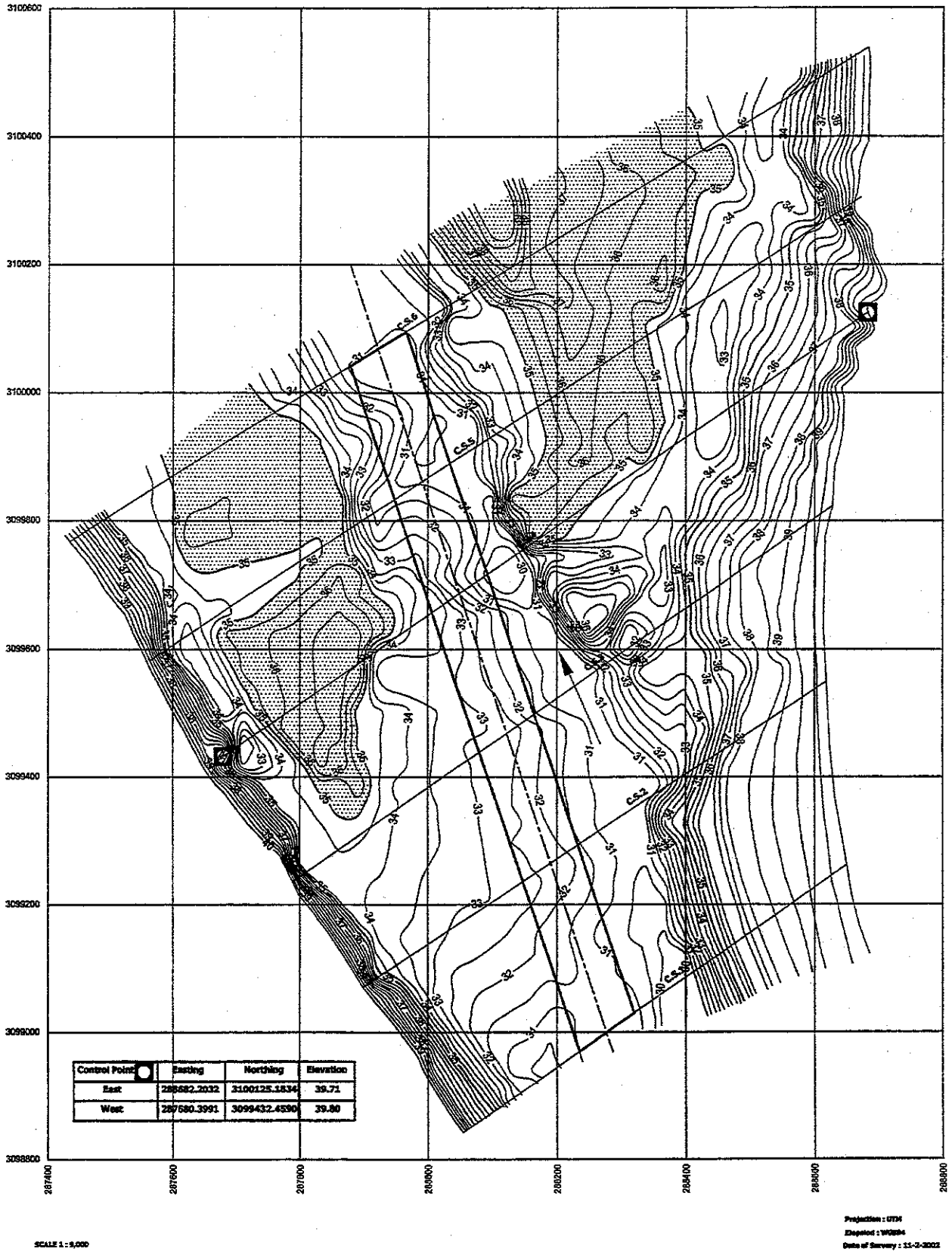
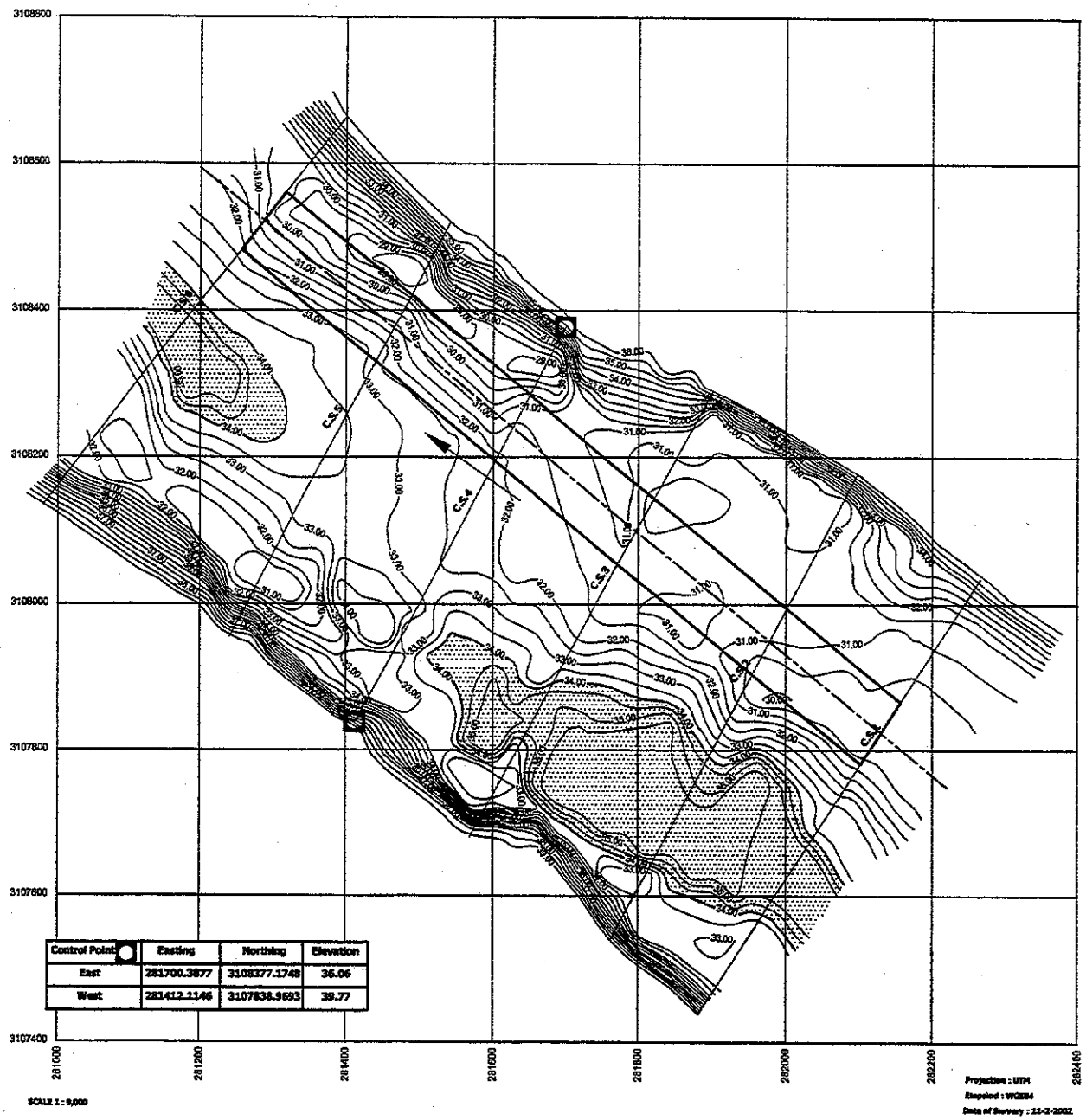
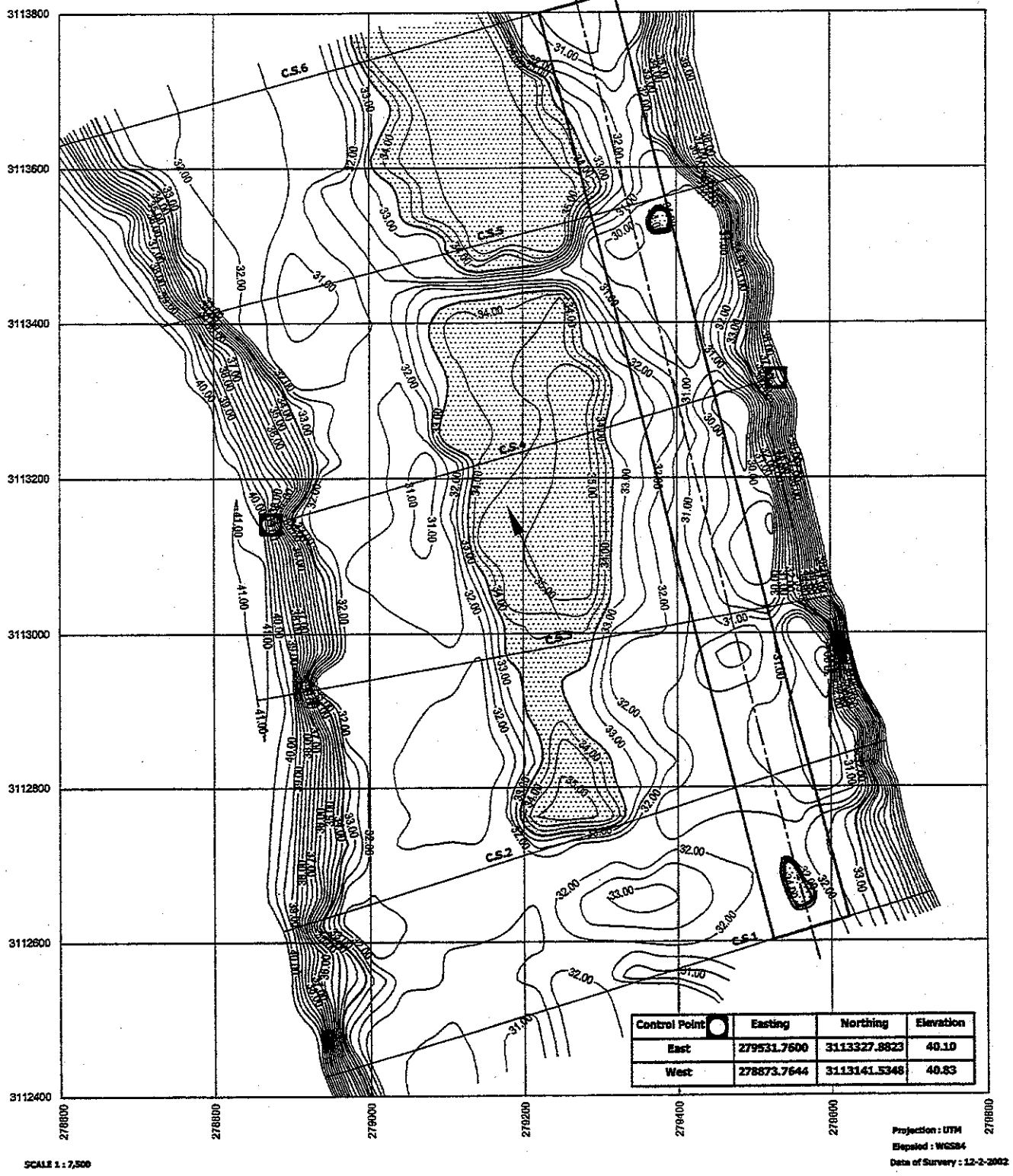
S13 : BNI MOHAMED SHARAWY SITE
(Km. 255.000 From EL-Roda)



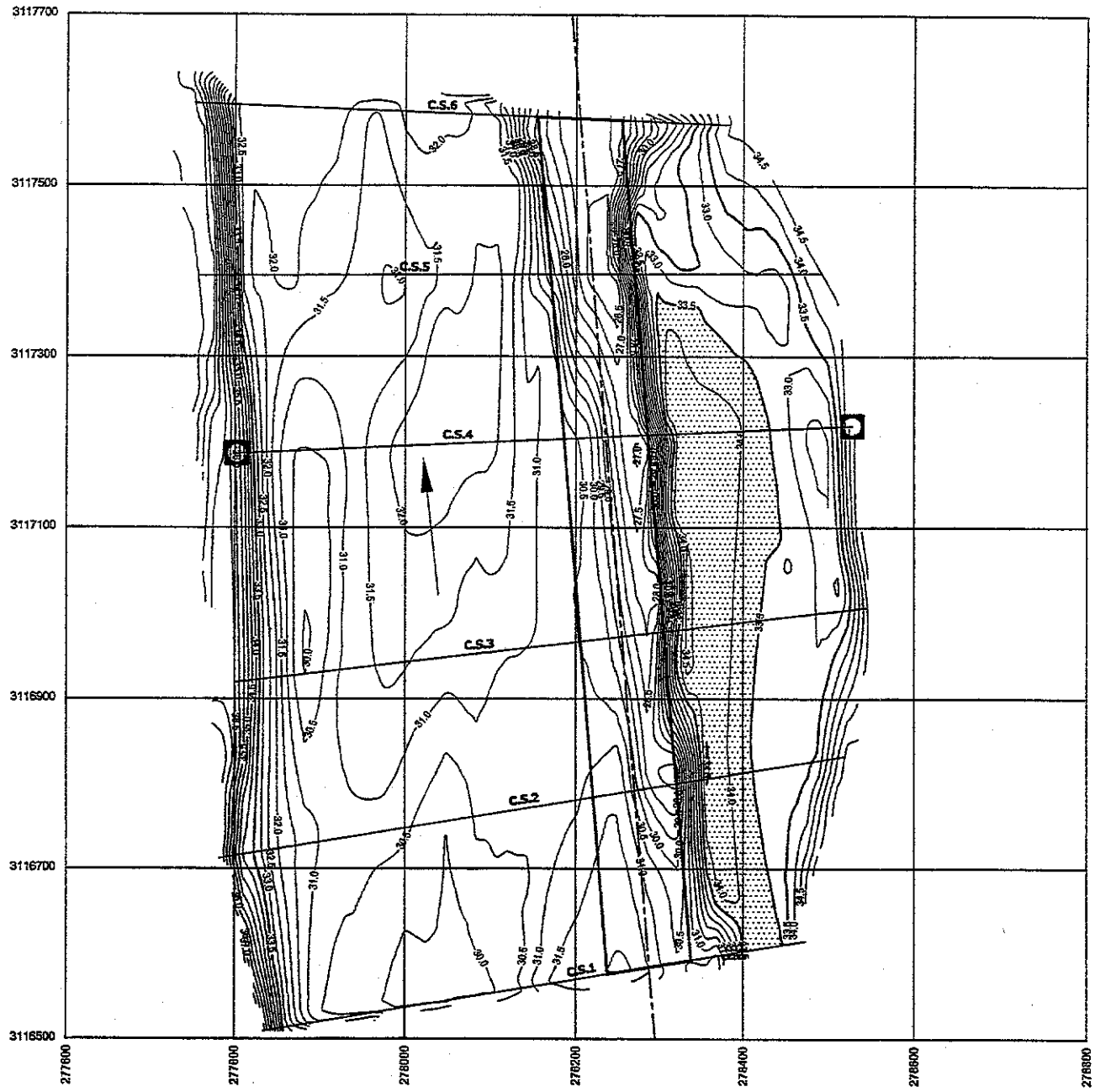
S14 : EL-ZAWIAH SITE
(Km. 246.000 From EL-Roda)



