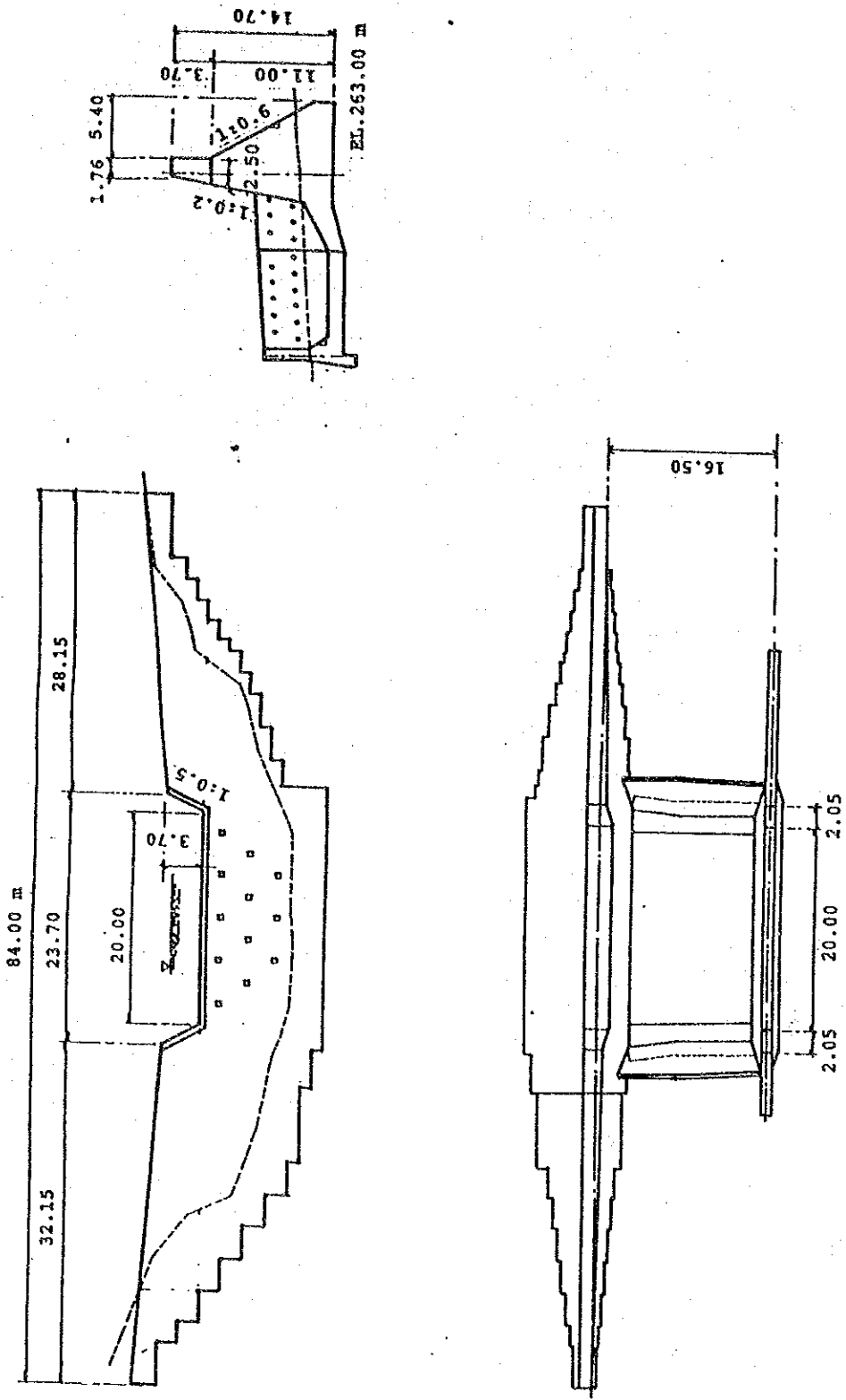


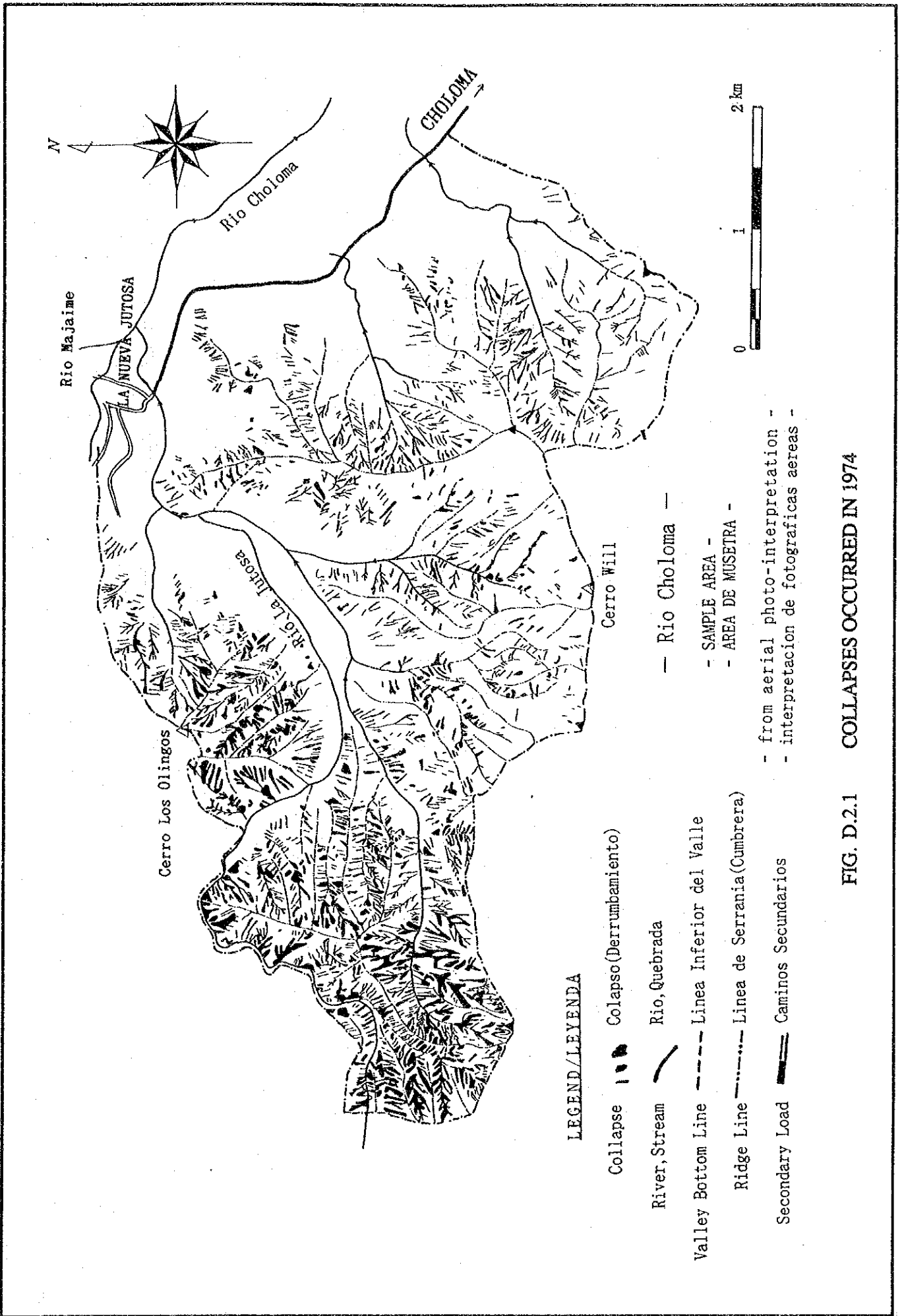
FIG. D.1.4 DEBRIS CONTROL PLAN BY SECOPT

SOURCE: SECOPT



EXISTING SABO DAM (RIO LA JUTOSA)

FIG. D.1.5 MAIN FEATURES OF EXISTING CHECK DAM



LEGENDA/LEYENDA






- Collapse 
- River, Stream 
- Valley Bottom Line 
- Ridge Line 
- Secondary Road 
- Colapso (Derrumbamiento)
- Rio, Quebrada
- Linea Inferior del Valle
- Linea de Serrania (Cumbrea)
- Caminos Secundarios
- Rio Choloma
- SAMPLE AREA
- AREA DE MUSETRA
- from aerial photo-interpretation
- interpretacion de fotograficas areas

FIG. D.2.1 COLLAPSES OCCURRED IN 1974



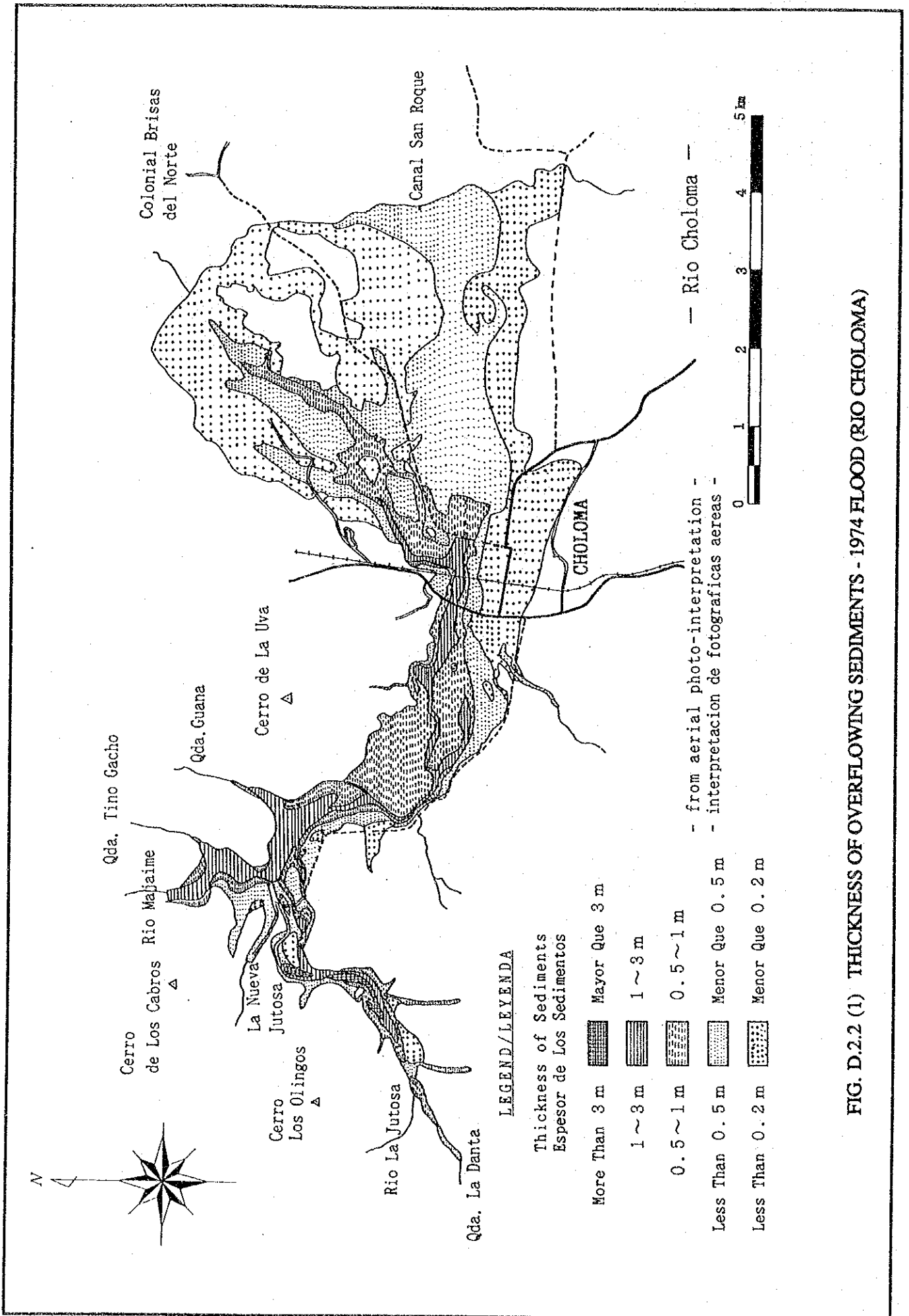


FIG. D.2.2 (1) THICKNESS OF OVERFLOWING SEDIMENTS - 1974 FLOOD (RIO CHOLOMA)

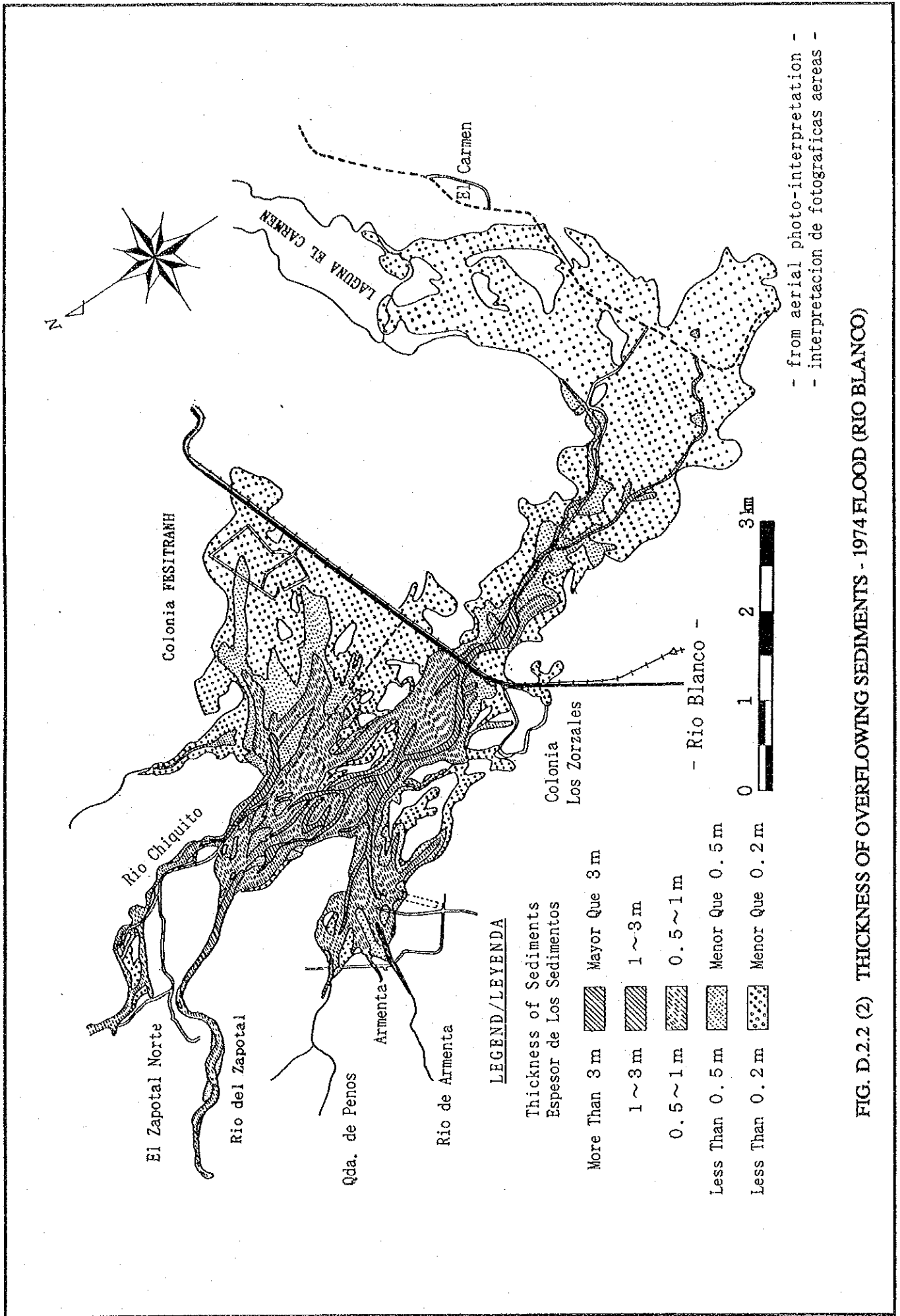
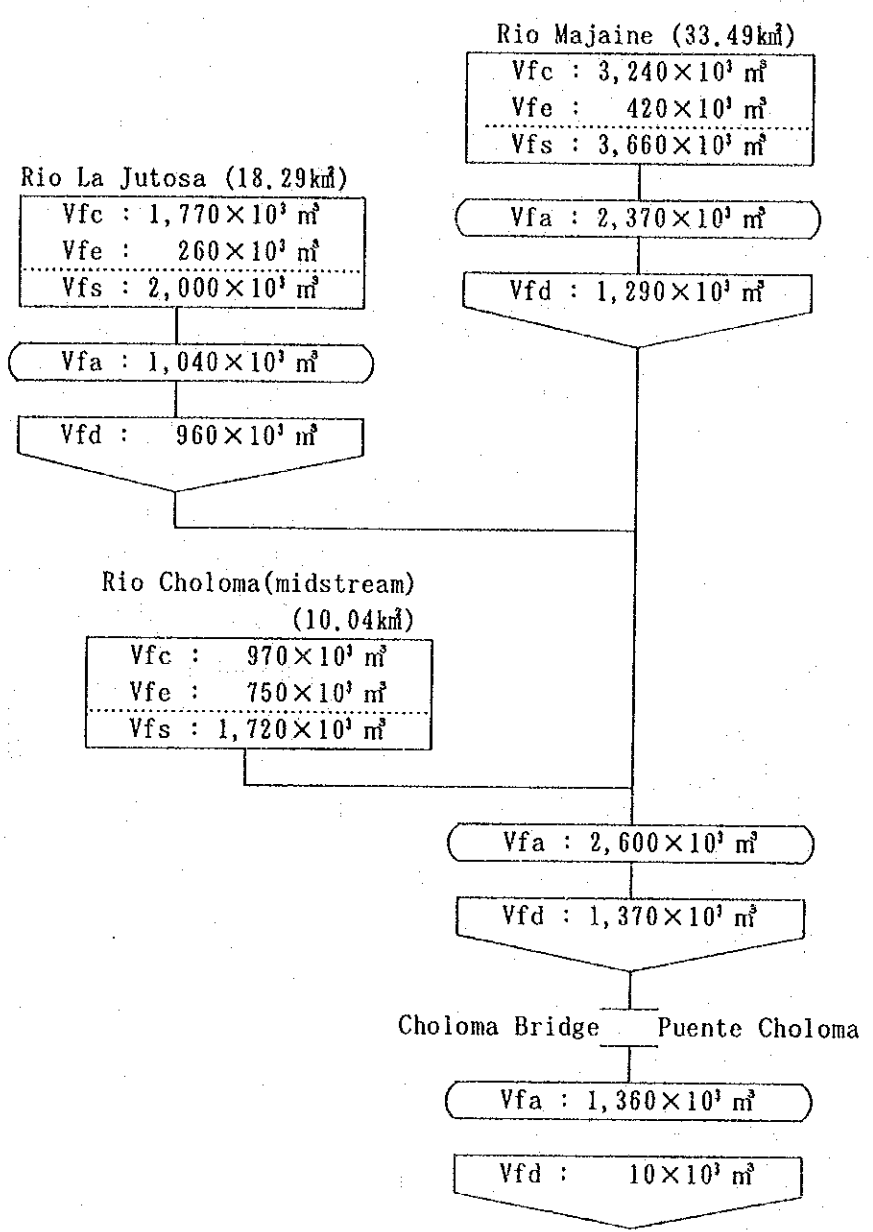


FIG. D.2.2 (2) THICKNESS OF OVERFLOWING SEDIMENTS - 1974 FLOOD (RIO BLANCO)



Vfc : Produced sediment volume from collapsed area
/ Volumen de sedimentos producido por colapsada

Vfe : Eroded sediment volume of the river course
/ Volumen de sedimentos erosionada en el curse del rio

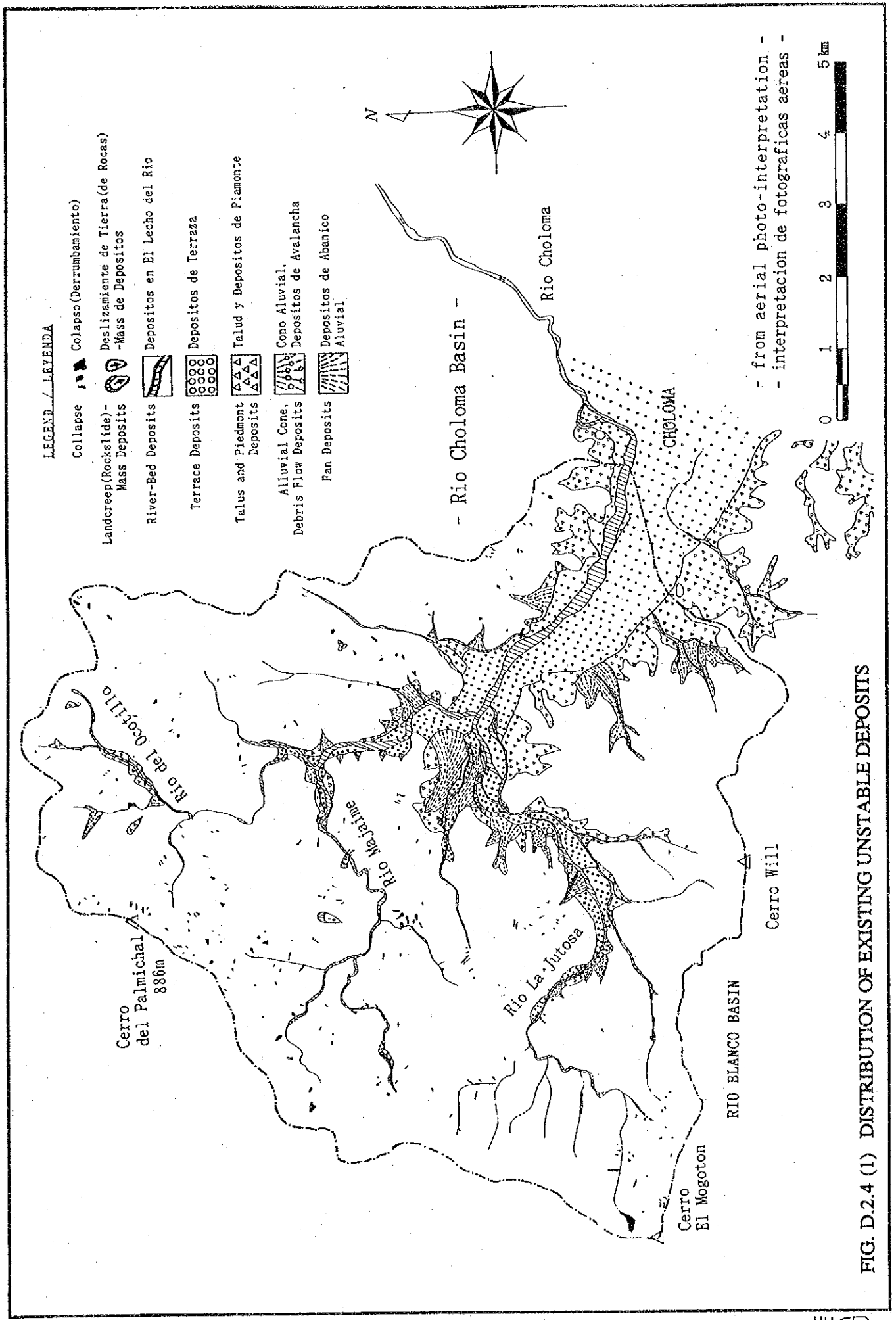
Vfs : Supplied sediment volume
/ Volumen de sedimentos suministrado(=Vfc+Vfe)

Vfa : Accumulated sediment volume
/ Volumen de sedimentos acumulado

Vfd : Sediment discharge volume
/ Volumen de descarga de sedimentos(=Vfs+Vfd)

(km²) : Mountain slope area / Area de montañosa

FIG. D.2.3 SEDIMENT BALANCE AT THE RIO CHOLOMA BASIN (1974 FLOOD)



LEGENDA / LEYENDA

- Collapse (Derrumbamiento)
- Landslide (Rockslide) - Mass Deposits (Deslizamiento de Tierra (de Rocas) - Mass de Depositos)
- River-Bed Deposits (Depositos en El Lecho del Rio)
- Terrace Deposits (Depositos de Terraza)
- Talus and Piedmont Deposits (Talud y Depositos de Piamonte)
- Alluvial Cone, Debris Flow Deposits (Cono Aluvial, Depositos de Avalancha)
- Fan Deposits (Depositos de Abanico Aluvial)
- Colapso
- Deslizamiento de Tierra (de Rocas) - Mass de Depositos
- Depositos en El Lecho del Rio
- Depositos de Terraza
- Talud y Depositos de Piamonte
- Cono Aluvial, Depositos de Avalancha
- Depositos de Abanico Aluvial

FIG. D.2.4 (1) DISTRIBUTION OF EXISTING UNSTABLE DEPOSITS



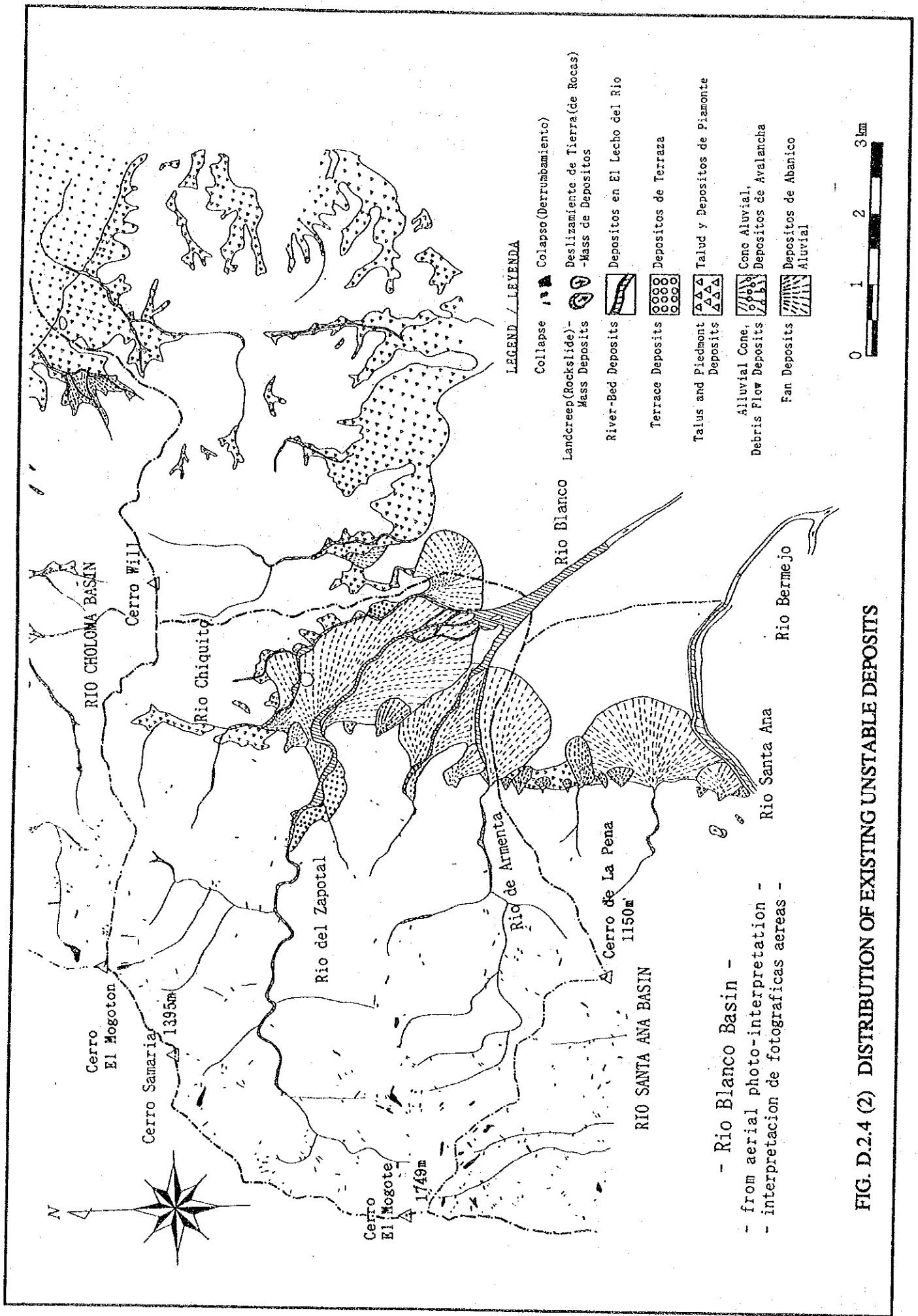


FIG. D.2.4 (2) DISTRIBUTION OF EXISTING UNSTABLE DEPOSITS



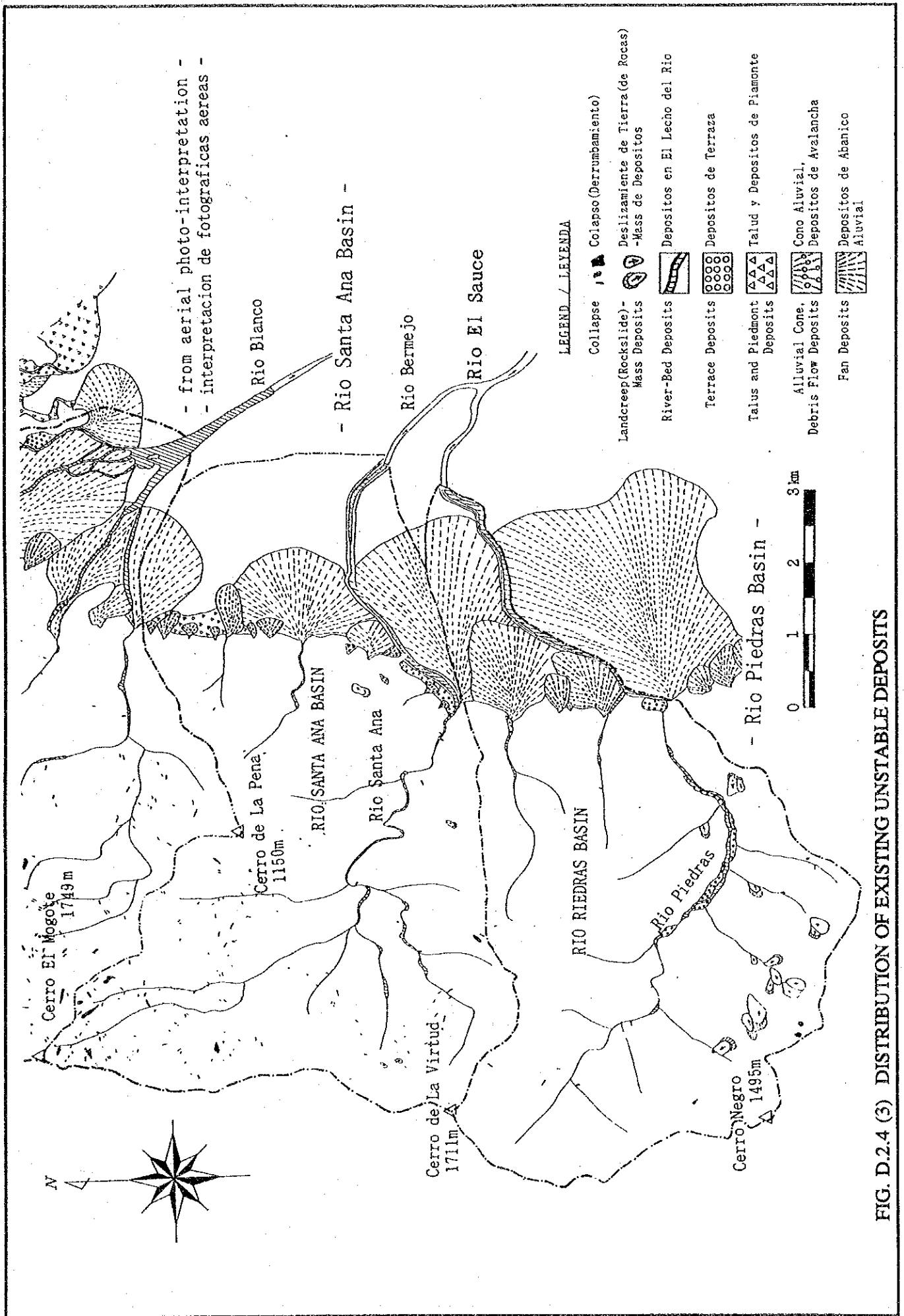
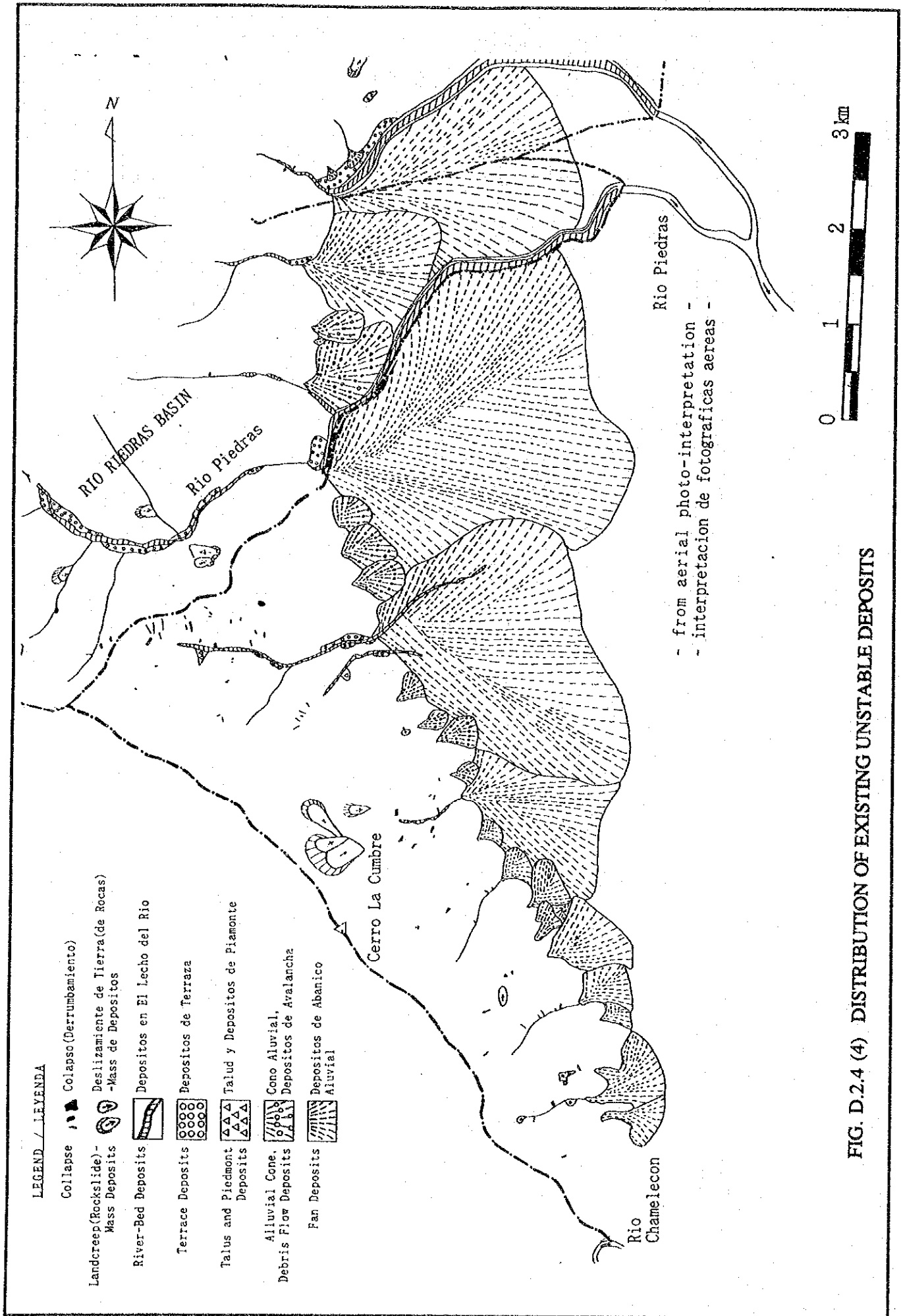


