
	Uquidity Ind	ex		0.560	0.887	0.633	0.631		0.424	0.345	0.560	4.040	0.577
	Water Cont	ent (%)	W	38.5	34.5	36.0	35.6	35.2	45.3	37.5	41.8	304.4	33.1
(0	Wet Density		Υw	1.74	1.82	1.75	1.78	1.76	1.75	1.79	1.76	14.15	1.77
PHYSICAL PROPERTIES	Dry Density		Yc	1,26	1.35	1.29	1.31	1.30	1,20	1.30	1.24	10.25	1.23
2 <u>2</u>	Specific Gra		٠۵	2.70	2,67	2.68	2.69	2.68	2.65	2.71	2.74	21.52	2.89
∑ G B	Void Ratio	•	£	1,149	0.973	1.083	1.049	1.059	1.200	1.062	1.208	8.803	1,100
£ &	Porosity (%	1	n	53.5	49.3	52.0	51.2	51.4	54.6	52.0	54.7	365.7	52.4
Ω.	Degree of S			90.5	94.7	89.1	91.3	89.1	99.6	93.8	94.7	742.8	929
	Coeff. of Pe				8.6						5.62	14.22	7.11
v Si	HEARING		Deg)		9°22	10 ⁵ 12	• • • • • • • • • • • • • • • • • • • •		905		6 20	36°59	ę°14
	TRENGTH		(G/cm²)			0.120		· · · · · · · · · · · · · · · · · · ·	0.100		0.09	0.42	0.11
DA	RAMETERS		(Deg)	8°19		1.9.1.2.9	8 30	11°00		8°17		36°06	9 01
	0万约23		(G/cm²)	0.101	**********	f	0.101	0.148		0.165		0.515	0.129
	COM.		in (%)					9.149.	• • • • • • • • • • • • • • • • • • • •	0.100			
	ENGTH		S/cm²)		}	·····							
	CTOR				• • • • • • • • • • • • • • • • • • • •	 		·····					· · · · · · · · · · · · · · · · · · ·
	PACTION		Moistare %									*****	· · · · · · · · · · · · · · · · · · ·
COMP			Oens. g/cm²										
	ONE-DIME								[
	ď	071=	0-0.125	ļ		ļ		 				0.280	
ō	Compressibility a. (cm?/KG)	İ	-0.250	}	0.136	0.144							0.140
Ş	흡奏	l	-0.500		0.112	*			0.060		0.132	0.419	0.105
žį.	188 1113		-1.000			0.076			0.060		0.078	0.290	0.073
Š	Ę S		-2.000		0.050	0.040			0.046		0.055	0.191	0.048
	ა		-4.000	ļ		ļ			0.034	· · · · · · · · · · · · · · · · · · ·	0.036	0.070	0.035
		L	-8.000	}		ļ							
Precons P	ress.	GC	KG/cm²		0.84	0.8			1.06		0.91	3.61	0.30
					ļ	ļ					-		
	SOIL CLASS		И	ļ	ļ	ļ		ļ			- .		.
	(AS	TM)			ļ		ļ			ļ			ļ
		•		CL	CL	CL	CL	CL	MH	СН	СН		
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				1	1	1	}	1		j .			1

LAYER 3a: Clayey SAND

		ľ	TC5	TC5	TC7	TC14	SUM	AVERAGE
		ŀ	22.50	24.00	22.40	12.78		
	from			24.22	22.90	13.00	:	
	to		23.00	24.22	22.00			
			40.0	40.0	120	10.0	42.0	10,5
Clay							****	7.5
Sitt	,002063	i 7	**********					17,2
		1 P	******					61.5
Sand	.063-2.0	.075425						3,3
		.425 - 2.0	4.0	4.0	1.0	4.0	13.0	
		2.0 - 4.75						
Gravel	2.0-63.0	4,75-20.0						
		20.0-75.0		.,,				
Cobble	>63.0	1						ļ.,
		<u> </u>	25.6	25.5	29.4	26.2		26.7
; ·					16.5	14.2	62.5	15.6
			1 T			10.5	42.5	10.6
1 .			,				1.255	0.314
			•••••					19.1
	•		}					2.01
			} <i></i>					1,68
Dry Den	sity (g/cm²)		, , , , , , , , , , , , , , , , ,					2.69
Specific	Grevity	Δ	h					0.597
Void Re	io	ε		-,		+		37.3
Porosity	(%)	n	36.6				*	. +
Decree	of Saturatio	n(%) G	92.3	73.1	•	+	•	86.4
Coeff. o	f Permeab.	(cm/s)×10 ⁻⁷		56.00	26.0	46.20	* · · · · · · · · · · · · · · · · · · ·	42.73
RING	01	Deg)		18,25]	1	+·····	18.25
				0.180]	<u> </u>		0.180
			19 ⁰ 15	[19 59	\	39°14	19°37
LICKO	1		0.210	† · · · · · · · · · · · · · · · · · · ·	0.107	Τ΄	0.317	0.159
			···········		1	1	1	1
				†······		1	1	
				†·····	! ······	· [· · · · · · · · · · · · · · · · · ·	1	1
	, ,				·	·†·····	1	1
						• ‡ • • • • • • • • • • • • • • • • • •	†·····	
ONE-DIA	MENS.CON	<u>S. </u>	<u> </u>	ļ		· ······	†	
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.0 2≻ :		-0.250					0.000	0.07
5 0		-0.500			. {		• • • • • • • • • • • • • • • • • • • •	·· † ·-····
쫎똣		-1.000		0.030			. 	0.03
e E				0.017	<u></u>		.	0.02
Ĕ				0.009	<u> </u>		0.009	0.01
ប័			***************************************			1		
	_L			1.03	1		1.03	1.03
ress.	OC.	NO/CIII_				``[}	
		1033					1	
		ION						
(ASTM)			·		sc	··· †	
			SC	.	<u></u>			···†·····
	Gravel Cobbie Liquid Lir Plastic Li Plasticity Liquidity Weter C Wet Der Specific Void Rei Porosity Degree Coeff. o RING IGTH ETERS OM. ONE-DIM TOR CTION ONE-DIM Toress. SOIL CL	Sitt .002063 Sand .063-2.0 Gravel 2.0-63.0 Cobbie >63.0 Liquid Limit (%) Plastic Limit (%) Plasticity Index (%) Liquidity Index Water Content (%) Wet Density (g/cm²) Dry Density (g/cm²) Specific Gravity Void Ratio Porosity (%) Degree of Saturatio Coeff. of Permeab. RING \(\phi\) GTH \(\chi\) COM. Stranger Stranger GTH \(\chi\) CTION \(\chi\) ONE-DIMENS.CON	Clay	Clay	Clay	Clay	Clay	Clay