S15 : DAMARIES SHARAWY SITE
(Km. 238.000 From EL-Roda)



S16 : EL-BERGAY SITE
(Km. 233.800 From EL-Roda)

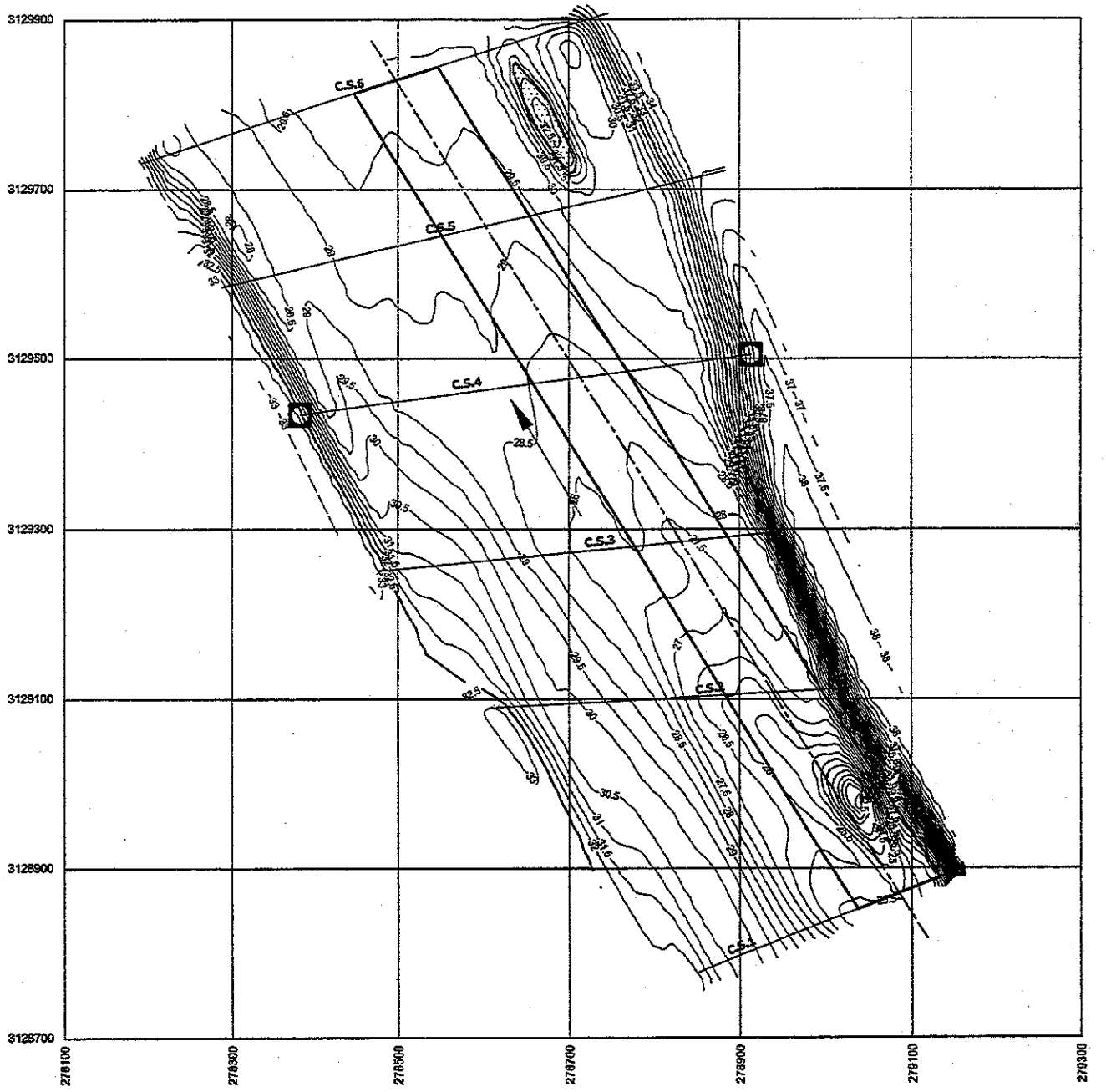


Control Point	Easting	Northing	Elevation
East	278528.0400	3117218.8100	35.90
West	277802.1800	3117186.4000	36.85

SCALE 1 : 7,500

Projection : UTM
Elepsiod : WGS84
Date of Survey : 4-3-2002

S17 : EL - BEHO SITE
(Km. 220.000 From EL-Roda)

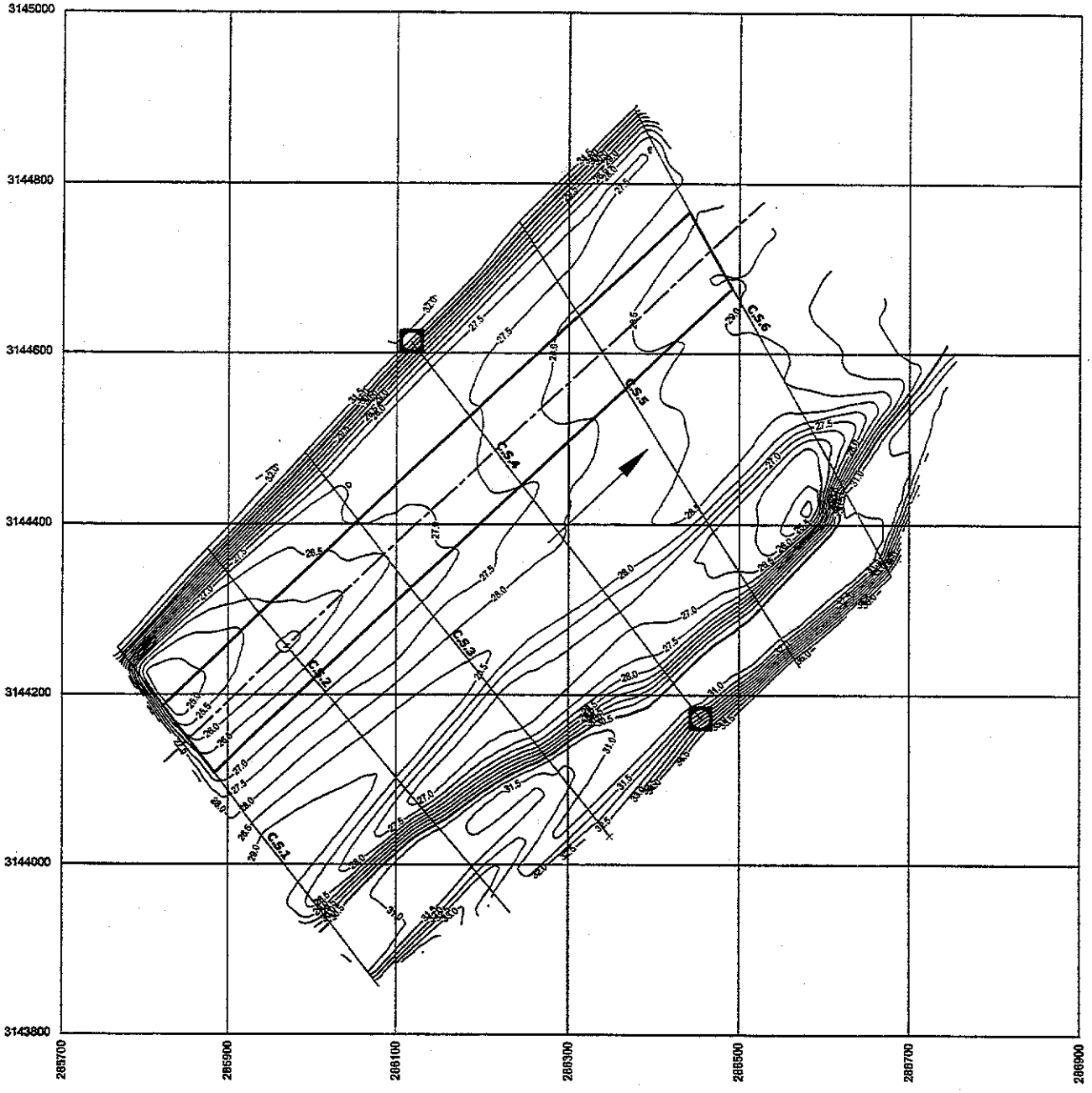


Control Point	Easting	Northing	Elevation
East	278913.1865	3129505.0112	38.10
West	278383.2293	3129434.1209	33.92

Projection : UTM
Elepsiod : WGS84
Date of Survey : 5-3-2002

SCALE 1 : 7,500

S18 : MATAY SITE
(Km. 201.850 From EL-Roda)

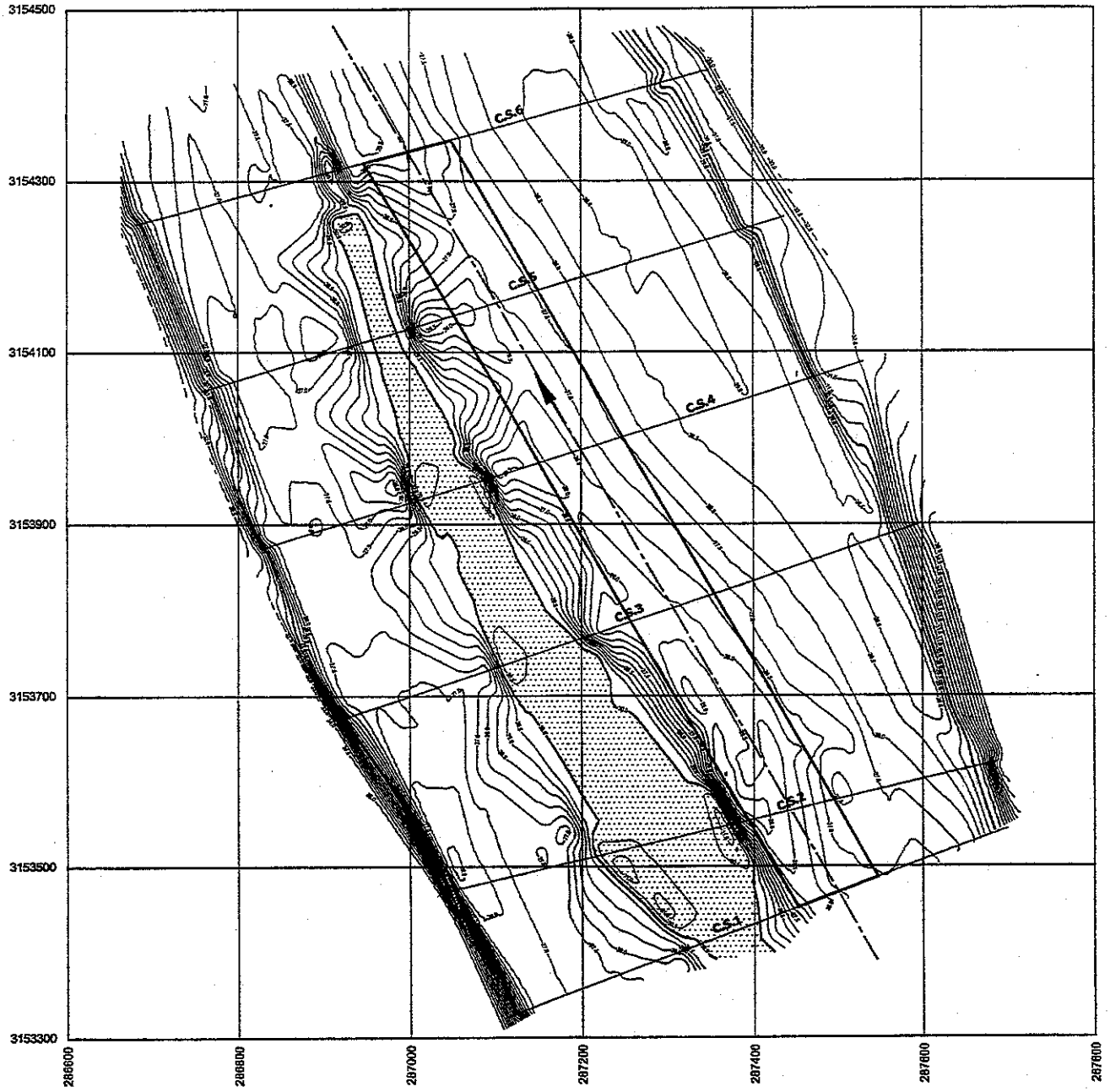


Control Point	Easting	Northing	Elevation
East	286455.9673	3144172.6977	34.01
West	286121.1259	3144608.5061	32.82

SCALE 1 : 7,500

Projection : UTM
Ellepsiod : WGS84
Date of Survery : 5-3-2002

S19 : EL-SHEKH FADL SITE
(Km. 190.663 From EL-Roda)

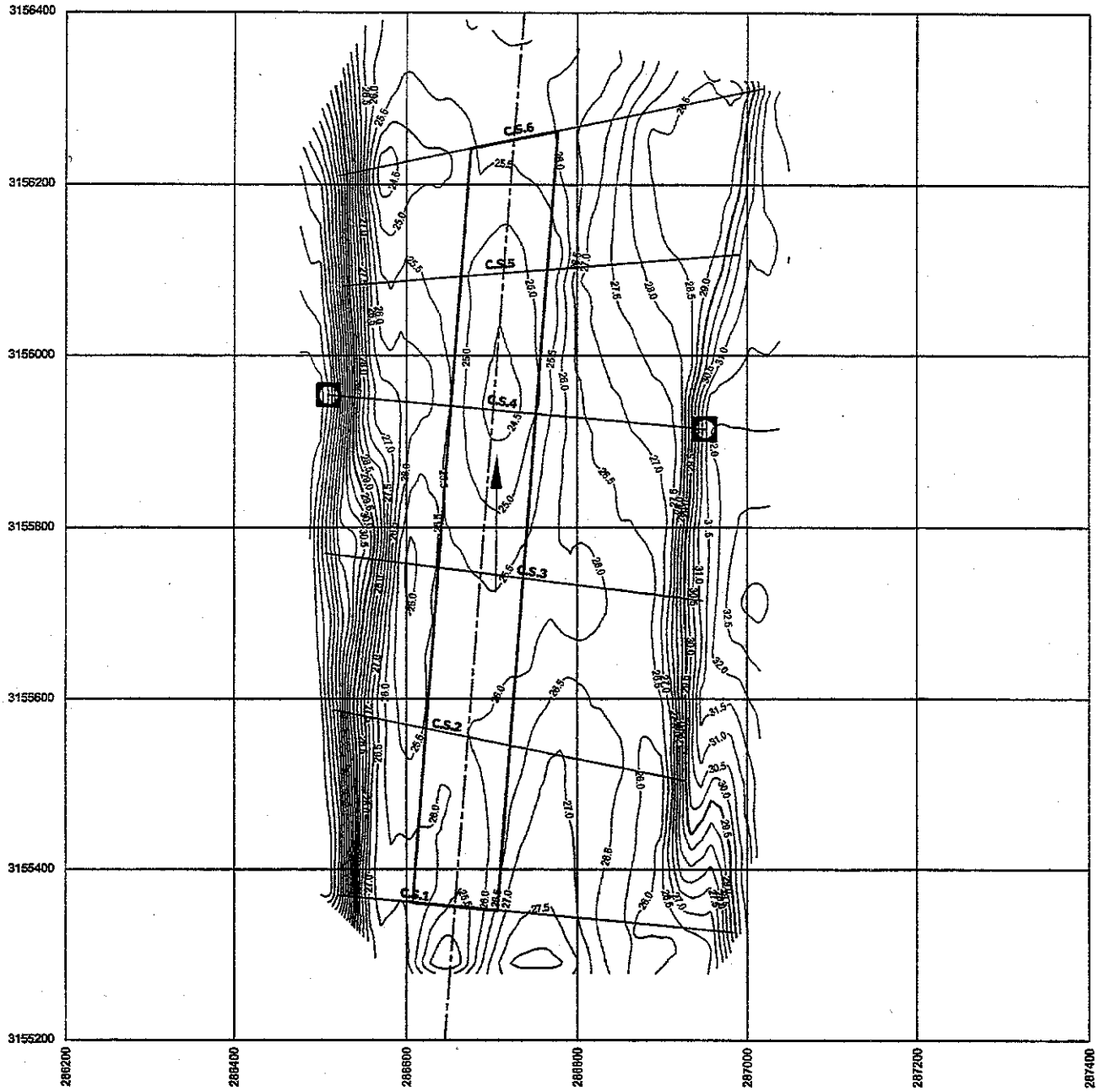


Control Point	Easting	Northing	Elevation
East	287531.5300	3154088.4400	32.20
West	286826.6900	3153871.4600	32.67