FIG. D.2.4 (3) DISTRIBUTION OF EXISTING UNSTABLE DEPOSITS



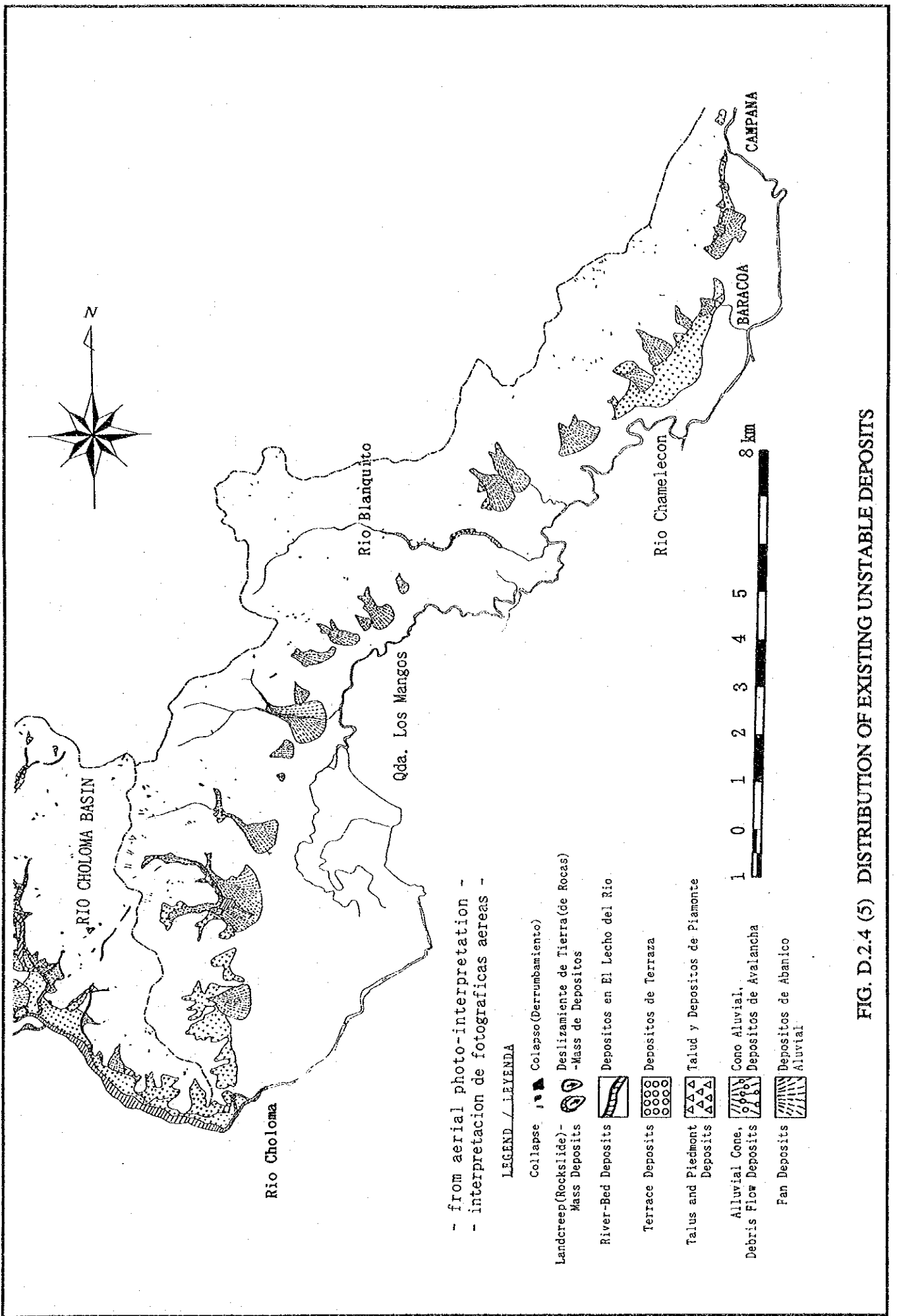
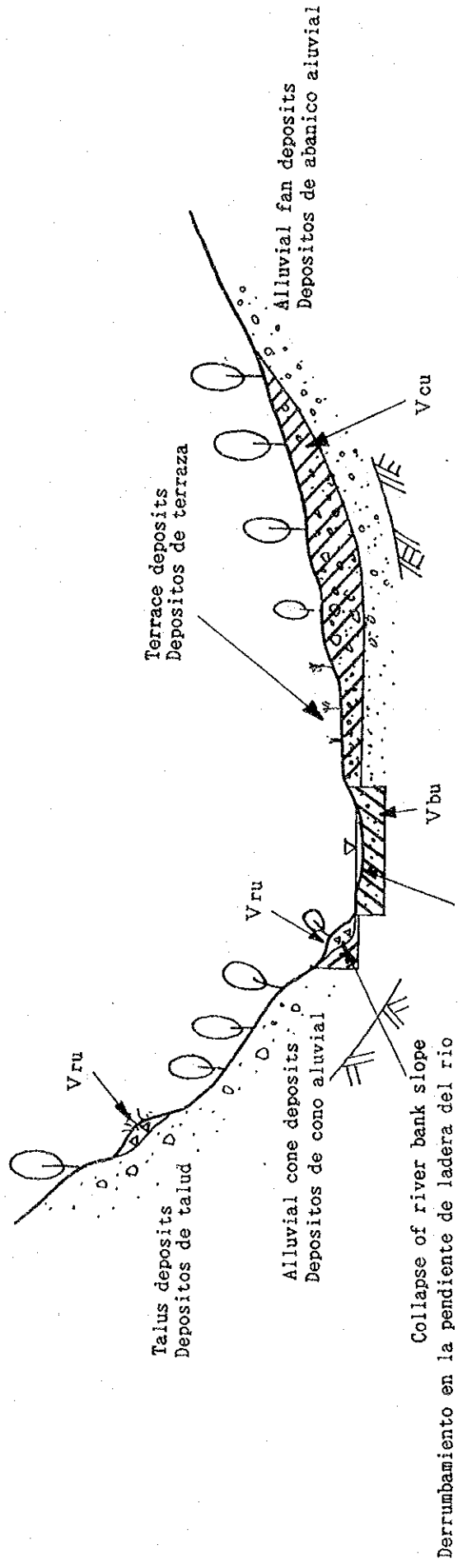


FIG. D.2.4 (5) DISTRIBUTION OF EXISTING UNSTABLE DEPOSITS



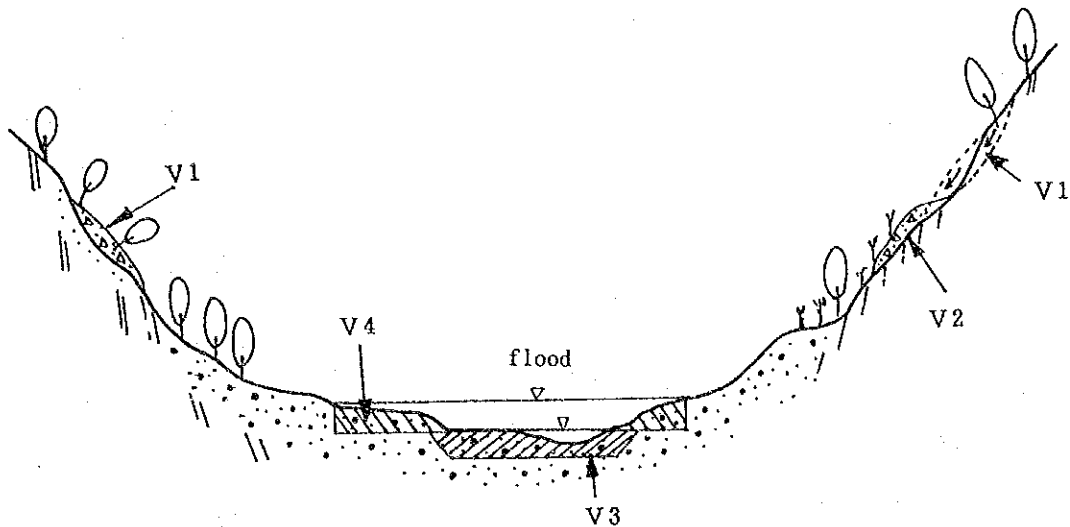


Existing river course : Curso del rio existente

- Vru : Residual unstable deposits existing of past collapsed area
Depositos residuales inestables existentes del area derrumbada anteriormente
- Vbu : Unstable riverbed deposits
Depositos inestables en el lecho del rio
- Vcu : Unstable deposits along the river course
Depositos inestables a lo largo del curso del rio

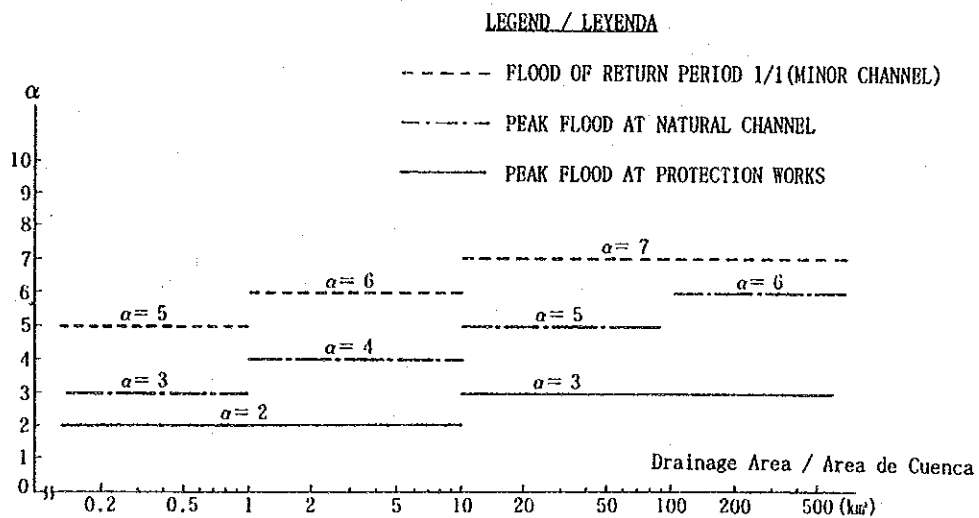
FIG. D.2.5 EXPLANATORY DIAGRAM OF UNSTABLE DEPOSITS DISTRIBUTION AND DISCHARGE ZONE





- V1=Sediment yield of expanding collapsed area
 Produccion de sedimentos de areas derrumbadas en expansion
- V1=Sediment yield of newly collapsed area
 Produccion de sedimento de nueva area derrumbada
- V2=Residual collapsed sediment yield of existing past collapsed area
 Produccion de sedimentos residuales existentes debido a areas derrumbadas anteriormente
- V3=Sediment yield of surrounding riverbed area
 Produccion de sedimentos alrededor en el area de lecho del rio
- V4=Sediment yield due to river bank erosion
 Produccion de sedimentos debido a la erosion de la ribera del rio
- V10=design sediment yield / Produccion de sedimentos de diseño(=V1+V2+V3+V4)

FIG. D.3.1 EXPLANATORY DIAGRAM OF DESIGN SEDIMENT YIELD



FLOOD OF RETURN PERIOD 1/1(MINOR CHANNEL) / PERIODO DE RETORNO DEL FLUJO 1/1(CANAL MENOR)
 PEAK FLOOD AT NATURAL CHANNEL / FLUJO MAXIMO EN CANAL NATURAL
 PEAK FLOOD AT PROTECTION WORKS / FLUJO MAXIMO EN TRABAJOS DE PROTECCION

FIG. D.3.2 DRAINAGE AREA - COEFFICIENT α OF REGIME THEORY

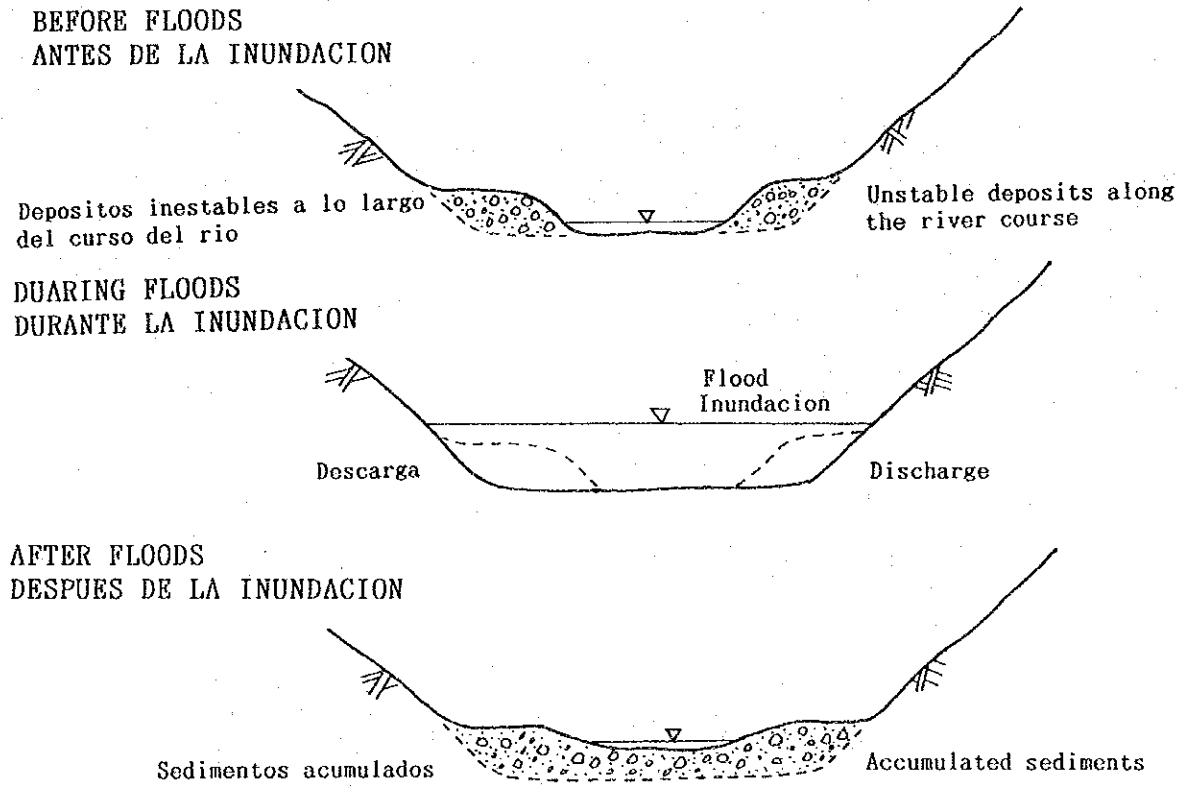
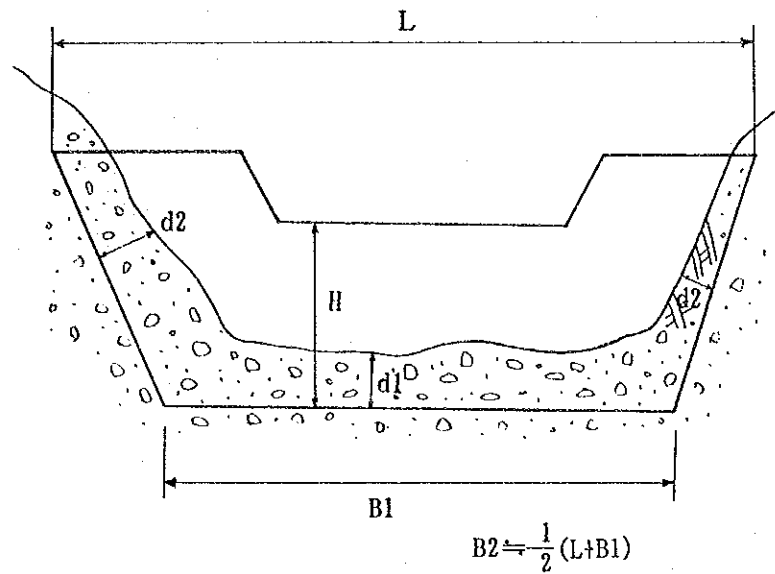
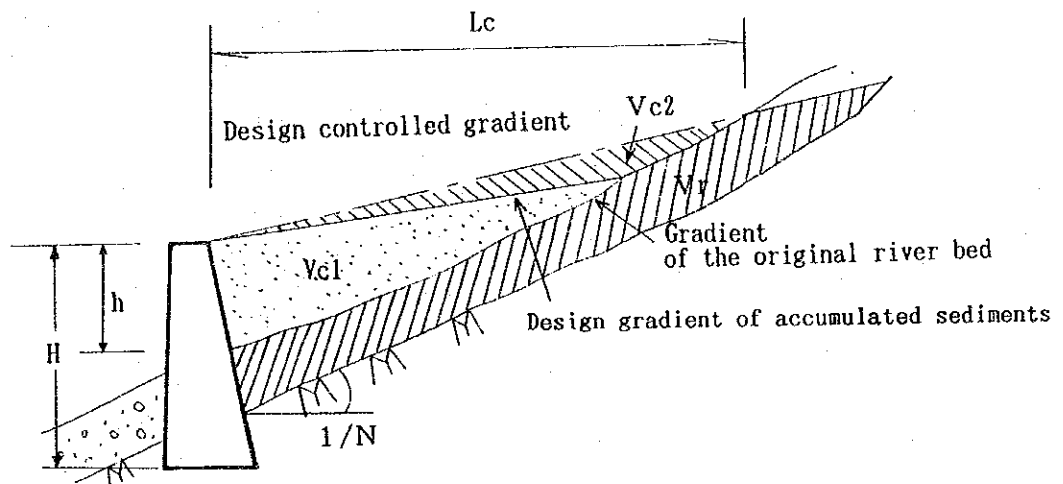


FIG. D.3.3 EXPLANATORY DIAGRAM OF NATURALLY CONTROLLED SEDIMENT DISCHARGE

CHECK DAM



- h : Effective dam height / Altura efectiva de presa
- B1 : Riverbed width / Anchura del lecho del rio
- B2 : Average width of sedimentation area / Anchura promedio de la area de sedimentacion
- d1 : Thickness of riverbed deposits / Espesor de sedimentos en del cauce del rio
- d2 : Thickness of sediments at river bank slope / Espesor de sedimentos en la ribera del Rio
- 1/N : Riverbed gradient / Inclination del cauce del rio
- Lc : Length of sedimentation area / Longitud de area de sedimentacion(=2XNhx)

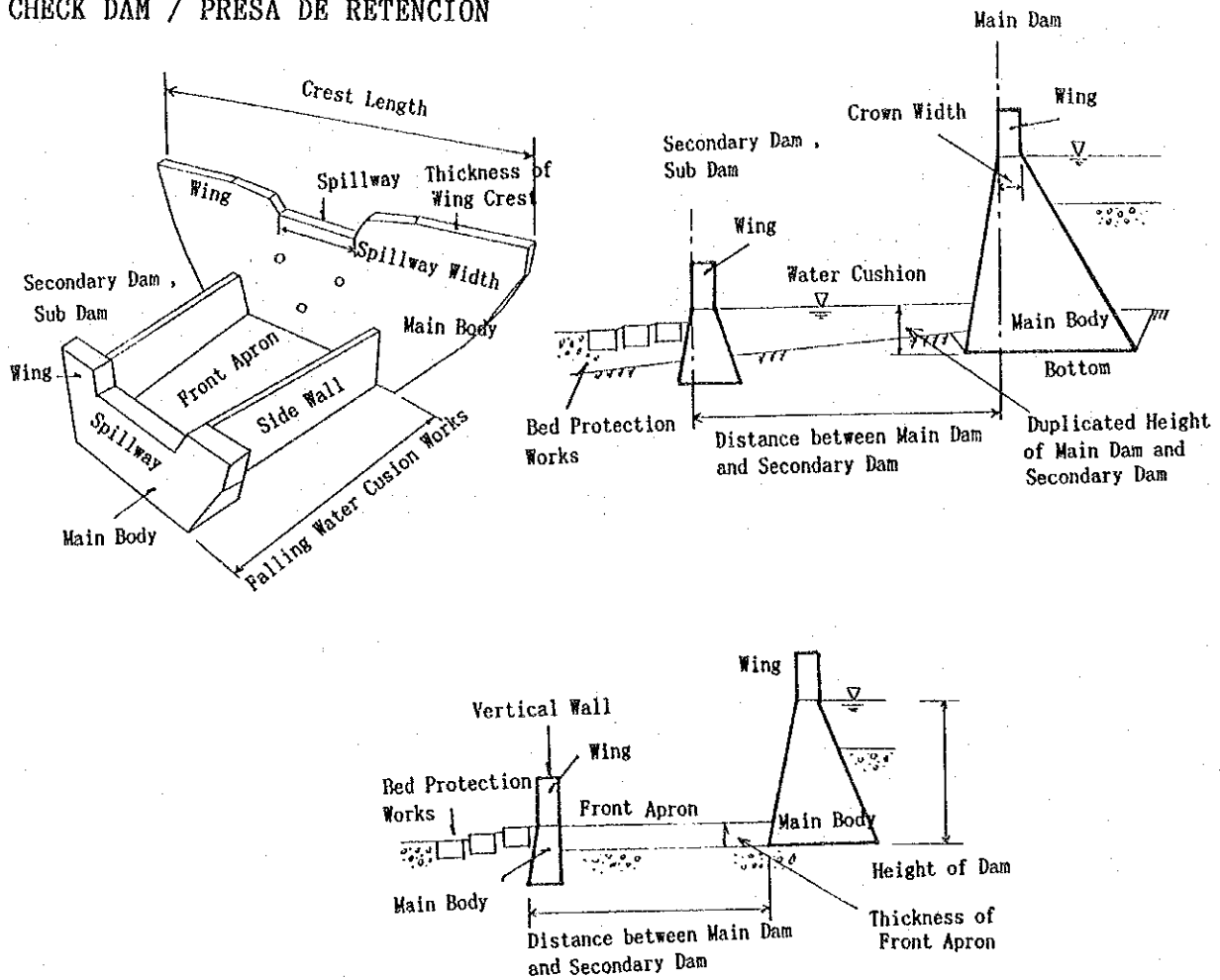


- Vc1 : Sediment trap capacity(=NxB2xh2)
Capacidad de la trampa de sedimentos
- Vc2 : Controlled sediment discharge capability(0.1xVc1)
Capacidad de descarga de sedimentos controlada
- Vr : Sediment discharge suppression capability(=LcX(hXd2+B1Xd1))
Capacidad de descarga de sedimentos represiro
- Vc2+Vr : Volume of facility effectiveness
Volumen de capacidad efectiva por instalacion

Design controlled gradient / Diseño de la gradiente controlada
 Gradient of the original riverbed / Gradiente del lecho original
 Design gradient of accumulated sediments / Diseño del gradiente de sedimentos acumulada

FIG. D.3.4 EXPLANATORY DIAGRAM OF VC1, VC2 AND VR

CHECK DAM / PRESA DE RETENCION



Bed Protection Works : Trabajos de Proteccion del Lecho

Bottom : Base

Crest Length : Longitud de Cresta

Crown Width : Anchos de Corona

Distance between Main Dam and Sub Dam : Distancia entre Presa Principal y Presa Secundaria,

Duplicated Height of Main Dam and Secondary Dam : Altura Duplicada de Presa

Falling Water Cusion Works : Trabajos de Almohadon para Agua de Caida

Front Apron : Disipador de Energia(Delantal)

Height of Dam: Altura de la Presa

Main Dam : Presa Principal

Main Body : Cuerpo Principal

Secondary Dam(Sub Dam) : Presa Secundaria(Contra Presa)

Side Wall : Pared de Proteccion

Spillway : Vertedero

Spillway Width : Ancho de Vertedero

Thickness of Front Apron : Espesor del Delantal Disipador

Thickness of Wing Crest : Espesor de la Cresta(Manga)

Vertical Wall : Pared Vertical

Water Cushion : Almohadon de Agua

Wing : Ala(Manga)

FIG. D.3.5 BASIC FORM OF CHECK DAM (SABO DAM)

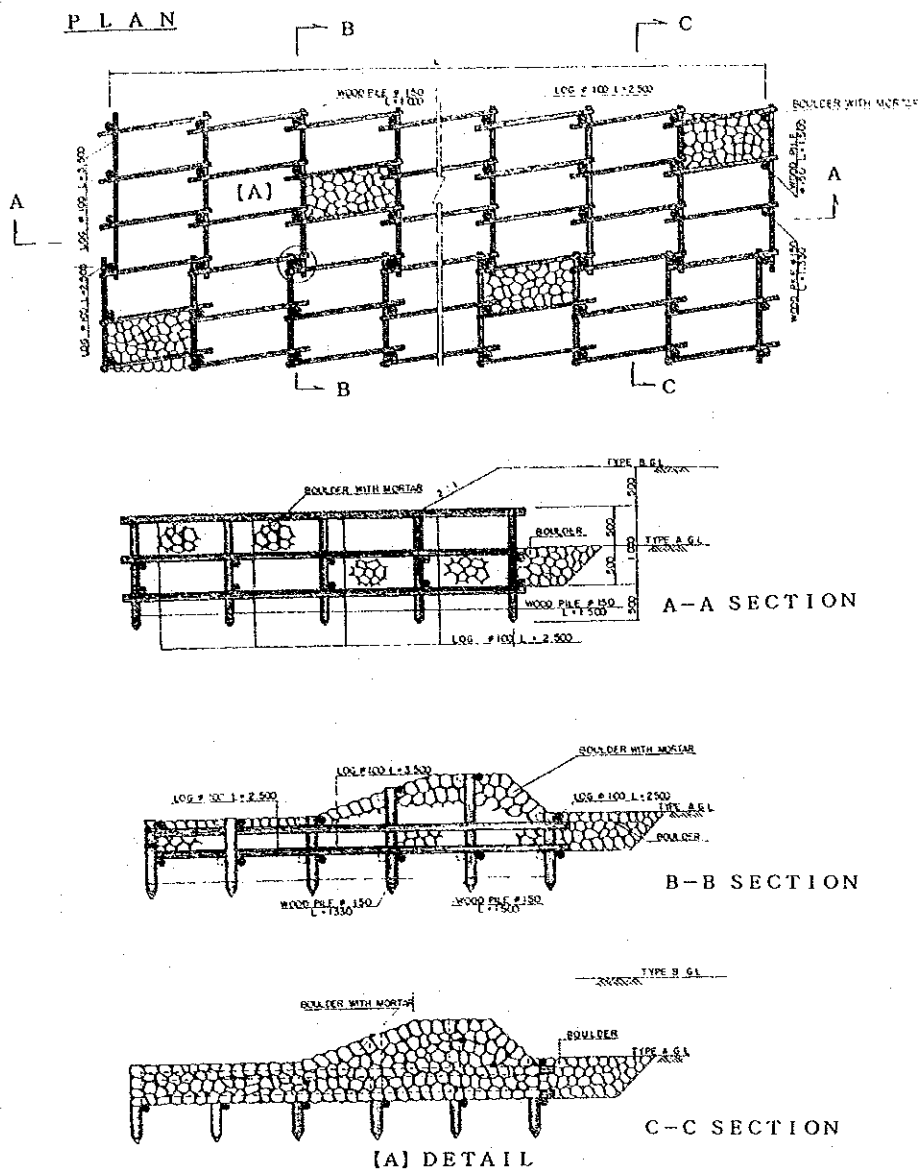


FIG. D.3.6 PROPOSED BASIC DESIGN OF CONSOLIDATION WORKS USING GABION

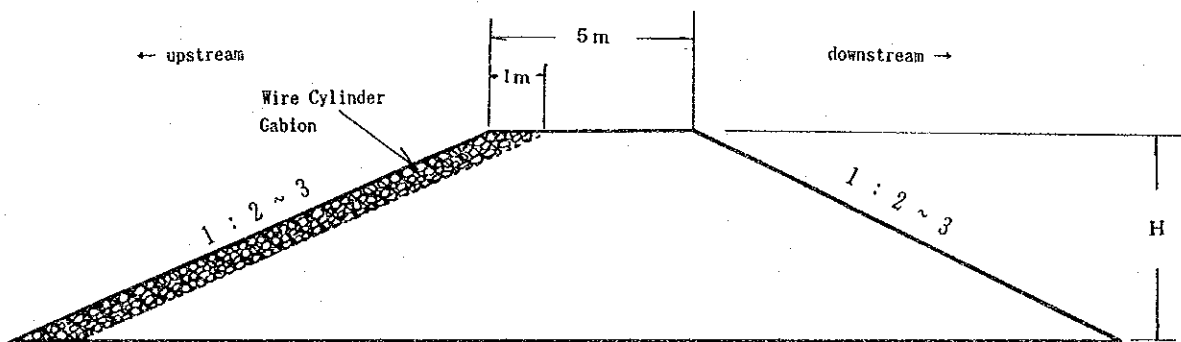
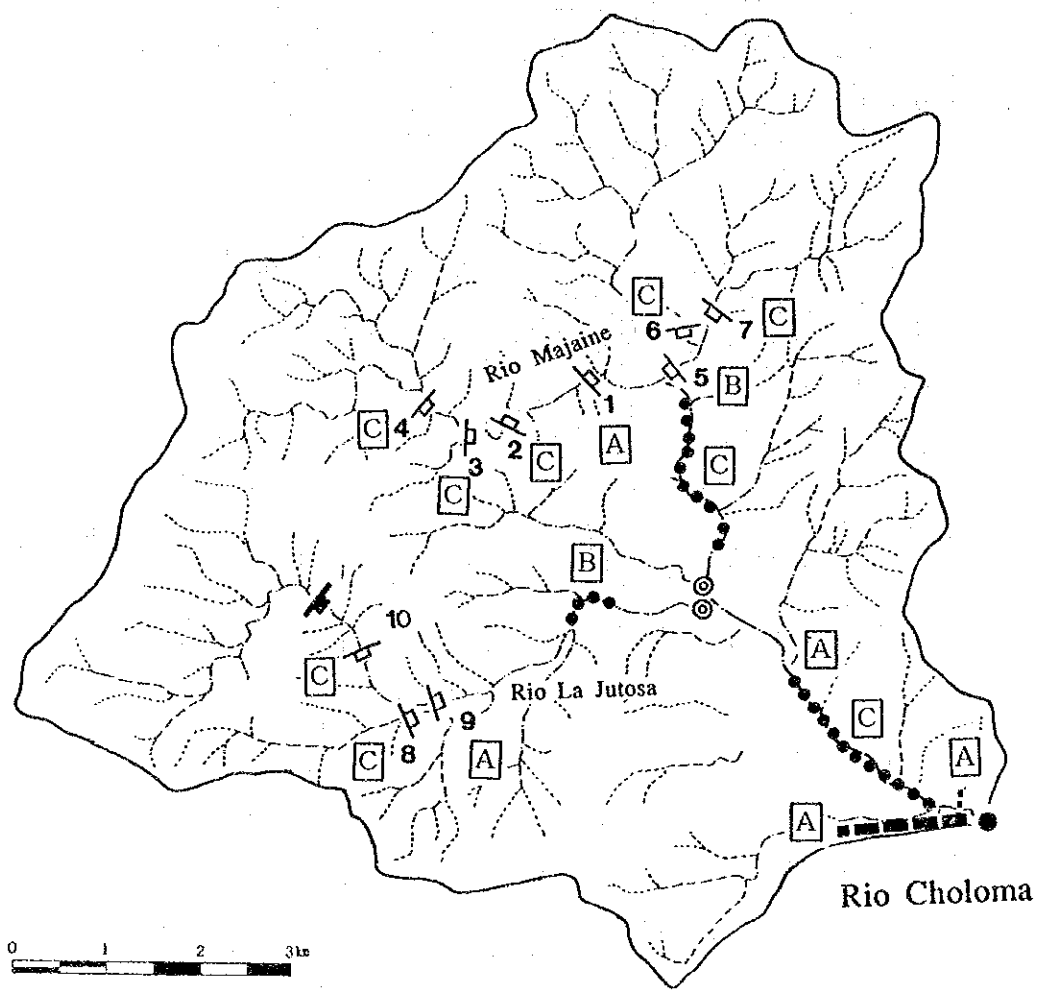
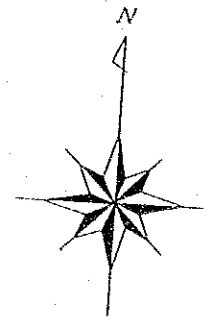


FIG. D.3.7 PROPOSED BASIC DESIGN OF TRAINING LEVEE (DEBRIS CONTROL LEVEE)



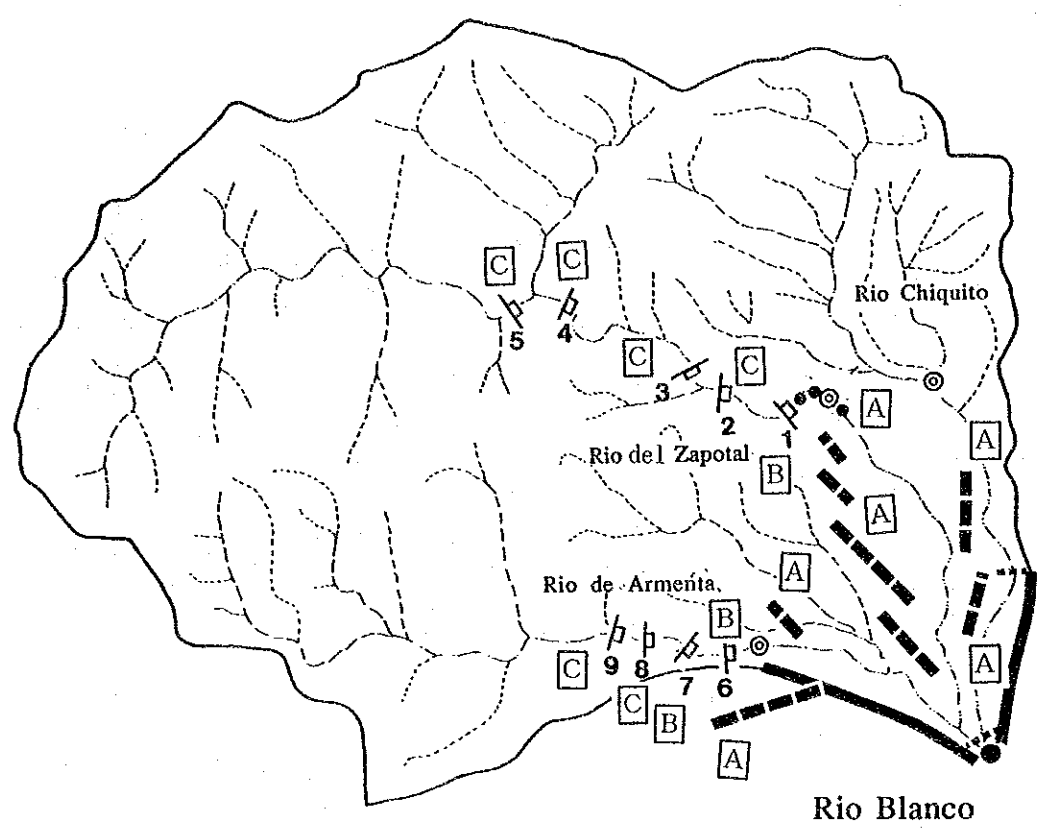
LEGENDO / LEYENDA

- CHECK (SABO) DAM (EXISTING) PRESA DE RETENCION (SABO) (EXISTENTES)
- CHECK (SABO) DAM (PLAN) PRESA DE RETENCION (SABO) (PROPUESTA)
- WATER INTAKE TOMA DE AGUA
- CHANNEL WORKS (PLAN) TRABAJOS EN EL CANAL (PROPUESTOS)
- CONSOLIDATION WORKS (PLAN) TRABAJOS DE CONSOLIDACION (PROPUESTOS)
- TRAINING LEVEE (PLAN) DIQUE DE GUIA (PROPUESTOS)
- EMBANKMENT (EXISTING) BORDOS (EXISTENTES)
- SUB-CONTROL POINT PUNTOS DE SUB-CONTROL
- DESIGN CONTROL POINT PUNTO DE CONTROL DE DISEÑO