LAYER 3b: Clayey to Silty SAND

Lab. No	—···			Υ28	T34	T35	T36	138	T40		
Sample No								700			4055405
Bore hole No	>			TC1	TC2	TC2	TC3	TC3	TC9	SUM	AVERAGE
Oepin (m)		from		11.30	21.78	22.00	21.10	24.33	14.20		İ
		to		11.52	22.00	22.50	21,32	24.55	14.42		
	1	88	ASTM								<u> </u>
-ww-	Clay	<0.002	<0.005	7.0	10.0	10.0	12.0	13.0	8.0	60.0	10.0
щ	Sit	.002063	.005020	4.0	7.0	9.0	8.0	5.0	6.0	39.0	€.5
SIZE %		.002,000	.050075	13.0	12.0	20.0	21.0	9.0	14.0	89.0	14.8
МŠ	Sand	.063-2.0	.075425	34.0	60.0	56.0	55.0	60.0	71,0	336.0	55.0
덕 원	34(I)	,000-2.0	.425 - 2.0	31.0	10.0	5.0	4.0	10.0	1.0	61.0	10.2
PARTICLE : DISTRIBUTION			2.0 - 4.75	8.0	1.0			2.0		11.0	1,8
X 5			1 1				• · · · · · · · · · · · · · · · · · · ·	1.0		4.0	0.7
νΩ	Gravei	2.0-63.0	4.75-20.0	3.0		*************				***************************************	Y.
ā			20.0-75.0								
	Cobble	>53.0	75.0-300.0						05.0	158.4	32.4
25 W	Liquid Lir			24.3	25.5	26.0	31.4	25.4	25.8		23.4
ER ATT	Plastic Li	art (%)		15.3	15.8	15.9	17.8	16.0	15.8	96.6	15.1
ATTERB LIMITS	Plasticity	Index (%)		9.0	9.7	10.1	13.6	9.4	10.0	61,8	10.3
	Liquidity	Index		-0.457	0.505	0.554	0.272	0.117	0.330	1,311	0 219
		ontent (%)	W	11,1	20,7	21.5	21.5	17,1	19.1	111.0	18.5
,,	Wet Den	sity (g/cm²)	Ϋ́w	.2.00	1.96	2.00	1.93	2.07	2.08	12.04	261
PHYSICAL PROPERTIES		sity (c/cm²)	Ϋ́c	1.80	1.52	1.65	1.59	1.77	. 1,75	10.18	1.70
ું દૂ	Specific		Δ	2.68	2.67	2.68	2.69	2.69	2.68	16.09	2.68
X ∏	Void Ret	•	ε	0.489	0.644	0.628	0.693	0.522	0.535	3.511	0.585
동유	Porosity		n	32.8	39.2	38.6	40.9	34.3	34,8	220.6	33.5
ā.	_	(n) of Seturation	-	60.9	85.8	91.7	63.4	88.2	95.8	505.8	84.3
			(7) (7) (7) (10) (7)	00,3	05.0	78.00	27.0	····	2.10	107.1	35.7
LA SHEAF				22°11	17°29	10.09	17°10		20°3ô	77°26	19°21
STREN			Deg)				0.170		0.260	0.790	0.193
	GIN		G/cm²)	0.200	0.160	16°31	9.179	22°11	0.200	40°42	29,31
3 PARAME	ELERS		Deg)			,				0.406	0.203
<u> </u>			G/cm² j			0.181		0.225		0.403	0.203
UN, C			n (%)	 						}	
STREN			/ cm²)					<u> </u>		ļ	
PROC			Moisture %					<u> </u>	.	 	
COMPA			Dens, o/cm²			ļ	ļ .				
<u> </u>	ONE-DIM	ENS CONS) <u>.</u>			ļ	<u> </u>				
نہ ا	t	່ ອກ =0	0-0.125			l	<u> </u>	<u> </u>			
icent of	, ;		-0.250			[<u> </u>	ļ 	
icent of	<u> </u>		-0,500		0.072	1	0.056		0.038	0.166	0.055
ညီး	,7/KG)		~1.000	,	0.032	1	0.030		0.019	0.081	0.027
50 5			-2.000		0.022	1	0.018		0.010	0.050	0.017
Coaffic	5		-4,000		0.012	1	0.011		0,006	0.029	0.010
	•		-8.000			·····					1
Precors, Pr		<u>σ</u> ς	KG/cm²	İ	1.00	1	1.02		1.05	3.07	1.023
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	(n.	STM }				}	· ·····	·····		}	
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Table 3 -6/6

SOIL PROPERTIES
LAYER 4: Lean CLAY, in place clayey sand

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c 0.656 at 0.750 bases 0.655 bases 0.750 bases		2.7	•	272	273	i	÷	2.74	•				2 6		2,00	-	3776	4	620		•	<u>. </u>
4) C 46.2 64.3 64.6 <th< td=""><td></td><td>-</td><td>•</td><td>0.853</td><td>0.783</td><td>i</td><td>÷</td><td>) 831 C</td><td>•</td><td></td><td>0</td><td></td><td>2 6 2 6</td><td>4.4</td><td>8 0</td><td></td><td>43.7</td><td>7-</td><td>5.4</td><td></td><td></td><td></td></th<>		-	•	0.853	0.783	i	÷) 831 C	•		0		2 6 2 6	4.4	8 0		43.7	7-	5.4			
4) C 66.5 <th< td=""><td></td><td></td><td></td><td></td><td>_</td><td>_</td><td>÷</td><td>40.4</td><td></td><td>÷</td><td>, ,</td><td></td><td>6</td><td></td><td>8</td><td>•</td><td>88.9</td><td>35.2 E</td><td>8 7.6</td><td>:</td><td></td><td></td></th<>					_	_	÷	40.4		÷	, ,		6		8	•	88.9	35.2 E	8 7.6	:		
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					_	-	_			-	_	-		-	-	-		***************************************	-			

Pump Check List (1/5)

Appendix 4 Checklist of Existing Pump and Motor

Judgement			×]	×					¢.	×	-			×	c.	×
Note			puou					Eletatric trouble		Eleigtric trouble						Eletetric trouble	
Switch	board	type	u	u	u	ř.	LL.	tı.	ų.	عا	Q.	u	LL.	u	ų	u	i.
Motor electric	()	waterin		52.3		49.5	46.3		53.5		51.7	51.3	50.3	52.3		49,3	54.0
Motor	current (A)	water none															
(w.	Motor	>		28		20	8		74		20	40	001	280			26
terio) (un	ž	χ		40		76	8		270		120	120	300	850			125
Vibration (water in) (1, mm)	Pump	>		8		22	8		80		80	72	125	260			100
	œ.	1		36		42	80		38		95	72	140	205			150
(mm #)	Motor	>															·
inter none)	~	I									:						
Vibration (water nong) (µ mm)	Pump	>: 	<u> </u>							-					-	-	
Motor	noise			٥		⊲	4		0		0	0	0				×
ump bearing	DOISC			0	×	0	۵		0		×	O	0	0	×		O
Used age Hand Centerring Seal space Pump bearing	Water Leak			٥		0	٥		.0		Q	0	٧	٧			0
Centerring	_			0		0	0		0		0	0	0	. 0			0
Hand	rou			0	×	0	0		0		0	0	0	0	×	- · · · · · ·	0
age po	Judge																
1 1	Age			٥	9	. 9			31	5	3.1	31	5		ຄ		31
Pump	Š			~	က	Ÿ	ب	٥	7	ස	6	ö	=	12	13	14	15