Projection : UTM
Elepsiod : WGS84
Date of Survery : 6-3-2002

SCALE 1 : 7,500

S20 : BENI MAZAR SITE
(Km. 188.637 From EL-Roda)

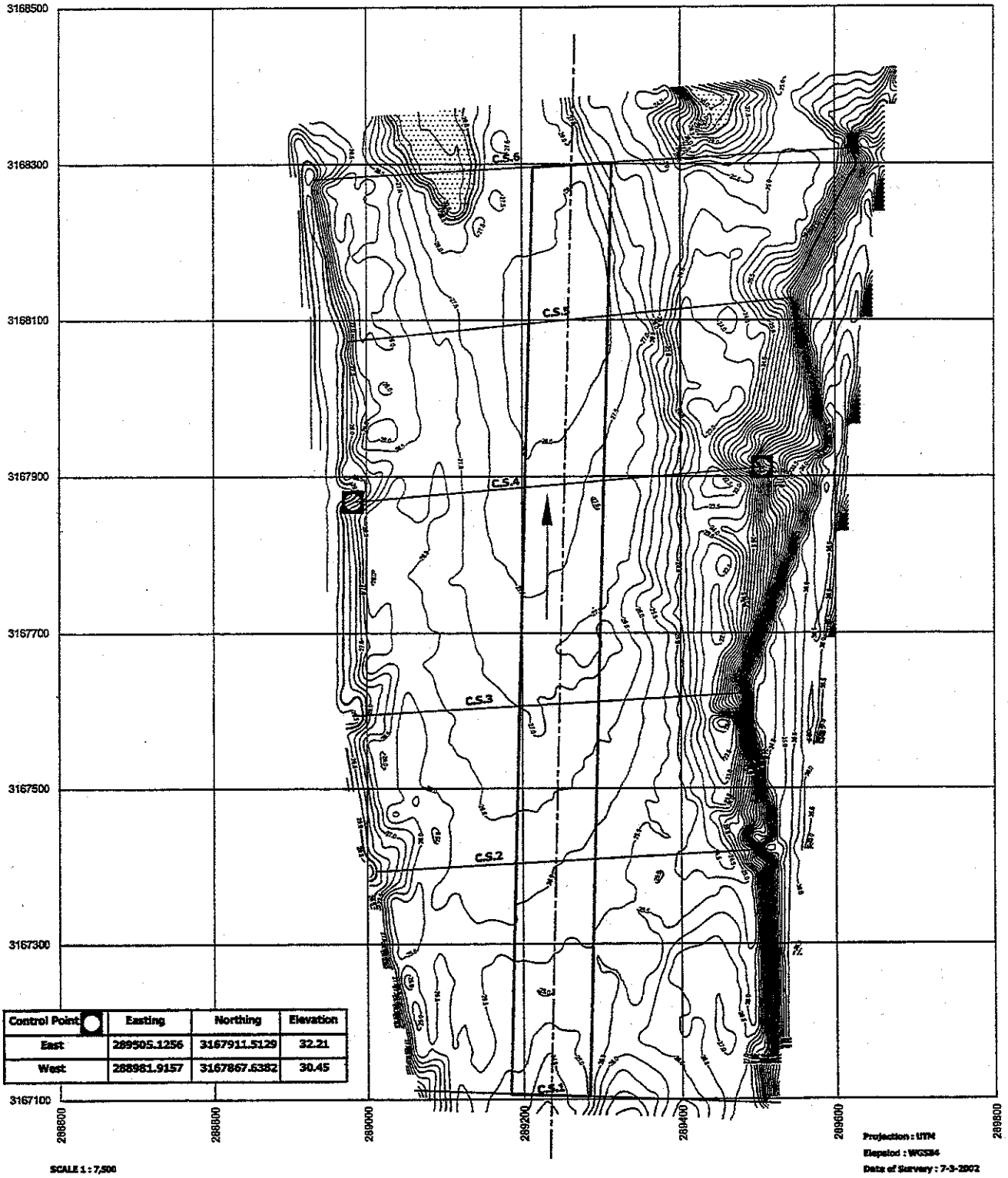


Control Point	Easting	Northing	Elevation
East	286949.7811	3155914.8404	32.35
West	286508.6711	3155954.0603	35.54

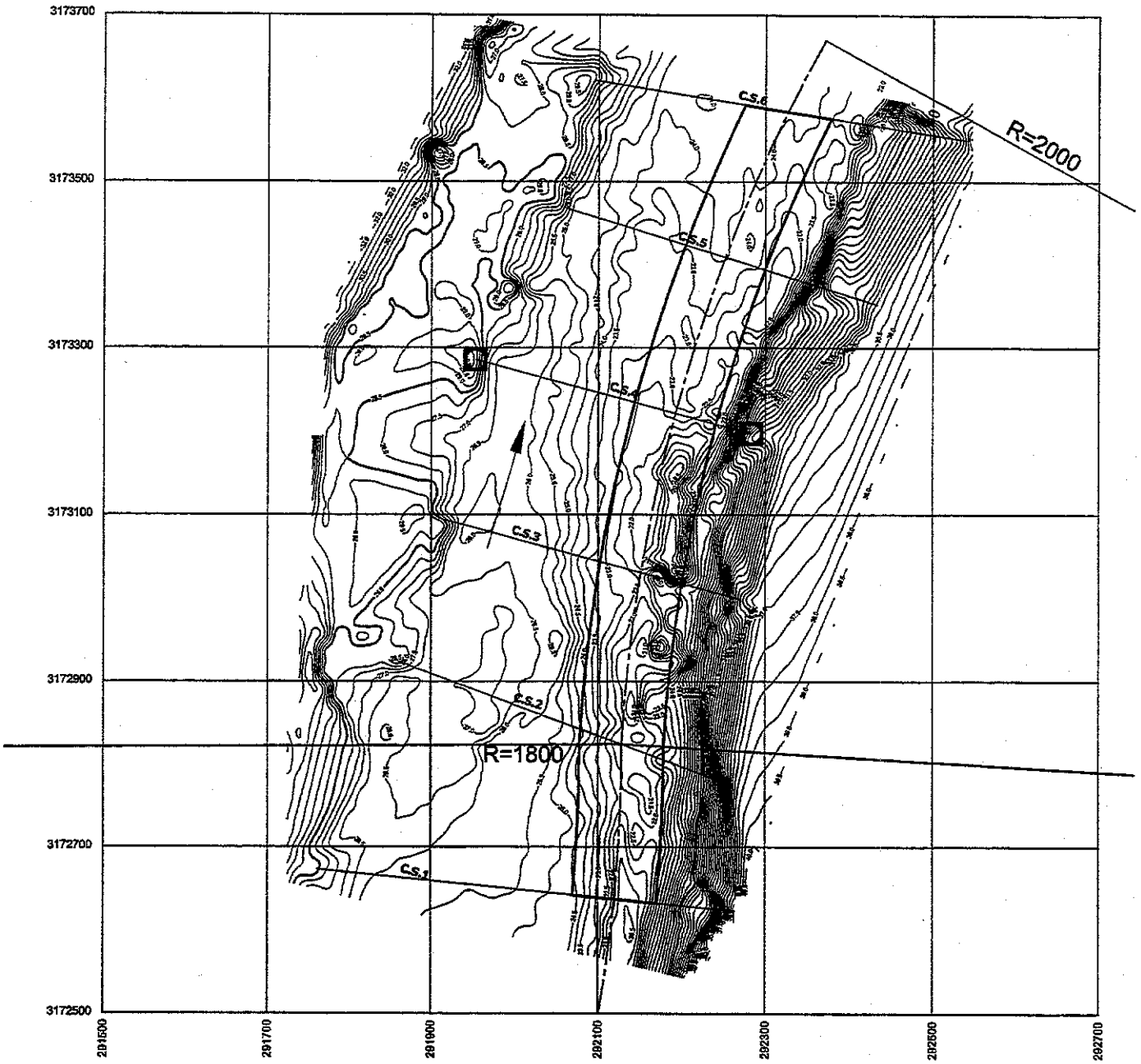
SCALE 1 : 7,500

Projection : UTM
Elepsiod : WGS84
Date of Survery : 6-3-2002

S21 : SHAROUNA ISLAND SITE
(Km. 176.000 From EL-Roda)



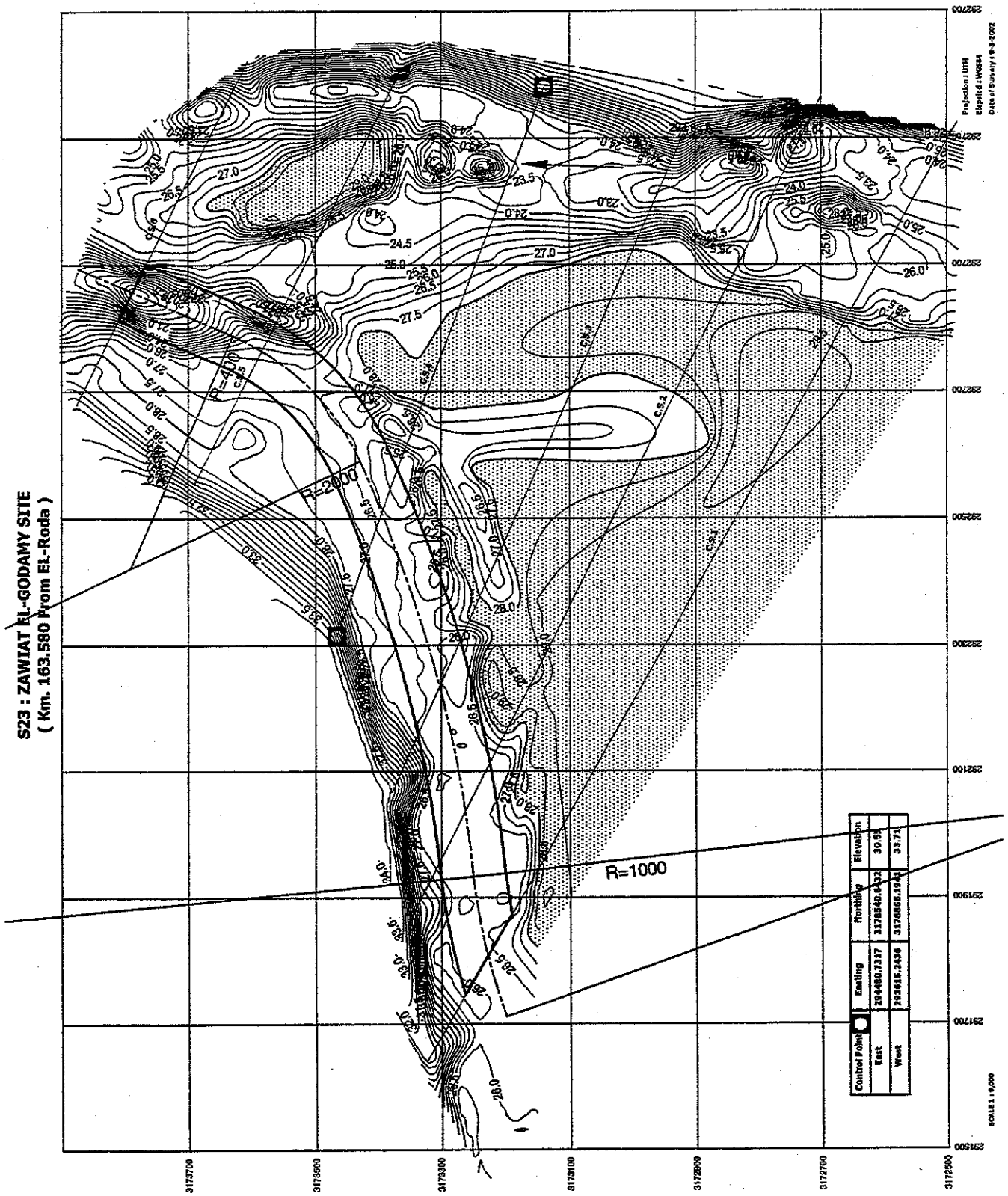
S22 : AWLAD EL-SHEIKH SITE
(Km. 169.810 From EL-Roda)