[PRIORITY]
 A B C
 High ← → Low

FIG. D.3.8 (1) LOCATION OF EROSION CONTROL FACILITY AND PRIORITY SEQUENCE (RIO CHOLOMA)





[PRIORITY]
 A B C
 High ← → Low

LEGENDO / LEYENDA

- CHECK (SABO) DAM (EXISTING) PRESA DE RETENCION (SABO) (EXISTENTES)
- CHECK (SABO) DAM (PLAN) PRESA DE RETENCION (SABO) (PROPUESTA)
- WATER INAKE TOMA DE AGUA
- CHANNEL WORKS (PLAN) TRABAJOS EN EL CANAL (PROPUESTOS)
- CONSOLIDATION WORKS (PLAN) TRABAJOS DE CONSOLIDACION (PROPUESTOS)
- TRAINING LEVEE (PLAN) DIQUE DE GUIA (PROPUESTOS)
- EMBANKMENT (EXISTING) BORDOS (EXISTENTES)
- SUB-CONTROL POINT PUNTOS DE SUB-CONTROL
- DESIGN CONTROL POINT PUNTO DE CONTROL DE DISEÑO

FIG. D.3.8 (2) LOCATION OF EROSION CONTROL FACILITY AND PRIORITY SEQUENCE (RIO BLANCO)

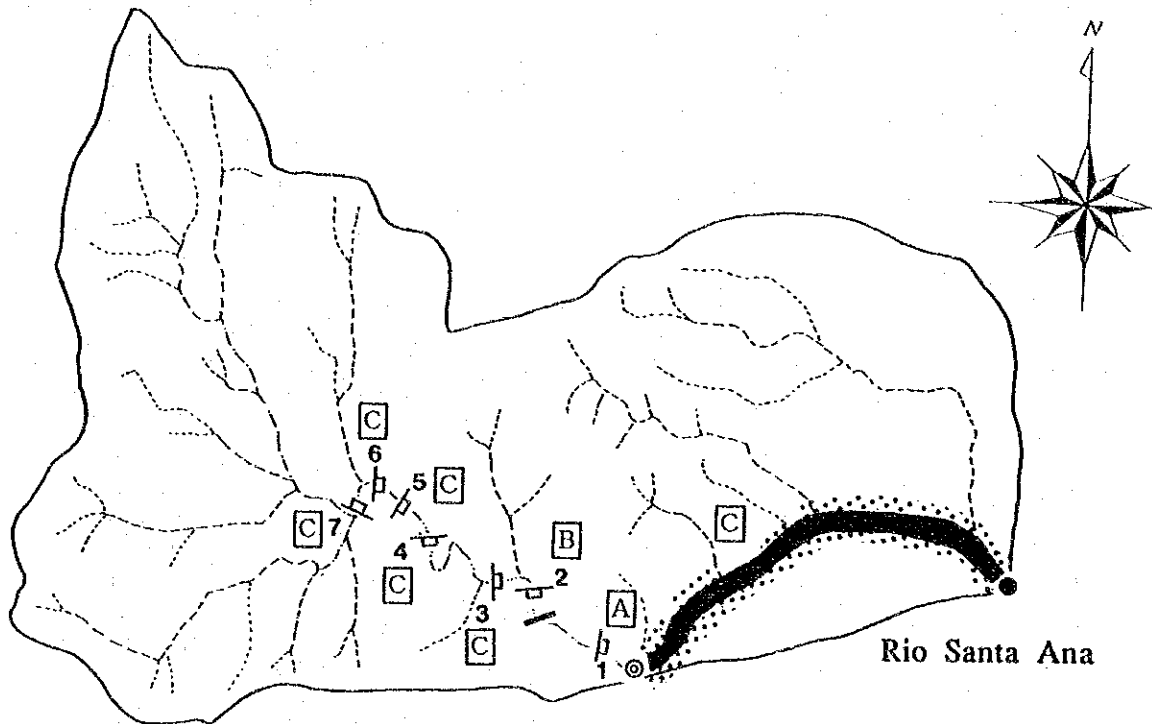
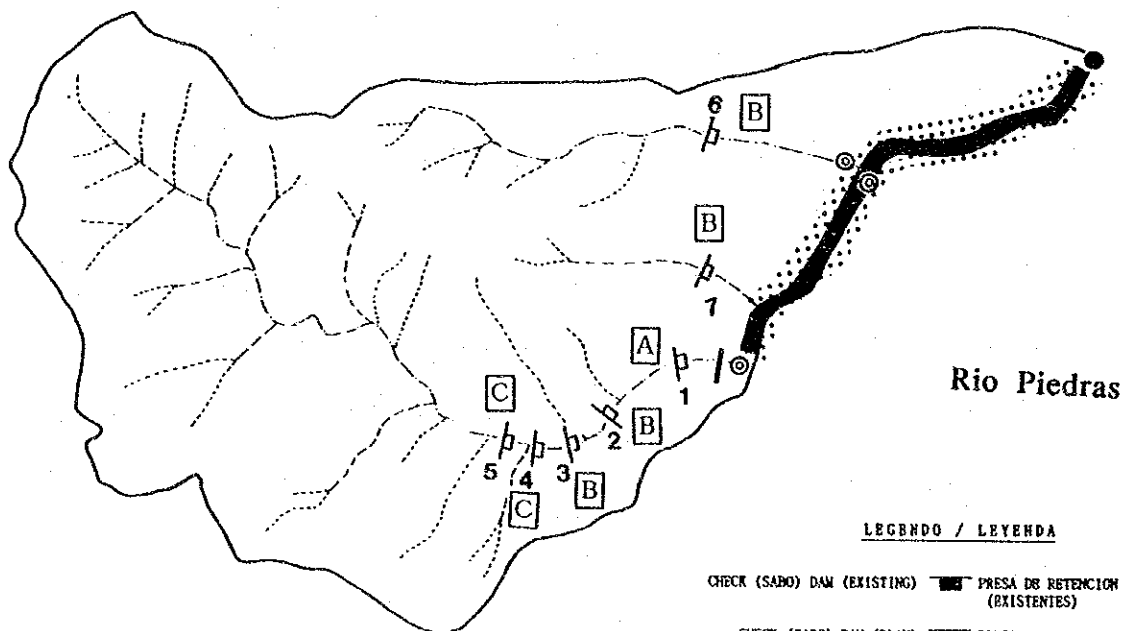


FIG. D.3.8 (3) LOCATION OF EROSION CONTROL FACILITY AND PRIORITY SEQUENCE (RIO SANTA ANA)



LEGENDO / LEYENDA

CHECK (SABO) DAM (EXISTING) PRESA DE RETENCION (SABO) (EXISTENTES)

CHECK (SABO) DAM (PLAN) PRESA DE RETENCION (SABO) (PROPUESTA)

WATER INTAKE TOMA DE AGUA

CHANNEL WORKS (PLAN) TRABAJOS EN EL CANAL (PROPUESTOS)

CONSOLIDATION WORKS (PLAN) TRABAJOS DE CONSOLIDACION (PROPUESTOS)

TRAINING LEVER (PLAN) DIQUE DE GUIA (PROPUESTOS)

EMBANKMENT (EXISTING) BORDOS (EXISTENTES)

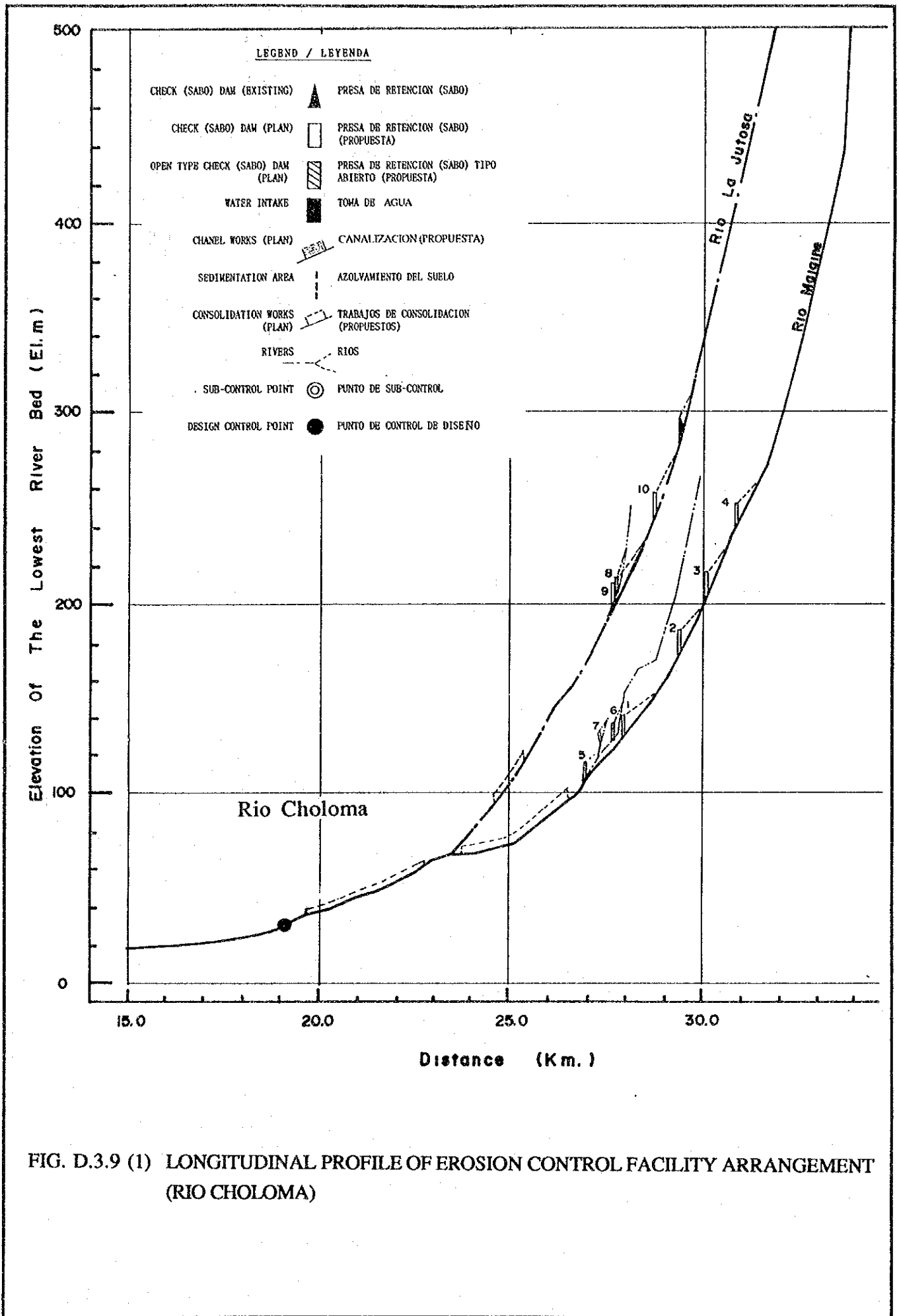
[PRIORITY]
 A B C
 High ← → Low

SUB-CONTROL POINT PUNTOS DE SUB-CONTROL

DESIGN CONTROL POINT PUNTO DE CONTROL DE DISEÑO

FIG. D.3.8 (4) LOCATION OF EROSION CONTROL FACILITY

AND PRIORITY SEQUENCE (RIO PIEDRAS)



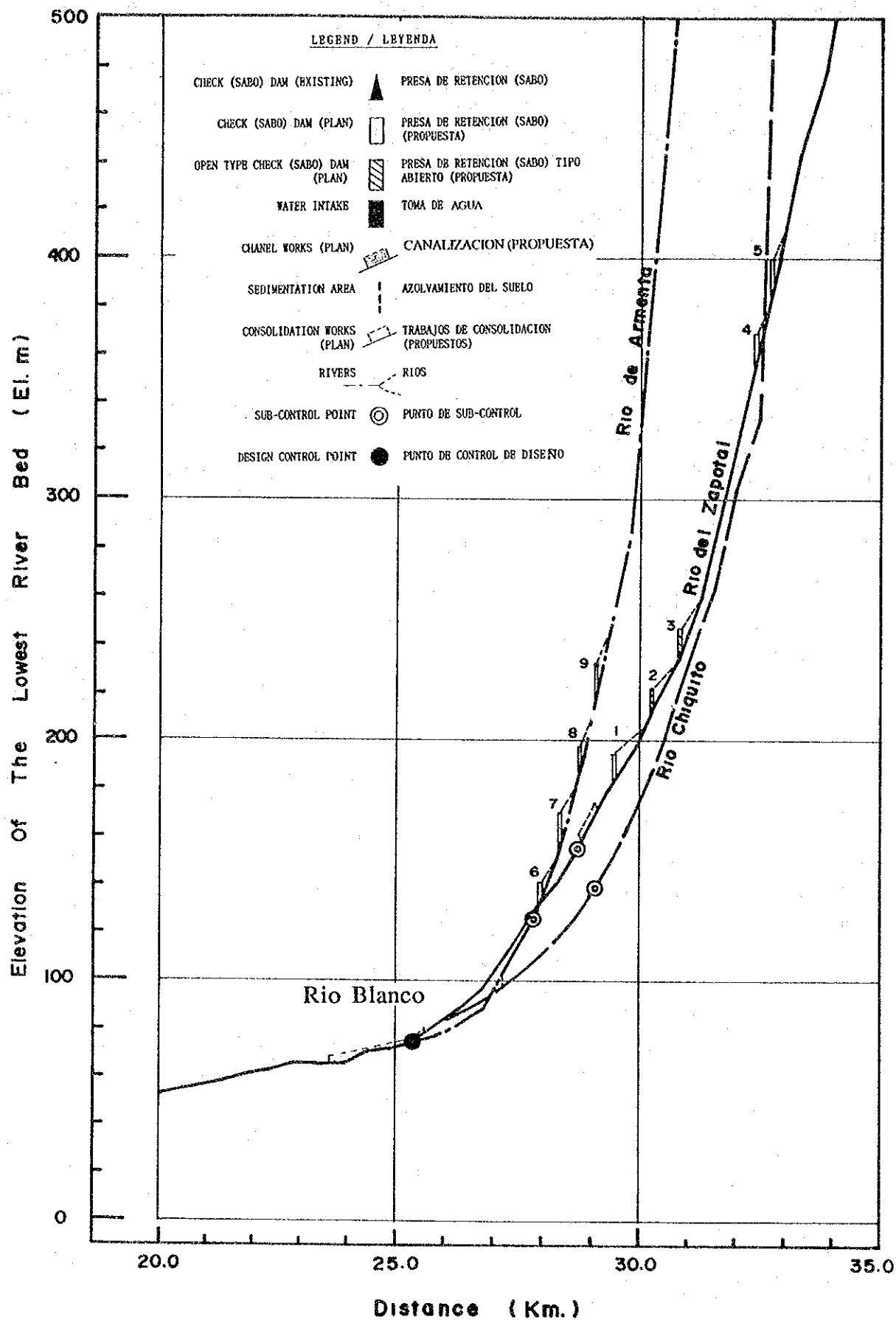


FIG. D.3.9 (2) LONGITUDINAL PROFILE OF EROSION CONTROL FACILITY ARRANGEMENT (RIO BLANCO)

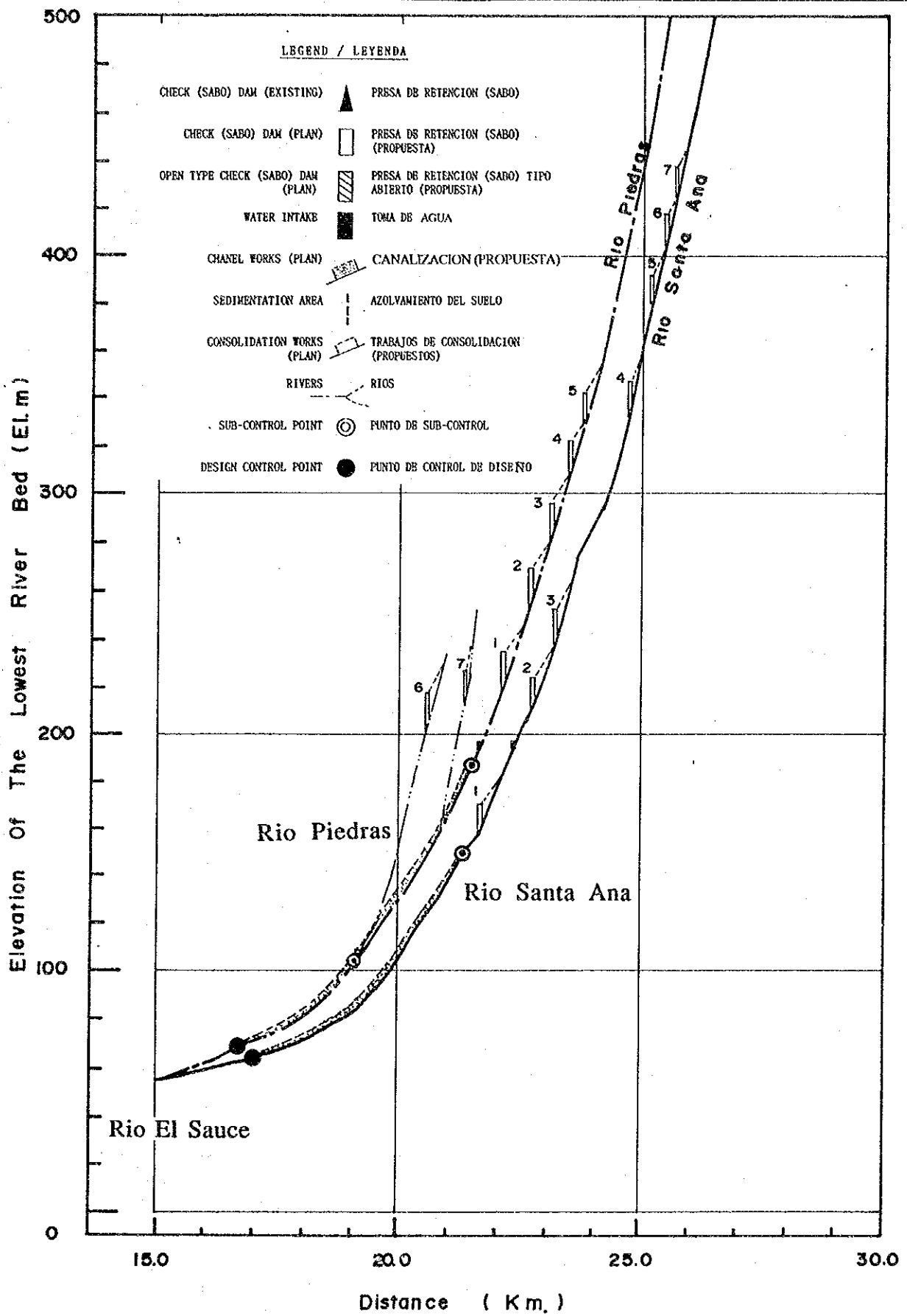


FIG. D.3.9 (3) LONGITUDINAL PROFILE OF EROSION CONTROL FACILITY ARRANGEMENT (RIO EL SAUCE)

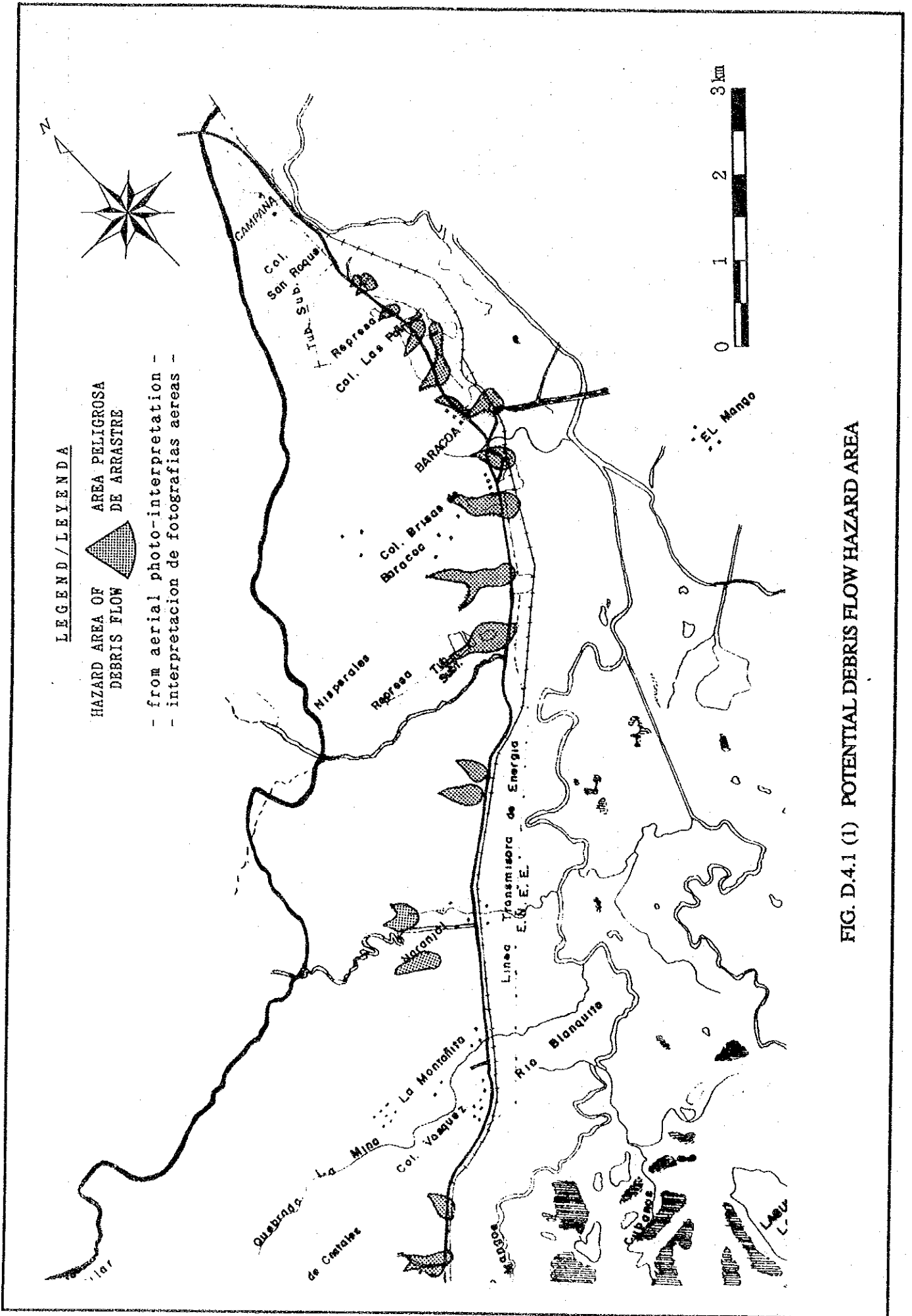
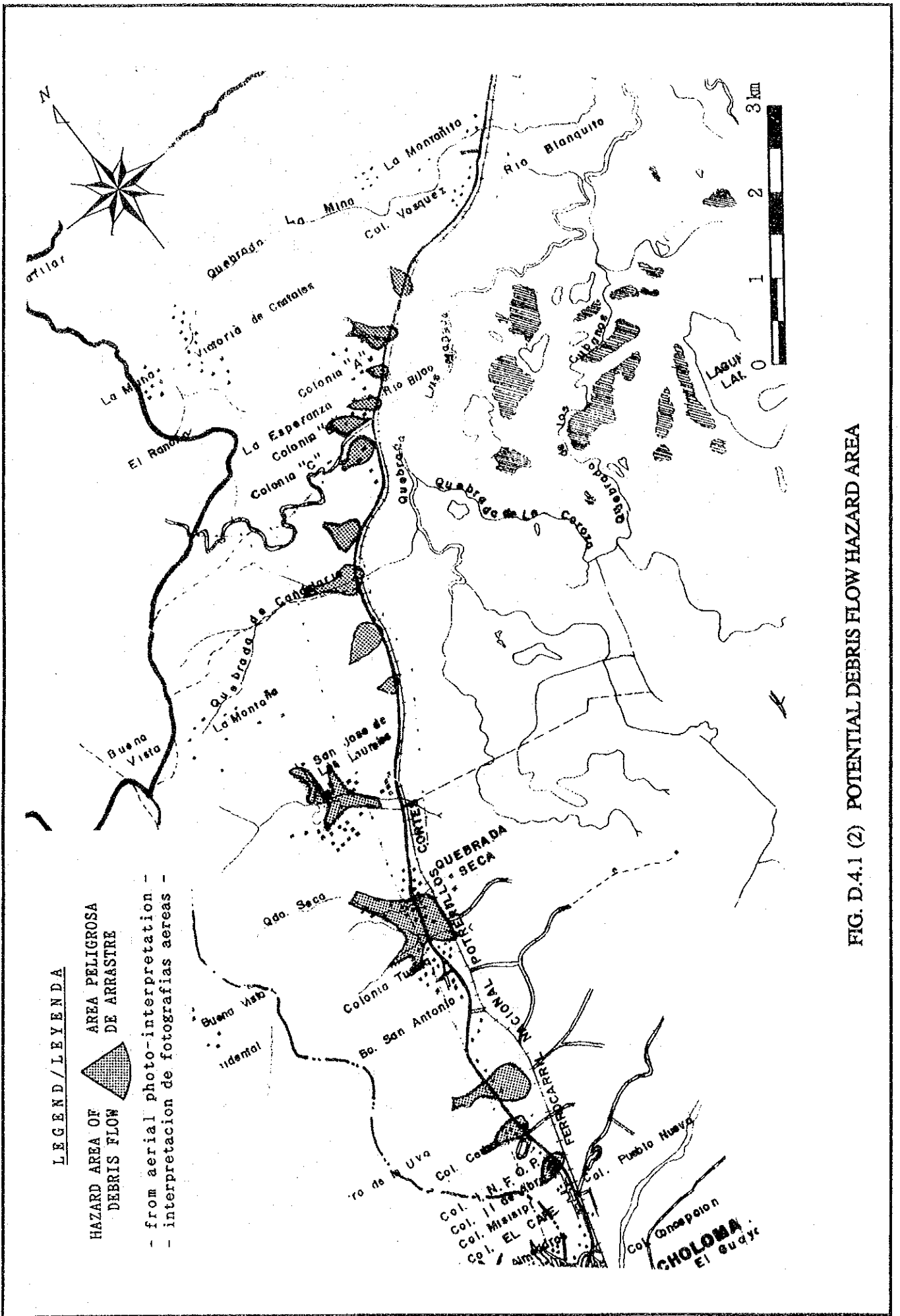
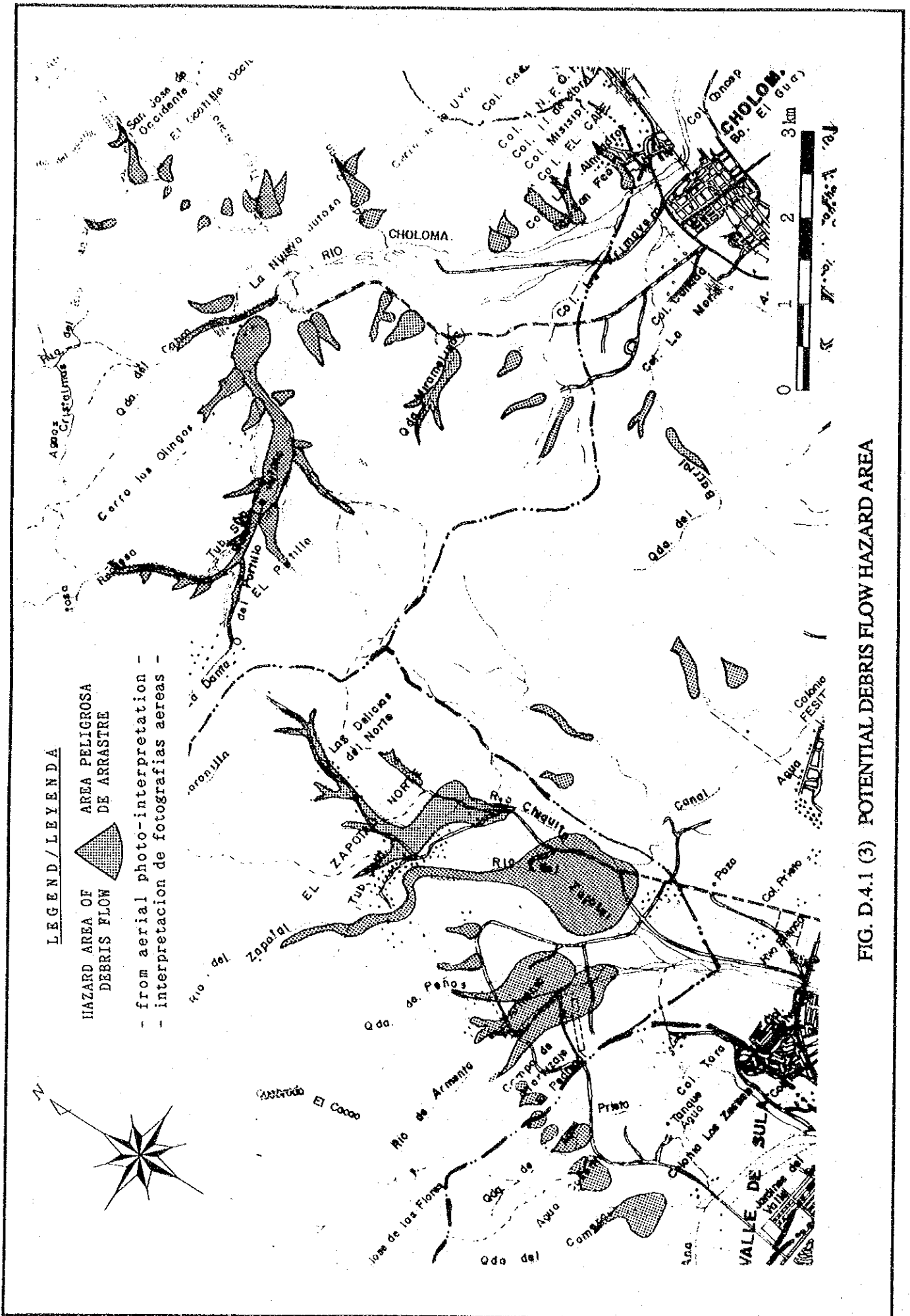


FIG. D.4.1 (1) POTENTIAL DEBRIS FLOW HAZARD AREA





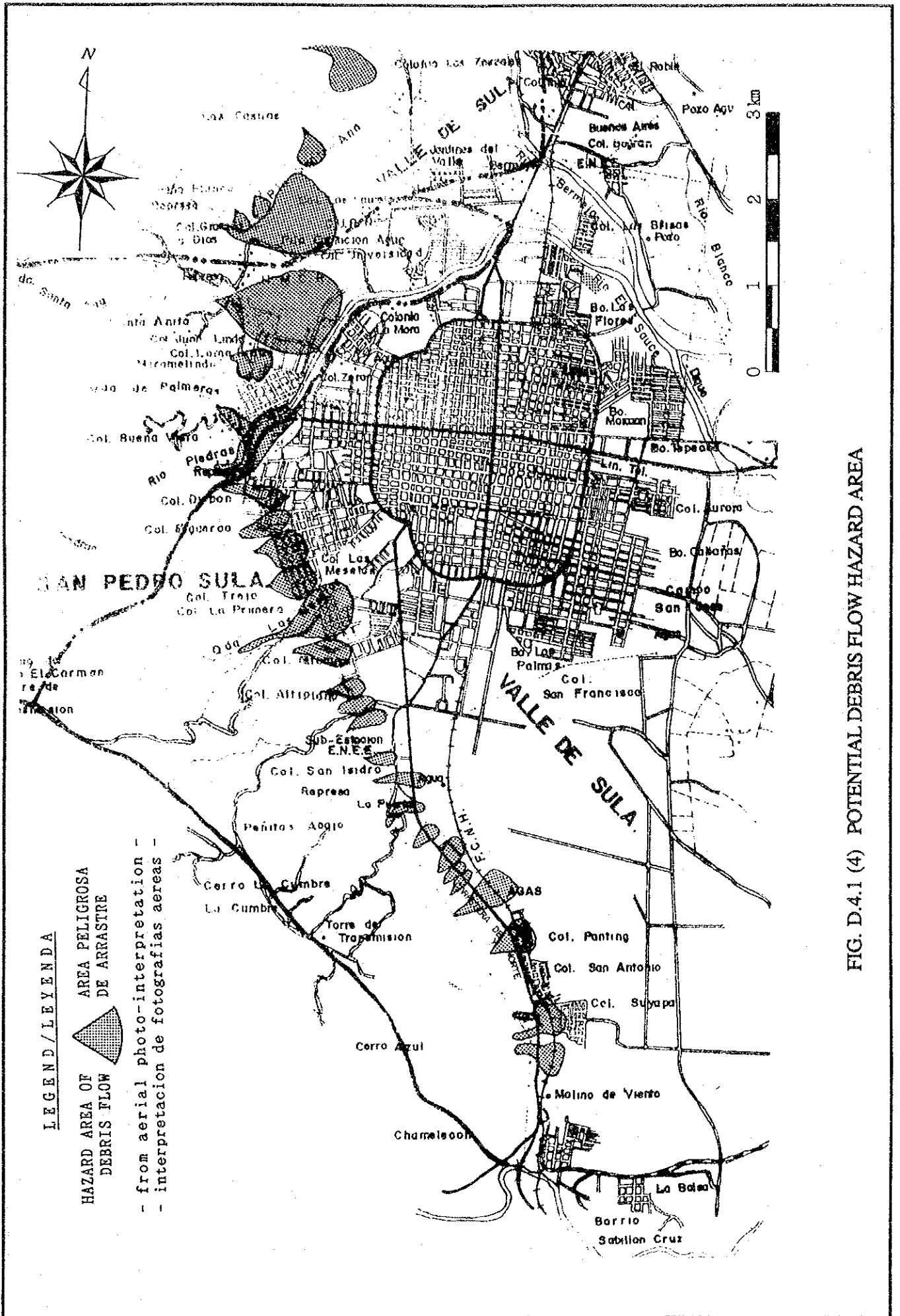
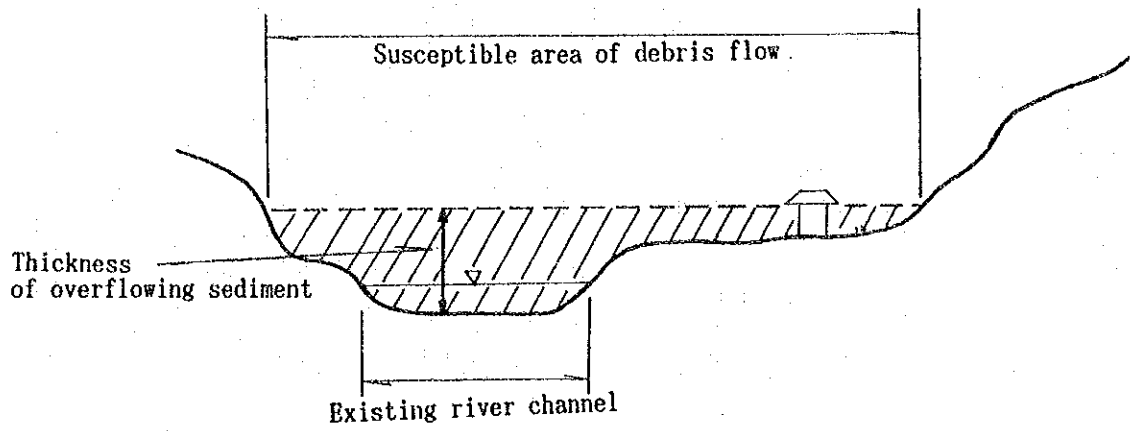