Pump Check List (2/5)

ó 9	Pump Used age		Hand Cente	erring S	eal space	Centerring Seal space Pump bearing Motor	Motor	Vibration (water none) (µ mm)	vater none	(mm n) (۶	Vibration (water in) (Jump)	er in) (µ	(m)	Motor electric	lectric	Switch	Note	Judgement
9	<u></u> ۷۵۷	- ogbou	io 		Water Leak	noise	noise	Pump		Motor	ď	Pump	W	Motor	current (A)	t (A)	board		<u>.</u>
9								, ,		>	Ţ	>	I	>	water none	water in	300		
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81			0	0	×	٥	0				03	ß	180	30			ш.		×
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2	ភ		0	0	4		0			_	00	170	32	46		42.3	ш,		
- 12	3		0	0	0	0	o			_	2.4	28	.84	35		55.0	u		
22	5		0	0	×	0	0		-		8	30	105	27		51.7	4		×
23			0		0	0	0				56	120	420	100		50.3	œ		
24	5		0	0	0	0	0				34	20	105	37		54.0	œ		
25	5		0	0	0	0	Q				26	8	40	18		\$1.3	a		
26	ē		0	0	0	0	0				210	165	135	38		46.0	c		
23	Ę.		0	0	×	0	0				8	160	180	50	33.0	49.3	<		×
28	31		0	0	٥	0	0				6	55	65	0		55.3	ee		
દ	31		0	0	0 ×	0	0			_	82	13	91	ō		51.0	4		
30			0	0	0	0	0				65	70	220	35		45.8	œ		

Pump Check List (3/5)

Judgement								×				×		×	×		×
Note			عاد			フランジ											
Switch	board	type		(te		tı.	u.		- 6	<	α	<	8	<		<	c
estric	3	waterin	47.0	53.0	535	42.5	46.0	463	49.8	50.2	45.3	47.3	51.3	46.7	49.7	43.7	42.3
Motor electric	current (A)	water none water in															
Ê	ž	>	120	88	250	25	300	170	SS	95	2:	23	07.1	8 8		8	ςγ
Vibration (water in) (11 mm)	Motor	ı	200	200	700	110	1000	700	150	280	0,	57	260	900		ę	250
ation (water	2	>	99	8	8	2	240	250	35	110	50	88	280	160		35	0:
Vibr	Pump	I	8:	20	120	53	200	200	85	210	20	99	170	999		53	8
(wu		>															
(h) (auou	Motor	x															-
Vibration (water none) (µ mm)	Primp	>															
ļ		Σ															
Motor	20. 88		0	0	0	0	0	0	0	0	0	0	0	0		- 0	0
Pymp bearing	00.56		٥	0	0	0	⊲	×	0	Ø	Ø	0	Ø	ℴ	×	⊲	<
Centerring Seal space Pump bearing Motor	Water Leak		⊲	0	0	0	٥	٥	0	V	٥	×	٥	×	х	ø	×
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Hand	Ę		0	0	0	0	0	0	0	0	Ø	0	0	٥	0	0	C
Used age	t t																
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Pump		<u> </u>	ត	33	33	ક	8	ဗ္ဂ	ţc	ន	မ	5	14	Ş	. S	V .	

Pump Check List (4/5)

Judgement						×	×					<u> </u>	×	×	×	×	×
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Switch	board	type	u	<	<	ø	<	œ	<	Ð	<	0	<	<	<	eo	<
ectric	3	waterin	48.3		49.2	51.7	52.0	46.0	0.03	52.3	45.7	52.3	53.7	49.3	41.0		44.3
Motor electric	current (A)	water none				32.8	31.3	30.2	29.0	32.2	250	35.5	31.6		31.3		26.3
Ę.	ŏ	>	5:0		110		38	50	46	180	28				36		
Vibration (water in) (μ mm)	Motor	r	340		200		જુ	. %	38	580	210				34		
ration (water	ç	>	150		03-		96	38	52	135	110				36		
Ϋ́	Pump	ı	250		160		94	52	బ్	:45	130				52		
n.e.)	رەر	>				90	0_	85	28	92	0	340	8	051	33		200
//) (audu	Motor	I				200	62	110	20	28	26	200	8	460	20		100
Vibration (water none) (11 mm)	Pump	>				160	16	40	10	89	10	360	140	120	9		ပ္သ
Vibra	ď	I				8	8	81	20	01	9	240	150	220	55		ę
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Hand Centerring Scal space Pump bearing	Water Leak		٥		0	¢	×	0	0	0	Q	0	0	0	۵		◊
Centerring			×		×	0	0	0	0	0	0	0	0	0	C		×
Hond			۵		o	0	0	0	0	0	0	0	⊲	0	<	×	0
Used age													·				
		-	F		Ē.	ភ	ä	31	6	31	e 1	<u></u>	31	- F	3		6
c)	ž		96	\$	1,8	Ş	S	25	52	53	7.	55	88	ភ	58	ន	3

Pump Check List (5/5)

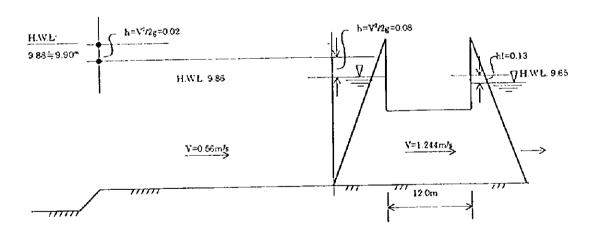
Pump	- 1	Used age	Hand	Centerming	Seal space	Hand Centerrring Seal space Pump bearing Motor	Motor		Vibration (water none) (u mm)	none) (u m	(w)	Vibr	ation (wate	Vibration (water in) (µ mm)	٤	Motor	Motor electric	Switch	Note	Judgement
Š	27	Judge	ģ		Water Leak	noise	ooise	Pump	d'	Motor	_	Pump		Motor	ò	entre entre	current (A)	board		
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ន	01		0	0	0	Q	0	50	59	30	8						55.3	60		
2	9		0	×	0	×	0	42	170	30	59	140	130	61.1	138			<		×
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93	9		0	0	×	Ø	0					72	430	580	907		61.3	Ŀ		
3	د د		0	0	0	0	0	12	28	20	0,					26.5	45.0	u		
5	٠		4	×	0	0	0	38	68	260	160					28.7	51.7	u		

Appendix 6-2 Study on Pump Type and Pump Combination Planning

(1) Delivery Water Level in the Discharge Reservoir

High water level of the Duong river at the Tan Chi pumping station is estimated at EL(+)9.65m with 10 year-probability. The delivery water level in the discharge reservoir is set up by the following calculation of head losses.