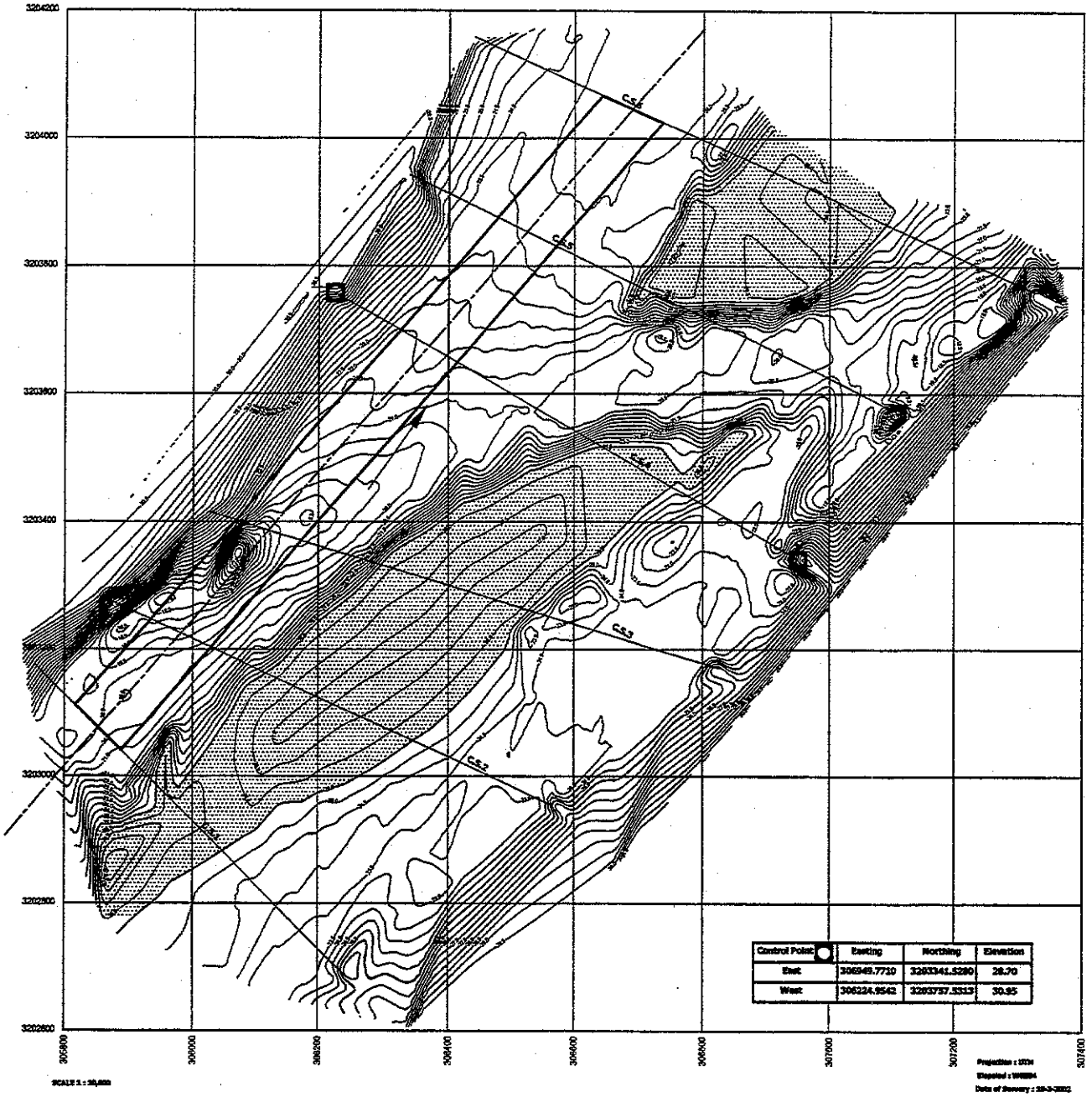
Control Point	Easting	Northing	Elevation
East	292282.3199	3173197.2537	32.71
West	291952.3232	3173285.8438	30.23

SCALE 1 : 7,500

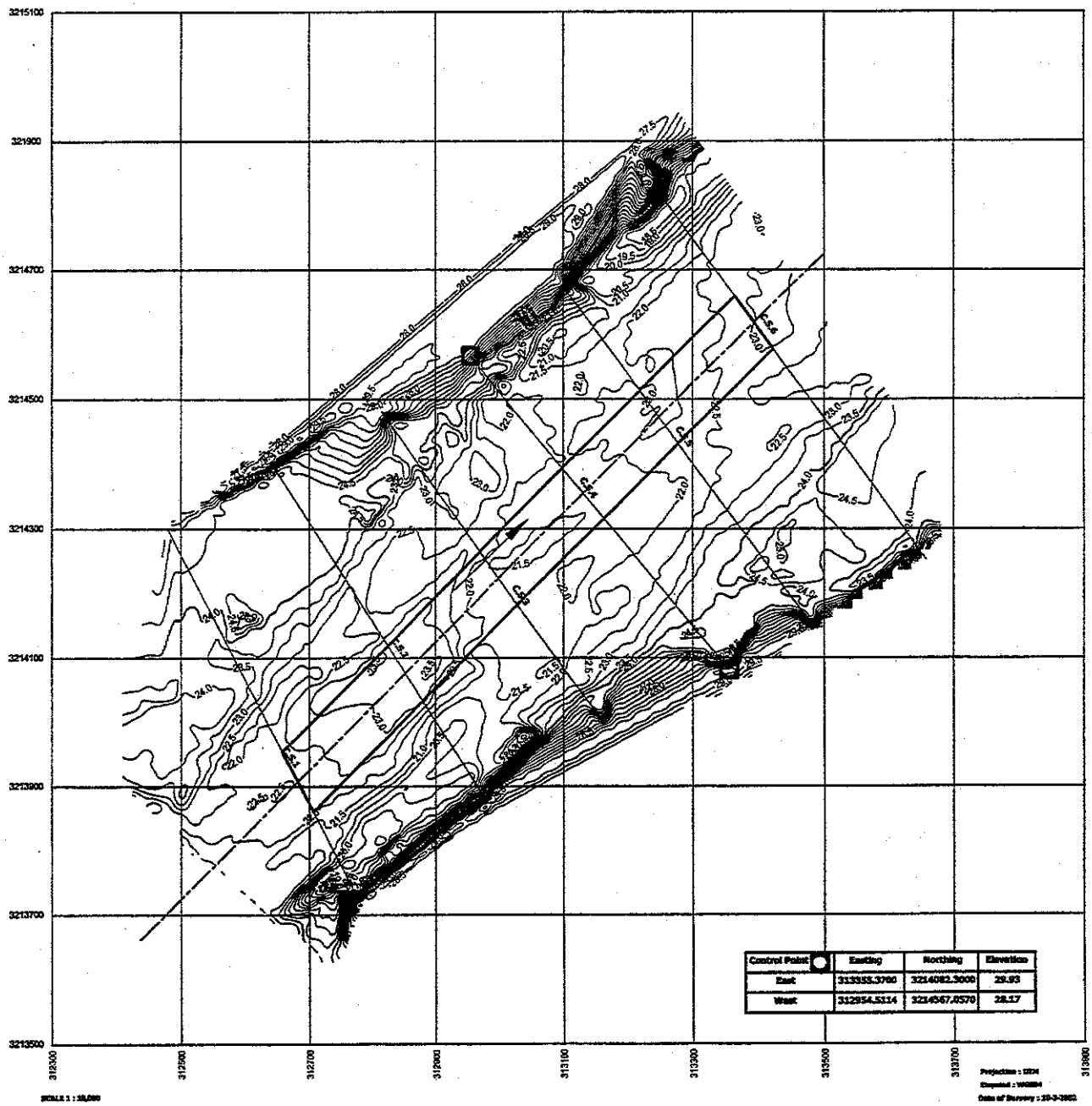
Projection : UTM
Elepsiod : WGS84
Date of Survery : 7-3-2002


S23 : ZAWIAT EL-GODAMY SITE
(Km. 163.580 From EL-Roda)
R=2000
R=4000
R=1000
Control Point
Easting
Northing
Elevation
East
294490.7317
3178540.8432
30.58
West
293615.2438
3176666.1941
33.71
Projection : UTM
Ellipsoid : WGS84
Date of Survey : 6-3-2002
SCALE 1 : 5,000

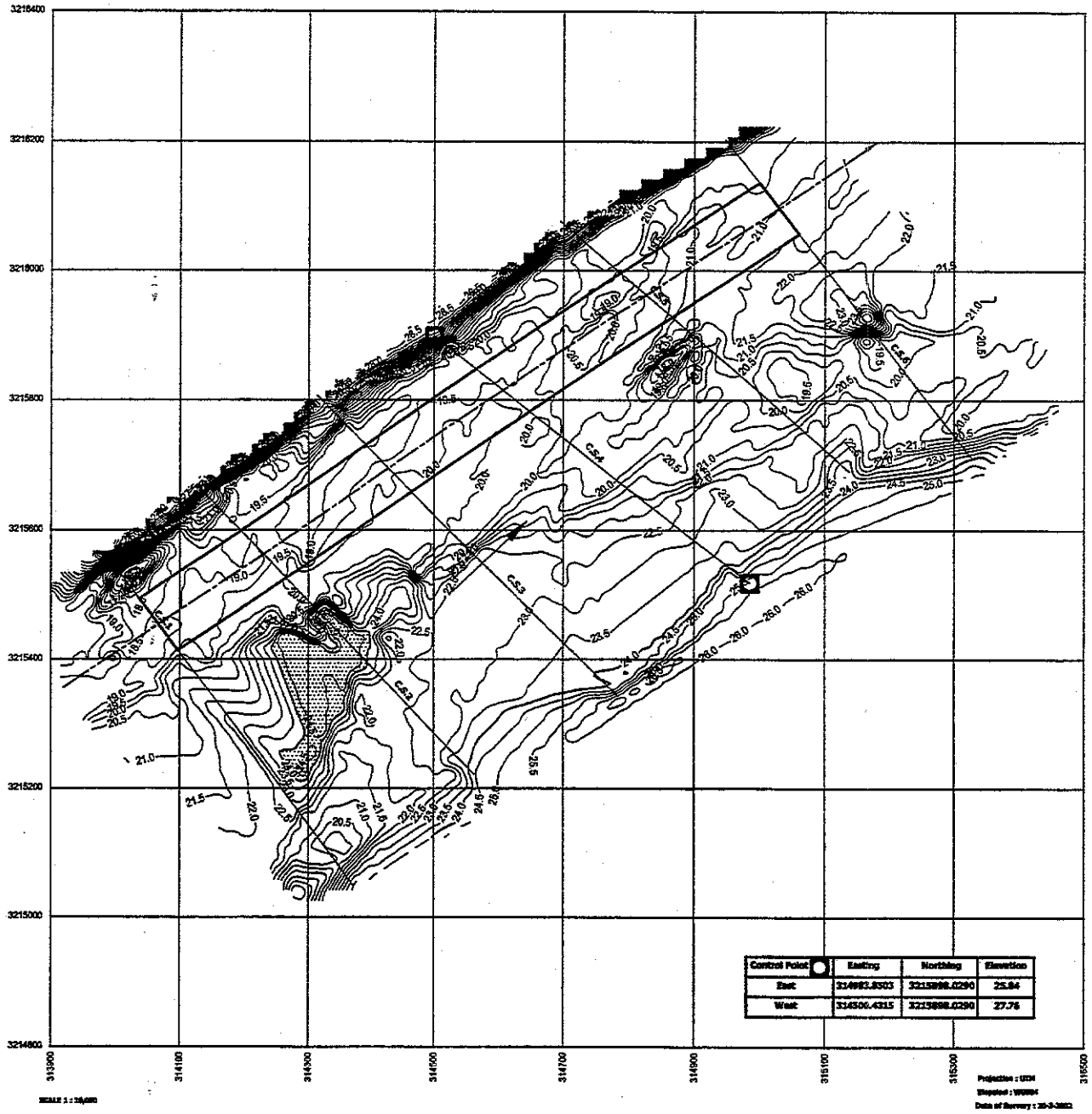
S24 : MAHMOUD EWEAS SITE
(Km. 134.050 From EL-Roda)



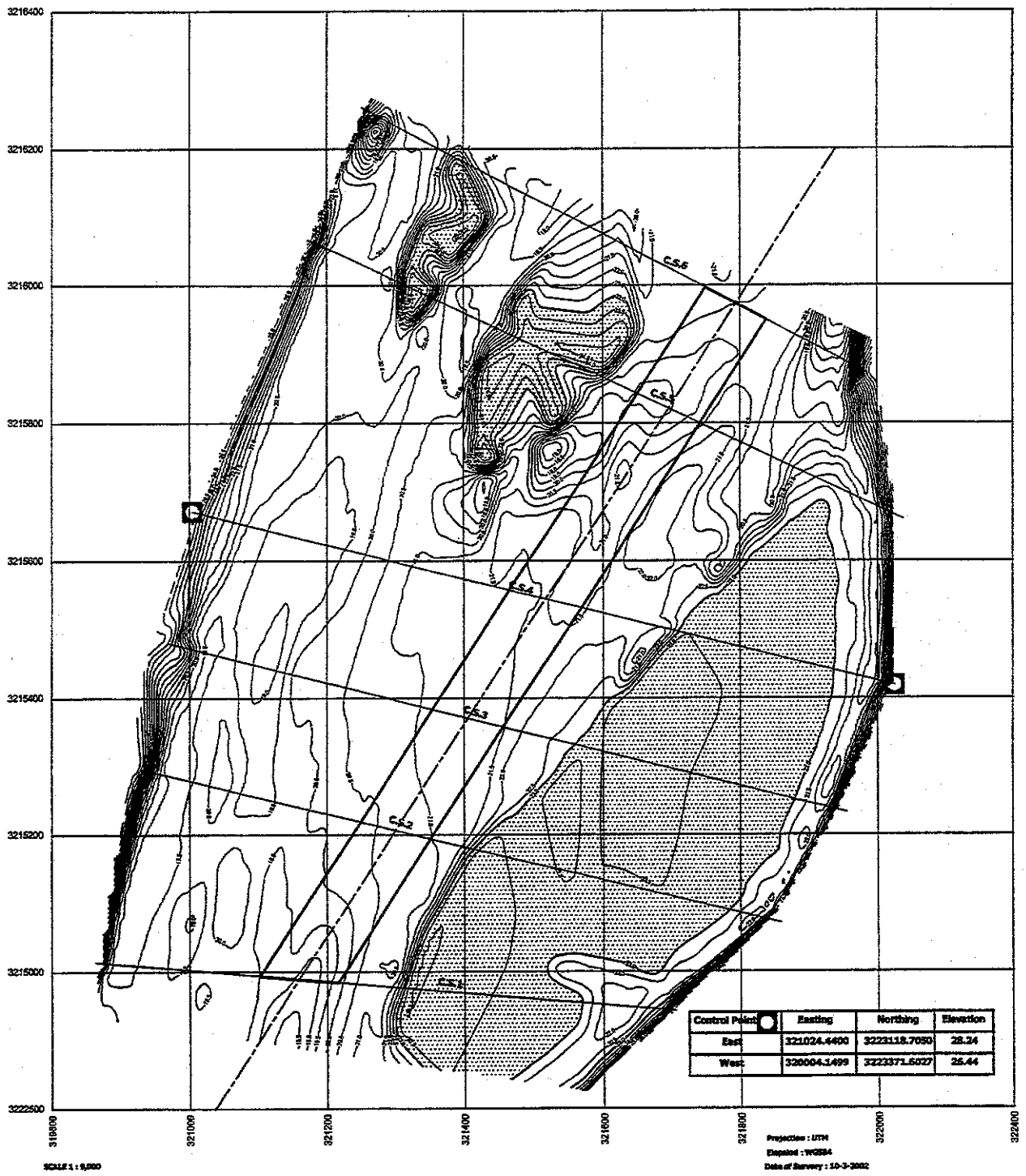
S25 : EL-DAWABA SITE
(Km. 121.120 From EL-Roda)



S26 : BENI SWEEF DRIDGE SITE
(Km. 119.00 From EL-Roda)