FIG. D.4.1 (4) POTENTIAL DEBRIS FLOW HAZARD AREA

VALLEY BOTTOM PLAIN



ALLUVIAL FAN

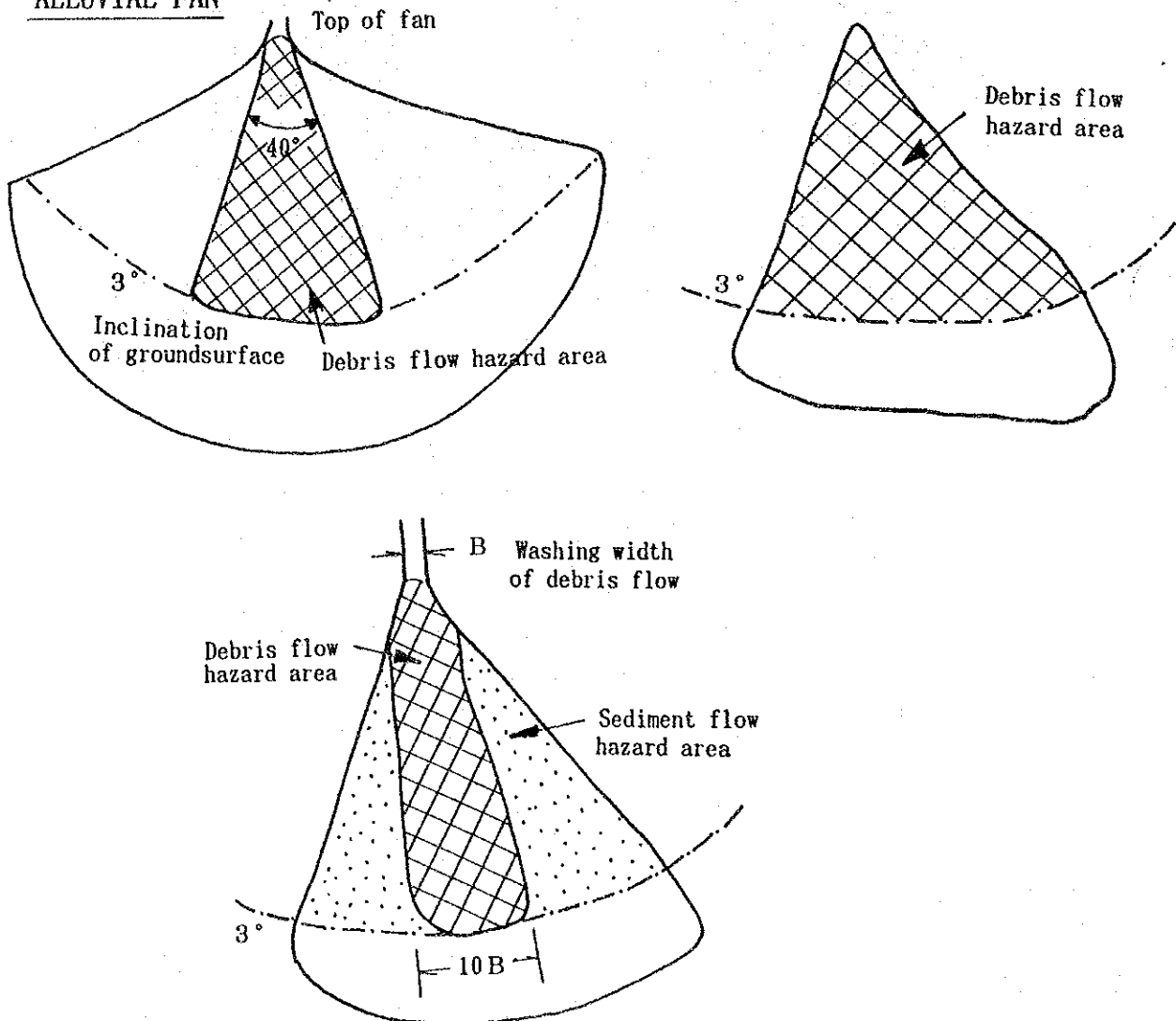
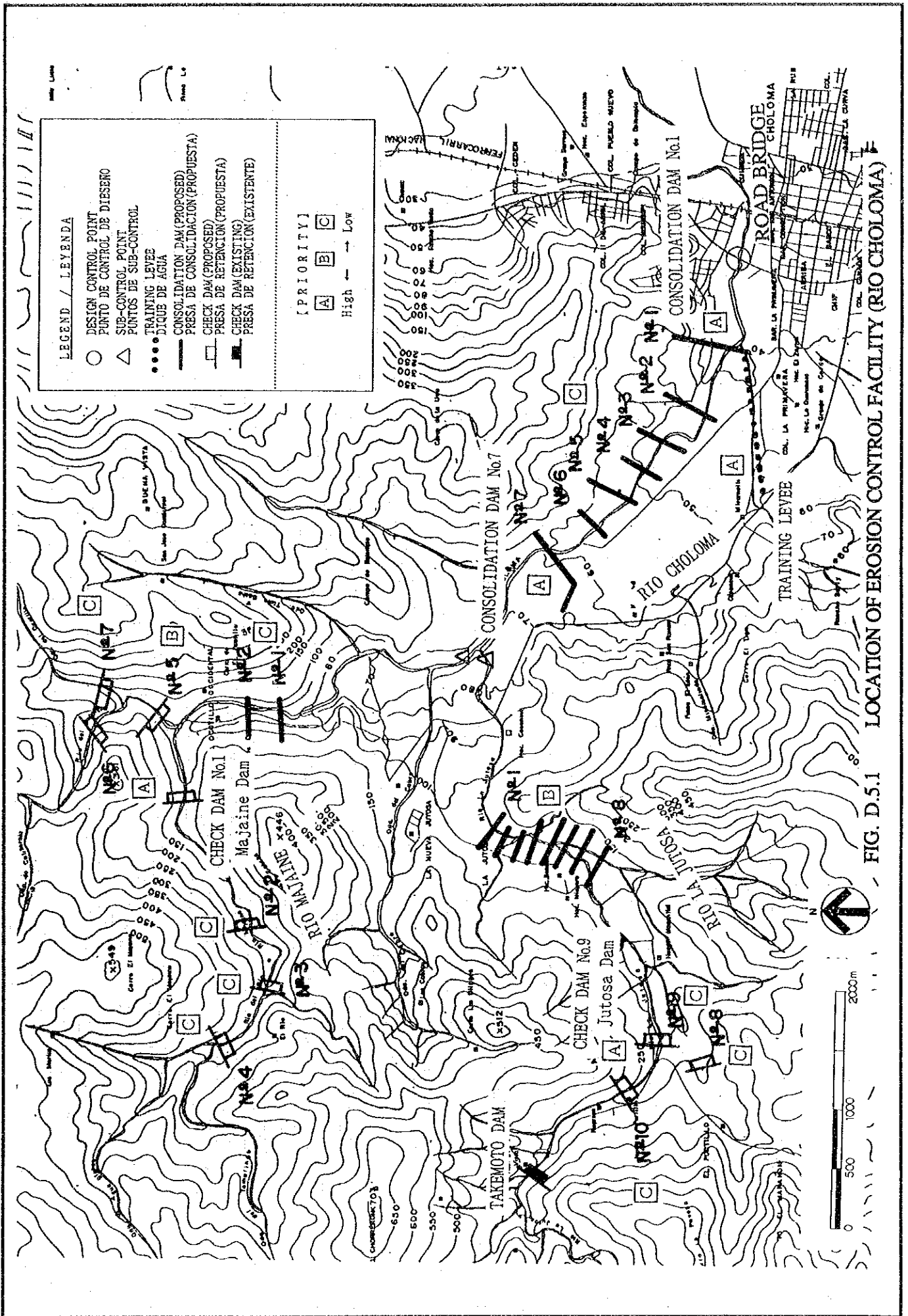
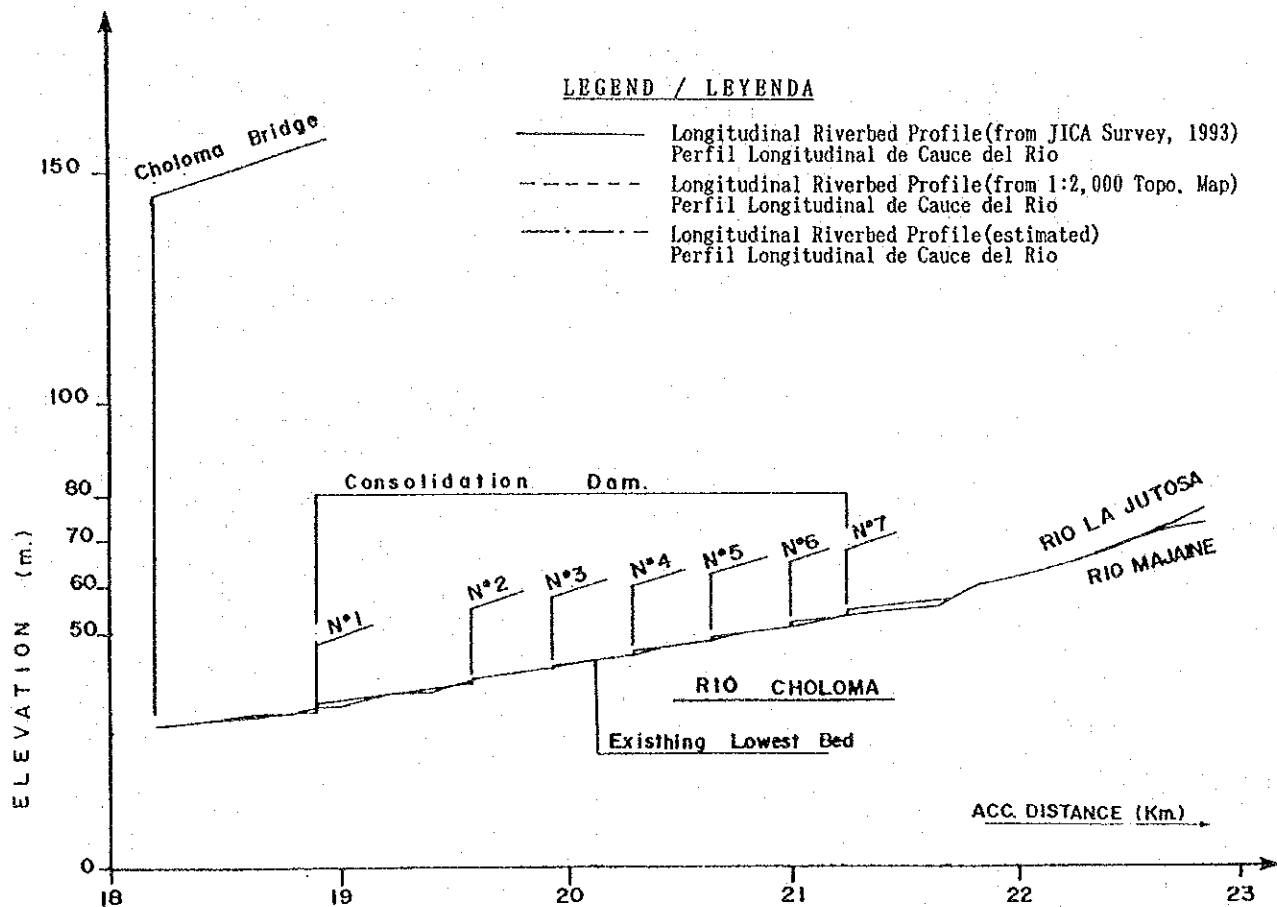


FIG. D.4.2 PRESUMPTION OF DEBRIS FLOW OVERFLOWING AREA





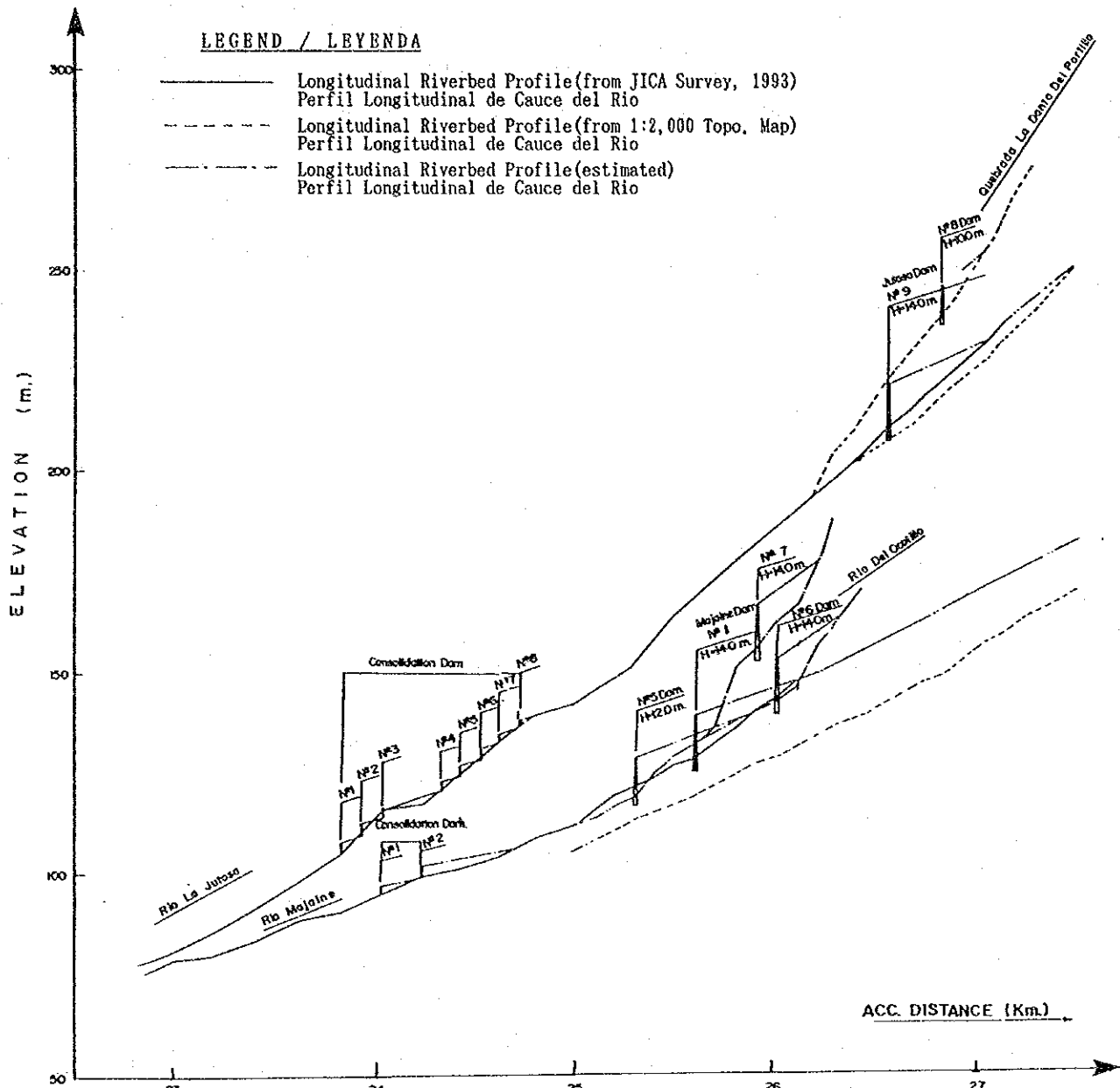
LEGEND / LBYENDA

- Longitudinal Riverbed Profile(from JICA Survey, 1993)
Perfil Longitudinal de Cauce del Rio
- - - Longitudinal Riverbed Profile(from 1:2,000 Topo. Map)
Perfil Longitudinal de Cauce del Rio
- · - Longitudinal Riverbed Profile(estimated)
Perfil Longitudinal de Cauce del Rio

Section Rio La Jutosa (Km.)	Design Acc. Dist. (Km.)	Lowest Bed El. Rio La Jutosa
JUL-001	22.435	68.33
JUL-002	22.635	72.11
JUL-003	22.835	76.66

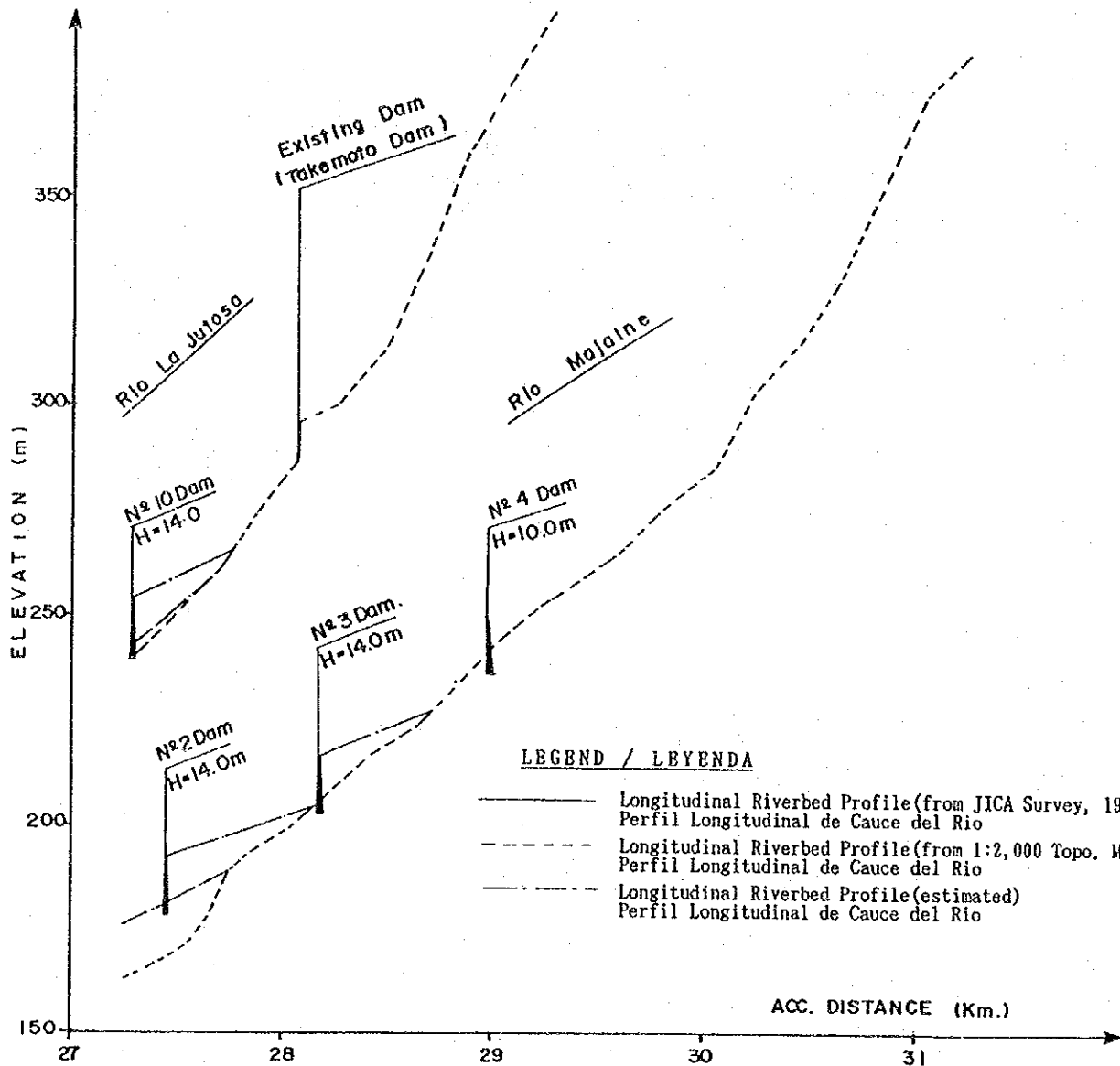
Section Rio Choloma & Majane (Km.)	Design Acc. Dist. (Km.)	Lowest Bed El. Rio Choloma & Majane
CH-040	18.185	29.93
CH-041	18.395	31.37
CH-042	18.605	32.23
CH-043	18.815	32.76
CH-044	18.995	33.80
CH-045	19.195	34.36
CH-046	19.415	36.62
CH-047	19.585	39.76
CH-048	19.825	41.50
CH-049	19.935	42.59
CH-050	20.235	44.04
CH-051	20.440	46.47
CH-052	20.635	47.98
CH-053	20.845	50.00
CH-054	20.985	51.18
CH-055	21.045	53.41
CH-056	21.235	54.18
CH-057	21.435	55.34
CH-058	21.635	60.38
CH-059	22.035	62.24
CH-060	22.235	64.67
MA-001	22.435	67.54
MA-002	22.635	71.31
MA-003	22.835	73.34

FIG. D.5.2 (1) DESIGN LONGITUDINAL SECTION OF EROSION CONTROL FACILITY



Lowest Bed Elev. (Rio La Jirosa)	7666	
Design Acc. Dist. (km)	22.635 - 22.835	22.835 - 23.035
Section (Rio La Jirosa)	JU-003	JU-004
Lowest Bed Elev. (Rio Mojaine)	7666	
Design Acc. Dist. (km)	23.035 - 23.235	23.235 - 23.435
Section (Rio Mojaine)	JU-005	JU-006
Lowest Bed Elev. (Rio La Jirosa)	7666	
Design Acc. Dist. (km)	23.435 - 23.635	23.635 - 23.835
Section (Rio La Jirosa)	JU-007	JU-008
Lowest Bed Elev. (Rio La Jirosa)	7666	
Design Acc. Dist. (km)	23.835 - 24.035	24.035 - 24.235
Section (Rio La Jirosa)	JU-009	JU-010
Lowest Bed Elev. (Rio La Jirosa)	7666	
Design Acc. Dist. (km)	24.235 - 24.435	24.435 - 24.635
Section (Rio La Jirosa)	JU-011	JU-012
Lowest Bed Elev. (Rio La Jirosa)	7666	
Design Acc. Dist. (km)	24.635 - 24.835	24.835 - 25.035
Section (Rio La Jirosa)	JU-013	JU-014
Lowest Bed Elev. (Rio La Jirosa)	7666	
Design Acc. Dist. (km)	25.035 - 25.235	25.235 - 25.435
Section (Rio La Jirosa)	JU-015	JU-016
Lowest Bed Elev. (Rio La Jirosa)	7666	
Design Acc. Dist. (km)	25.435 - 25.635	25.635 - 25.835
Section (Rio La Jirosa)	JU-017	JU-018
Lowest Bed Elev. (Rio La Jirosa)	7666	
Design Acc. Dist. (km)	25.835 - 26.035	26.035 - 26.235
Section (Rio La Jirosa)	JU-019	JU-020
Lowest Bed Elev. (Rio La Jirosa)	7666	
Design Acc. Dist. (km)	26.235 - 26.435	26.435 - 26.635
Section (Rio La Jirosa)	JU-021	JU-022
Lowest Bed Elev. (Rio La Jirosa)	7666	
Design Acc. Dist. (km)	26.635 - 26.835	26.835 - 27.035
Section (Rio La Jirosa)	JU-023	JU-024

FIG. D.5.2 (2) DESIGN LONGITUDINAL SECTION OF EROSION CONTROL FACILITY

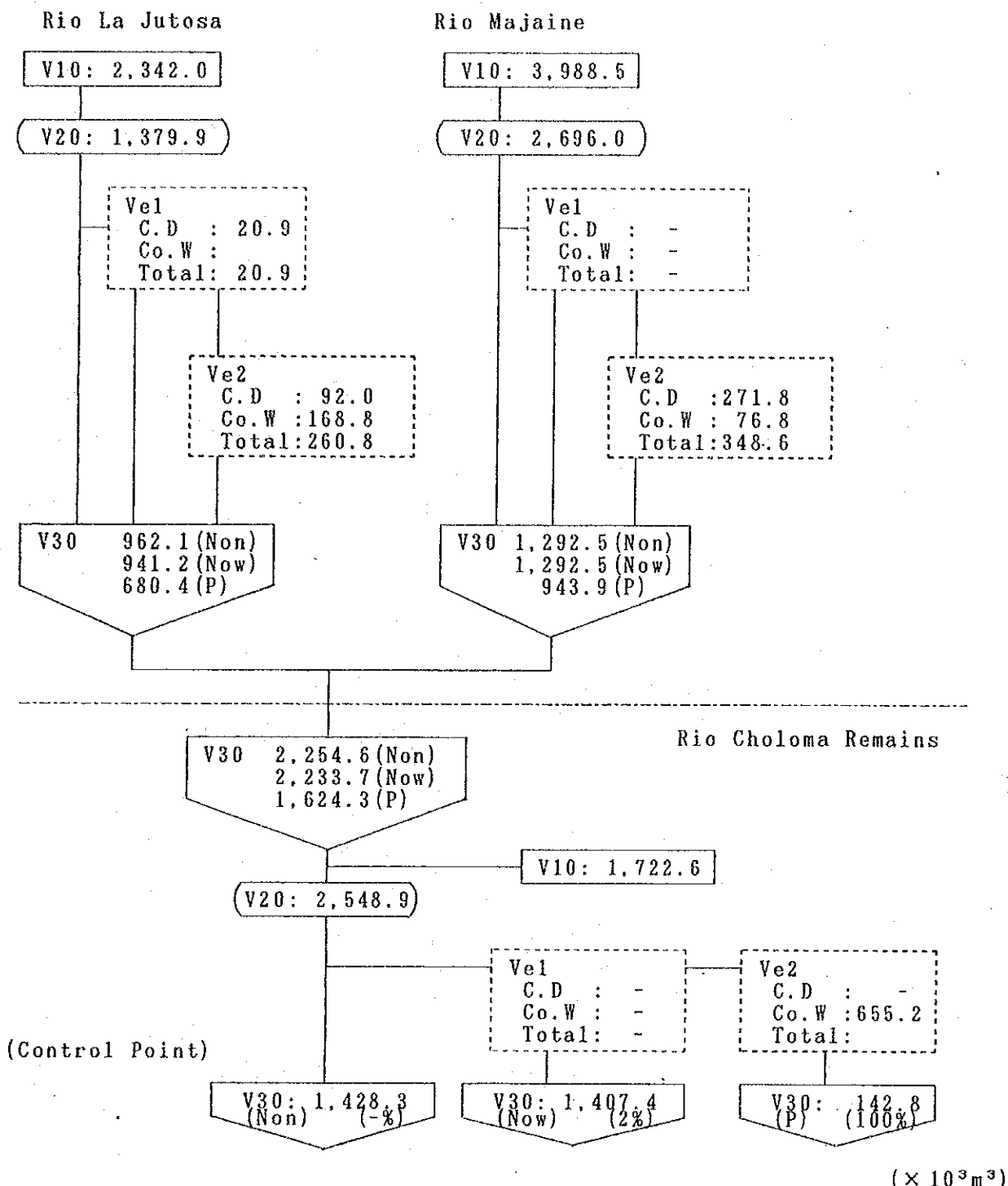


LEGEND / LBYENDA

- Longitudinal Riverbed Profile (from JICA Survey, 1993)
Perfil Longitudinal de Cauce del Rio
- - - Longitudinal Riverbed Profile (from 1:2,000 Topo. Map)
Perfil Longitudinal de Cauce del Rio
- · - Longitudinal Riverbed Profile (estimated)
Perfil Longitudinal de Cauce del Rio

Section (Rio Majalme)	Design Acc. Dist. (km.) (Rio Majalme)	Lowest Bed El. (m.) (Rio Majalme)	Section (Rio La Jutosa)	Design Acc. Dist. (km.) (Rio La Jutosa)	Lowest Bed El. (m.) (Rio La Jutosa)
-27.230	175.7	-27.270	242.89		
-27.430	181.0	-27.470	251.0		
-27.630	186.0	-27.670	260.0		
-27.830	193.0	-27.870	275.0		
-28.030	198.70	-28.070	287.0		
-28.230	216.50	-28.270	300.0		
-28.630	222.80	-28.470	312.0		
-28.830	233.20	-28.670	334.0		
-29.030	243.40	-28.870	360.0		
-29.230	252.00	-29.070	376.0		
-29.430	258.70	-29.270	393.0		
-29.630	266.00	-29.470	413.0		
-29.830	276.50				
-30.030	285.00				
-30.230	304.00				
-30.430	315.00				
-30.630	330.00				
-30.830	352.00				
-31.030	374.00				
-31.230	384.00				
-31.430	401.40				
-31.630	420.00				
-31.830	448.00				

FIG. D.5.2 (3) DESIGN LONGITUDINAL SECTION OF EROSION CONTROL FACILITY



V10 : Design sediment yield
V20 : Naturally controlled sediment discharge along the river course
V30 : Design sediment discharge
(Non): Without facility, (Now): present conditions, (Plan): Plan
Ve1 : Facility effect (Existing), Ve2 : Facility effect (Plan)
C.D: Check dam, Co.W: Consolidation works
% : Sediment settlement percentage

FIG. D.5.3 SEDIMENT BALANCE IN THE RIO CHOLOMA BASIN

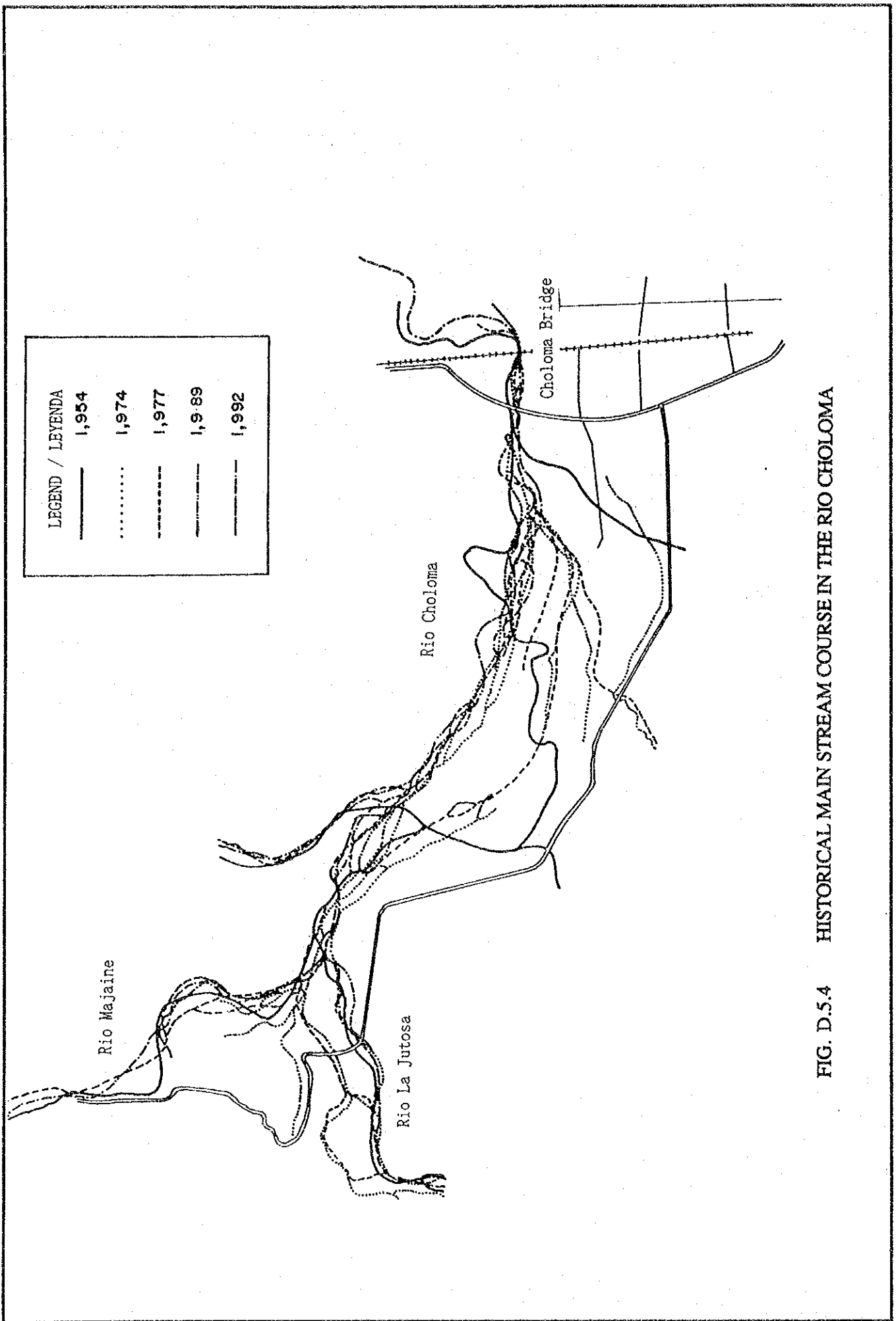


FIG. D.5.4 HISTORICAL MAIN STREAM COURSE IN THE RIO CHOLOMA

LEGEND / LEYENDA

Proposed Consolidation Dam	—	Presa de Consolidación Propuesta
Training Levee	▬▬▬	Dique de Agua
Center Line	- - -	Línea Central
Accumulative Distance	km	Distancia Acumulativa