Size of sluiceway	$B \times H \times No.$	$2.50(m)\times2.5(m)\times4(No.)$
Discharge	Q	31.1m³/s
Velocity	V=Q/A	1.244m/s
Velocity head	$h = V^2/2g$	0.08m
Outlet losses	$h1 = f \cdot V^2/2g$ $f = 1.0$	0.08m
Inlet losses	$hl = f \cdot V^2/2g$ $f = 0.5$	0.04m
Friction losses	$hl = \frac{n^2 \cdot V^2}{R^{3/4}} \cdot L$	0.01m
	L=12.0	
	n = 0.018	
	$R = \frac{BH}{2(B+H)} = 0.625$	
	$R^{4/3} = 0.534$	



Total losses 0.08+0.08+0.04+0.01=0.21m The highest delivery water level in the discharge reservoir is 9.65+0.21=9.86=9.9m The lowest delivery water level in the discharge reservoir is set up at EL(+)5.80m being equivalent to the bottom elevation of the discharge reservoir in the beginning point of upstream side, although the sill elevation of sluiceway is EL(+)5.2m.

(2) Actual Head

The actual head = highest delivery water level-lowest suction water level = 9.9 - 1.7 = 8.2m

(3) Pump Type

1) In Case of Axial Flow Pump

Required NPSH(Hsvo)=
$$\left(\frac{H\sqrt{Q}}{S}\right)^{4/3}$$
 (1)

Number of pump rotation(N)= Ns
$$\times \frac{H^{4/3}}{\sqrt{Q}}$$
 (2)

It follow that

Hsvo =
$$\left(\text{Hs} \times \frac{\text{H}^{4/3}}{\sqrt{Q}} \times \sqrt{Q} \times \frac{1}{\text{S}}\right)^{4/3}$$
(3)
= $\left(\frac{\text{Ns}}{\text{S}}\right)^{4/3} \times \text{H}$

where H=Total pump head------9.0m

Ns=Specific speed in case axial flow 1500

S=Suction specific speed

①Checking Cavitation under Design Conditions

Friction loss by pipe	hlo=0.58 m
Actual head	ha=8.2 m
Total oumo head	H=9.0 m

$$\frac{\text{ha}}{\text{H}} = \frac{8.2}{9.0} = 0.911$$
 $\frac{\text{hlo}}{\text{H}} = \frac{0.58}{9.0} = 0.064$

From Figure and Table, q=1.03 $\alpha=1.1$ s=1270

Then

Hsvo=
$$\left(\frac{1500}{1270}\right)^{4/3} \times 9.0 = 1.248 \times 9.0 = 11.24 \text{m}$$

 $Hsv = \alpha \times Hsvo = 1.1 \times 11.24m = 12.4m$

$$Hsvo = Da + hso - Ba - hlso - \beta$$

where	Da: Atmospheric pressure	10.3 m
	hso: Suction actual head	2.0 m
	Ba: Saturated vapor pressure	0.3 m
	hlso: Friction loss by pipe(suction)	0.0 m
	B: Surplus head	0.5 m

Hsvo=Da+hs-Ba-hlso-B

hs: Suction actual head except design point 2.0 m hls: Friction loss by pipe (suction) 0.0 m

From the above calculation, cavitation occurs in case of axial flow pump.

©Checking Cavitation under other Conditions

Friction loss by pipe line hlo=0.58m

Actual head ha=5.8m-1.7m=4.1m

Total pump head H=9.0 m

$$\frac{\text{ha}}{\text{H}} = \frac{4.1}{9.0} = 0.455 \qquad \qquad \frac{\text{hlo}}{\text{H}} = \frac{0.58}{9.0} = 0.064$$

From the Table q=1.22 $\alpha=2.0$ s=980

Hsvo =
$$\left(\frac{1500}{980}\right)^{4/3} \times 9.0 = 15.87 \text{m}$$

$$Hsv = 15.87 \times 2.0 = 31.78m$$

$$Hsvo = 11.5m < Hsv = 31.78m$$

From the above calculation, cavitation occurs, therfore, axial flow pump can not be used.

In Case of Mixed Flow Pump

H: Total pump head

9.0m

Hs: Specific speed

900

S: Suction specific speed

OChecking Cavitation under Design

Friction loss

hlo=0.58m

Actual head

ha=8.2m

Total pump head

H=9.0m

$$\frac{ha}{H} = \frac{8.2}{9.0} = 0.911$$

$$\frac{ha}{H} = \frac{8.2}{9.0} = 0.911 \qquad \qquad \frac{hlo}{H} = \frac{0.58}{9.0} = 0.064$$

From the figure

$$q = 1.02$$

$$\alpha = 1.05$$

s=1280

$$Hsvo = \left(\frac{900}{1280}\right)^{4/3} \times 9.0 = 5.63$$

$$Hsv = 1.05 \times 5.63 = 5.91m$$

$$Hsvo = 11.5m > Hsv = 5.91m$$

From the above result, cavitation will not occur.

©Checking Caviation under other Conditions

Friction loss by pipe

hto=0.58m

Actual head

ha=5.8m-1.7m=4.1m

Total pump head

H = 9.0 m

$$\frac{ha}{H} = \frac{4.1}{9.0} = 0.455 \qquad \frac{hlo}{H} = \frac{0.58}{9.0} = 0.064$$

From the figure

$$\alpha=1.6$$

$$Hsvo = \left(\frac{900}{880}\right)^{4/3} \times 9.0 = 9.27$$

$$Hsv = 1.6 \times 9.27 = 14.8m$$

$$Hsv = 11.5m < Hsv = 14.8m$$

In this case, cavitation occurs. It is necessary to control discharge by discharge valves at the time of the low head.

Based on the study on cavitation, vertical axial mixed flow pump is suitable as pump type.

(4) Pump Combination Planning

1) Basic Conditions

Design Dischrage	16 m ³ /s=960 m	³/min
Design Head	Actual head	9.9m-1.7m=8.2m
	Head loss	0.58m
	Surplus	0.22m
	Total	9.0m

Under the above conditions, the following five types of pump sets have been studied.