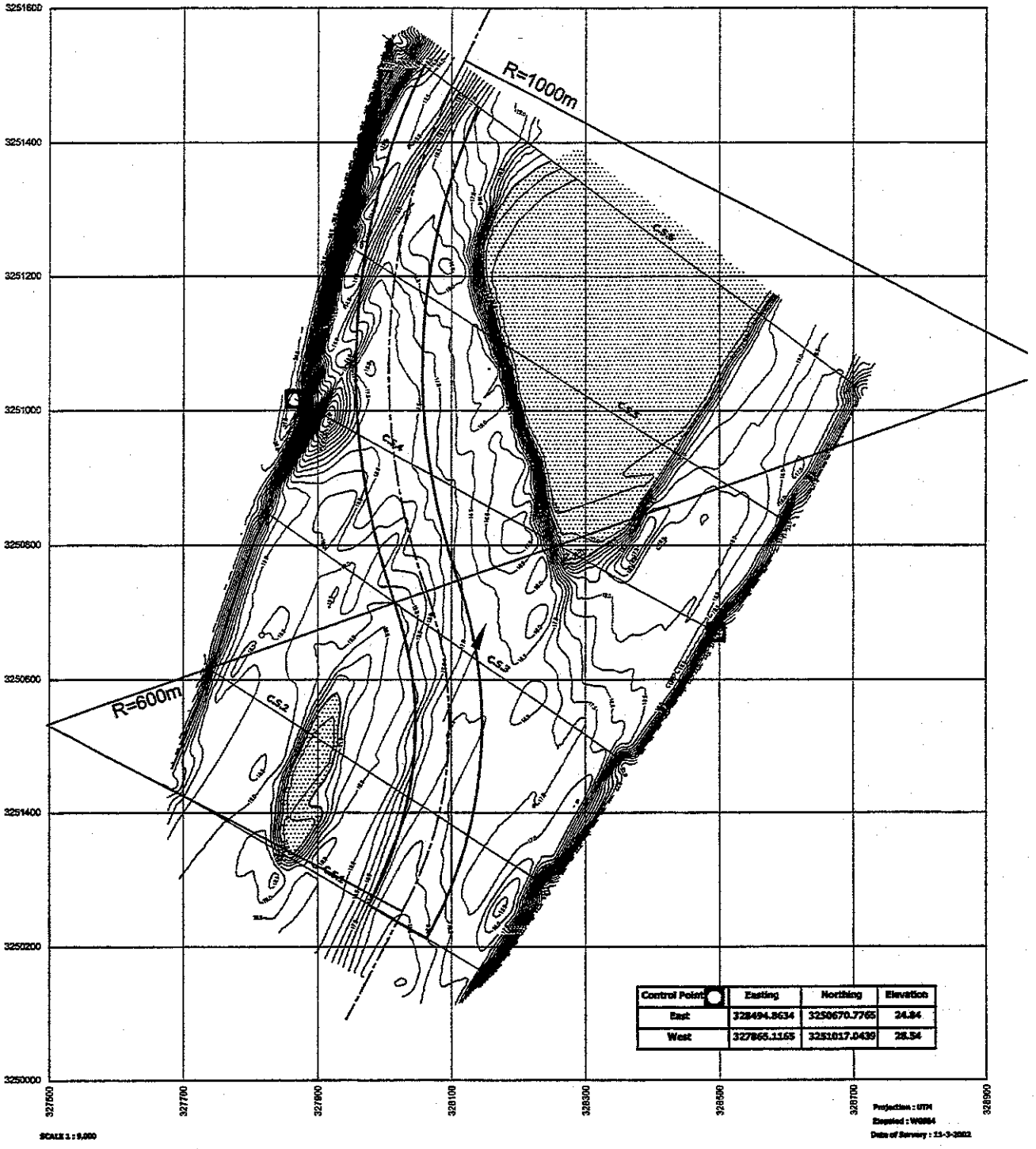


S27 : EL-ALALMA SITE
(Km. 109.150 From EL-Roda)

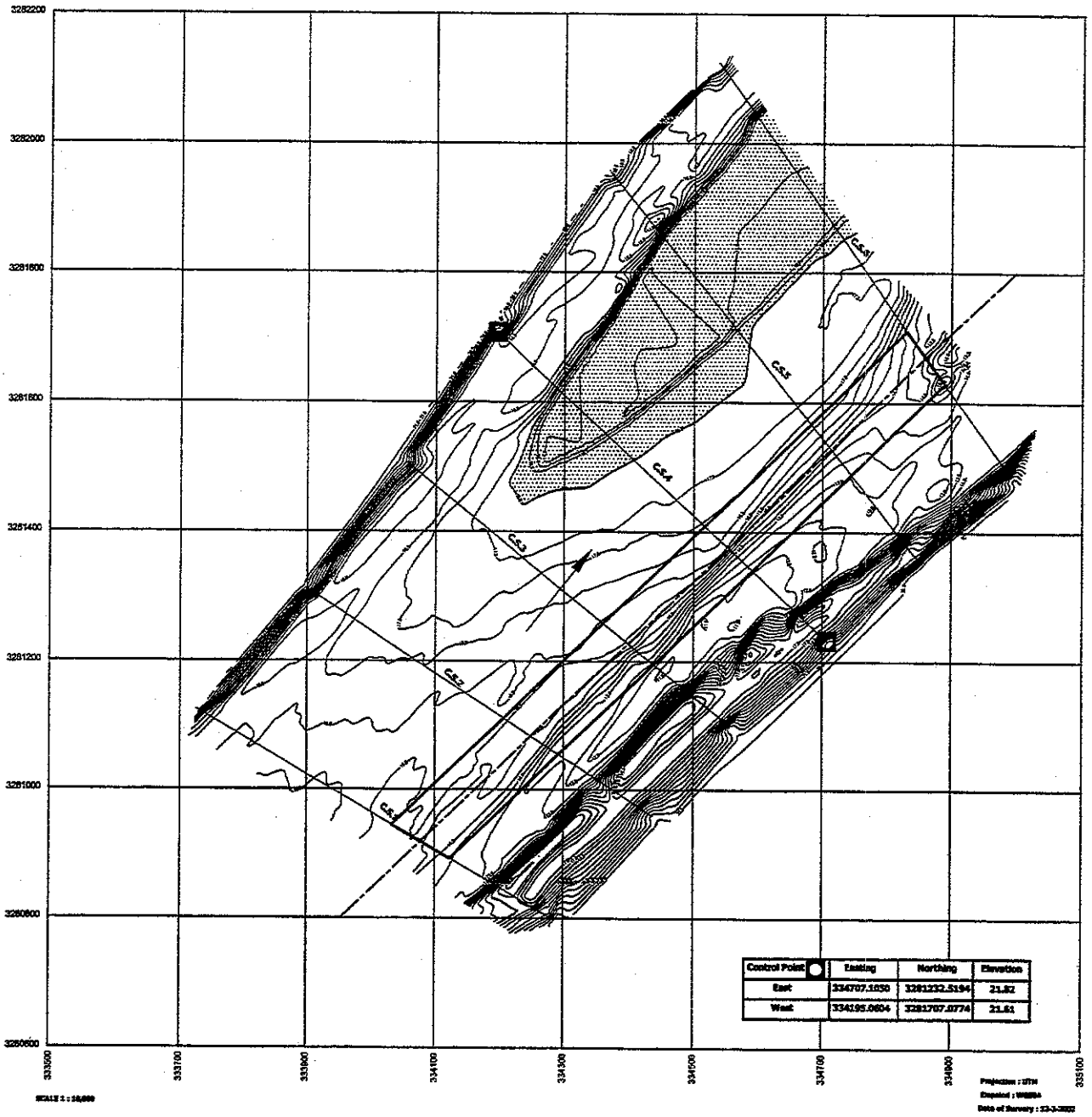


S28 : EL-KOREIMAT SITE
(Km. 89.100 From EL-Roda)

S29 : SOUL SITE
(Km. 79.070 From EL-Roda)

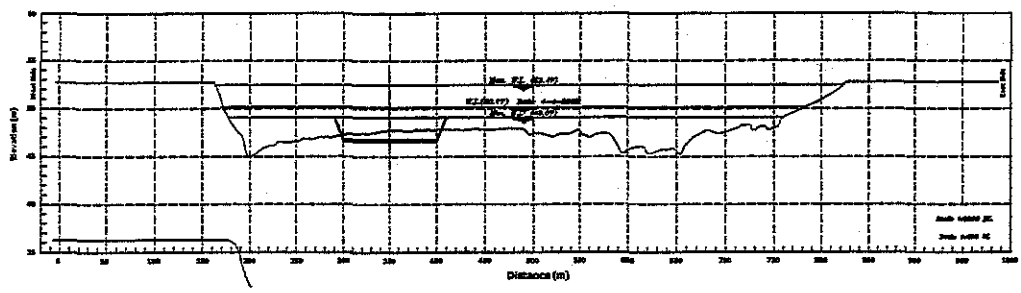


S30 : EL-SAAF SITE
(Km. 44.000 From EL-Roda)

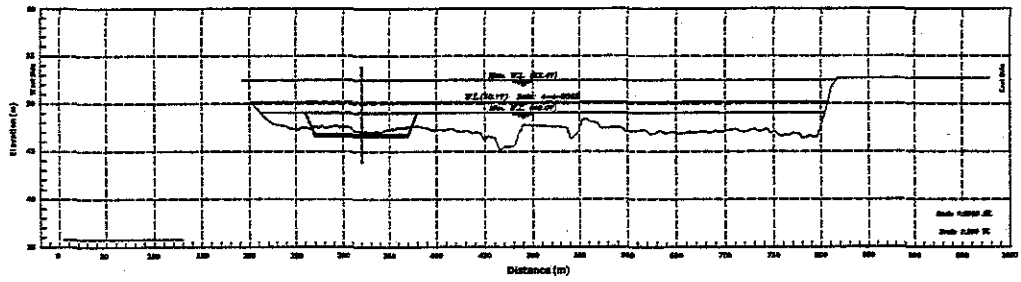


S01 : EL-NEKHEELA SITE (Km. 411.000 From EL-Roda)

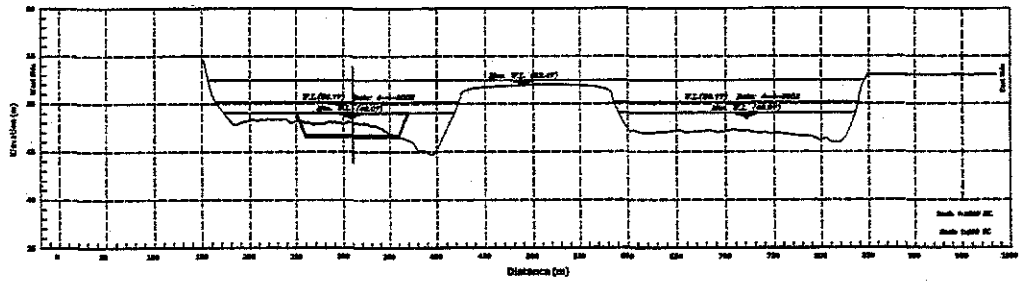
Cross Section No. 1 (411.708 Km)



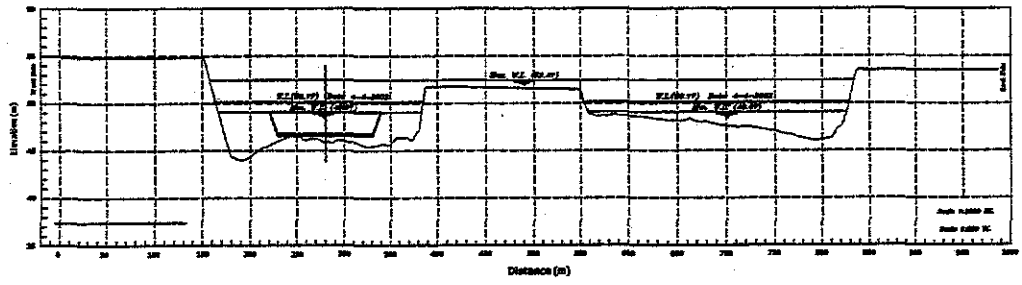
Cross Section No. 2 (411.404 Km)



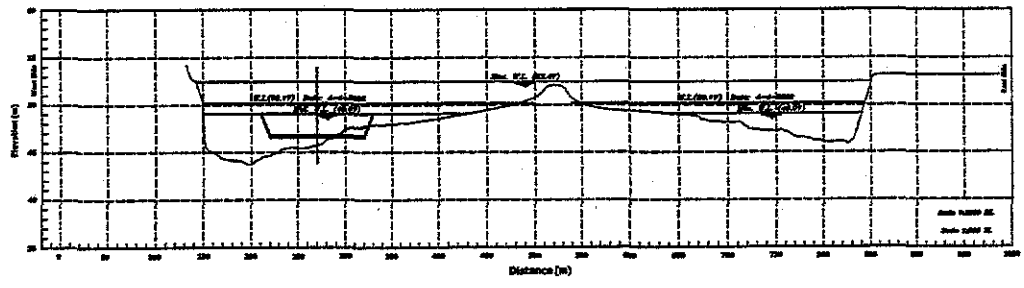
Cross Section No. 3 (411.204 Km)



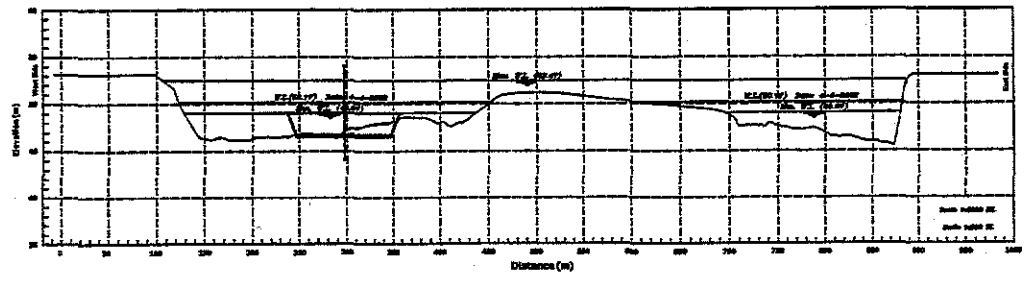
Cross Section No. 4 (411.000 Km)



Cross Section No. 5 (410.767 Km)

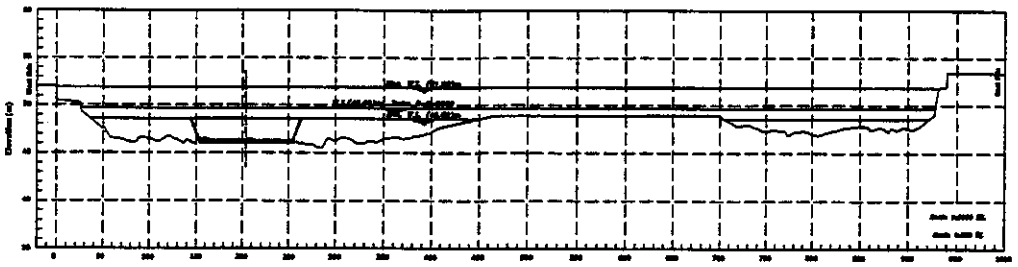


Cross Section No. 6 (410.553 Km)

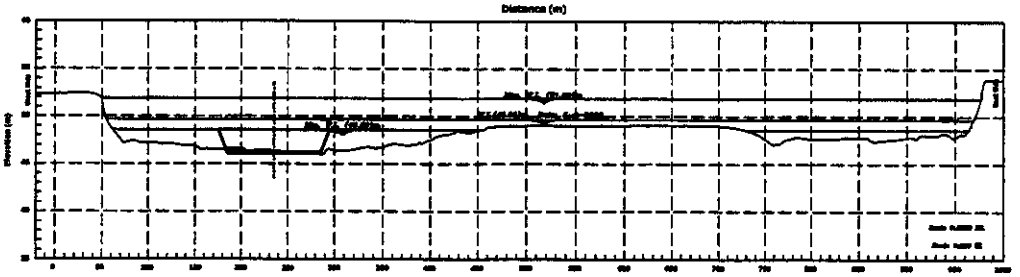


S02 : SAKOUR SITE (Km. 402.000 From EL-Roda)