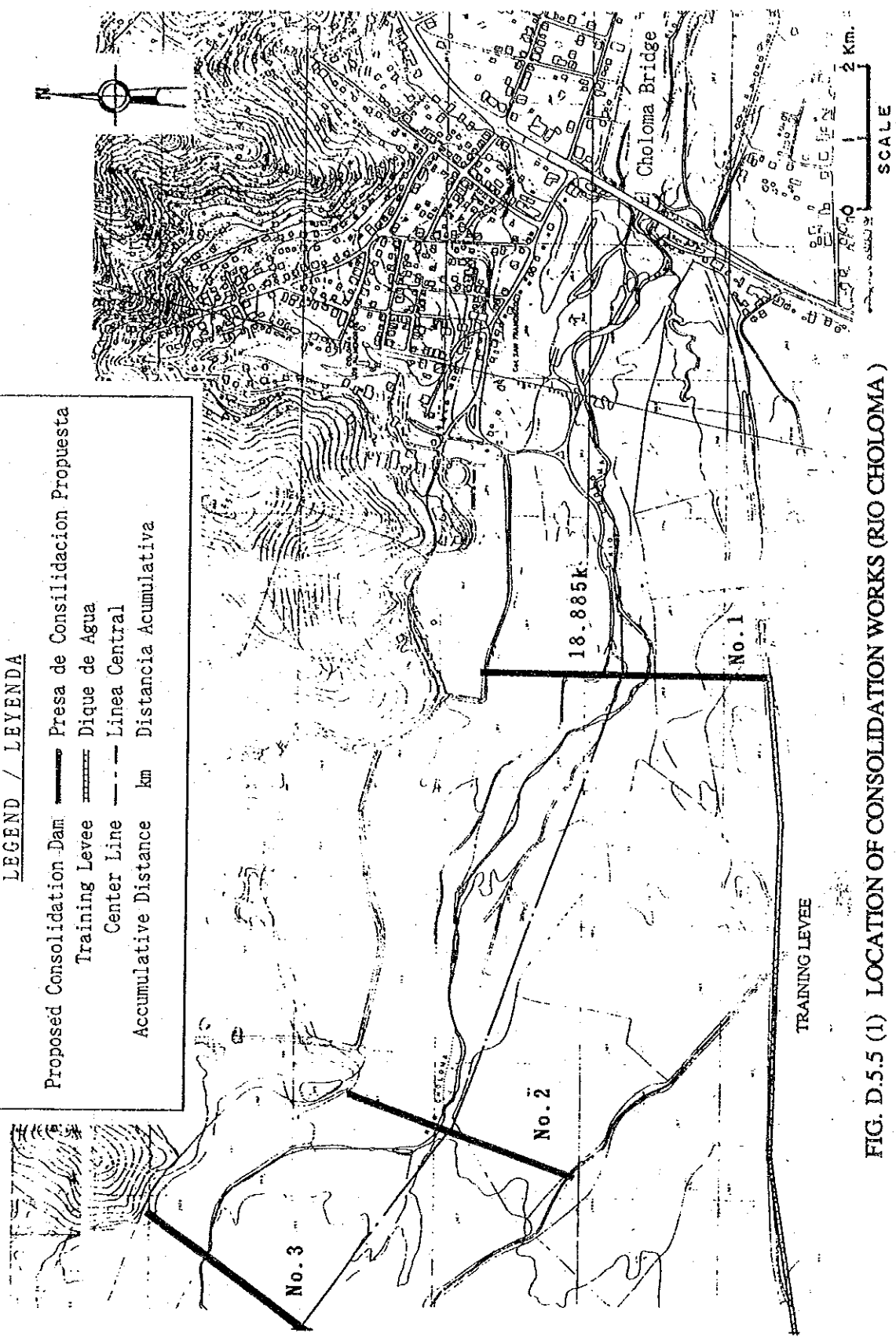


FIG. D.5.5 (1) LOCATION OF CONSOLIDATION WORKS (RIO CHOLOMA)

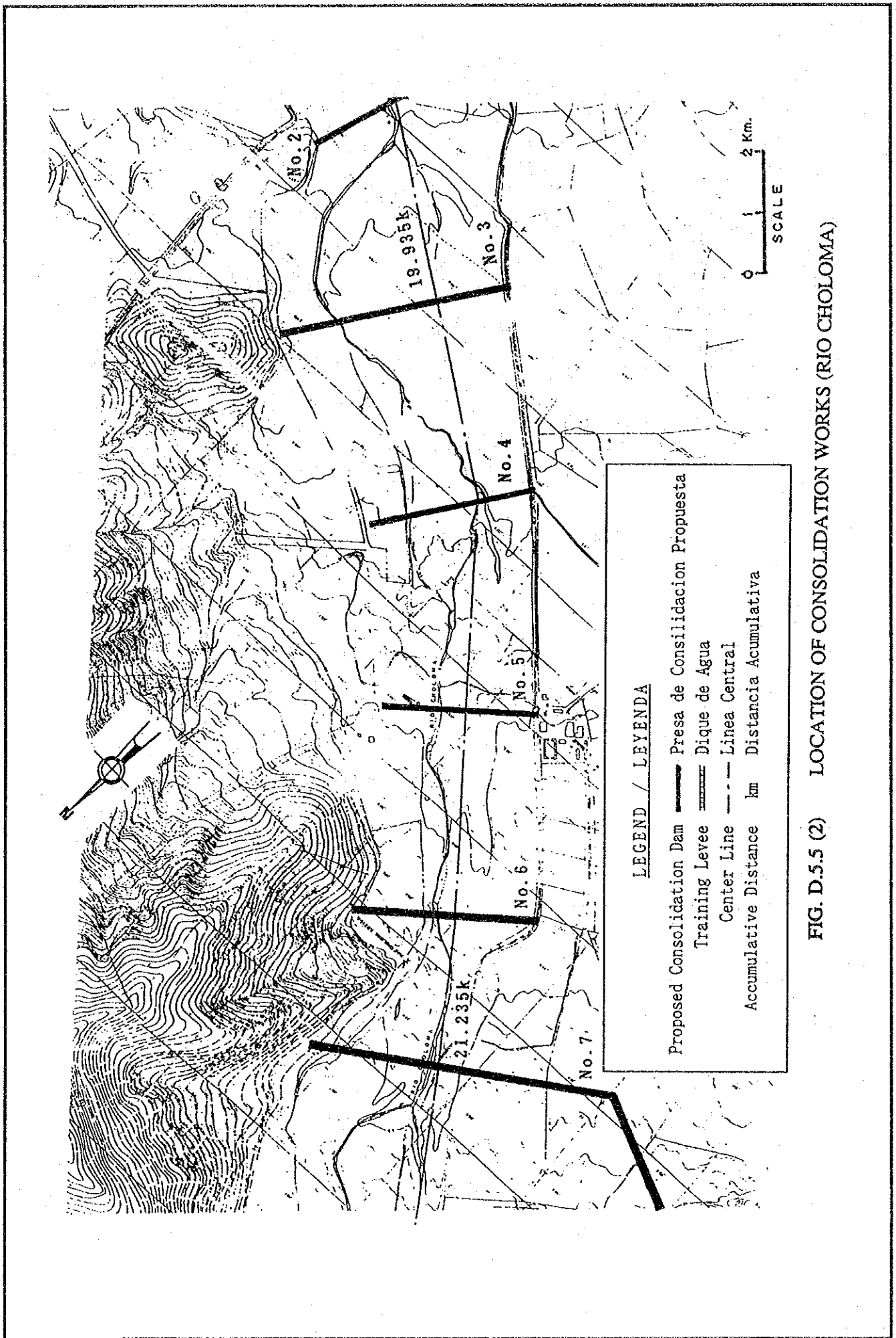


FIG. D.5.5 (2) LOCATION OF CONSOLIDATION WORKS (RIO CHOLOMA)

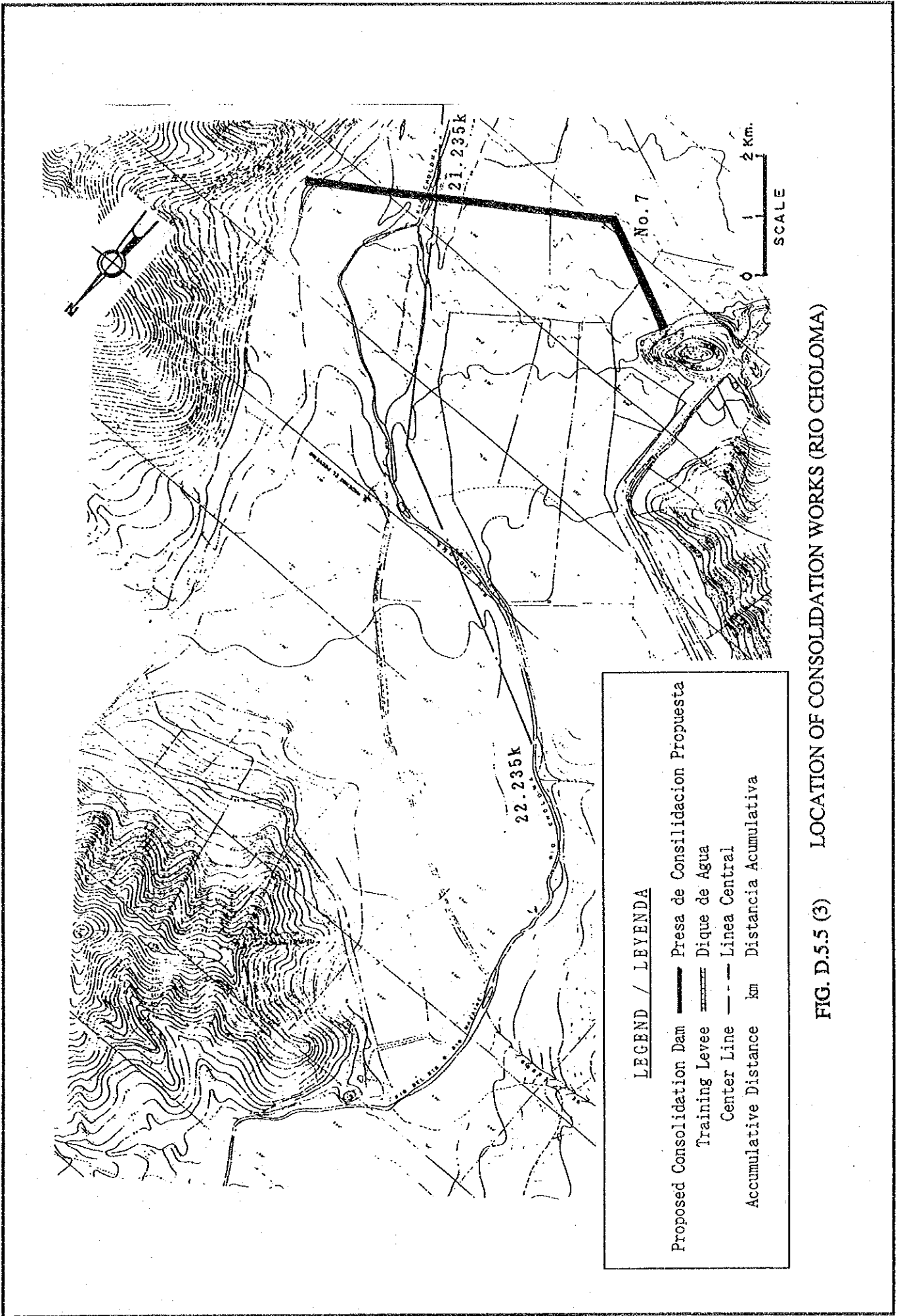
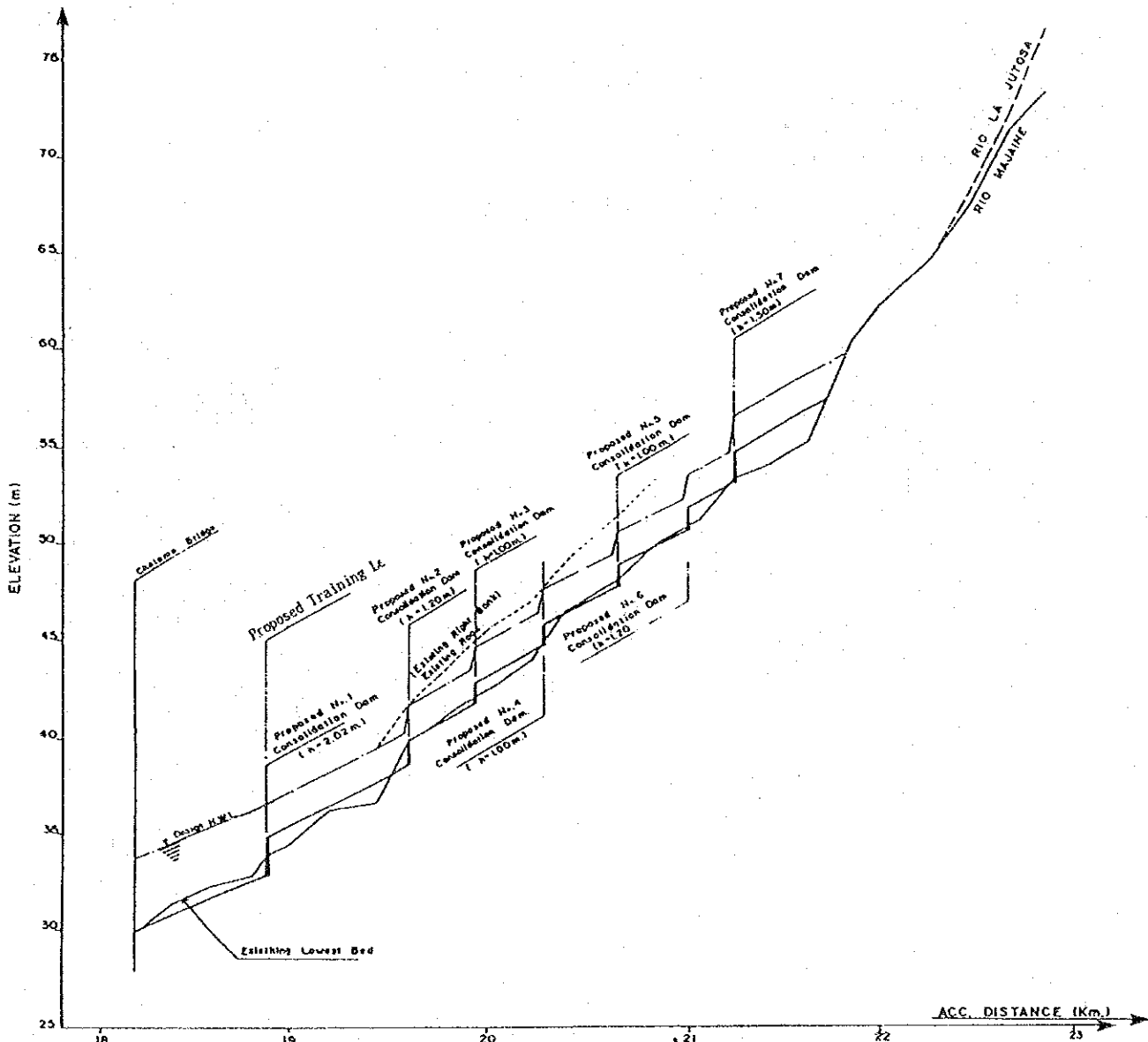


FIG. D.5.5 (3) LOCATION OF CONSOLIDATION WORKS (RIO CHOLOMA)



Section	Design Acc. Dist. (km)	EXISTING			PROPOSED		
		Lowest Bed (m)	Left Right (m)	Right (m)	Design Bed (m)	Design Right (m)	Design Bed (m)
CH-001	18.180	29.93	37.00	37.00	37.00	37.00	34.70
CH-002	18.300	31.37			30.80	30.80	30.04
CH-003	18.600	32.23			31.80	31.80	34.34
CH-004	18.810	32.78			33.50	34.22	37.21
CH-005	18.860	33.80			34.00	34.80	36.80
CH-006	19.010	34.36					
CH-007	19.100	34.00					
CH-008	19.150	34.00			34.00	34.00	34.00
CH-009	19.250	34.00			34.00	34.00	34.00
CH-010	19.350	34.00			34.00	34.00	34.00
CH-011	19.450	34.00			34.00	34.00	34.00
CH-012	19.550	34.00			34.00	34.00	34.00
CH-013	19.650	34.00			34.00	34.00	34.00
CH-014	19.750	34.00			34.00	34.00	34.00
CH-015	19.850	34.00			34.00	34.00	34.00
CH-016	19.950	34.00			34.00	34.00	34.00
CH-017	20.050	34.00			34.00	34.00	34.00
CH-018	20.150	34.00			34.00	34.00	34.00
CH-019	20.250	34.00			34.00	34.00	34.00
CH-020	20.350	34.00			34.00	34.00	34.00
CH-021	20.450	34.00			34.00	34.00	34.00
CH-022	20.550	34.00			34.00	34.00	34.00
CH-023	20.650	34.00			34.00	34.00	34.00
CH-024	20.750	34.00			34.00	34.00	34.00
CH-025	20.850	34.00			34.00	34.00	34.00
CH-026	20.950	34.00			34.00	34.00	34.00
CH-027	21.050	34.00			34.00	34.00	34.00
CH-028	21.150	34.00			34.00	34.00	34.00
CH-029	21.250	34.00			34.00	34.00	34.00
CH-030	21.350	34.00			34.00	34.00	34.00
CH-031	21.450	34.00			34.00	34.00	34.00
CH-032	21.550	34.00			34.00	34.00	34.00
CH-033	21.650	34.00			34.00	34.00	34.00
CH-034	21.750	34.00			34.00	34.00	34.00
CH-035	21.850	34.00			34.00	34.00	34.00
CH-036	21.950	34.00			34.00	34.00	34.00
CH-037	22.050	34.00			34.00	34.00	34.00
CH-038	22.150	34.00			34.00	34.00	34.00
CH-039	22.250	34.00			34.00	34.00	34.00
CH-040	22.350	34.00			34.00	34.00	34.00
CH-041	22.450	34.00			34.00	34.00	34.00
CH-042	22.550	34.00			34.00	34.00	34.00
CH-043	22.650	34.00			34.00	34.00	34.00
CH-044	22.750	34.00			34.00	34.00	34.00
CH-045	22.850	34.00			34.00	34.00	34.00
CH-046	22.950	34.00			34.00	34.00	34.00
CH-047	23.050	34.00			34.00	34.00	34.00
CH-048	23.150	34.00			34.00	34.00	34.00
CH-049	23.250	34.00			34.00	34.00	34.00
CH-050	23.350	34.00			34.00	34.00	34.00
CH-051	23.450	34.00			34.00	34.00	34.00
CH-052	23.550	34.00			34.00	34.00	34.00
CH-053	23.650	34.00			34.00	34.00	34.00
CH-054	23.750	34.00			34.00	34.00	34.00
CH-055	23.850	34.00			34.00	34.00	34.00
CH-056	23.950	34.00			34.00	34.00	34.00
CH-057	24.050	34.00			34.00	34.00	34.00
CH-058	24.150	34.00			34.00	34.00	34.00
CH-059	24.250	34.00			34.00	34.00	34.00
CH-060	24.350	34.00			34.00	34.00	34.00
CH-061	24.450	34.00			34.00	34.00	34.00
CH-062	24.550	34.00			34.00	34.00	34.00
CH-063	24.650	34.00			34.00	34.00	34.00
CH-064	24.750	34.00			34.00	34.00	34.00
CH-065	24.850	34.00			34.00	34.00	34.00
CH-066	24.950	34.00			34.00	34.00	34.00
CH-067	25.050	34.00			34.00	34.00	34.00

FIG. D.5.6 DESIGN LONGITUDINAL SECTION OF CONSOLIDATION WORKS (RIO CHOLOMA)

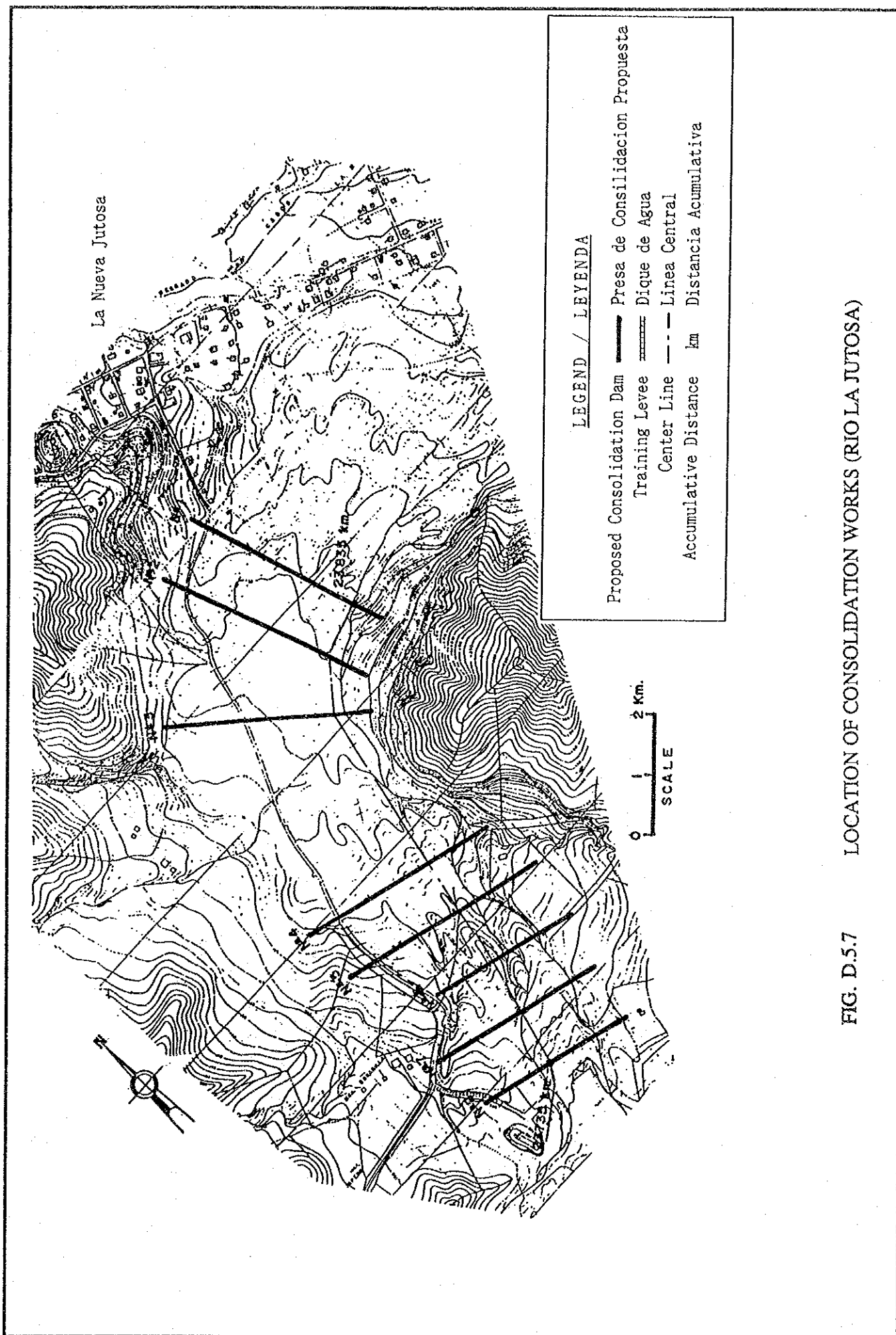
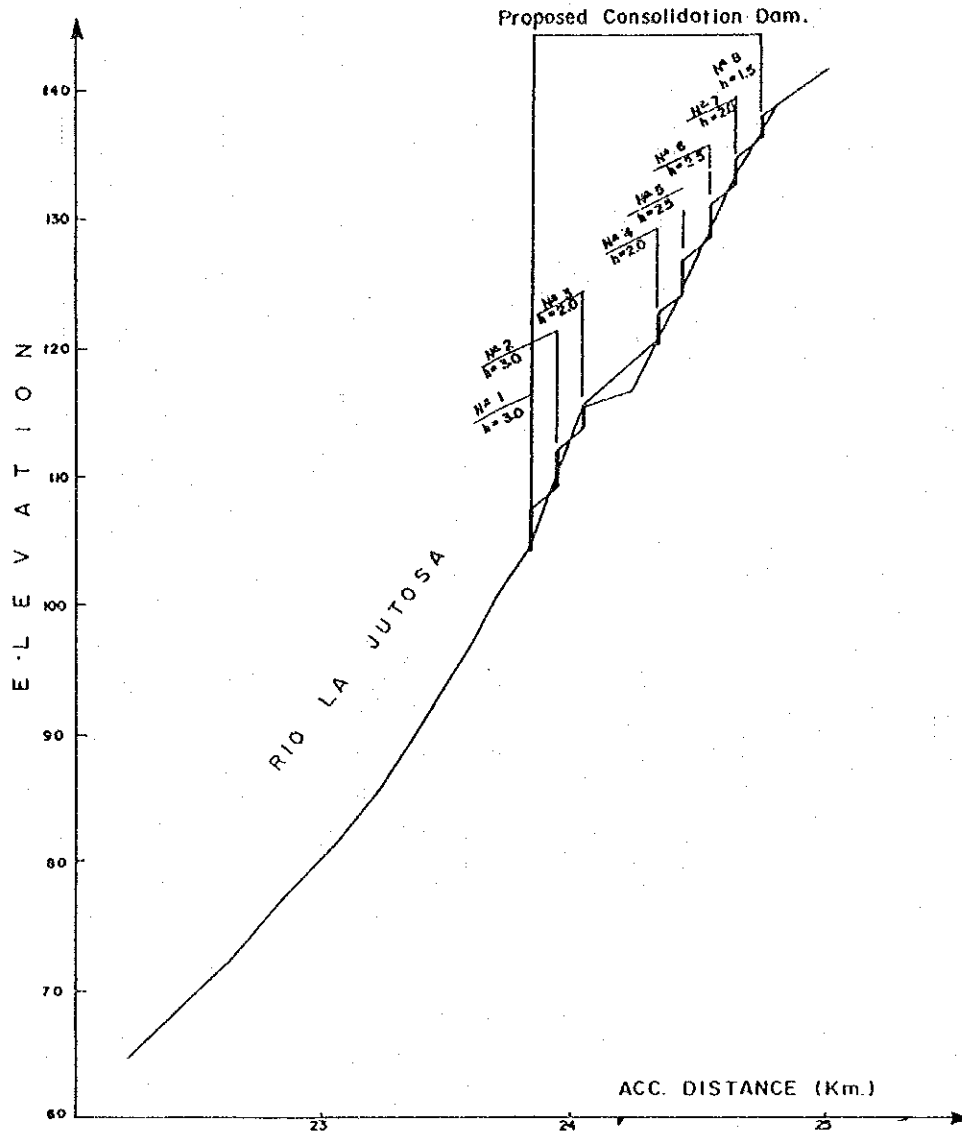


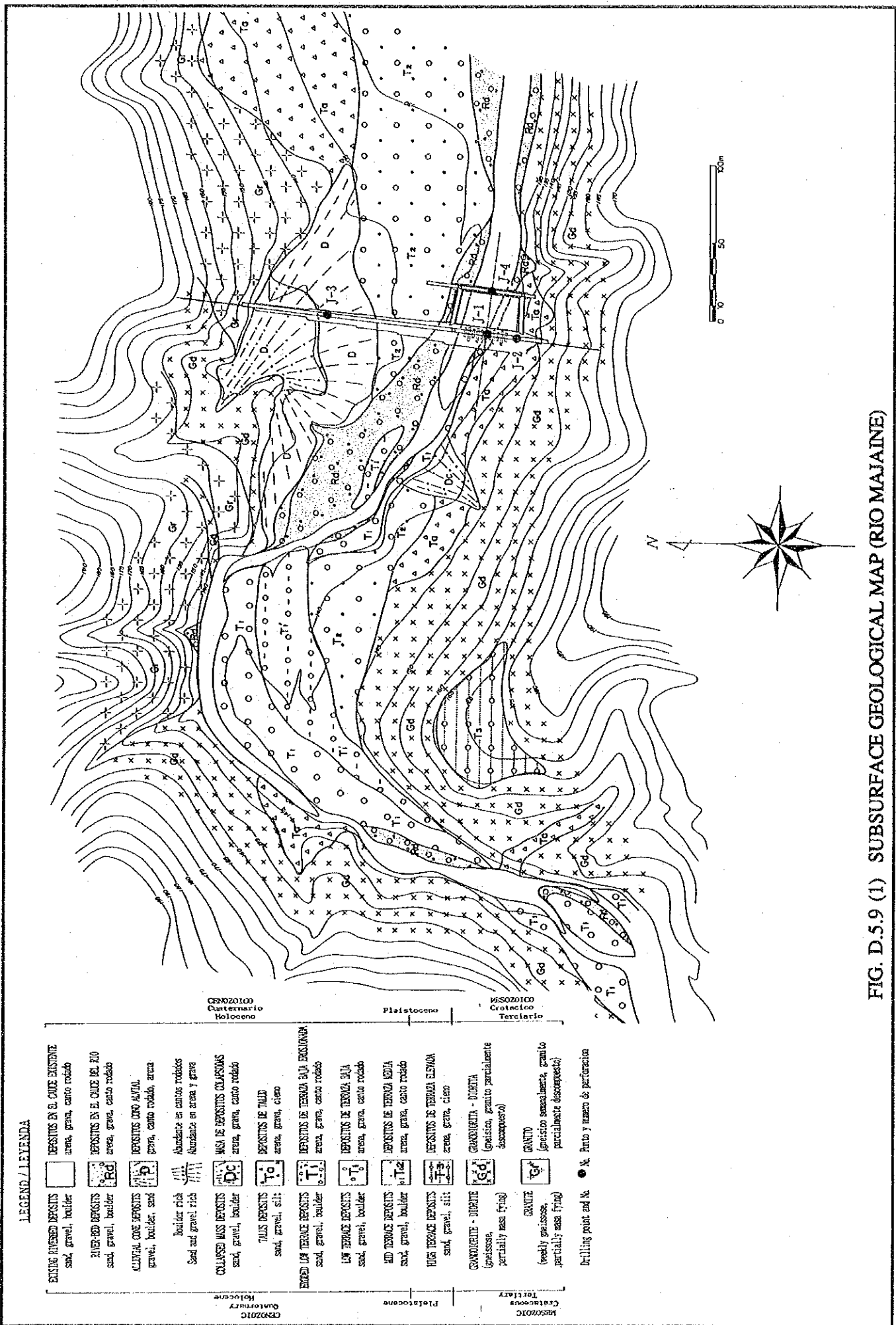
FIG. D.5.7 LOCATION OF CONSOLIDATION WORKS (RIO LA JUTOSA)





Section	Design Distance (km)	Design Gage (E.L.M.)	Existing 	Proposed Design Top (E.L.M.)	Design Bed Elev. (E.L.M.)
JU-001	22.335	84.67			
JU-002	22.435	0.200	14.73		
JU-003	22.635	0.200	72.11		
JU-004	22.835	0.200	76.86		
JU-005	23.035	0.200	80.81		
JU-006	23.235	0.200	85.97		
JU-008	23.435	0.200	91.96		
JU-007	23.635	0.200	98.01		
JU-008	23.835	0.200	104.57		
JU-009	24.035	0.10	115.45		
JU-010	24.240	0.203	118.73		
JU-011	24.435	0.095	124.29		
JU-02	24.535	0.085	131.99		
JU-013	24.805	0.070	138.05		
	25.005	0.200	141.85		

FIG. D.5.8 DESIGN LONGITUDINAL SECTION OF CONSOLIDATION WORKS (RIO LA JUTOSA)



LEGENDA / LEYENDA

- | | |
|---|--|
| EXISTING REVERSED DEPOSITS
sand, gravel, boulder | DEPOSITOS EN EL CAUCE EXISTENTE
arena, grava, canto rodado |
| REVERSED DEPOSITS
sand, gravel, boulder | DEPOSITOS EN EL CAUCE DEL RIO
arena, grava, canto rodado |
| ALLUVIAL CONE DEPOSITOS
gravel, boulder, sand | DEPOSITOS CONO ALVIAL
grava, canto rodado, arena |
| Boulder rich
Sand and gravel rich | Abundante en cantos rodados
Abundante en arena y grava |
| COLLAPSED MUD DEPOSITOS
sand, gravel, boulder | MUDA DEPOSITOS CLASIONADOS
arena, grava, canto rodado |
| TALUS DEPOSITOS
sand, gravel, silt | DEPOSITOS DE TALUD
arena, grava, cieno |
| ERODED LOW TERRACE DEPOSITOS
sand, gravel, boulder | DEPOSITOS DE TERRAZA BAJA EROSIONADA
arena, grava, canto rodado |
| LOW TERRACE DEPOSITOS
sand, gravel, boulder | DEPOSITOS DE TERRAZA BAJA
arena, grava, canto rodado |
| MID TERRACE DEPOSITOS
sand, gravel, boulder | DEPOSITOS DE TERRAZA MEDIA
arena, grava, canto rodado |
| HIGH TERRACE DEPOSITOS
sand, gravel, silt | DEPOSITOS DE TERRAZA ALTA
arena, grava, cieno |
| GRAWOLITE - DURITE
(gneissos, partially mass firing) | GRANULITA - DURITA
(gneisico, granito parcialmente descompuesto) |
| GRANITE
(weedy gneissos, partially mass firing) | GRANITO
(gneisico semaluberto, granito parcialmente descompuesto) |
| Drilling point and No. | ● No. Punto y numero de perforacion |

CR202010 Cuaternario Holoceno Pleistoceno MESOZOICO Cretacico Terciario

CR202010 Cuaternario Holoceno Pleistoceno Mesozoico Cretacico Terciario

FIG. D.5.9 (1) SUBSURFACE GEOLOGICAL MAP (RIO MAJAINÉ)