Table 2-1 Pump Specification for Each Alternative

	Number of Punp	2 sets	3 sets	4 sets	5 sets
Pump	Capacity (m3/min)	480	320	240	92
	Head (m)	6	6	6	6
	Bore $(mm \phi)$	1800	1500	1350	1200
	Velocity (m/s)	3.15	3	2.8	2.83
	Length (m)	5.8	5.4	5.2	4.9
	Efficiency (%)	88	\$	83.5	88
	Ns = 700(rpm)	166	203	235	263
	Rotation Ns=900(rpm)	213	261	302	338
	Ns=1300(rpm)	308	377	436	487
Motor	Specified Output (kw)	1000	920	200	400
	Rotation (rpm)	022	240	290	325
	Pole (P)	26	24	20	18
	Calculated Output (kw)	911.3	614.8	463.8	372.3
Auxiliary	Discharge Bore (mm \$\phi\$)	1800	1500	350	1200
Device	Valve Velocity (m/s)	3.15	3	2.4	2.83
	Flap Valve Bore $(mm\phi)$	2200	1800	1650	1500
	Velocity (m/s)	2.1	2.1	1.87	1.81
	Capacity of Overhead Crane (T)	32	20	20	13
					1

2) Monthly Operation Hours

Monthly operation hours are estimated from the daily report of the existing pumping station, because hourly rainfall patterns are not available. The following table shows pump operation hours for each set of pump.

Table 2-2 Pump Operation Hour

		range 2-2 Pu	mb Oher	ation arou		
Month	Operation Hour	Estimation Discharge	Pump	Operation F	lours per O	ne Set
	(hour · set)	(m³/month)	2 sets	3 sets	4 sets	5 sets
1	2,470	1,482,000	51	77	103	129
2	1,608	964,800	34	50	67	84
3	867	520,200	18	27	36	45
4	635	381,000	13	20	26	33
5	6,124	3,674,400	128	191	255	319
6	1,096	657,600	23	34	46	57
7	4,316	2,589,600	90	135	180	225
8	8,507	5,104,200	177	266	354	443
9	6,234	3,740,400	130	195	260	325
10	3,455	2,073,000	72	108	144	180
11	369	221,400	8	12	15	19
12	380	228,000	8	12	16	20
Total	36,061	21,636,600	751	1,127	1,502	1,878

Note: Operation Hours are based on the 1993 year's record at Tan Chi Pumping Station.

In the above table, estimated discharge and pump operation hours are obtained by the following calculation.

()Estimated Discharge

The existing pump capacity per one set is 600 m³/h, so the discharge is estimated as follows:

Estimated discharge = operation hours ×600 m³/h set In case of January, 2,470m³/h·set×600m³/h·set=1,482,000m³/month

2Pump Operation Hours

Operation Hours = Estimated Discharge + Capacity of One Pump

In case of pump operation hours per one set of pump in January for option-1 (two sets of pump) is calculated as follows:

 $1,482,000 \text{ m}^3/\text{month} + 480 \text{m}^3/\text{min} = 3,087 \text{ min} = 51 \text{ hour}$

Minimum operation hours are estimated as follows, if pump is operated 6 hours per week.

6 hours $\times 4\sim 5$ weeks/month = $24\sim 30$ hours/month

3 Operation Hours for Storage Capacity of Suction Side

The area of suction side including intake reservoir and Tan Chi leading canal is about 26m(W) ×1000m(L)

Available water depth for pump operation:

$$LWL-LLWL = 1.7 \text{ m} - 1.4 \text{ m} = 0.3 \text{ m}$$

The storage capacity at the suction side:

$$26 \text{ m} \times 1000 \text{ m} \times 0.3 \text{ m} = 7,800 \text{ m}^3$$

The amount of natural inflow to suction sump

LWL=
$$1.7 \text{ m}$$
 Inflow = about $3 \text{ m}^3/\text{s}$

The pump operation hours from LWL to pump stopping water level is calculated as follows:

Operation hours =
$$\frac{\text{strage capacity at the suction side}}{\text{pump capacity per one set inf low}}$$

In case of option-1 (2 sets of pump)
$$\frac{7800\text{m}^3}{480\text{m}^3 / \text{min} - 180\text{m}^3 / \text{min}} = 26\text{min}$$

Operation hours for each option are calculated according to the same process as option-1 and summarized as follows:

	Operation Hours fo	or the Storage Cap	acity of the Suction	n Side (minute)
Number of Pump(set)	2 sets	3 sets	4 sets	5 sets
Operation Hours(min)	26	56	130	650

From a view point of stable pump operation, it requires around 2 hours to operate pumps, therefore, option -4 (4 sets of pump) is recommendable.

(4)Cost Study

The cost study for each option is shown in Table 2-3.