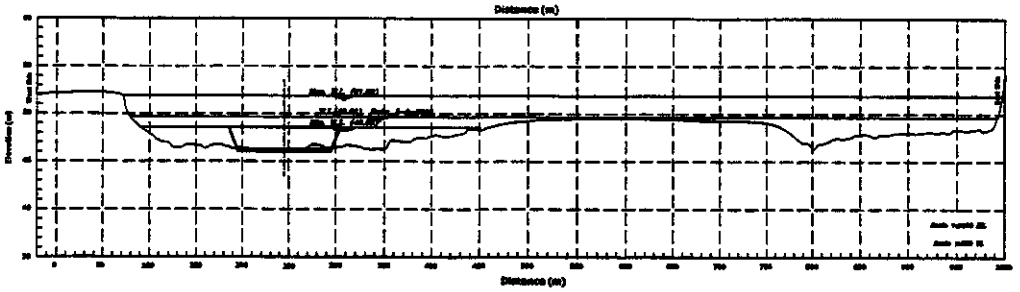
Cross Section No. 1 (402.553 Km)



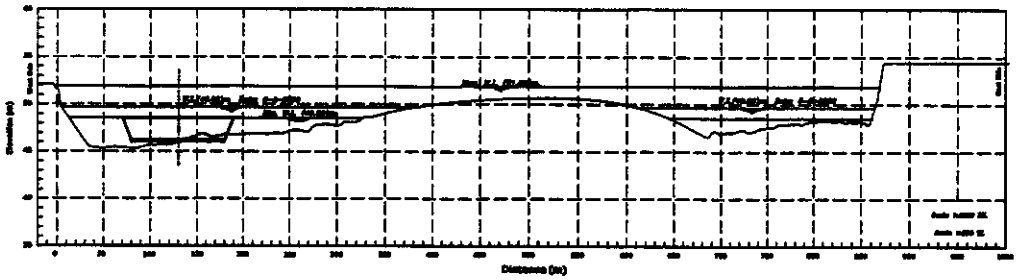
Cross Section No. 2 (402.307 Km)



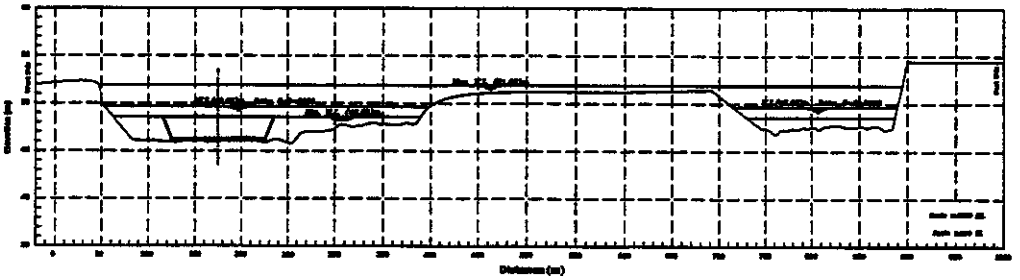
Cross Section No. 3 (402.164 Km)



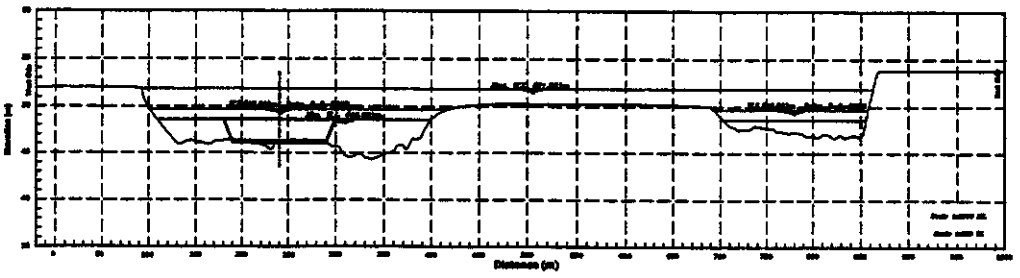
Cross Section No. 4 (402.000 Km)



Cross Section No. 5 (401.815 Km)

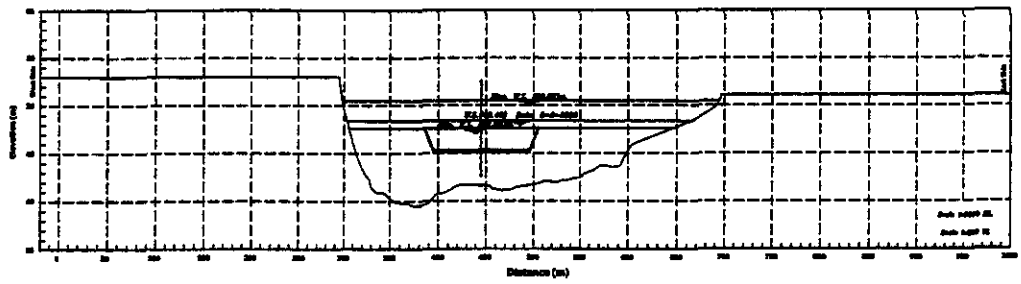


Cross Section No. 6 (401.549 Km)

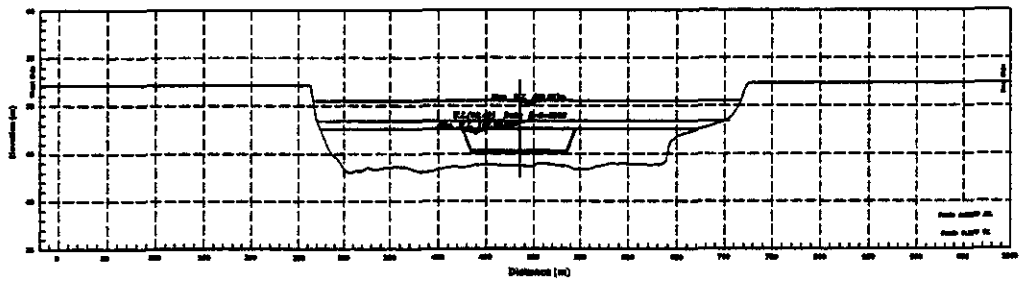


S03 : ASSUIT LOCK SITE (Km. 382.000 From EL-Roda)

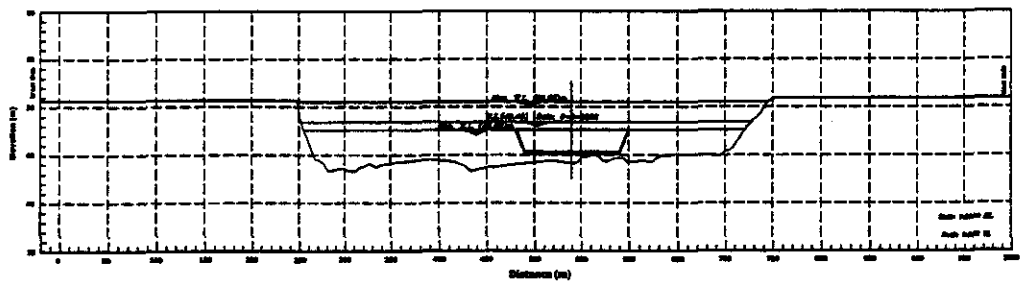
Cross Section No. 1 (382.723 Km)



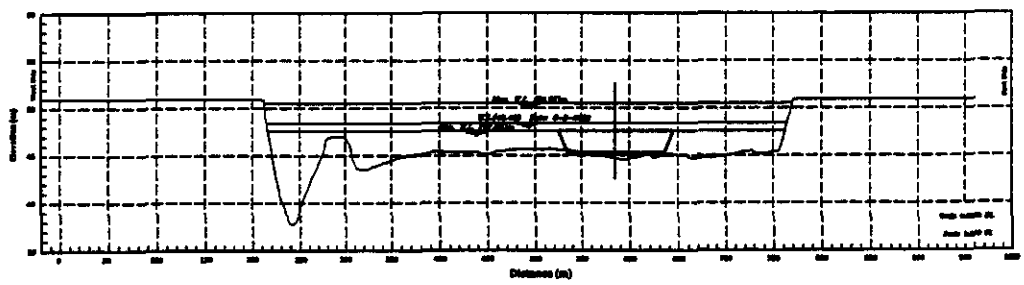
Cross Section No. 2 (382.100 Km)



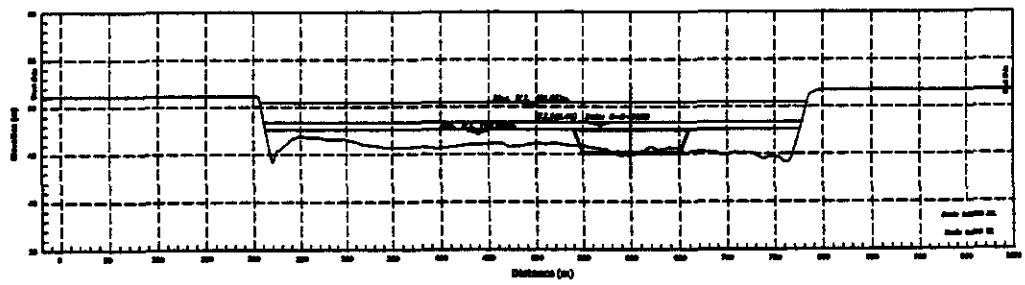
Cross Section No. 3 (382.000 Km)



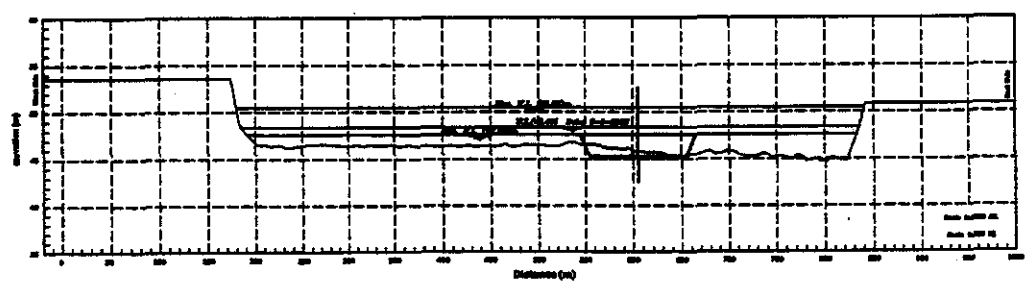
Cross Section No. 4 (382.700 Km)



Cross Section No. 5 (382.800 Km)

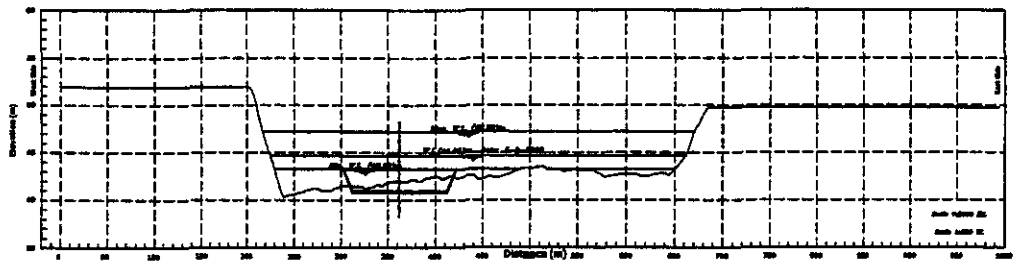


Cross Section No. 6 (381.841 Km)

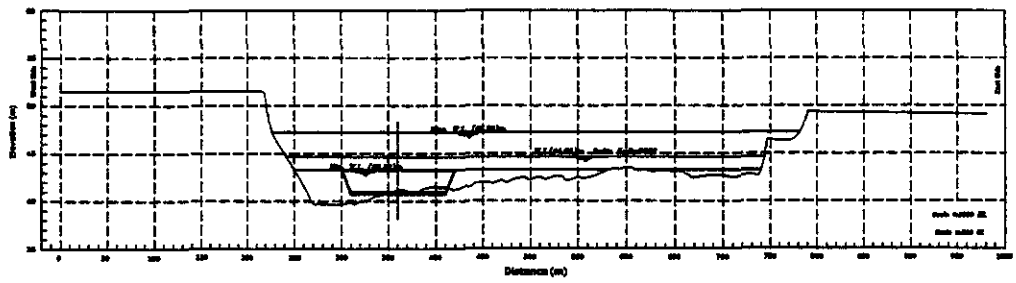


S04 : EL-TAWABERIA SITE (Km. 376.000 From EL-Roda)

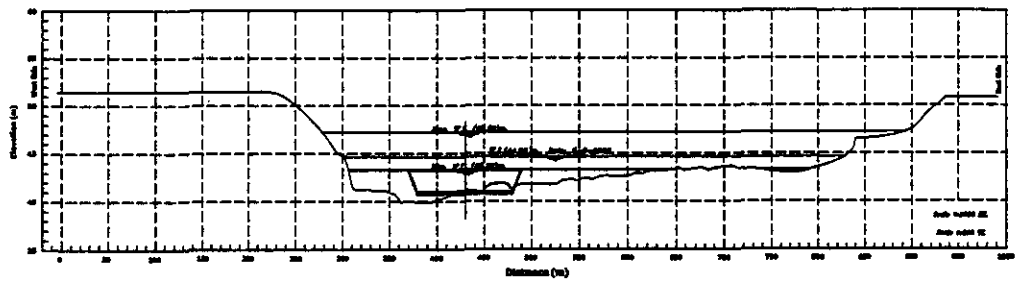
Cross Section No. 1 (376.669 Km)



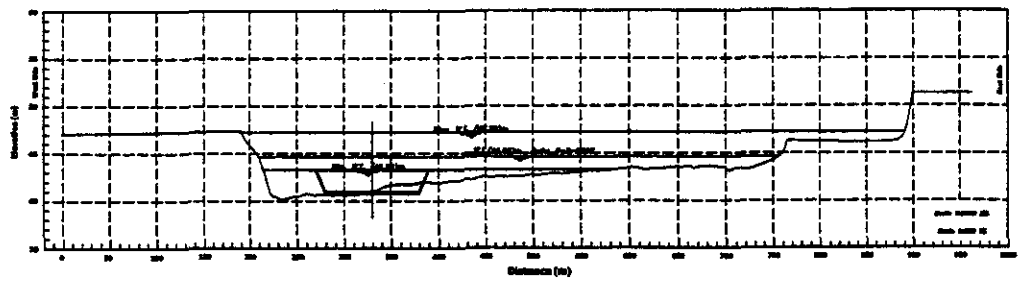
Cross Section No. 2 (376.337 Km)



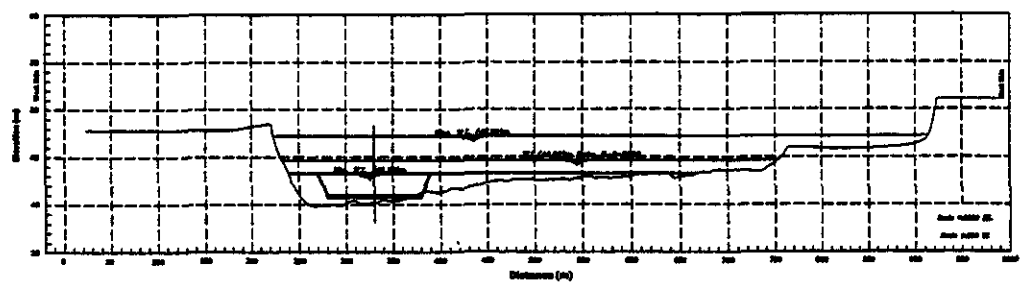
Cross Section No. 3 (376.202 Km)