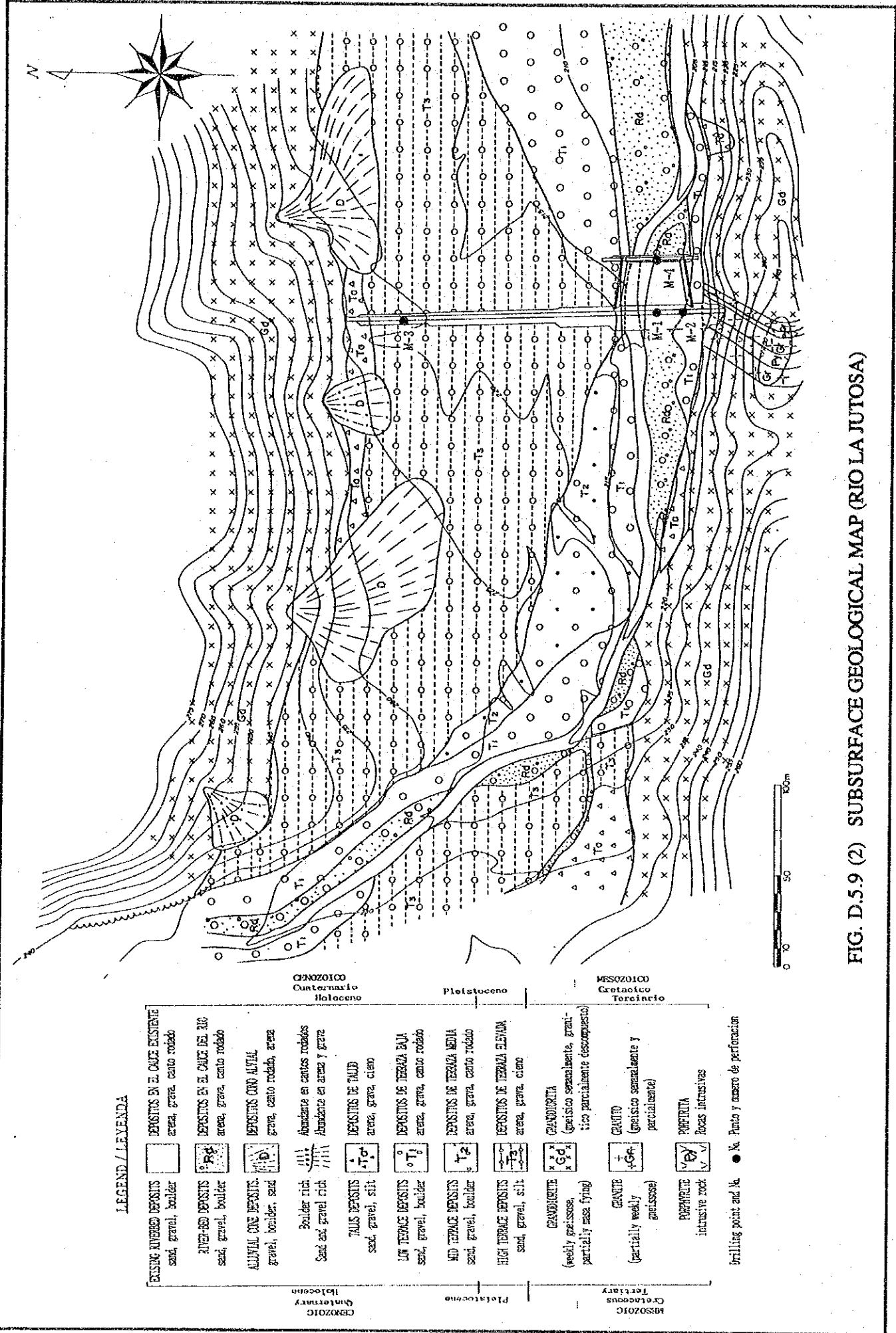
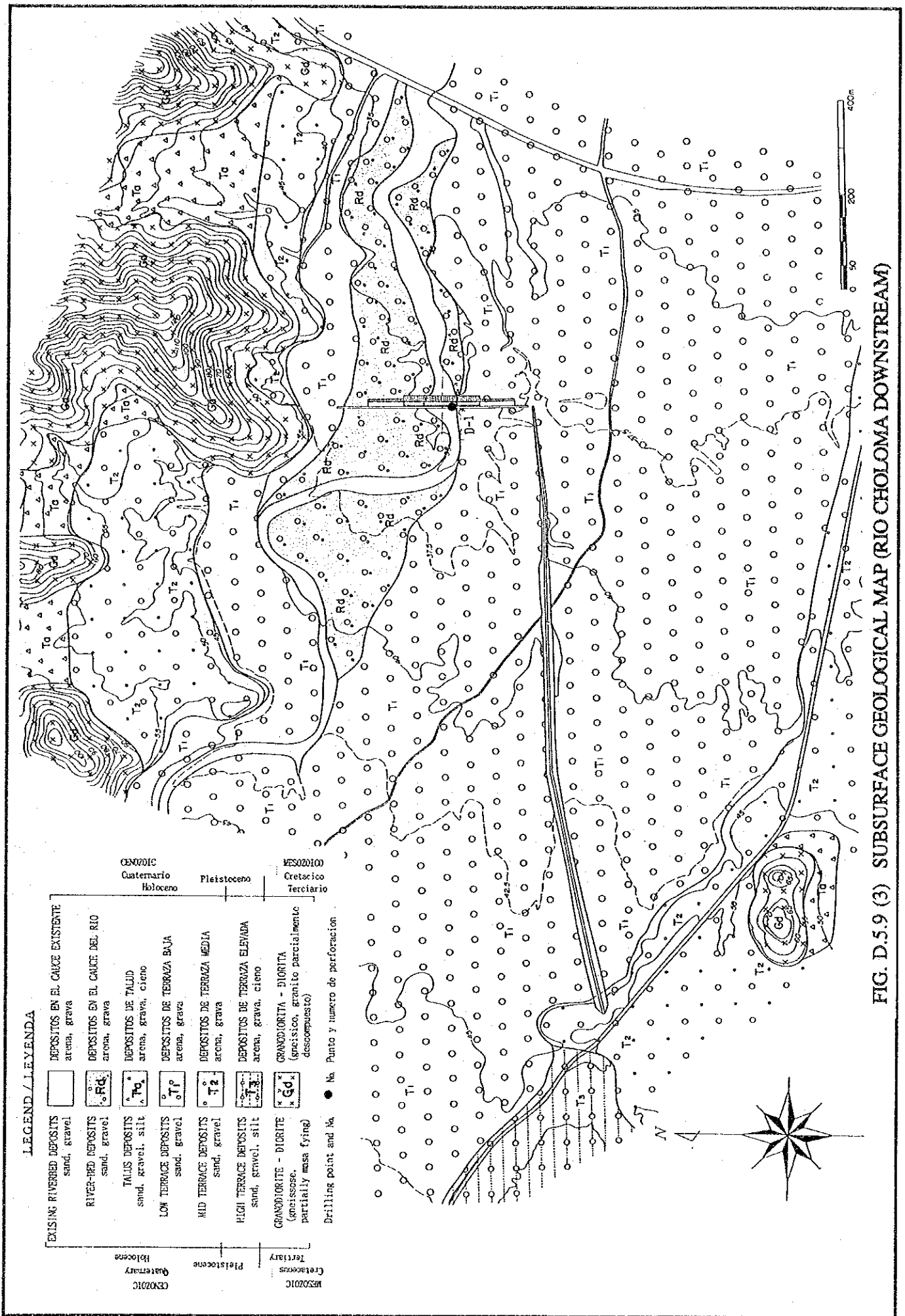


FIG. D.5.9 (2) SUBSURFACE GEOLOGICAL MAP (RIO LA JUTOSA)

LEGENDA / LEYENDA

MESOZOICO Cuaternario Holoceno		Platoceno		MESOZOICO Cretácico Terciario	
<p>BASES INVERTED DEPOSITS sand, gravel, boulder</p> <p>ALUE-RED DEPOSITS sand, gravel, boulder</p> <p>ADULTAL ONE DEPOSITS. gravel, boulder, sand</p> <p>Boulder rich Sand and gravel rich</p> <p>TALLS DEPOSITS sand, gravel, silt</p> <p>LOW TERRACE DEPOSITS sand, gravel, boulder</p> <p>MID TERRACE DEPOSITS sand, gravel, boulder</p> <p>HIGH TERRACE DEPOSITS sand, gravel, silt</p>	<p>DEPOSITOS EN EL CAUCE EXISTENTE arena, grava, canto rodado</p> <p>DEPOSITOS EN EL CAUCE DEL RIO arena, grava, canto rodado</p> <p>DEPOSITOS CON ALVAL grava, canto rodado, arena</p> <p>Abundante en cantos rodados Abundante en arena y grava</p> <p>DEPOSITOS DE TALUD arena, grava, cieno</p> <p>DEPOSITOS DE TERRAZA BAJA arena, grava, canto rodado</p> <p>DEPOSITOS DE TERRAZA MEDIA arena, grava, canto rodado</p> <p>DEPOSITOS DE TERRAZA ELEVADA arena, grava, cieno</p>	<p>GRANODIORITE (weakly gneissose, partially mica fmg)</p> <p>GRANITE (partially weakly gneissose)</p> <p>POPHALITE intrusive rock</p>	<p>GRANODIORITA (gneisico separalmente, granítico parcialmente descompuesto)</p> <p>GRANITO (gneisico separalmente y parcialmente)</p> <p>POPHALITA Rocas intrusivas</p>	<p>BRILLING POINT AND M. ● M. Punto y numero de perforacion</p>	





LEGENDA / LEYENDA

CENOZOIC		MESOZOIC	
Cuaternario Holoceno		Cretacico Terciario	
Pleistoceno			
EXISTING RIVERBED DEPOSITS sand, gravel	DEPOSITOS EN EL CAUCE EXISTENTE arena, grava		
RIVER-BED DEPOSITS sand, gravel	DEPOSITOS EN EL CAUCE DEL RIO arena, grava		
TALUS DEPOSITS sand, gravel, silt	DEPOSITOS DE TALUD arena, grava, cieno		
LOW TERRACE DEPOSITS sand, gravel	DEPOSITOS DE TERRAZA BAJA arena, grava		
MID TERRACE DEPOSITS sand, gravel	DEPOSITOS DE TERRAZA MEDIA arena, grava		
HIGH TERRACE DEPOSITS sand, gravel, silt	DEPOSITOS DE TERRAZA ELEVADA arena, grava, cieno		
GRANODIORITE - DIORITE (gneissose, partially masa fying)	GRANODIORITA - DIORITA (gneissico, granito parcialmente descompuesto)		

● No. Punto y numero de perforacion

FIG. D.5.9 (3) SUBSURFACE GEOLOGICAL MAP (RIO CHOLOMA DOWNSTREAM)



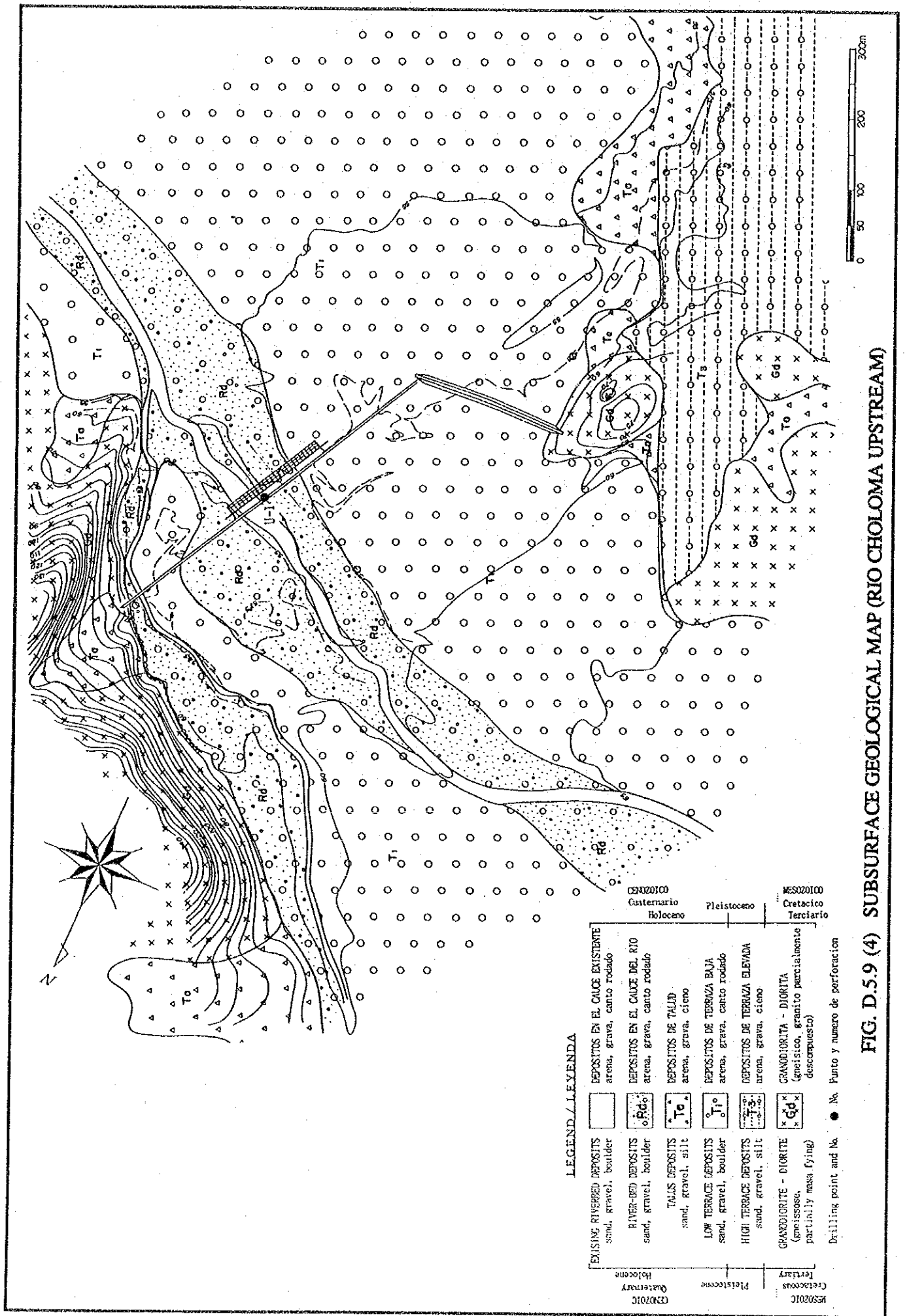


FIG. D.5.9 (4) SUBSURFACE GEOLOGICAL MAP (RIO CHOLOMA UPSTREAM)



DRILLING Nº / Nº DE PERFORACION		MAJAJINE - 2	
WORKS/OBRA		CHECK DAM Nº.1 / PRESA RETENCION Nº.1	
SITE/UBICACION		RIGHT BANK ON DAM AXIS/ORILLA DERECHA EN EL EJE DE PRESA	
SCALE/ESCALA	10	ELEVATION/ALTITUD	11350
DEPTH/PROFUNDIDAD	m	THICKNESS/ESPAESOR	m
COLUMNAR SECTION/SECCION DE COLUMNA		SOIL NAME/NOMBRE DE TIERRA	GRAVEL BED/ESTRATO DE GRAVA
DESCRIPTION/DESCRIPCION			
STANDERO PENETRATION TEST/PRUEBA DE PENETORACION			
N	N-VALUE/-VALOR		
Nº/cm			
50/30		GRAVEL AND SAND/GRVA Y ARENA	
46/30			
60/25		GRAVEL BED/ESTRATO DE GRAVA	
21/30		3.60 ~ 400m COBBLES OF CLAYEY APLITE	
60/16		/PIEDRA REDONDA ARCILLOSA DE APLITE	
60/20		MAINLY COBBLES	
60/15		BOULDERS OF GRANITIC ROCK	
60/10		/PIEDRA REDONDA Y CANTO RODADO DE ROCA GRANITICO	
60/12		PRINCIPALMENTE	
60/12			

DRILLING Nº / Nº DE PERFORACION		MAJAJINE - 1	
WORKS/OBRA		CHECK DAM Nº.1 / PRESA RETENCION Nº.1	
SITE/UBICACION		CENTER OF DAM AXIS/CENTRO DE EJE DE PRESA	
SCALE/ESCALA	10	ELEVATION/ALTITUD	11680
DEPTH/PROFUNDIDAD	m	THICKNESS/ESPAESOR	m
COLUMNAR SECTION/SECCION DE COLUMNA		SOIL NAME/NOMBRE DE TIERRA	GRAVEL BED/ESTRATO DE GRAVA
DESCRIPTION/DESCRIPCION			
STANDERO PENETRATION TEST/PRUEBA DE PENETORACION			
N	N-VALUE/-VALDR		
Nº/cm			
26/30		GRAVEL AND SAND/GRVA Y ARENA	
26/30			
29/30		GRAVEL BED/ESTRATO DE GRAVA	
50/12		COBBLES	
50/5		/PIEDRA REDONDA Ø 0 ~ 28 cm	
60/20		MAINLY COBBLES OF GRANITIC ROCK	
60/21		/PIEDRA REDONDA DE ROCA GRANITICO	
60/20		PRINCIPALMENTE	
60/13			
60/12			

FIG. D.5.10 (1) BOREHOLE LOG (RIO MAJAJINE)

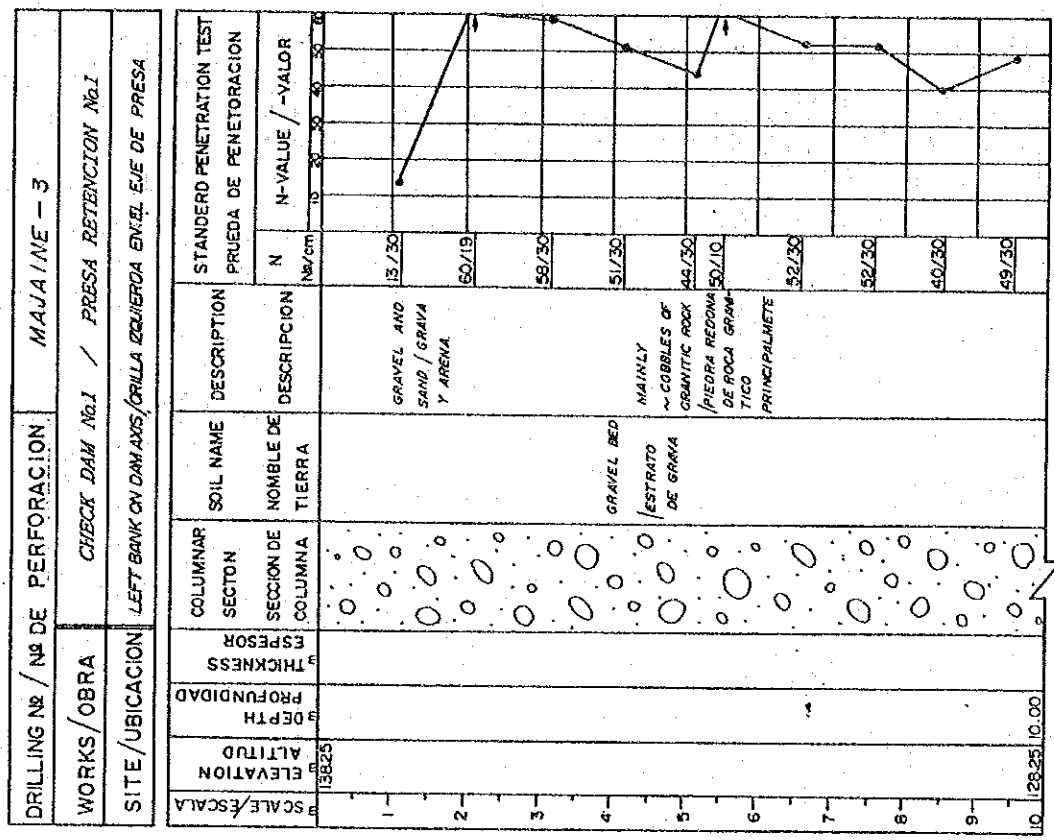
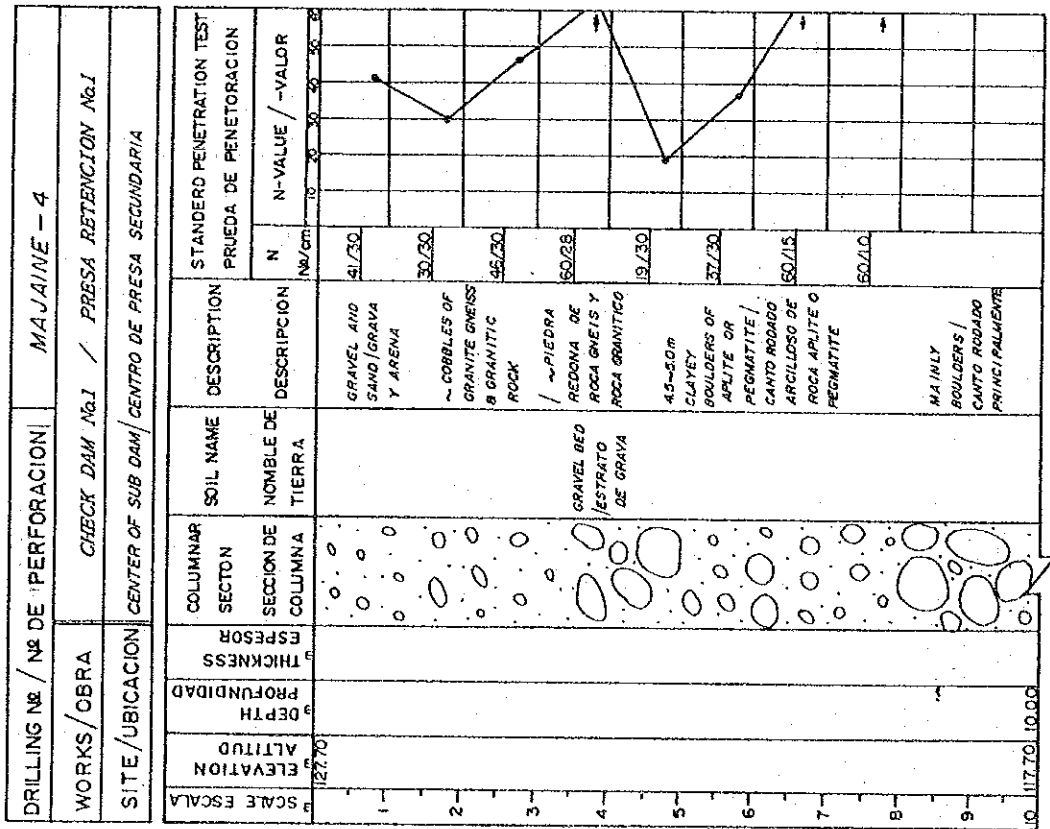


FIG. D.5.10 (1) BOREHOLE LOG (RIO MAJAJINE)



DRILLING Nº / Nº DE PERFORACION		JUTOSA - 2							
WORKS/OBRA		CHECK DAM Nº.9 / PRESA RETENCION Nº.9							
SITE/UBICACION		RIGHT BANK ON DAM AXIS/DRILLA DERECHA EN EL EJE DE PRESA							
SCALE/ESCALA	ELEVATION ALTITUD	DEPTH PROFUNDIDAD	THICKNESS ESPESOR	COLUMNAR SECCION DE COLUMNA	SOIL NAME NOMBRE DE TIERRA	DESCRIPTION DESCRIPCION	N	N-VALUE / -VALOR	STANDARD PENETRATION TEST PRUEBA DE PENETORACION
							Nº/CM		
1	21175					GRAVEL AND SAND / GRAVA Y ARENA	29/30	30	
2						GRAVEL AND SAND / GRAVA Y ARENA	58/30	40	
3						GRAVEL AND SAND / GRAVA Y ARENA	42/30	50	
4					GRAVEL BED / ESTORATO DE GRAVA		>60/1	60	
5						MAINLY BOULDERS OF GRANITIC ROCK / CANTO RODADO DE ROCA GRANITICO PRINCIPALMENTE			
6									
7									
8									
9									
10	20175	10.00							

DRILLING Nº / Nº DE PERFORACION		JUTOSA - 1							
WORKS/OBRA		CHECK DAM Nº.9 / PRESA RETENCION Nº.9							
SITE/UBICACION		CENTER OF DAM AXIS/CENTRO DE EJE DE PRESA							
SCALE/ESCALA	ELEVATION ALTITUD	DEPTH PROFUNDIDAD	THICKNESS ESPESOR	COLUMNAR SECCION DE COLUMNA	SOIL NAME NOMBRE DE TIERRA	DESCRIPTION DESCRIPCION	N	N-VALUE / -VALOR	STANDARD PENETRATION TEST PRUEBA DE PENETORACION
							Nº/CM		
1	21165						52/30	30	
2						GRAVEL AND SAND / GRAVA Y ARENA	39/30	40	
3						GRAVEL AND SAND / GRAVA Y ARENA	60/23	50	
4					GRAVEL BED / ESTORATO DE GRAVA		60/23	60	
5							60/13	70	
6							60/12	80	
7						MAINLY COBBLES ~ BOULDERS OF GRANITIC ROCK / PIEDRA REDONDA Y CANTO RODADO DE ROCA GRANITICO PRINCIPALMENTE	60/12	90	
8							60/12	100	
9									
10	20165	10.00							

FIG. D.5.10 (2) BOREHOLE LOG (RIO LA JUTOSA)



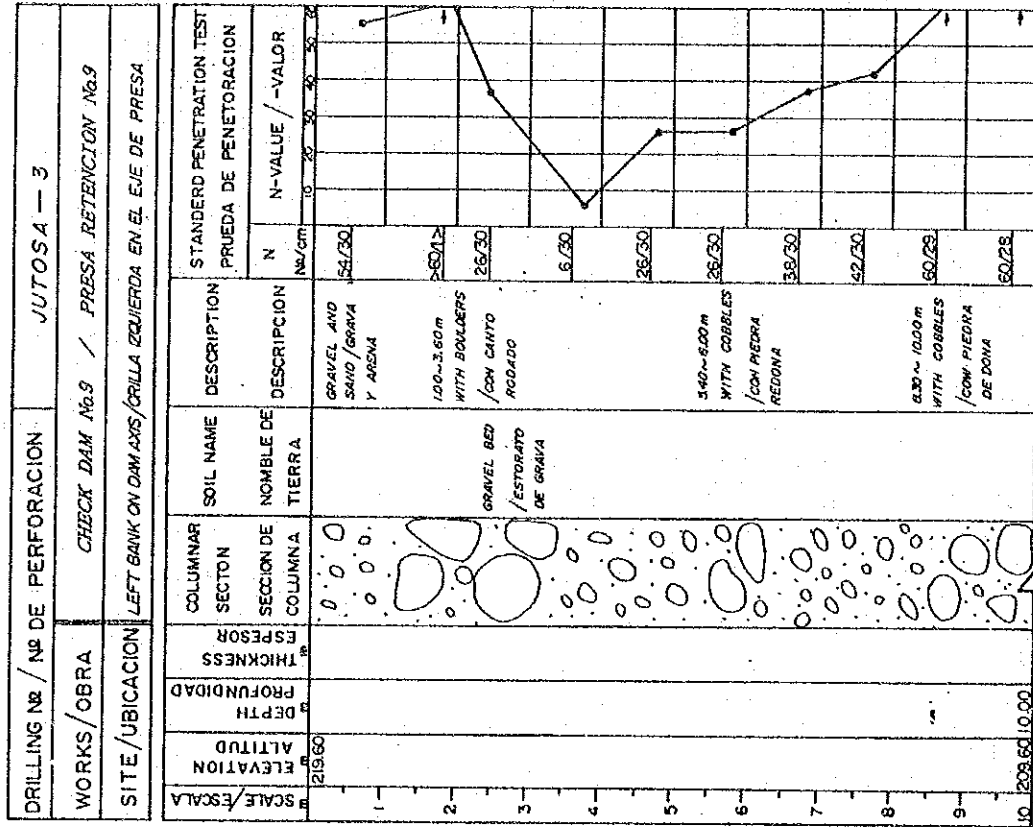
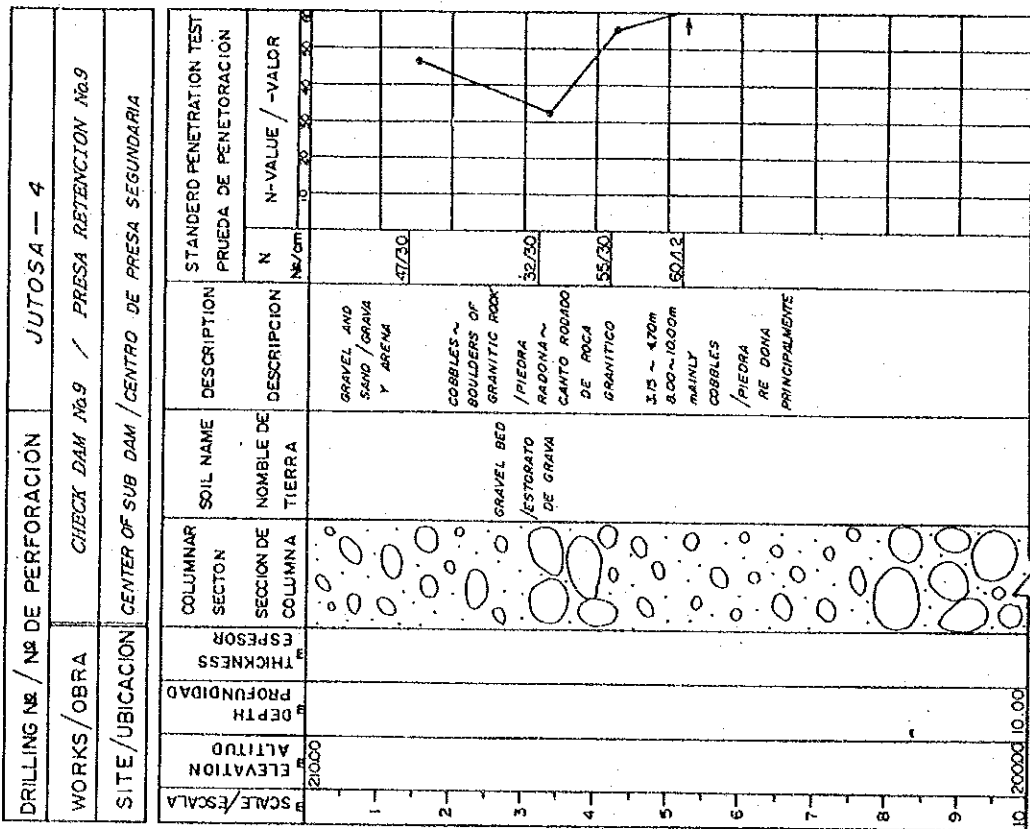


FIG. D.5.10 (2) BOREHOLE LOG (RIO LA JUTOSA)

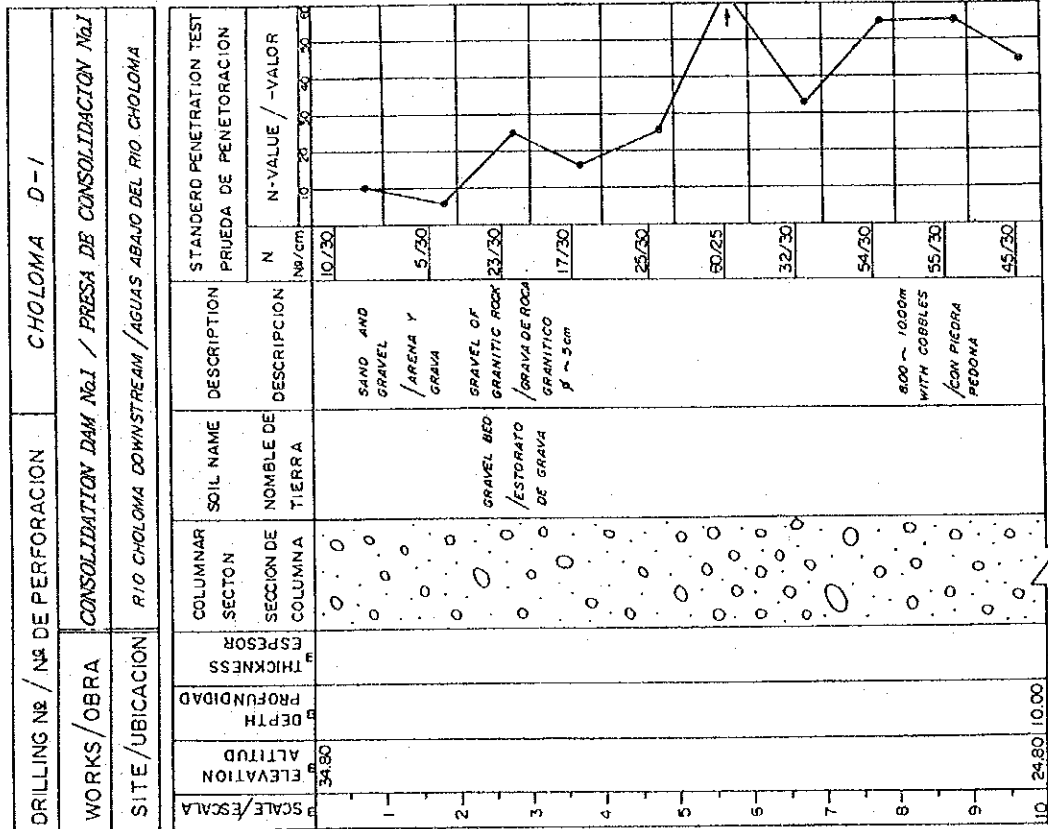


FIG. D.5.10 (3) BOREHOLE LOG (RIO CHOLOMA DOWNSTREAM)

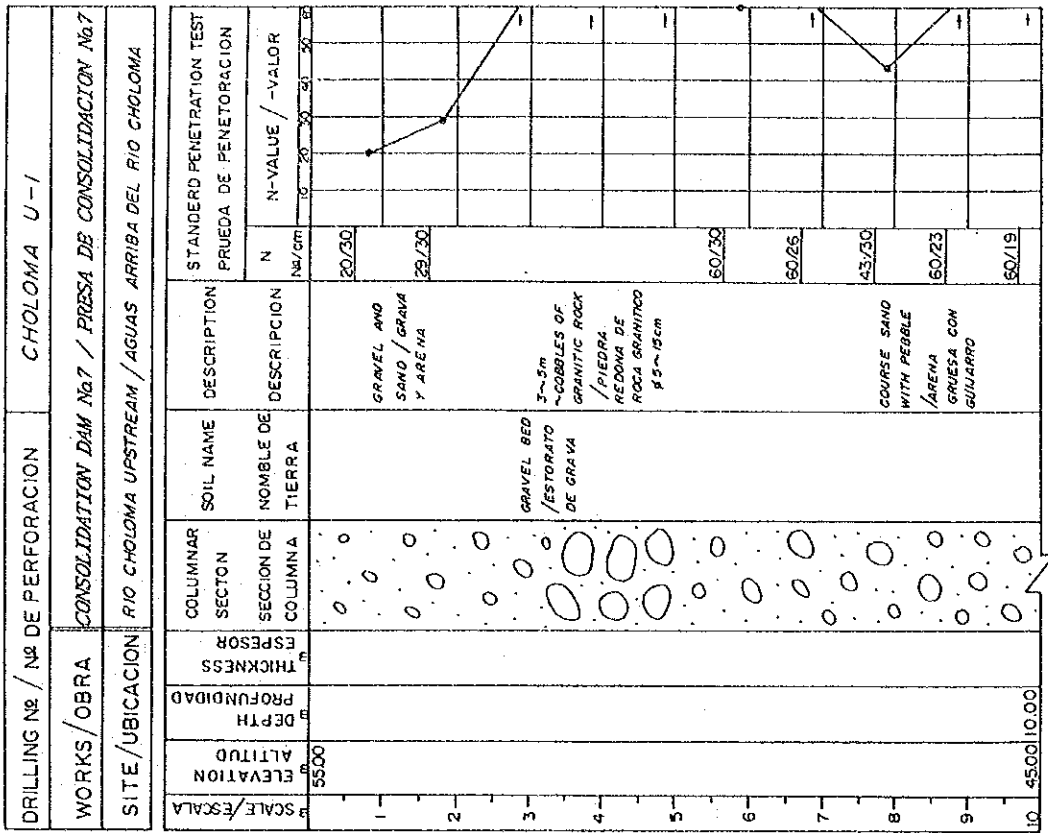


FIG. D.5.10 (4) BOREHOLE LOG (RIO CHOLOMA UPSTREAM)



FRONT VIEW OF DOWNSTREAM SIDE - CHECK DAM No.1, MAJAJNE DAM -

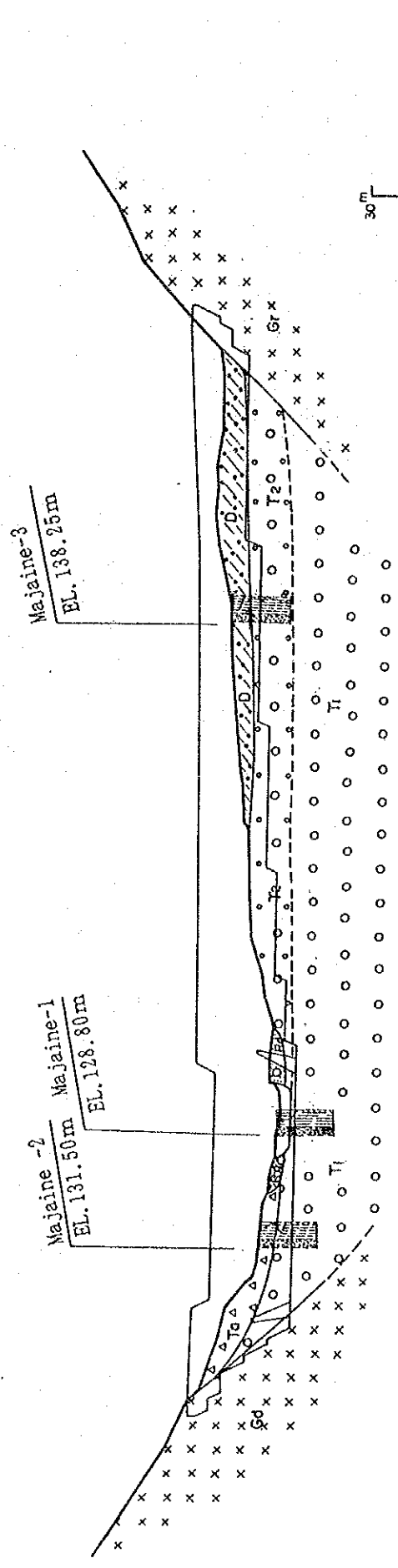


FIG. D.5.11 (1) SYNTHETIC GEOLOGICAL PROFILE (RIO MAJAJNE)