Companison of Cost	
Table 2.3	
ξ	

Cost Pump 2 Sests 3 Sests 4 Sests 5 S	Number of Pump 2 Sets 3 Sets 4 Sets 5 Sets	Number of Pump 2 Sets 3 Sets 3 Sets 5 Sets					1						
Pump Pump 189,920 215,120 191,120	Phump Phum	Plump Plump 175,040 205,280 314,240 315,040 10,000		Numbe	of Pump	2 Š	ets	S S	ets	4.5	sets	がい	ets
Motor 189,920 219,120 197,120 197,120 100 Discharge valve 23,600 24,100 25,600 10,000 Flap valve 23,600 24,100 10,000 10,000 Sortead Crane (1unit) 18,600 (1unit) 16,600 (1unit) 12,000 (5unit) Step pipe	Motor	Discharge valve 189,920 219,120 197,12	3	Pumn			275,040		305,280		314,240		316,400
Sub-total Section Se	National Color 10,000 10	Section Sect	3	Motor			189,920		219,120		197,120		189,600
According to the control plant 15,000 10,0	According to the first color 10,000 1,000 1	According		Discharge	valve		23.600		26,100		29,600		31,000
Crane	Cranc	Cranc Clunit 18,600 (1unit) 16,600 (1unit) 16,600 (1unit) 16,600 (1unit) 16,600 (1unit) 12,000 (2unit) 12,000 (2unit) 12,000 (2unit) 12,000 (2unit) 12,000 (2unit) 12,000 (2unit) 12,000 (2unit) 12,000 (2unit) 12,000 (2unit) 12,000 (2unit) 16,3		Flan valve			7,200		8,700		10,000		11,000
Sikry Primary panel 15,200 3unit 8,700 4unit 12,000 5unit	Signature Continuity 7,200 3unity 8,700 4unity 12,000 5unity 12,000 5unity 15,200 18,900 20,800 20,800 20,800 20,800 20,800 20,800 20,00	Size Necessity 12,000 5umit 12,000 5umit 12,000 5umit 16,200 18,900 12,000 5umit 16,200 19,300		Overhead	Crane	(lunit)	18,600	(lunit)	16,600		16,600	(lumit)	12,100
Sich Primary panel 16,200 18,900 20,800 50,360	Sign Primary panel 16,200 18,900 20,800 50,360	Sikv Primary panel 16,200 18,900 20,800 50,360		Serven		(4unit)	7,200	(3unit)	8,700	l	12,000	(Supit)	13,000
Panel S37.760 603.400 600.360 55 Panel 19,300 19,300 19,300 19,300 Isat 26,000 26,000 26,000 26,000 Isat 8,100 1sat 8,100 1sat 8,100 1sat 2sats 18,600 3sats 21,300 4sats 25,600 5sats 2sats 19,200 3sats 23,100 4sats 25,600 5sats 2sats 19,200 3sats 23,100 4sats 25,600 5sats 2sats 19,200 2sats 2,600 1sat 2,600 1sat 2sats 11,000 2sats 11,000 2sats 11,000 2sats 2sats 10,400 2sats 10,400 3sats 10,400 3sats 2sats 10,750 1.S 18,500 1.S 19,500 1.S 2sats 10,700 1.S 18,500 1.S 19,500 2sats 10,400 2sats 10,400 3sats 10,400 3sats 2sats 10,400 2sats 10,400 3sats 10,400 3sats 2sats 10,400 2sats 10,400 3sats 10,400 3sats 2sats 10,400 2sats 10,400 3sats 10,400 3sats 2sats 10,400 2sats 10,400 3sats 10,400 3sats 2sats 10,400 2sats 10,400 3sats 10,400 3sats 2sats 10,400 2sats 10,400 3sats 10,400 3sats 2sats 10,400 2sats 10,400 3sats 10,400 3sats 2sats 10,400 2sats 10,400 3sats 10,400 3sats 2sats 10,400 2sats 10,400 3sats 10,400 3sats 2sats 2,400 2sats 2,400 2sats 2,400 2,400 2sats 2,400 2sats 2,400 2,400 2,400 2sats 2,400 2sats 2,400 2,400 2,400 2sats 2,400 2sats 2,400 2,400 2sats 2,400 2sats 2,400 2,400 2sats 2,400 2sats 2,400 2,400 2sats 2,400 2sats 2,400 2,400 2sats 2,400 2,400 2,400 2sats 2,400 2,400 2,400 2sats 2,400 2,400 2,400 2sats 2,400 2,400 2,400 2sats 2,400 2,400 2,400 2sats 2,400 2,400 2,400 2sats 2,400 2,400 2,400 2sats 2,400 2,400 2,400 2sats 2,400 2,400 2,400 2sats 2,400 2,400 2,400 2sats 2,400 2,400 2,400 2sats 2,400 2,400 2,400 2sats 2,400 2,400 2,400 2sats 2,	Part S27,760 603,400 600,360 55	19,300 19,300 19,300 19,300 19,300 19,300 19,300 19,300 19,300 19,300 19,300 19,300 19,300 19,300 10,300 1		Sten pine			16,200		18,900		20.800		23.000
Panel 19,300 19,300 19,300 19,300 19,300 16,300 26,000 26,000 26,000 16,300 16,300 16,300 16,300 16,300 16,300 16,300 16,300 16,300 16,300 16,300 16,300 16,300 16,300 16,300 16,300 16,300 16,300 1	19,300 19,300 19,300 19,300 19,300 19,300 19,300 26,000 26,000 26,000 16,300 16,300 16,300 16,300 16,300 16,300 16,300 16,300 16,300 16,300 16,300 16,300 16,300 16,300 16,300 15et 8,100 15et 8,100 15et 8,100 15et 8,100 15et 8,100 15et 8,100 15et 8,100 15et 8,100 15et 8,100 15et 8,100 15et 8,100 15et 8,100 15et 8,200 15et 8,200 15et 2,600 15et	19,300 19,300 19,300 19,300 19,300 16,300 16,300 16,300 16,300 16,300 16,300 16,300 16,300 16,300 16,300 16,300 16,300 16,300 16,300 15,600 1			Sub-total		537,760		603,400		600,360		596,100
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1 16,300 16,300 16,300 16,300 15,400 15et 8,100 15et 8,100 15et 8,100 15et 8,100 15et 8,100 15et 8,100 15et 8,100 15et 8,100 15et 8,100 15et 8,100 15et 8,100 15et 25,600 25ets 23,100 45ets 28,400 25ets 23,100 15et 9,800 15et 9,800 15et 2,600 15et 2	16.300 16.300 16.300 16.300 16.300 16.300 16.400 16.600 1	16,300		reciving	35kv Metering PT&CT panel		26,000		26,000		26,000		26,000
1set 8,100 1set 8,100 1set 8,100 1set 2sets 18,600 3sets 21,300 4sets 25,600 5sets 2sets 19,200 3sets 23,100 4sets 28,400 5sets 2sets 19,200 1set 9,800 1set 9,800 1set 2sets 6,200 2sets 6,200 2sets 11,000 2sets 2sets 10,400 2sets 11,000 2sets 11,000 2sets 2sets 10,400 2sets 10,400 3sets 10,400 3sets 2sets 10,400 2sets 10,400 3sets 10,400 3sets 49,460 781,700 751,160 55,380 113,080 125,080 125,080 126,560 Ottal 869,100 961,500 973,100 973,100 1	1set 8,100 1set 8,100 1set 8,100 1set 2sets 18,600 3sets 21,300 4sets 25,600 5sets 2sets 19,200 3sets 23,100 4sets 25,600 5sets 2sets 19,200 1set 9,800 1set 9,800 1set 2sets 10,000 2sets 11,000 2sets 11,000 2sets 11,000 2sets 10,400 3sets 10,400 3sets 10,400 3sets 10,400 3sets 10,400 2sets 10,400 3sets 10,400 2sets 10,400 3sets 10,400 3sets 10,400 3sets 10,400 2sets 11,000 2sets 11	1set 8.100 1set 8.100 1set 8.100 1set 8.100 1set 8.100 1set 8.100 1set 8.100 1set 8.100 1set 8.100 1set 8.100 1set 8.100 1set 8.100 1set 8.100 1set 8.100 1set 9.800 1se		facilities	35kv In		16,300		16,300		16.300		16.300