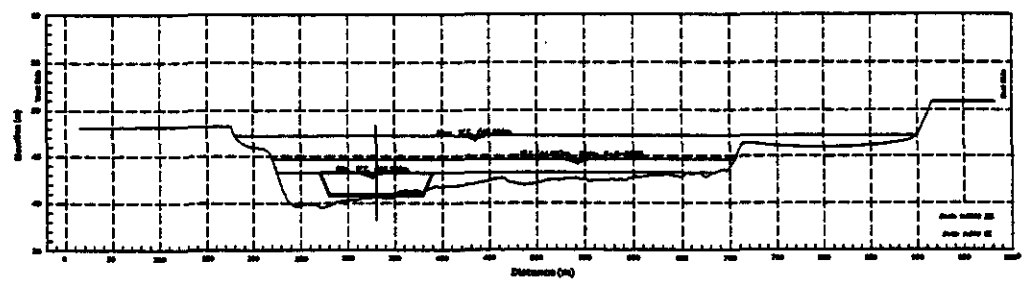
Cross Section No. 4 (376.000 Km)



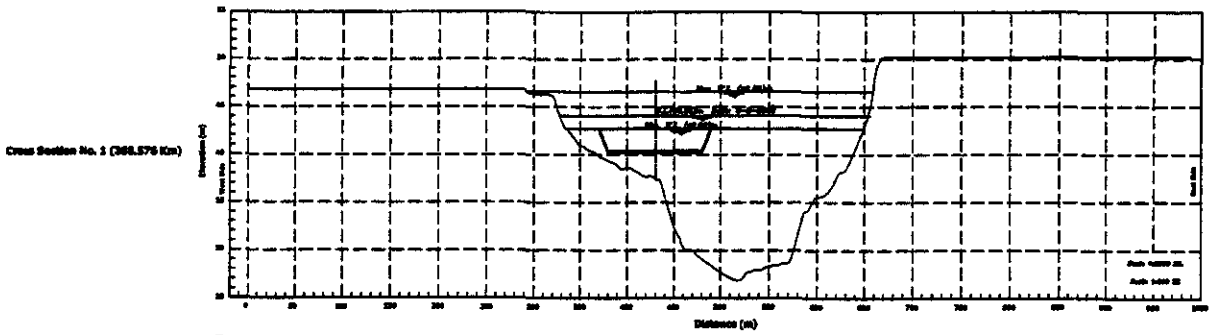
Cross Section No. 5 (375.832 Km)

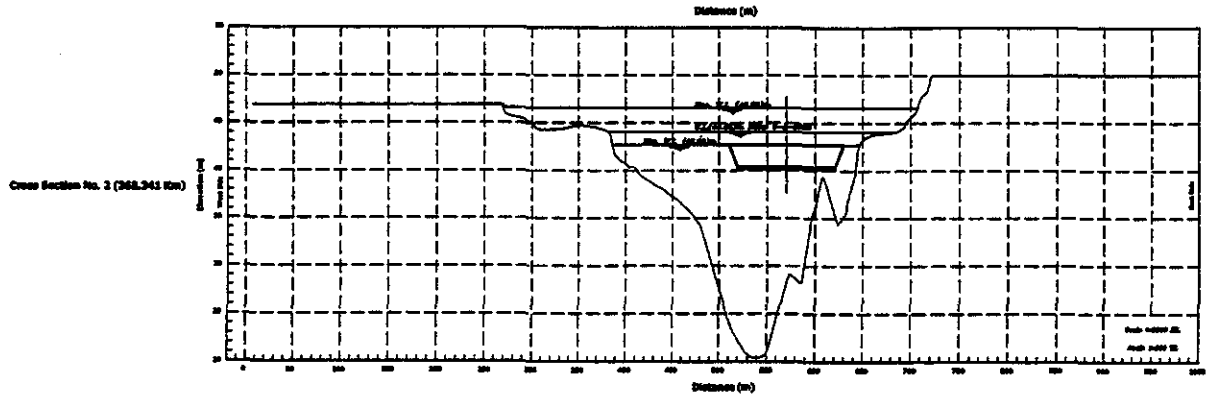


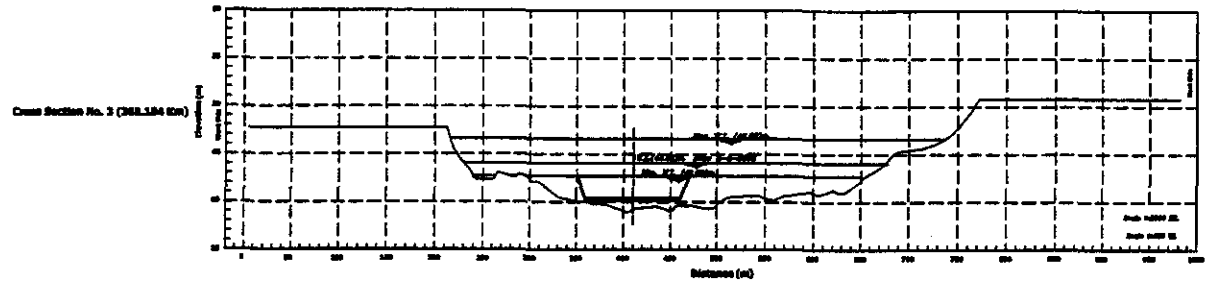
Cross Section No. 6 (375.595 Km)

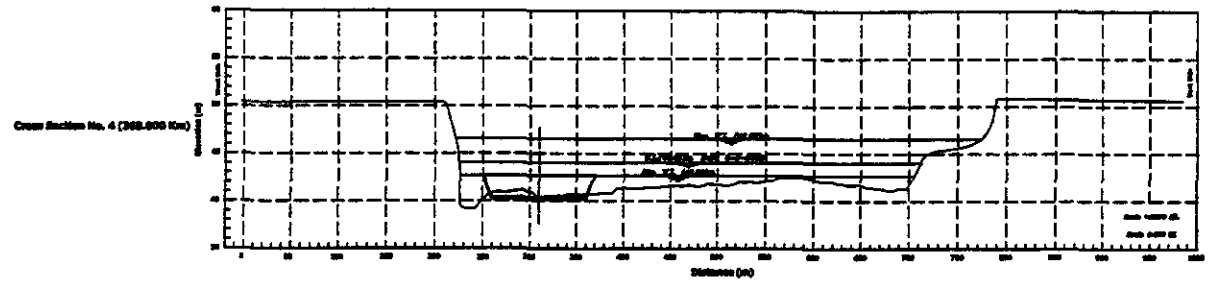


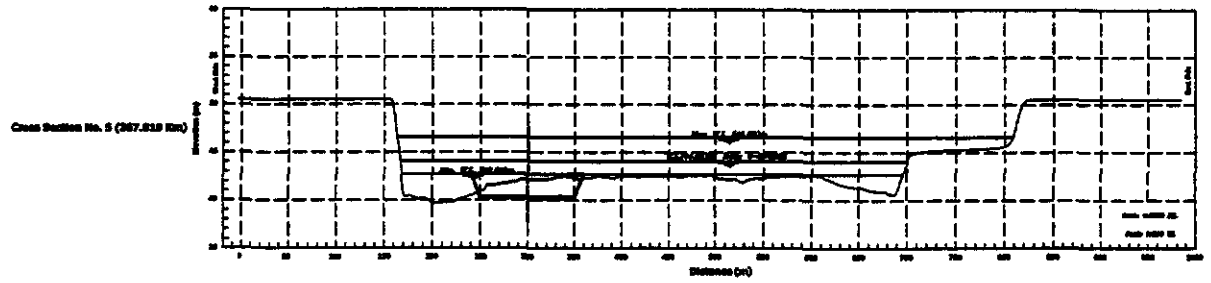
S05 : BAHEEG ISLAND SITE (Km. 368.000 From EL-Roda)

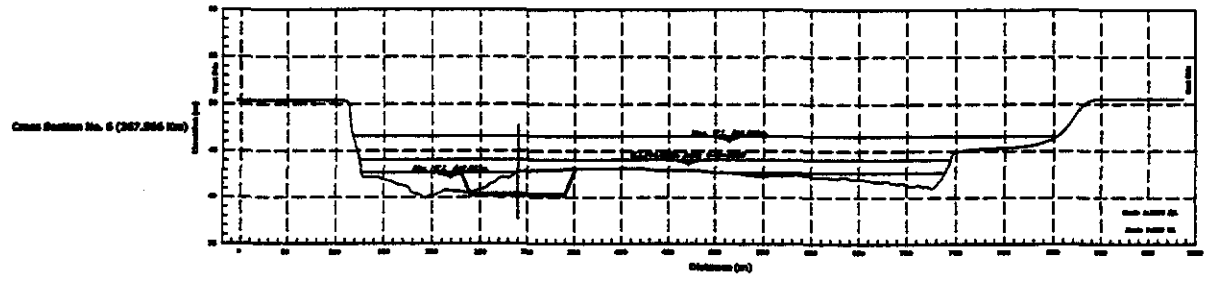






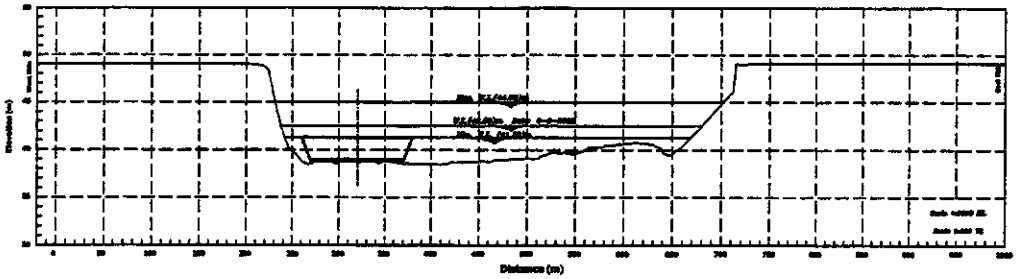




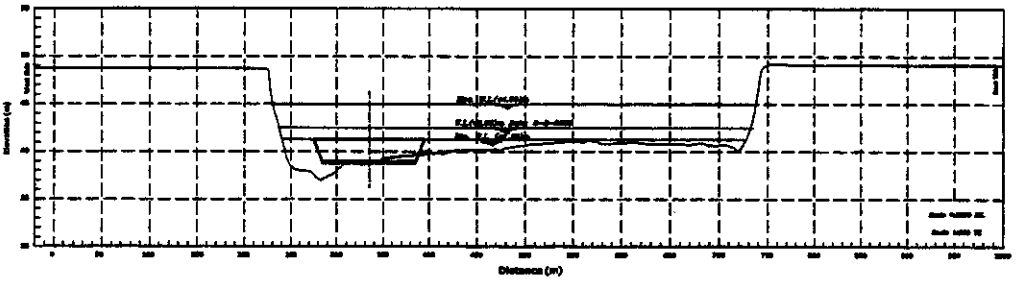


S06: HASSAN ATIAH SITE (Km. 348.000 From EL-Roda)

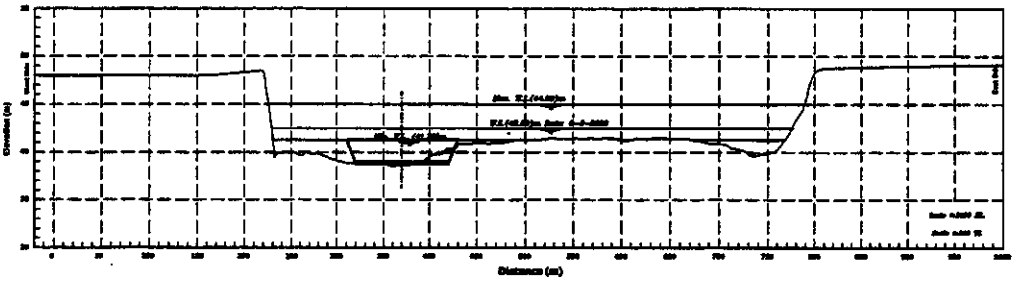
Cross Section No. 1 (348.846 Km)



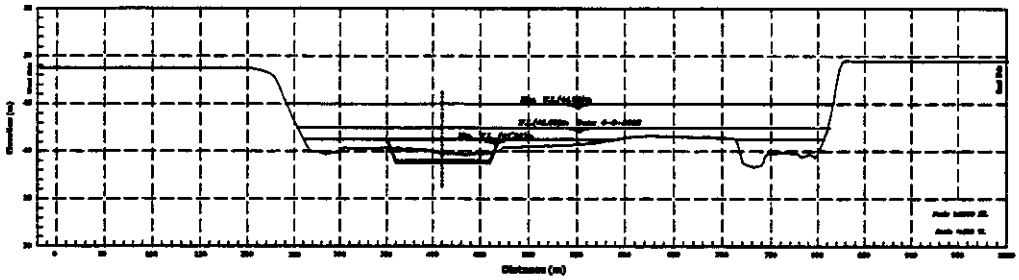
Cross Section No. 2 (348.381 Km)



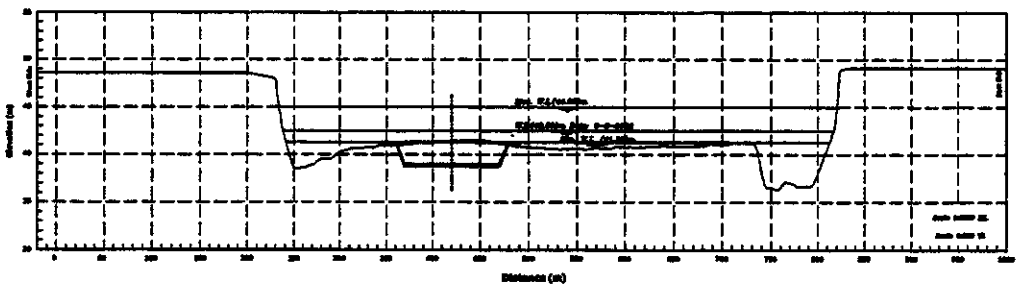
Cross Section No. 3 (348.177 Km)



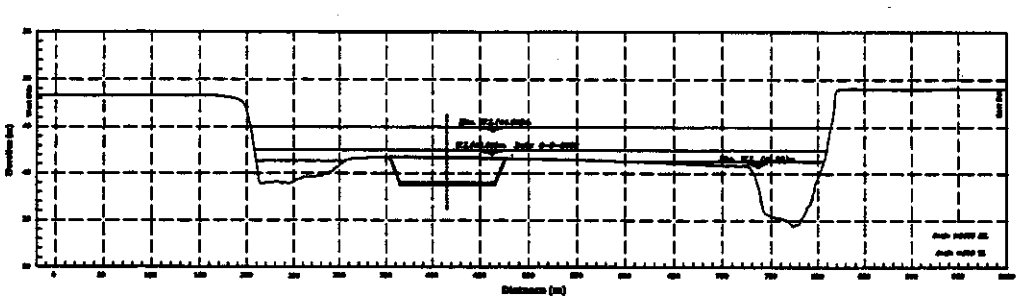
Cross Section No. 4 (348.000 Km)



Cross Section No. 5 (347.795 Km)