FRONT VIEW OF DOWNSTREAM SIDE - CHECK DAM No.9, JUTOSA DAM -

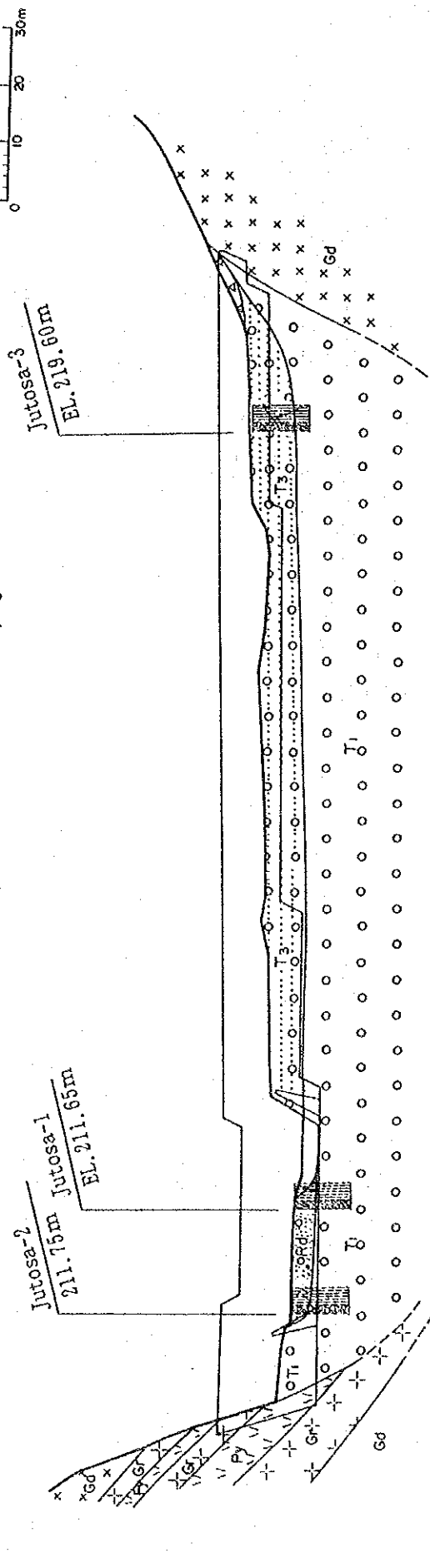
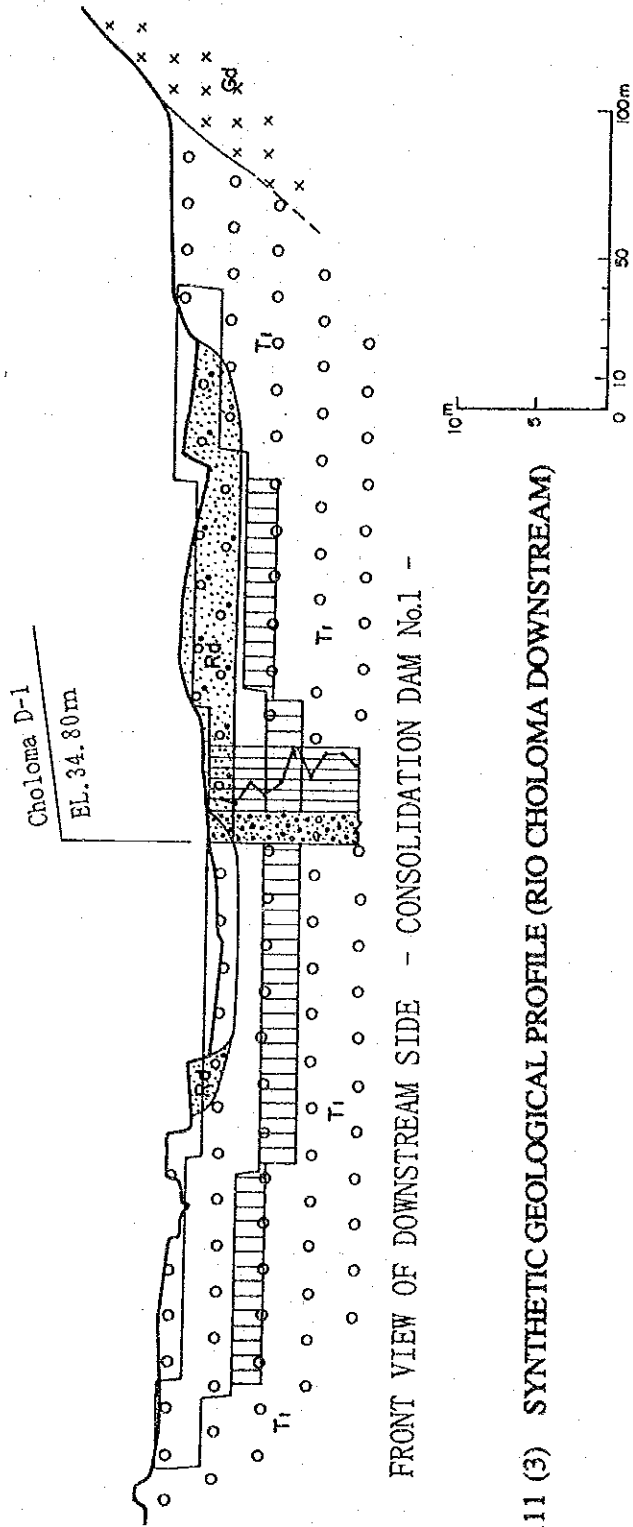


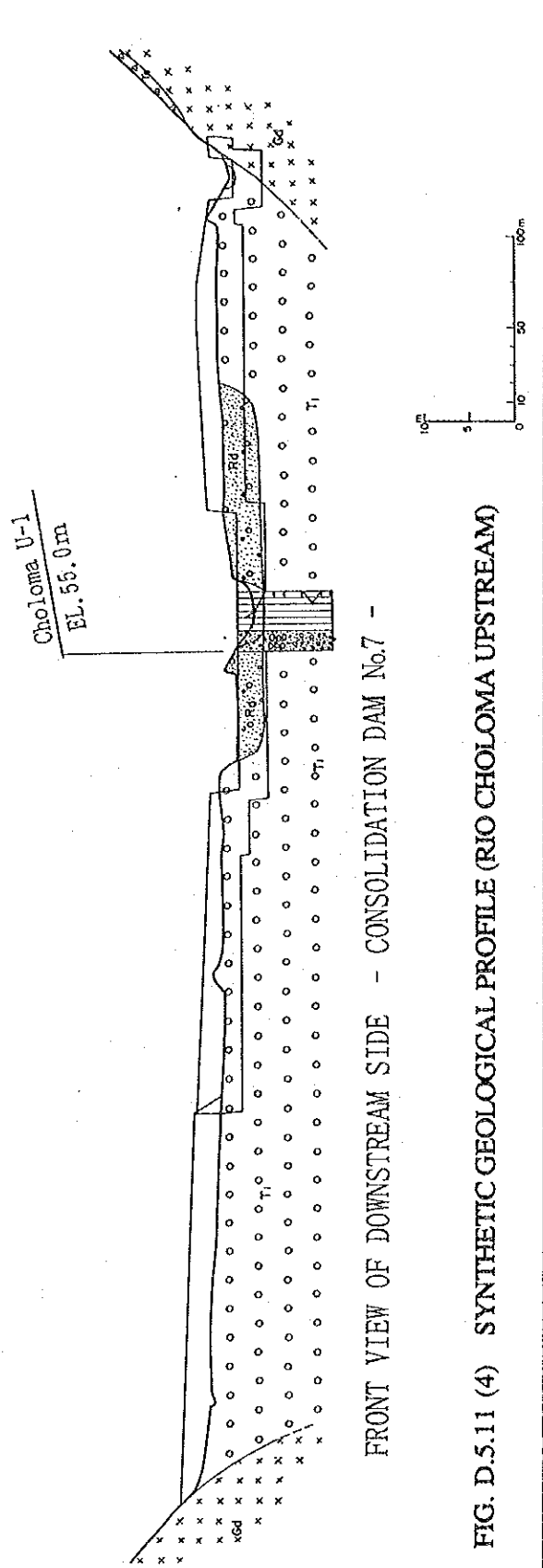
FIG. D.5.11 (2) SYNTHETIC GEOLOGICAL PROFILE (RIO LA JUTOSA)





FRONT VIEW OF DOWNSTREAM SIDE - CONSOLIDATION DAM No.1 -

FIG. D.5.11 (3) SYNTHETIC GEOLOGICAL PROFILE (RIO CHOLOMA DOWNSTREAM)



FRONT VIEW OF DOWNSTREAM SIDE - CONSOLIDATION DAM No.7 -

FIG. D.5.11 (4) SYNTHETIC GEOLOGICAL PROFILE (RIO CHOLOMA UPSTREAM)

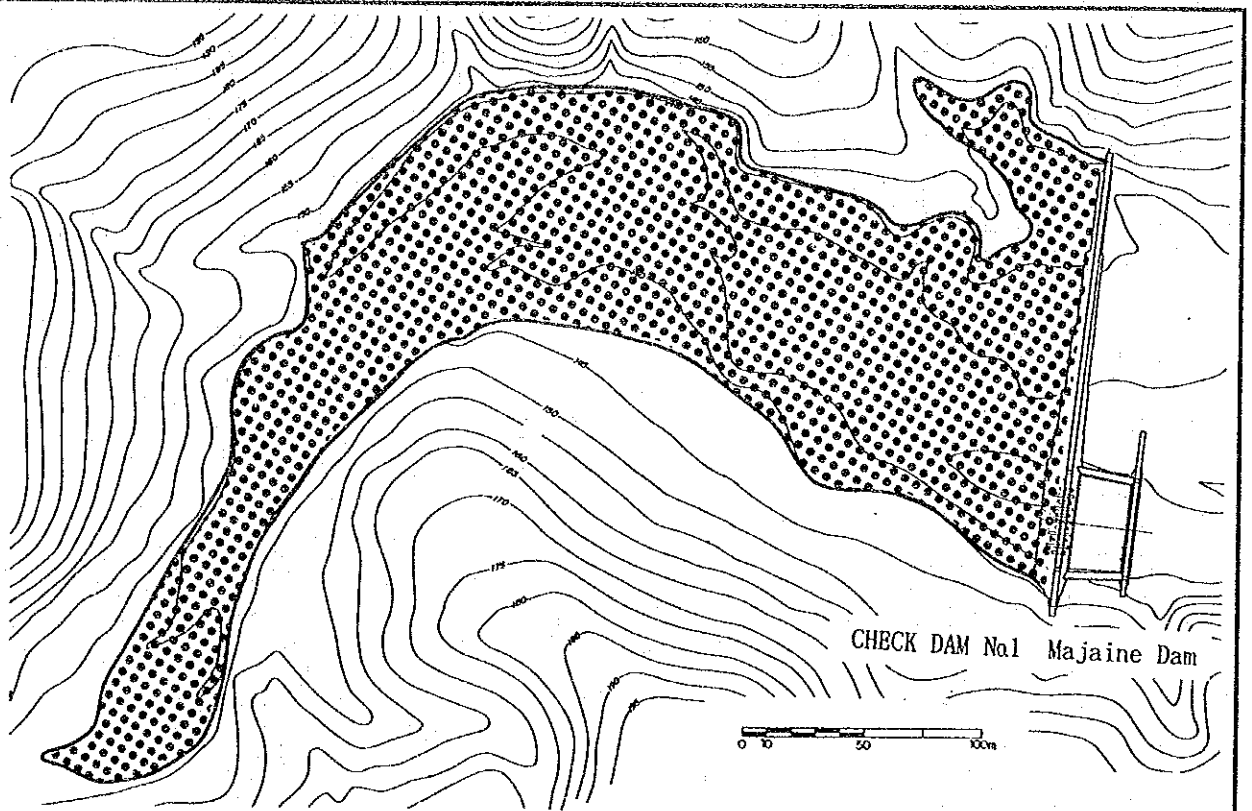


FIG. D.5.12 (1) PREDICTED SEDIMENTATION AREA (MAJAINÉ DAM)

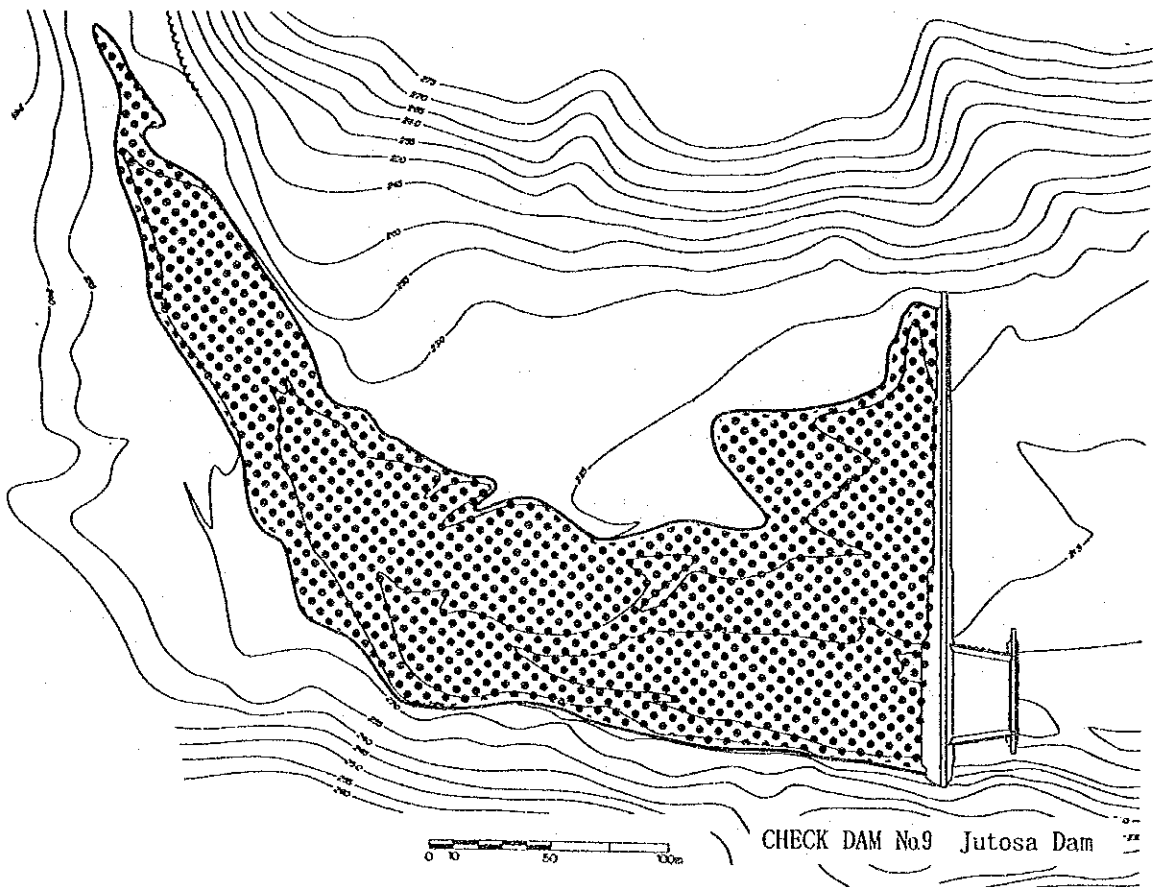
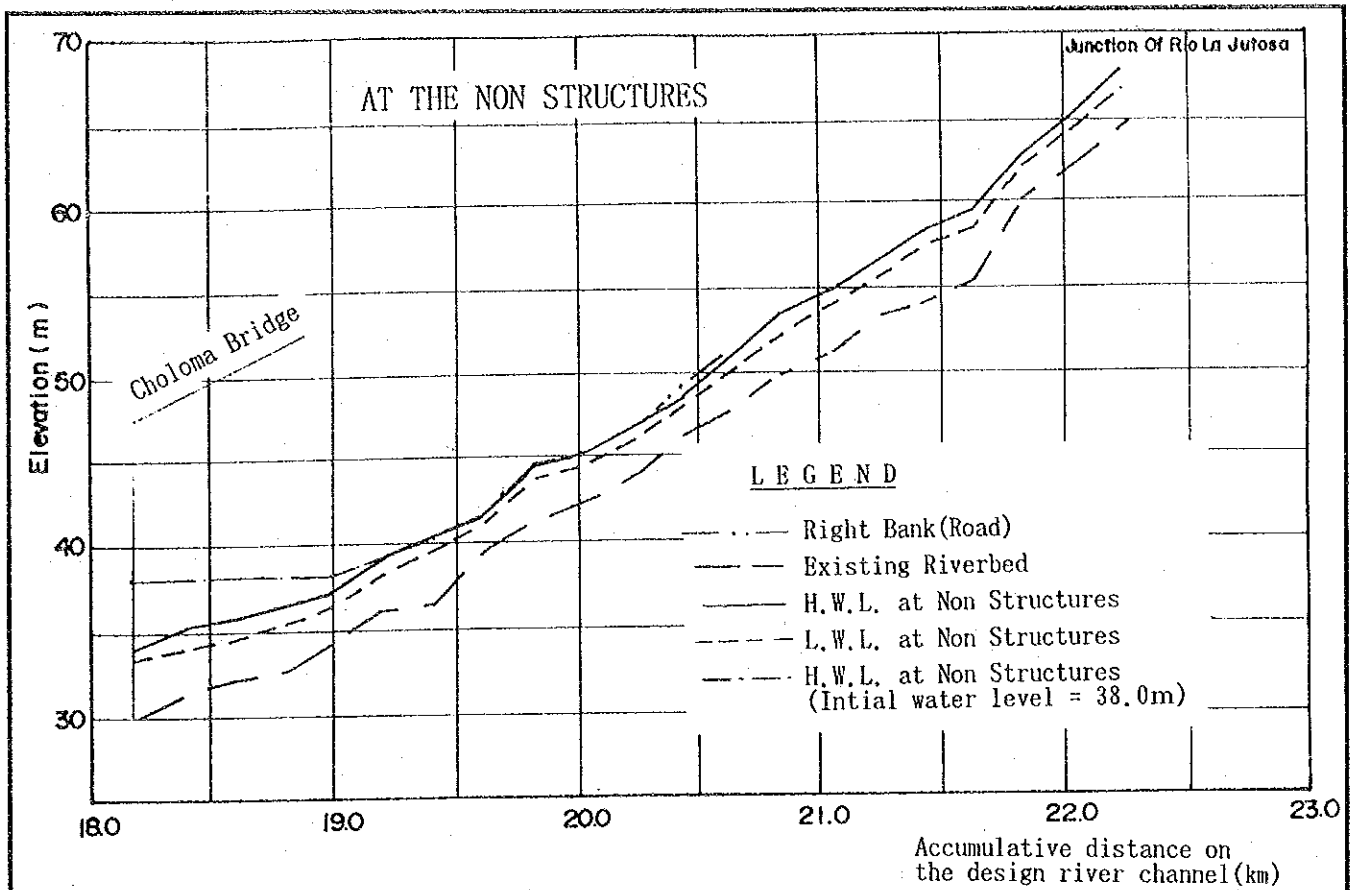
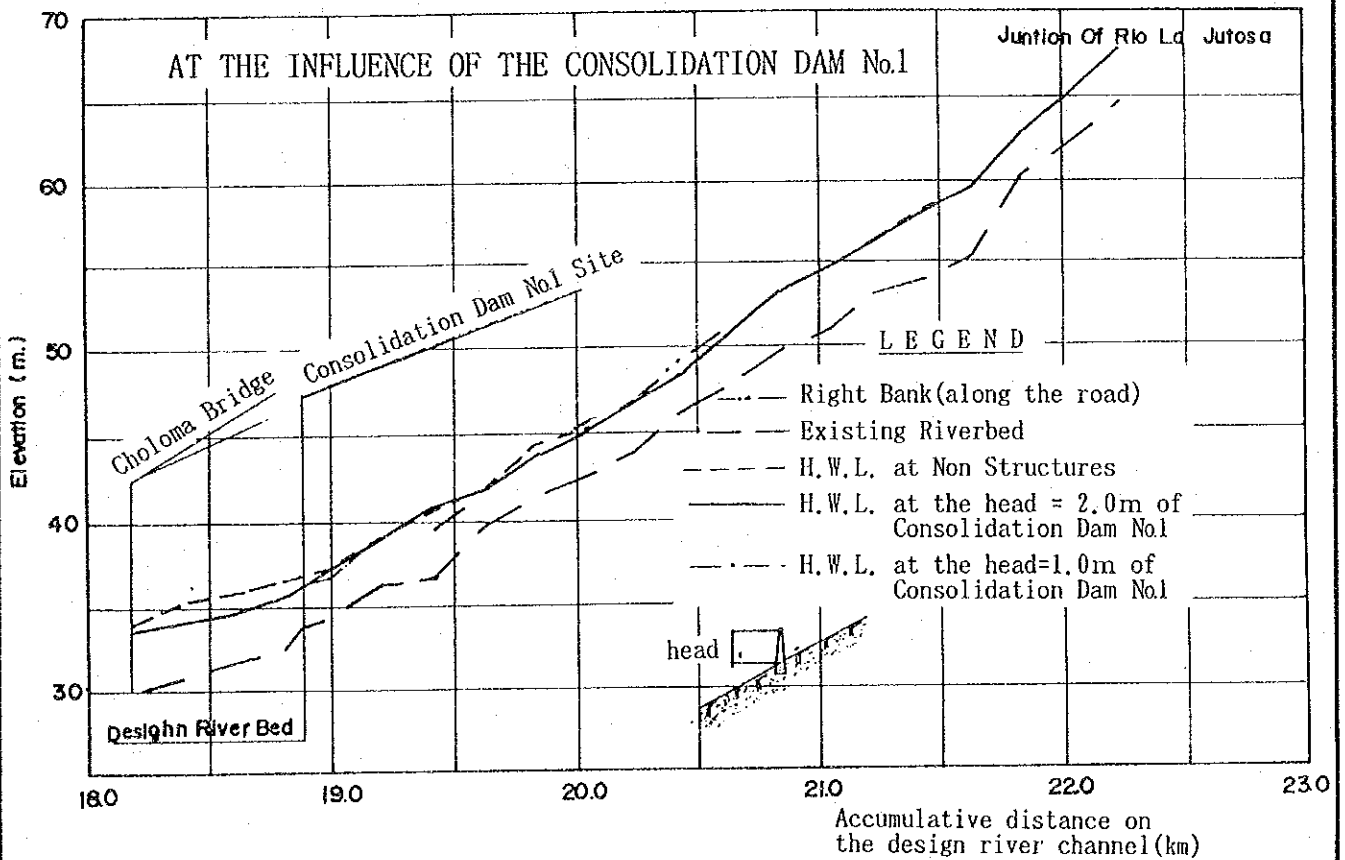


FIG. D.5.12 (2) PREDICTED SEDIMENTATION AREA (JUTOSA DAM)