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xiliary feeder 1set 9,800 1set 9,800 1set 2,600 1set 3,800 3sets 6,200 3sets 6,200 3sets 11,000 11,000 3sets 11,000 11,000 3sets 11,000 11,000 11,000 11,000 11,000 11,000 11,000 11,000 11,000 11,000 11,000 11,000 11,000 <td>xiliary feeder 1set 9,800 1set 9,800 1set 2,600 3sets 2,600 2sets 11,000 2</td> <td>xiliary feeder 1set 9,800 1set 9,800 1set 2,600 3sets 6,200 3sets 6,200 3sets 11,000 2sets 11,000 <t< td=""><td></td><td></td><td>6kv Motor starter</td><td>2sets</td><td>19,200</td><td>3sets</td><td>23,100</td><td>4sets</td><td>28,400</td><td>Ssets</td><td>32,000</td></t<></td>	xiliary feeder 1set 9,800 1set 9,800 1set 2,600 3sets 2,600 2sets 11,000 2	xiliary feeder 1set 9,800 1set 9,800 1set 2,600 3sets 6,200 3sets 6,200 3sets 11,000 2sets 11,000 <t< td=""><td></td><td></td><td>6kv Motor starter</td><td>2sets</td><td>19,200</td><td>3sets</td><td>23,100</td><td>4sets</td><td>28,400</td><td>Ssets</td><td>32,000</td></t<>			6kv Motor starter	2sets	19,200	3sets	23,100	4sets	28,400	Ssets	32,000
ge panel 2sets 6,200 1set 2,600 1set 2,600 1set 2,600 1set 2,600 1set 2,600 1set 2,600 3sets 6,200 2sets 11,000 2sets 11,000 2sets 11,000 2sets 11,000 2sets 11,000 2sets 11,000 2sets 10,400 2sets 10,400 2sets 10,400 3sets 10,400 10,4	ge panel 2sets 6,200 1set 2,600 1set 2,600 1set ge panel 2sets 6,200 2sets 11,000 2sets 11,000 2sets barger panel 2sets 11,000 2sets 11,000 2sets 11,000 2sets control plant 2sets 10,400 2sets 10,400 3sets 10,400 3sets clay panel 2sets 10,400 2sets 10,400 3sets 10,400 3sets Sub-total 10,7500 LS 18,500 LS 19,500 LS Sub-total 706,560 781,700 791,160 85,380 A aculities Total 49,460 54,720 55,380 126,560 973,100 Total 869,100 961,500 973,100 973,100 9	ge panel 2sets 6,200 2sets 6,200 2sets 11,000 2sets 10,400 3sets 10,400 1sets 10,400 1sets 10,400 1sets 10,400 1sets 10,400 1sets			500kva Aixiliary feeder transformer	lset	008'6	lset	9,800	Iset	6,800	1set	008'6
ge panel 2sets 6,200 2sets 6,200 2sets 11,000 11,000 11,000 11,000 11,000 11,000 <th< th=""><td>ge panel 2sets 6,200 2sets 6,200 2sets 11,000 2sets 11,000 2sets 11,000 2sets 11,000 2sets 2,200 3sets 2,500 2sets 11,000 2sets 2,500 2sets 11,000 2sets 2,500 2sets 10,400 2sets 10,400 2sets 10,400 3sets 10,400</td><td>ge panel 2sets 6,200 2sets 6,200 2sets 11,000 2sets 11,000 2sets 11,000 2sets 11,000 2sets 11,000 2sets 11,000 2sets 2,500 4sets 1,000 2sets 2,500 2sets 10,400 2sets 10,400 2sets 10,400 2sets 10,400 3sets 10,400 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 2,500 <t< td=""><td></td><td></td><td>la</td><td>1set</td><td>2,600</td><td>lset</td><td>2,600</td><td>lset</td><td>2,600</td><td></td><td>2,600</td></t<></td></th<>	ge panel 2sets 6,200 2sets 6,200 2sets 11,000 2sets 11,000 2sets 11,000 2sets 11,000 2sets 2,200 3sets 2,500 2sets 11,000 2sets 2,500 2sets 11,000 2sets 2,500 2sets 10,400 2sets 10,400 2sets 10,400 3sets 10,400	ge panel 2sets 6,200 2sets 6,200 2sets 11,000 2sets 11,000 2sets 11,000 2sets 11,000 2sets 11,000 2sets 11,000 2sets 2,500 4sets 1,000 2sets 2,500 2sets 10,400 2sets 10,400 2sets 10,400 2sets 10,400 3sets 10,400 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 1,500 2,500 <t< td=""><td></td><td></td><td>la</td><td>1set</td><td>2,600</td><td>lset</td><td>2,600</td><td>lset</td><td>2,600</td><td></td><td>2,600</td></t<>			la	1set	2,600	lset	2,600	lset	2,600		2,600
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clay panel 2sets 10,400 2sets 10,400 3sets 10,400 3sets LS 17,500 LS 18,500 LS 19,500 LS Sub-total 107,200 116,700 129,200 LS 791,160 8 Pacilities Total 49,460 54,720 55,380 8 113,080 125,080 126,56	clay panel 2sets 10,400 2sets 10,400 3sets 10,400 3sets Sub-total 17,500 LS 18,500 LS 19,500 LS Sub-total 706,560 781,700 791,160 8 Agailties Total 49,460 54,720 55,380 8 Total 869,100 961,500 973,100 973,100	clay panel 2sets 10,400 2sets 10,400 3sets 10,400 3sets Sub-total LS 17,500 LS 18,500 LS 19,500 LS 3acilities Total 706,560 781,700 791,160 8 A9,460 54,720 55,380 55,380 Total 869,100 961,500 973,100			Local pump control plant	2sets	3.800		5,700		7,600	Ssets	9,500
Sub-total LS 17,500 LS 18,500 LS 19,500 LS Pacifities Total 706,560 781,700 791,160 85,380 85,380 113,080 125,080 126,560	Sub-total LS 17,500 LS 18,500 LS 19,500 LS Sub-total 107,200 116,700 129,200 129,200 129,200 125,200 125,200 125,200 125,380 125,380 125,380 125,380 125,560 <t< td=""><td>Sub-total LS 17,500 LS 18,500 LS 19,500 LS Pacifities Total 706,560 781,700 791,160 85,380 85,380 113,080 125,080 126,560 126,560 961,500 973,100</td><td></td><td></td><td>Auxiliary relay panel</td><td>2sets</td><td>10,400</td><td></td><td>10,400</td><td></td><td>10,400</td><td>3sets</td><td>15,600</td></t<>	Sub-total LS 17,500 LS 18,500 LS 19,500 LS Pacifities Total 706,560 781,700 791,160 85,380 85,380 113,080 125,080 126,560 126,560 961,500 973,100			Auxiliary relay panel	2sets	10,400		10,400		10,400	3sets	15,600
Sub-total 107,200 116,700 129,200 Pacilities Total 706,560 781,700 791,160 8 113,080 113,080 125,080 126,560 Total 869,100 961,500 973,100	Sub-total 107,200 116,700 129,200 Pacifities Total 706,560 781,700 791,160 8 113,080 125,080 126,560 961,500 973,100 973,100	Sub-total 107,200 116,700 129,200 Pacifities Total 706,560 781,700 791,160 8 113,080 125,080 126,560 961,500 973,100 9			Cables	श	17,500	LS.	18,500		19,500		21.500
Pacilities Total 706,560 781,700 791,160 8 49,460 54,720 55,380 113,080 125,080 126,560 126,	Pacilities Total 706,560 781,700 791,160 8 113,080 125,080 126,560 961,500 973,100 973,100	Pacilities Total 706,560 781,700 791,160 8 113,080 125,080 126,560 961,500 973,100 973,100					107,200		116,700		129,200		148,900
49,460 54,720 55,380 113,080 125,080 126,560 Total 869,100 961,500 973,100	49,460 54,720 55,380 113,080 125,080 126,560 Total 869,100 961,500 973,100	49,460 54,720 55,380 113,080 125,080 126,560 Total 869,100 961,500 973,100			Facilities Total		706,560		781.700	:	791,160		806,600
Total 869,100 961,500 973,100	Total 869,100 961,500 973,100	Total 869,100 961,500 973,100		Packing an	nd transport		49,460		54,720		55,380		56.46
Total 869,100 961,500 973,100	Total 869,100 961,500 973,100	Total 869,100 961,500 973.100		Installation	1 Cost		113,080		125,080		126,560		129,04
							869,100		961,500		973.100		992,100

Table 2-4 Summary of Comparison Study on Pump Combination

Table 2-4 Summa	ary of Compai			
Option	<u> </u>	2	3	4
Number of Pump (set)	2	3	4	5
Pump Bore (mm)	1800	1500	1350	1200
Pump Capacity (m³/min)	480	320	240	192
Pump Load (1)	65	50	39	19.8
Motor Spec.	vertical shaft	vertical shaft	vertical shaft	vertical shaft
•	opened type	opened type	opened type	opened type
	dip proof	dip proof	dip proof	dip proof
	1000kw×26P×6kv	630kw×24P×6kv	500kw×20P×6kv	400kw×18P×6kv
Motor Weight(t)	25	20	<u>15</u>	10
Operational flexibility	low	low	medium	medium
for discharge fluctuation	26 min	56 min	130 min	650 min
·		(Opera	ation hour for mir	nimum discharge)
Risk of incidental failures(%)	50	33	25	20
Exchangeability for spare part	low	low	medium	high
Suction sump(m²)	91.5	165.4	163.4	143.4
Depth of suction sump(m)	6.9	5.6	5.25	4.5
Weight of suction sump(t)	1,580	2,500	2,352	1,860
Pump house(m²)	104	202	219	174
-do- weight(1)	720	1,255	1,265	904
Suction sump load(t)	2,470	3,965	3,833	2,913
Number of pile	21	32	36	33
Load per one pile(t/pcs)	117.6	123.9	106.5	88.3
Bearing capacity (t/pcs)	130.7	130.7	130.7	130.7
Safety factor	1.1	1.05	1.23	1.48
Cost of pump equipment(1000yen)	869,100	961,500	973,100	992,100
Cost of pump facilities (1000yen)	206,100	302,300	280,000	211,000
Pump house (1000yen)	15,100	34,400	35,200	30,500
Total cost of pumping station	1,090,300	1,298,200	1,288,300	1,233,600
Operation Cost for 30 years	112,650	106,500	96,870	112,650
Renewal of motor(1000yen)	118,700	91,300	61,600	47,400
Total Cost	1,321,650	1,496,000	1,446,770	1,393,650
9 Ratio	100	113	100	105

(5)Conclusion

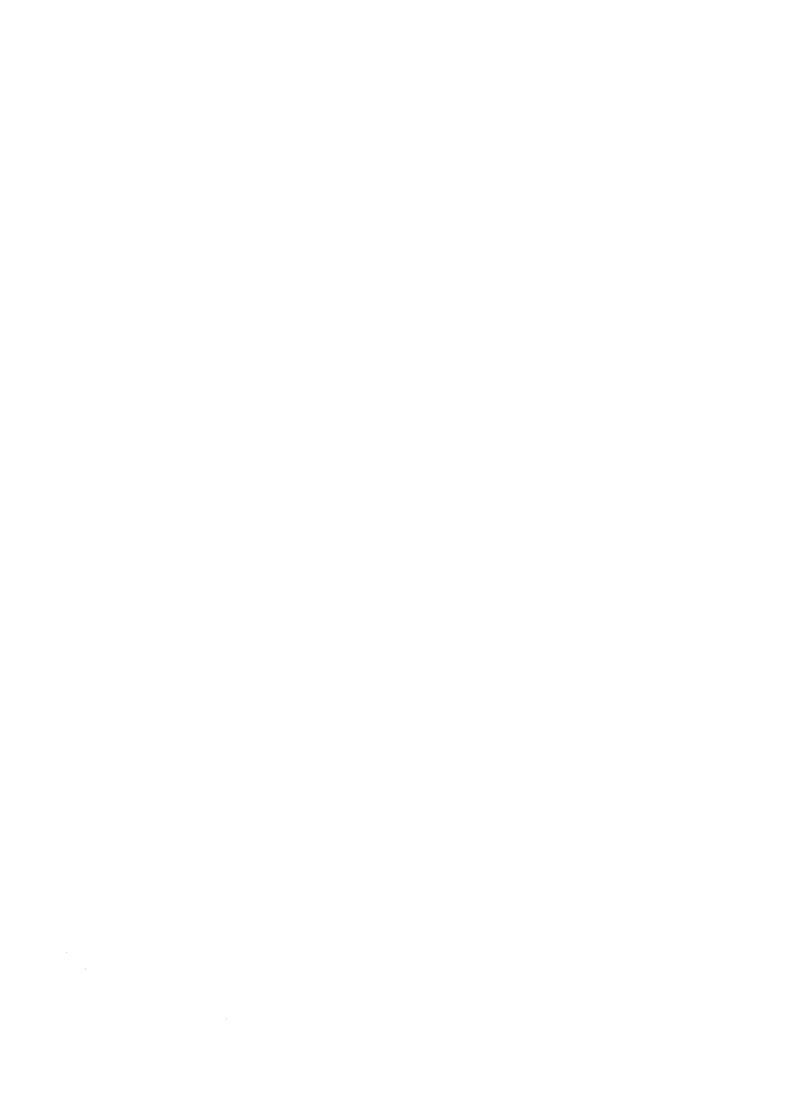
Based on the above studies, the following issues are justified.

^{*} Cost of pump equipment becomes cheaper coping with the decrease of pump sets. The area of a suction sump becomes smaller following the decrease of

- pump sets. On the other hand, when pump bore becomes larger, load per unit area is larger because the depth of suction sump is more deeper.
- * When the number of pump increases, the following merits can be listed.

 Discharge to be secured at the time of pump failure, Exchangeability of spare parts Stability of structures
- * Operation cost for 30 years consisting of electrical charge and renewal of motor becomes more economical in case the size of motor is smaller. Regarding the total cost including construction and operation, option 1 (2 sets) is the most economical. However, from a view point of operation and maintenance option 3 (4 sets) have more advantages in terms of operational cost, safety, risk of incidental failure, exchangeability of spare parts.

Therefore, 4 sets of pump combination with 1350 mm of pump bore is selected for the Tan Chi new pumping station.



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