**FIG. D.5.13 RESULTS OF NON-UNIFORM FLOW CALCULATION
- PRESENT CONDITIONS**



**FIG. D.5.14 (1) RESULTS OF NON-UNIFORM FLOW CALCULATION
- INFLUENCE OF CONSOLIDATION DAM NO. 1**

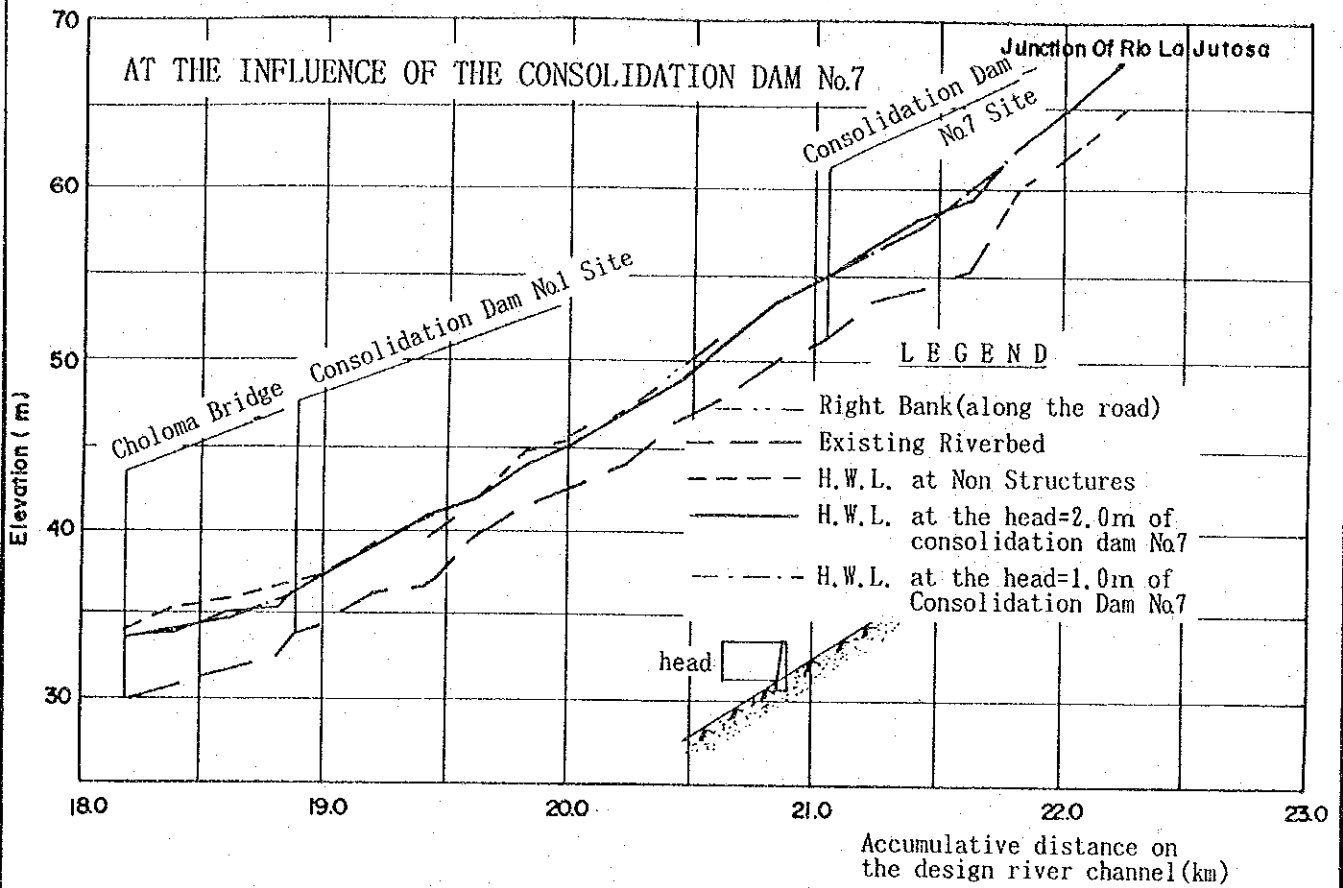


FIG. D.5.14 (2) RESULTS OF NON-UNIFORM FLOW CALCULATION
- INFLUENCE OF CONSOLIDATION DAM NO. 7

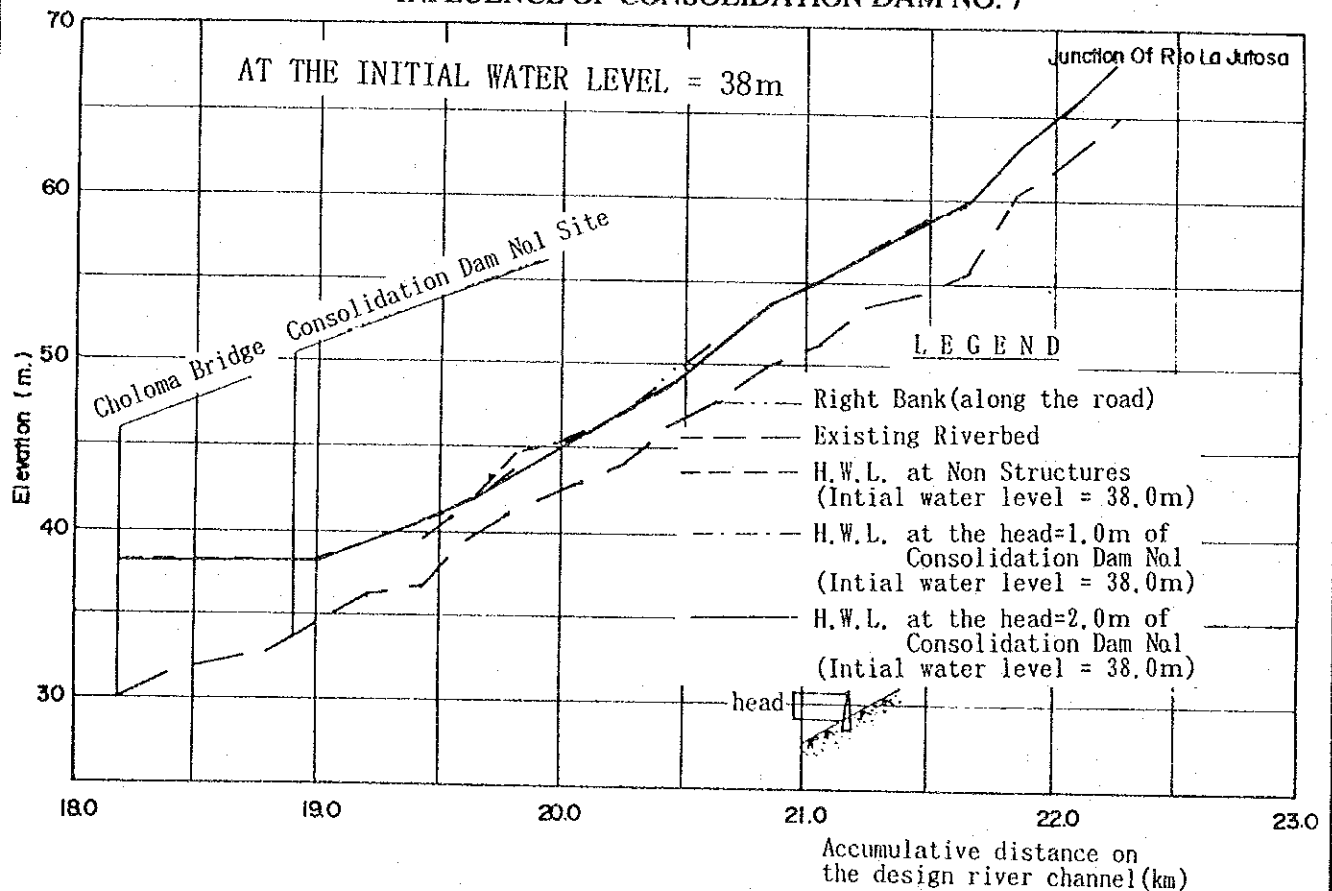


FIG. D.5.14 (3) RESULTS OF NON-UNIFORM FLOW CALCULATION
- INFLUENCE OF CHOLOMA BRIDGE OCCLUSION

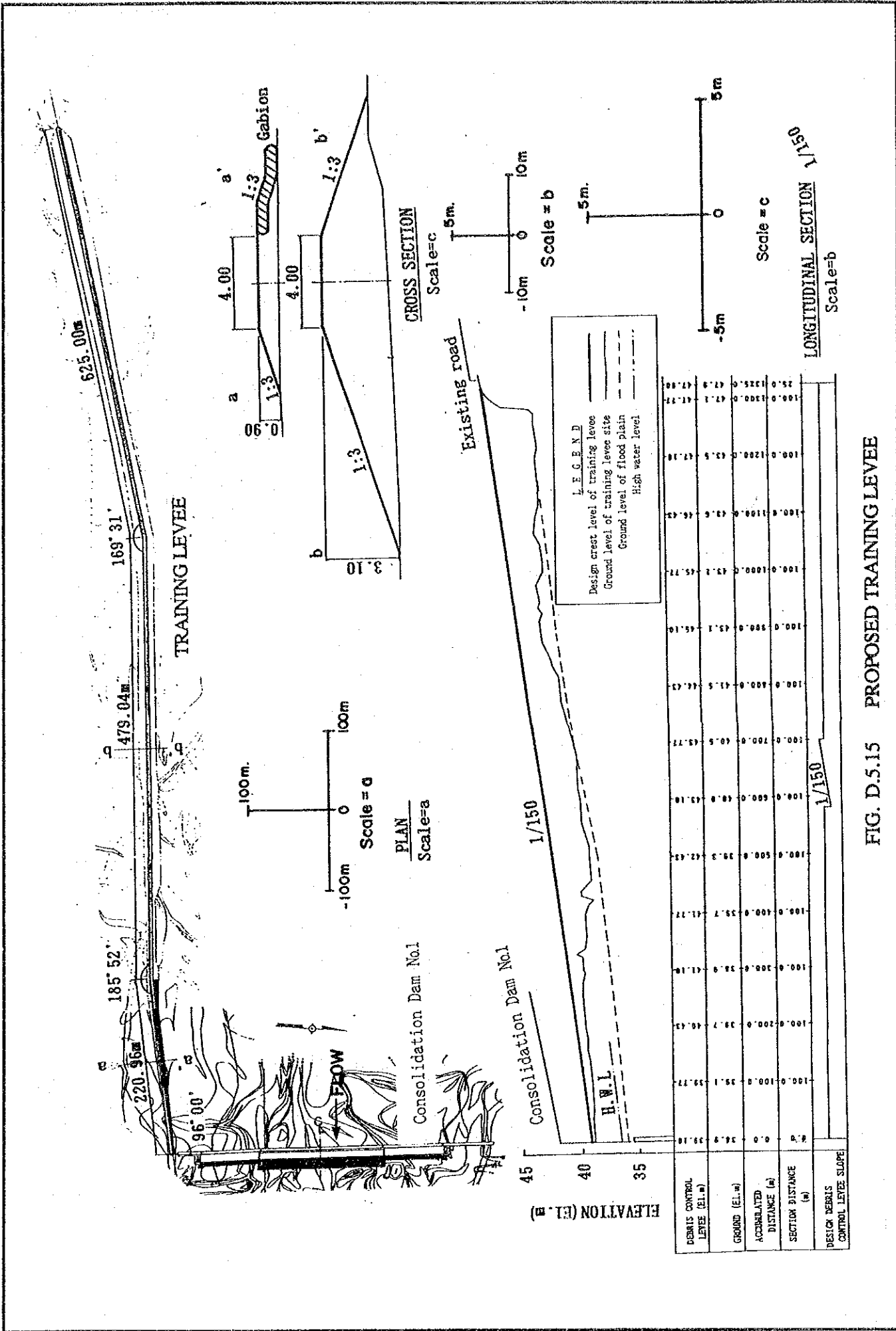


FIG. D.5.15 PROPOSED TRAINING LEVEE



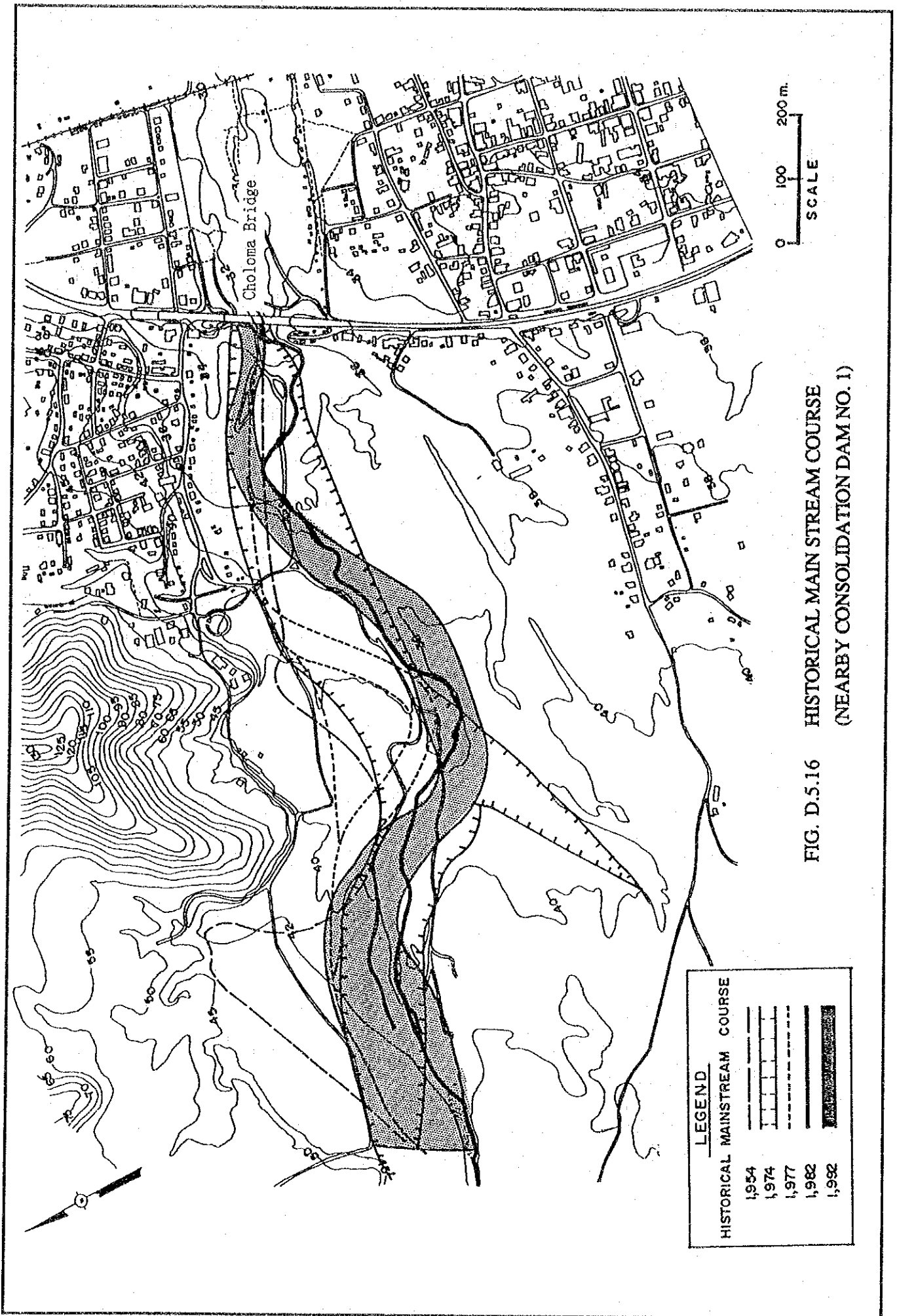
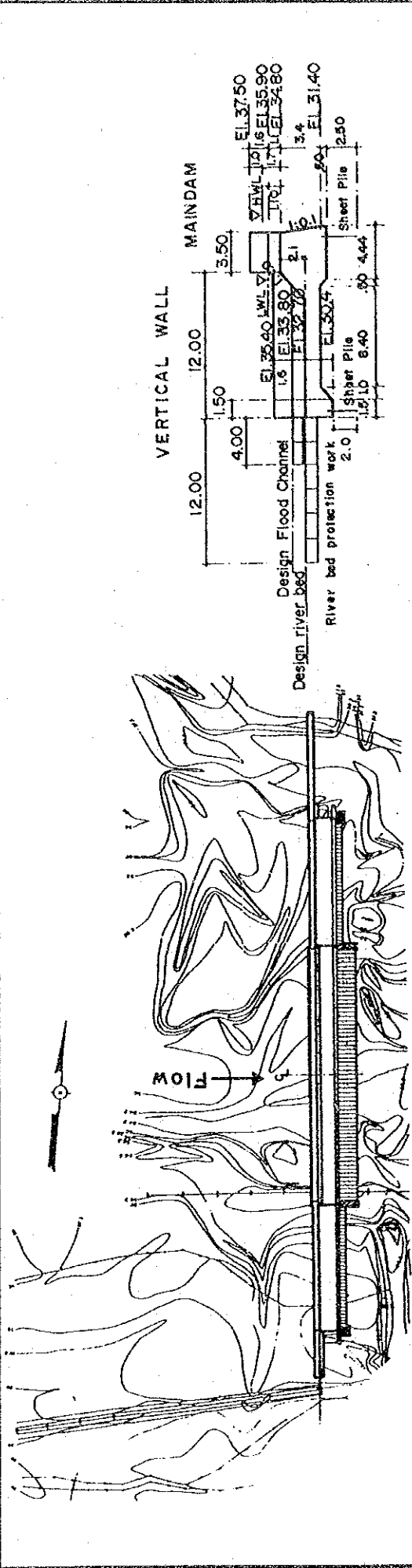
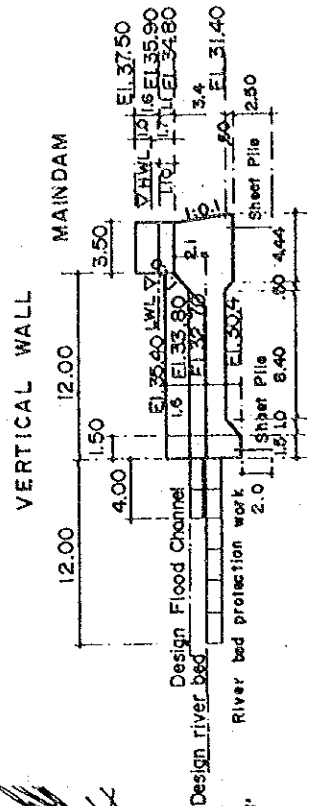


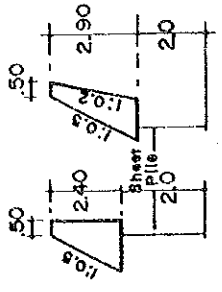
FIG. D.5.16 HISTORICAL MAIN STREAM COURSE
(NEARBY CONSOLIDATION DAM NO. 1)



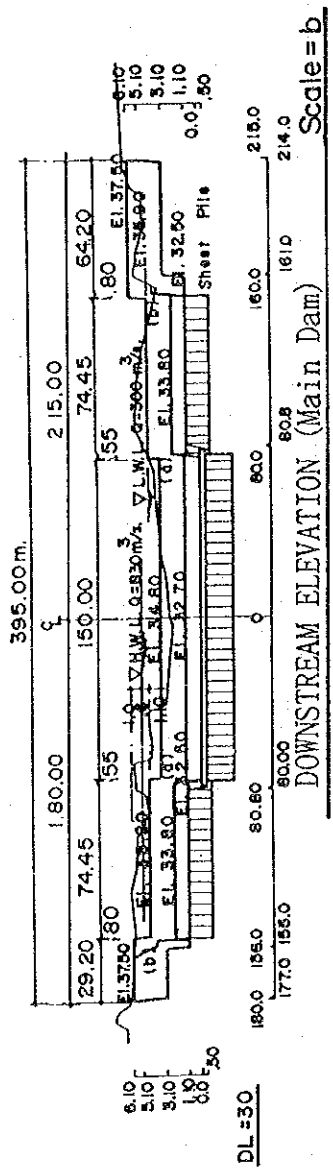
PLAN (Scale = a)



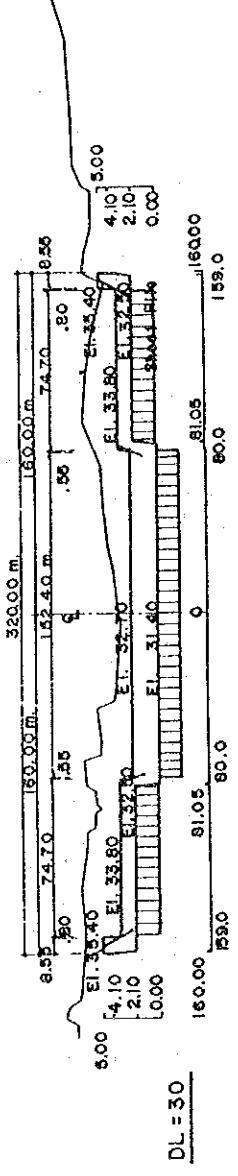
**CROSS SECTION
Scale = c**



SIDE WALL (Scale = d)



Scale = b



DOWNSTREAM ELEVATION (Vertical Wall)

Scale = b

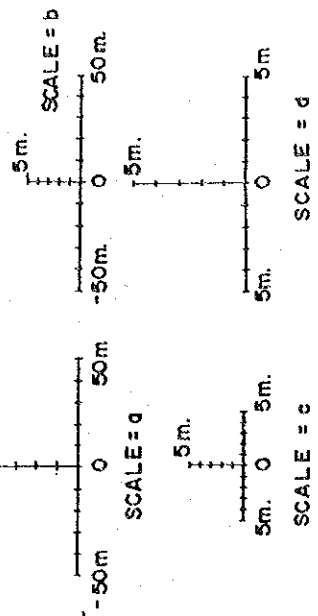
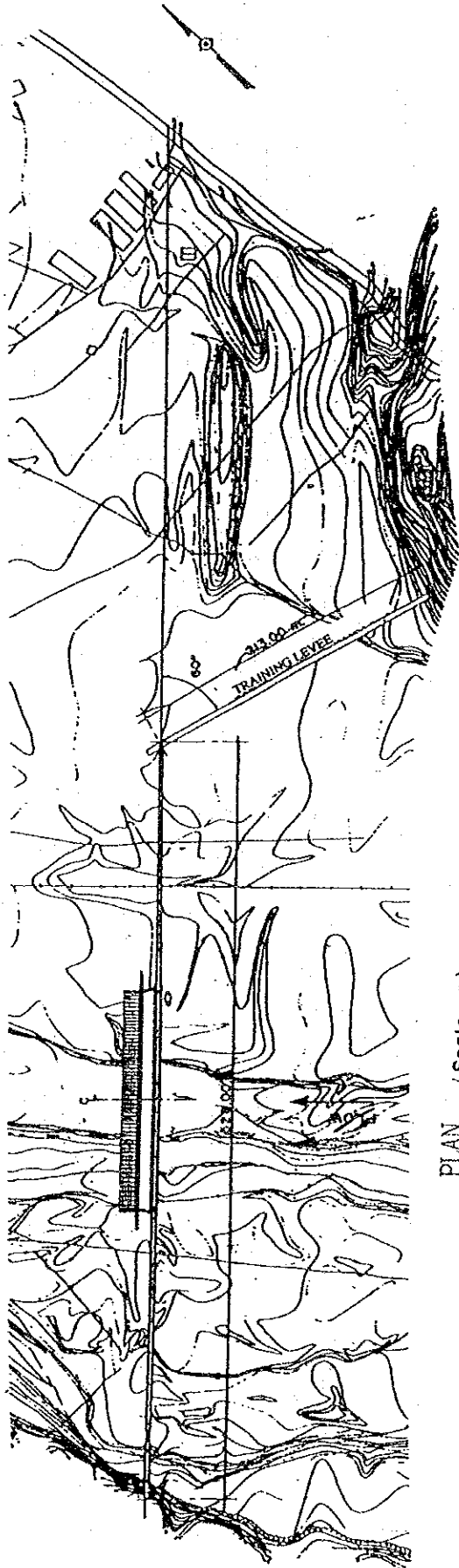
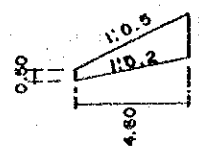
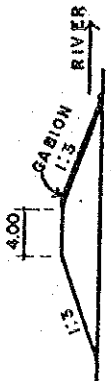


FIG. D.5.17 PROPOSED CONSOLIDATION DAM NO. 1

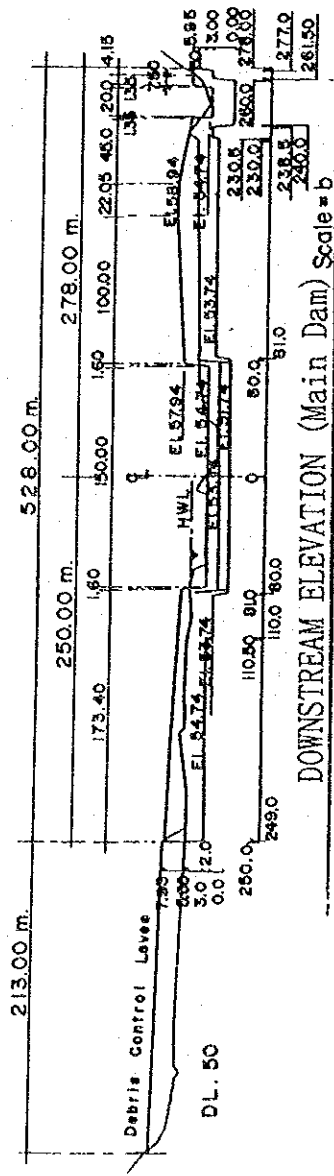




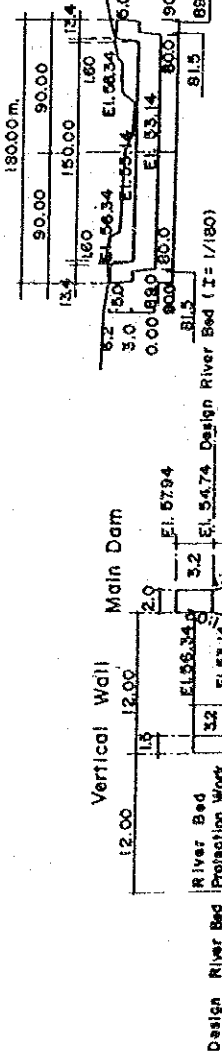
PLAN (Scale = c)



SIDE WALL (Scale = d)

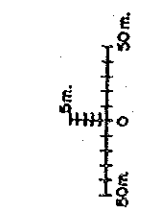


DOWNSTREAM ELEVATION (Main Dam) Scale = b

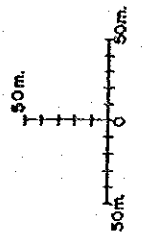


DOWNSTREAM ELEVATION (Vertical Wall) Scale = b

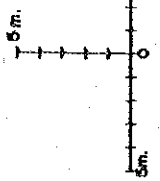
CROSS SECTION Scale = c



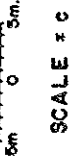
SCALE = b



SCALE = d



SCALE = c



SCALE = d

FIG. D.5.18 PROPOSED CONSOLIDATION DAM NO. 7



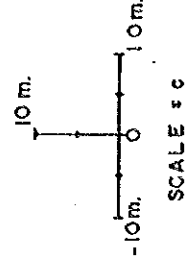
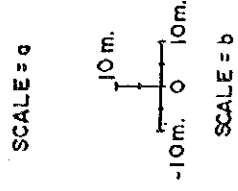
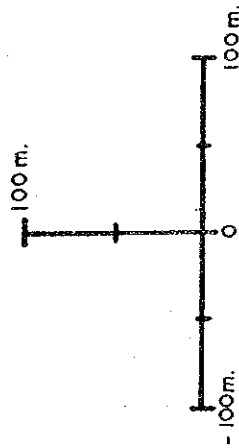
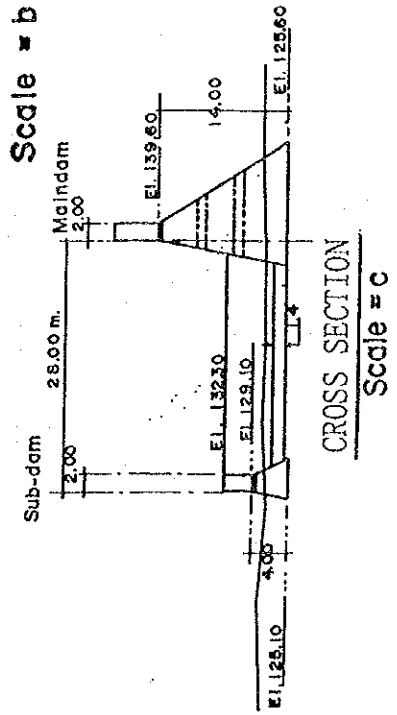
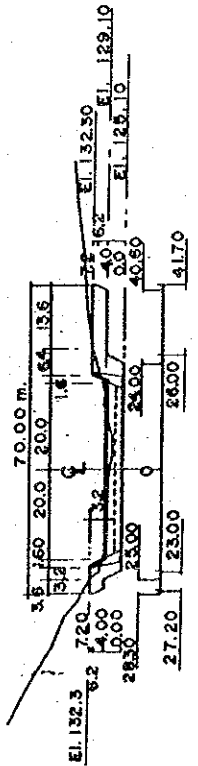
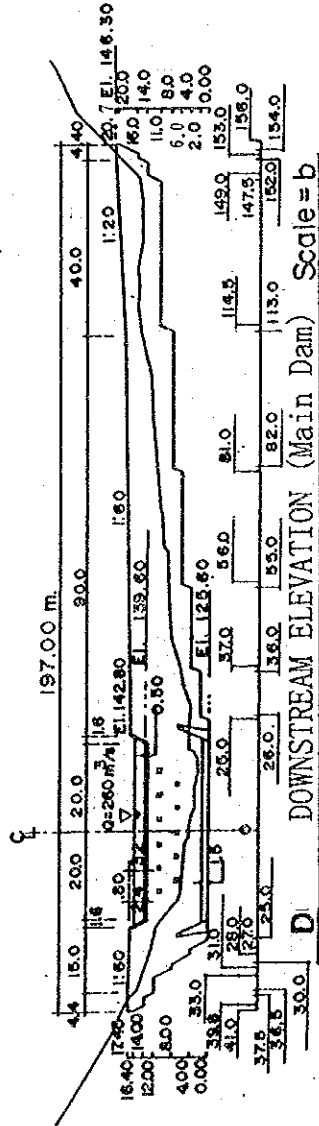
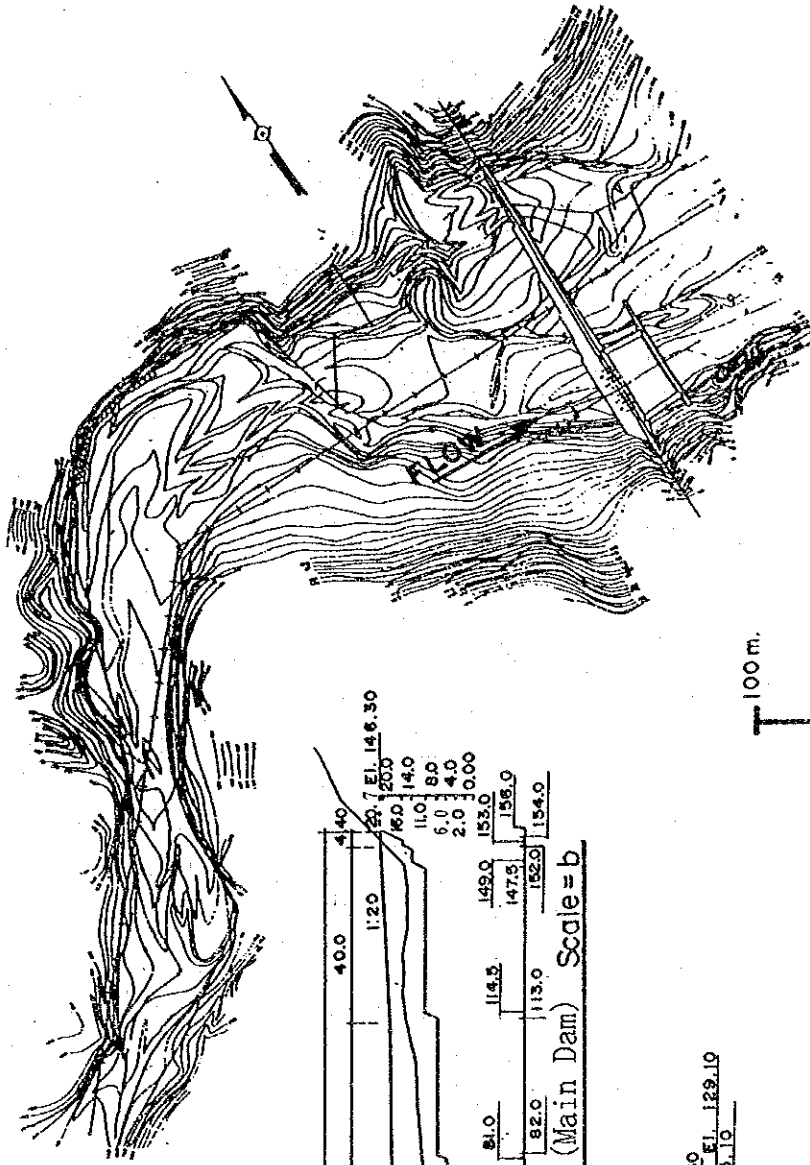


FIG. D.5.19 PROPOSED CHECK DAM NO. 1 (MAJAJNE DAM)



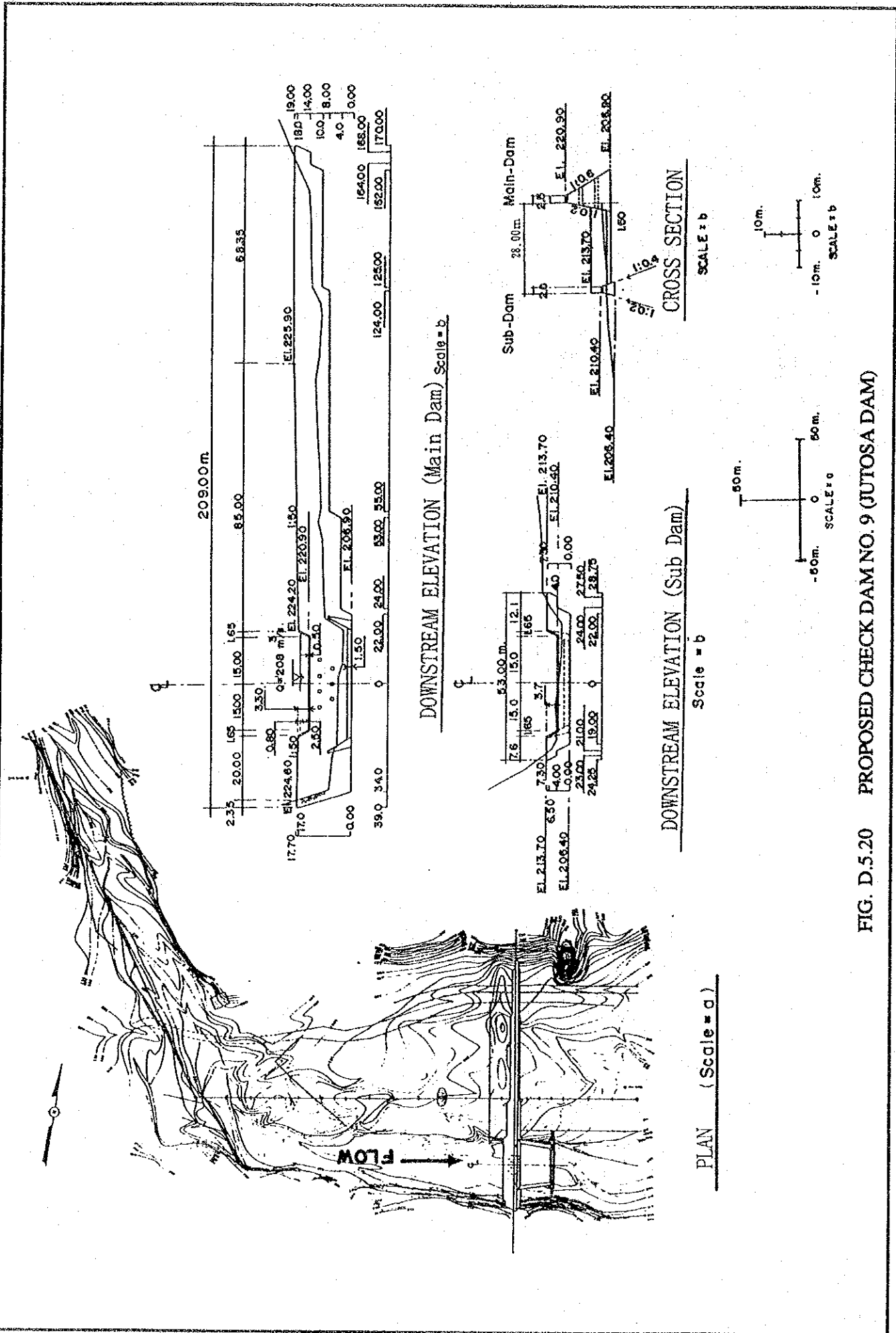


FIG. D.5.20 PROPOSED CHECK DAM NO. 9 (JUTOSA DAM)



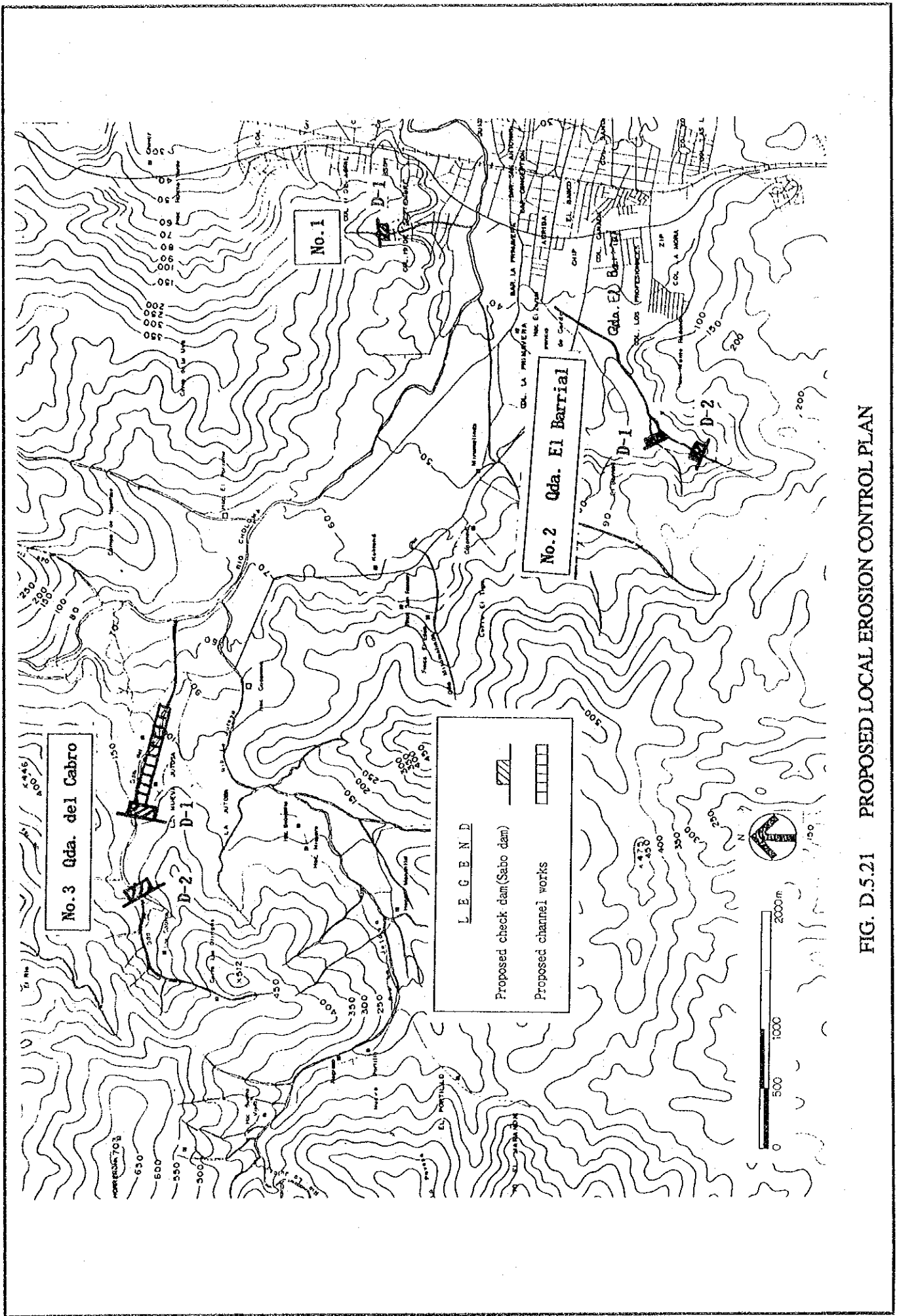


FIG. D.5.21 PROPOSED LOCAL EROSION CONTROL PLAN

**SUPPORTING REPORT E
SEDIMENTOLOGY**

SUPPORTING REPORT E SEDIMENTOLOGY

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SUPPORTING REPORT E SEDIMENTOLOGY**1. SEDIMENTOLOGICAL STUDY IN THE MASTER PLAN STUDY STAGE****1.1 General**

In the Study area, there are three major tributaries and several other small tributaries of the Rio Chamelecon. The major tributaries are the Rio Choloma(catchment area 106.89 km²), the Rio Blanco(catchment area 190.24 km²) and the Rio El Sauce (catchment area 118.33 km²). The quantities of sediment discharge of these rivers are informed to be very large. The sediment deposition can be observed especially in the midstream and downstream reaches of these rivers and this also causes the sediment problems including aggradation of river bed and reducing the flood discharge capacity.

On the contrary, in the midstream reach of the Rio Blanco, degradation of the river bed can be observed. By this degradation of the river bed, the footing and the wooden pile of the foundation of the Railway Bridge have been exposed above the river bed and the Railway Bridge is becoming to be in a dangerous condition. This degradation seems to be caused by the excessive sand taking in the midstream reach of the Rio Blanco. This kind of degradation of the river bed also generally causes the sediment problem such as the collapse of foundation of revetment of river banks as well as collapse of foundation of river structures including bridge.

Hence, for the stabilization of river channel, it is necessary to keep the dynamic equilibrium condition of sediment discharge of the channel which means the balance of sediment inflow into the upstream sections of the channel and the sediment outflow from the downstream sections of the channel through the river course from the upstream reach to the downstream reach.

Considering the above sediment problems, the purpose of the sedimentological study in this supporting report is composed of following items ;

- (1) For the present condition of the rivers of the study area including the Rio Choloma, the Rio Blanco and the Rio El Sauce,
 - a) To estimate the sediment discharge capacity of the present rivers of the Study area,

- b) To evaluate the tendency of aggradation and degradation of the river bed of the present rivers,
 - c) To evaluate the sediment discharge balance in terms of the stabilization of the channels of the present rivers,
- (2) For the future condition of the rivers of the study area including the Rio Choloma, the Rio Blanco and the Rio El Sauce,
- a) To estimate the sediment discharge capacity of the future rivers of the Study area,
 - b) To evaluate the sediment discharge balance in terms of the stabilization of the channels of the future rivers,
 - c) To find the appropriate design of future river cross sections and longitudinal profile in the aspect of stabilization of the channels considering also the flood control.

1.2 History of Sediment Flow Condition of the Rivers

In this chapter, recent history of sediment flow conditions such as deposition of sand, aggradation or degradation of river bed of the rivers in the Study area including the Rio Choloma, the Rio Blanco and the Rio El Sauce is described.

1.2.1 The Rio Choloma

By the hurricane "Fifi" in September 1974, the largest debris flow among the records was occurred. By this debris flow, a huge quantity of sediment was deposited along the river course. The depth of the deposition of the sediment by this debris flow is estimated to be between 0.5 and 3.0 m in the upstream reach between the road bridge and the junction of the Rio Choloma with the Rio La Jutosa (distance about 5 km) and between 0.5 m and 1.0 m in the downstream reach of the road bridge (distance about 7 km).

After "Fifi", in order to improve the flood condition of the downstream area of the Rio Choloma, the Canal San Roque and the Canal San Roque-Cuabanos were constructed in 1977 and 1978. The Rio Choloma joins with the Canal San Roque and flows into the Rio Chamelecon first through the Canal San Roque-Cuabanos and second through the under-constructed Canal Copen-Higuero-Cuabanos. Furthermore, SECOPT conducted the dredging in the downstream reach from the road bridge of the Rio Choloma in 1979 to ensure the flood flow capacity.

In spite of these river improvements relating to the Rio Choloma, as the quantity of the sediment discharge from the upstream reach of the Rio Choloma has been very large, sediment deposition and aggradation of the river bed have been occurred until now.

One of the evidence of the sediment deposition and aggradation can be found at the most downstream reach of the Canal San Roque-Cuabanos of about 700 m length which is the connection reach of the Canal San Roque-Cuabanos with the Canal Copen-Higuero-Cuabanos as shown in *Fig. E.1.1*. In this reach, the Comision Ejecutiva Valle de Sula (Commission of the Sula Valley) conducted the river dredging of the existing channel of the Canal San Roque-Cuabanos (about 200 m) and excavating the new cut-off channel between the original channel of the Canal San Roque-Cuabanos and the Canal Copen-Higuero-Cuabanos (about 500 m) in 1992. The sediment deposition and aggradation of the river bed of about 1.0 m to 2.0 m can be observed by this figure. This sediment deposition is included in the sediment deposition between 1977 and 1992.

1.2.2 The Rio Blanco

By the hurricane "Fifi" in September 1974, the largest debris flow among the records also occurred in the Rio Blanco. By this debris flow, a huge quantity of sediment was deposited along the river course. The depth of the deposition of the sediment by this debris flow is estimated to be about 1.0 m to 3.0 m in the upstream reach between the Road Bridge and the most upstream portions of the alluvial fans of the Rio del Zapotal and the Rio de Armenta (distance about 4 to 5 km) and about 1.0 m to 0.2 m in the downstream reach from the Road Bridge (distance about 3 km).

After "Fifi", river improvement of the Rio Blanco was conducted in 1978 by SECOPT and Municipality of San Pedro Sula based on the flood control study of Sir William Halcrow & Partners in 1975. By this river improvement, excavation of the river bed of

which the depth was about 2.0 m to 3.0 m in the downstream reach and about 3.0 m and 4.0 m in the upstream reach was conducted as well as the widening and diking of the channel.

In spite of above river improvement, as the quantity of sediment discharge from the upstream reach as well as from the large quantity of sediment deposition made by the debris flow of "Fifi" had been large, aggradation of the river bed about 2.0 to 3.0 m was observed at the Road Bridge in around 1980.

On the contrary, degradation of the river bed by the excessive sand taking for construction materials can be observed in the midstream reach in 1992, and this causes a structural problem to both the Railway Bridge and the Road Bridge as described in Section 1.1. The depth of the degradation at the Railway Bridge is estimated to be more than 2.0 m.

1.2.3 The Rio El Sauce

Even by the hurricane " Fifi" in September 1974, large debris flow like the debris flow of the Rio Choloma and the Rio Blanco did not occur in the Rio El Sauce and its tributaries of the Rio Santa Ana/Rio Bermejo and the Rio Piedras. But the sediment deposition can be estimated to be about 2.0 m in the downstream reach of the Rio Santa Ana/Rio Bermejo according to the present trace of sediment deposition made in 1974.

After " Fifi", river improvement of the Rio El Sauce, the Rio Santa Ana/Rio Bermejo and the Rio Piedras was conducted by Municipality of San Pedro Sula and SECOPT in 1976 and 1977. By this river improvement, excavation of the river bed about 1.0 m to 2.0 m depth in these rivers were conducted.

The quantity of the aggradation or degradation of the river bed after the above river improvement is not clear until now.

1.3 Present Sediment Flow Condition of the Rivers

In this section, present sediment flow conditions of the rivers in the Study area is described in terms of pattern of sediment flow of the rivers and the bed materials of the rivers.