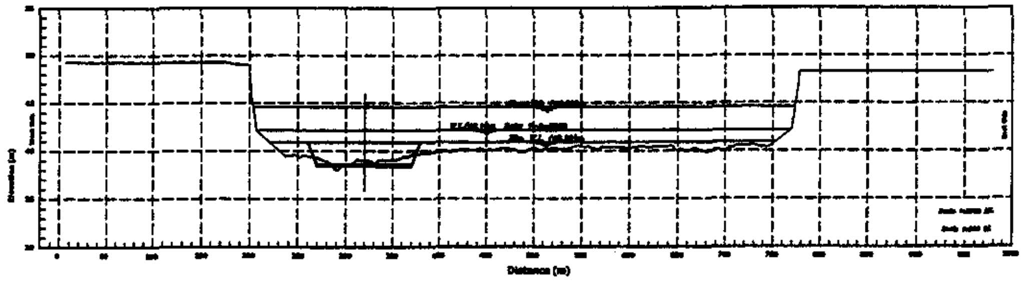


Cross Section No. 6 (347.604 Km)

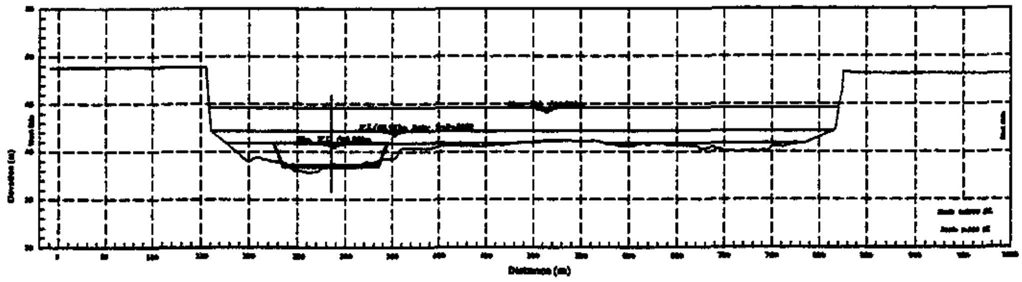


S07 : BENI SHOUKEAR SITE (Km. 343.000 From EL-Roda)

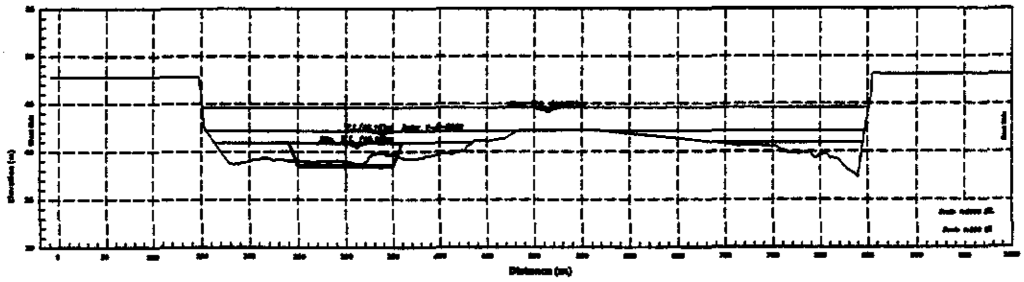
Cross Section No. 1 (343.622 Km)



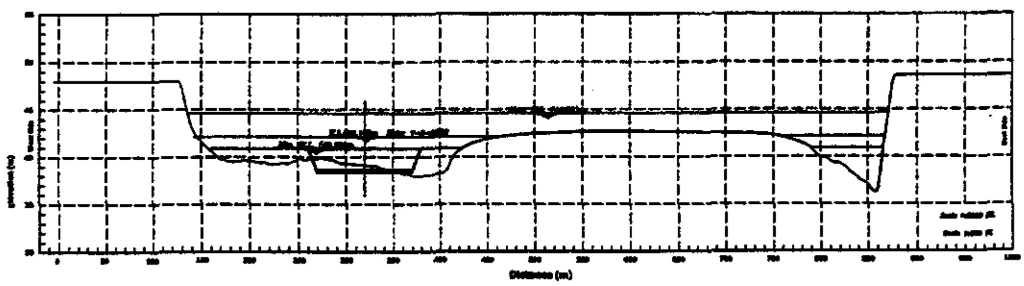
Cross Section No. 2 (343.399 Km)



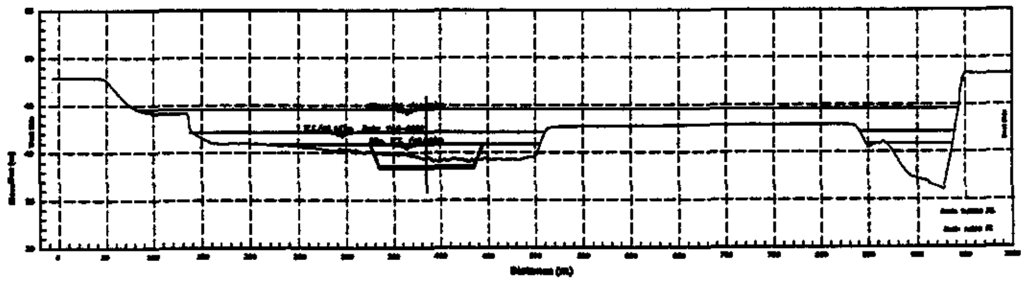
Cross Section No. 3 (343.184 Km)



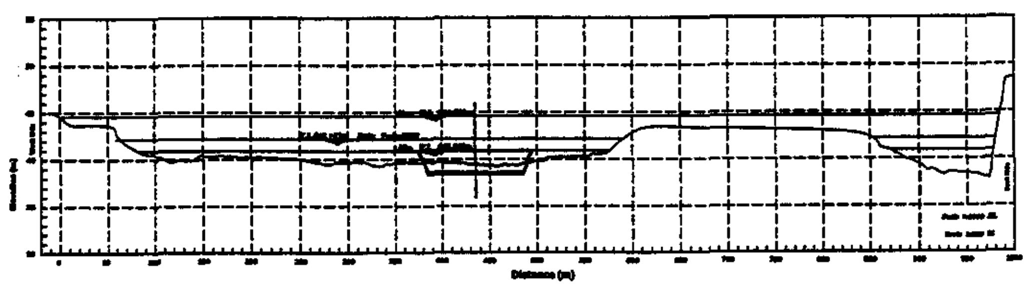
Cross Section No. 4 (342.606Km)



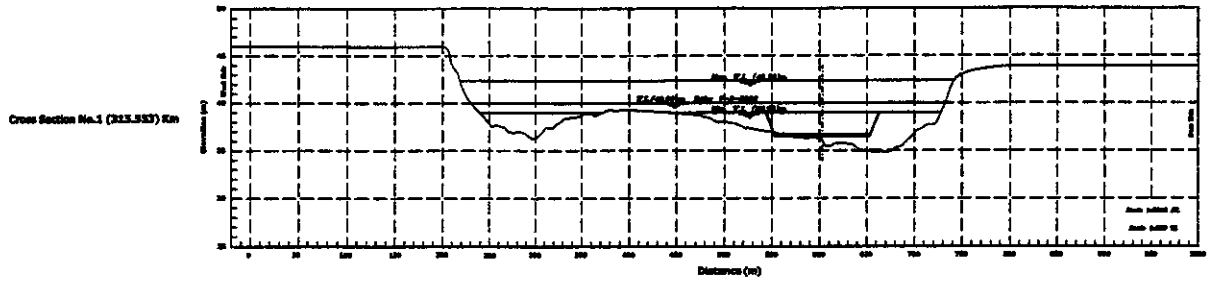
Cross Section No. 5 (342.838 Km)

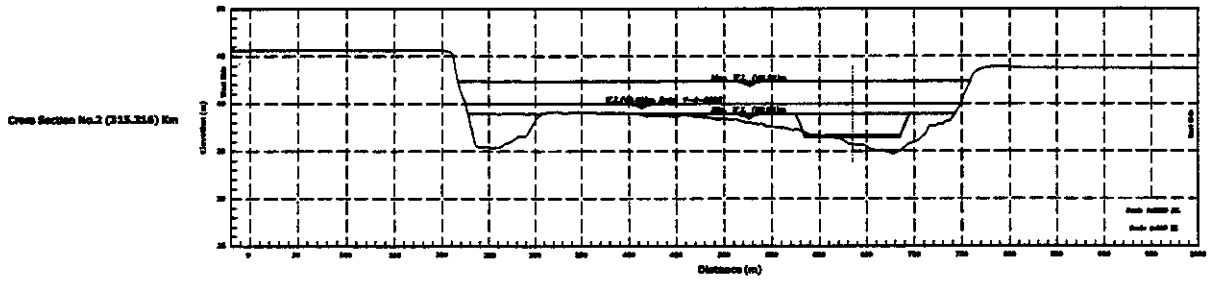


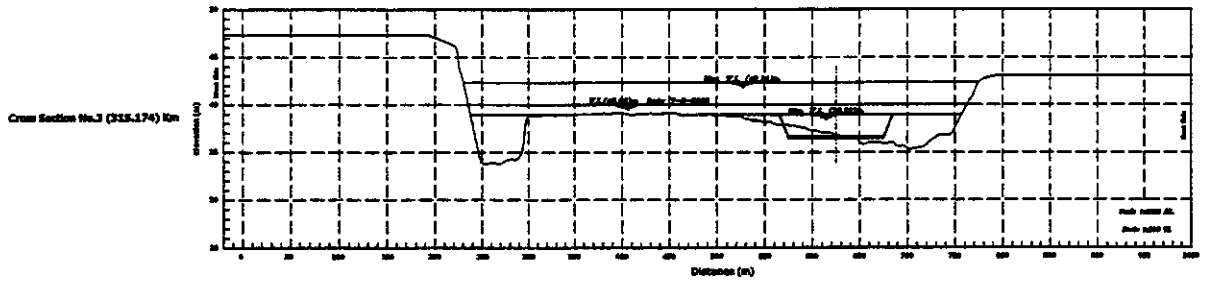
Cross Section No. 6 (342.615 Km)

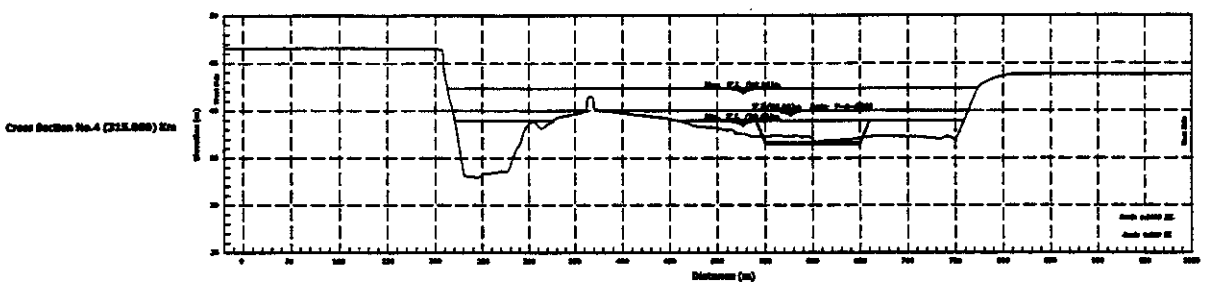


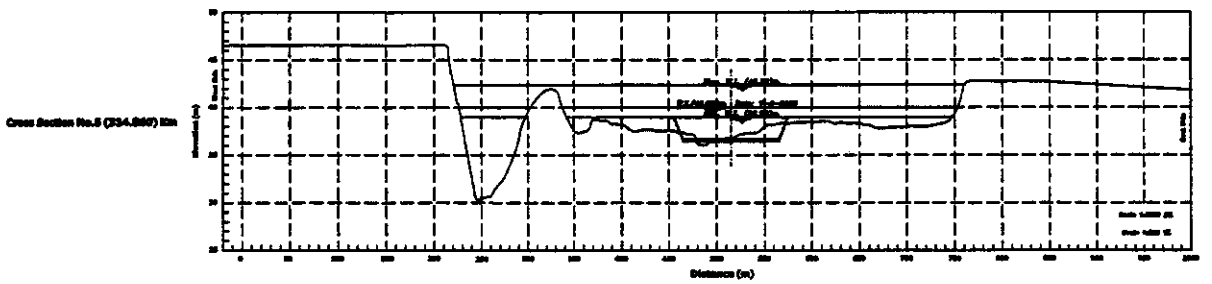
S08 : EL-MANDARAH SITE (Km. 315.000 From EL-Roda)

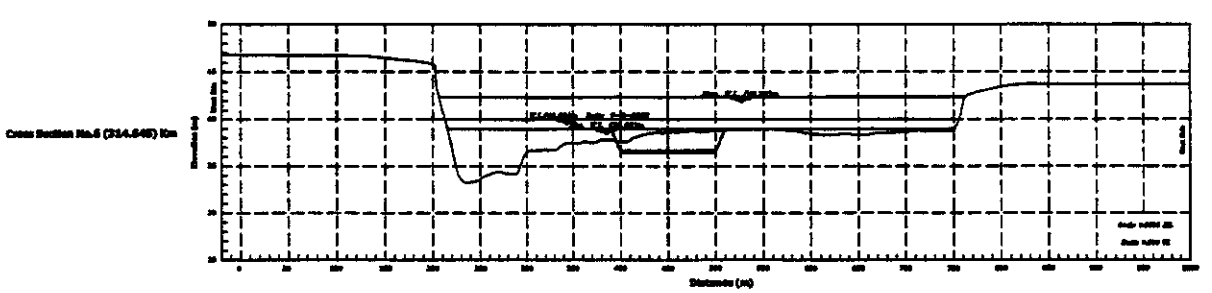






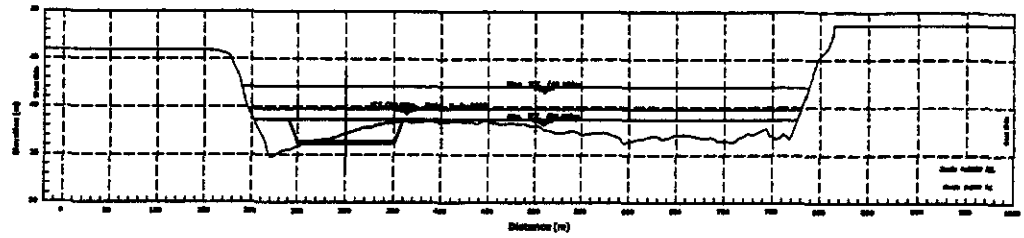




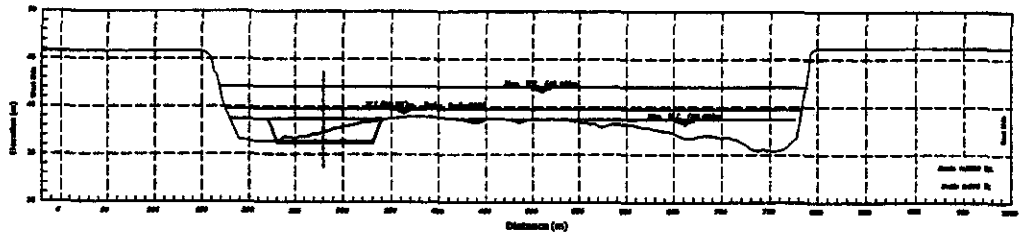


S09 : NAZLET EL-AWAMER SITE (Km. 312.000 From EL-Roda)

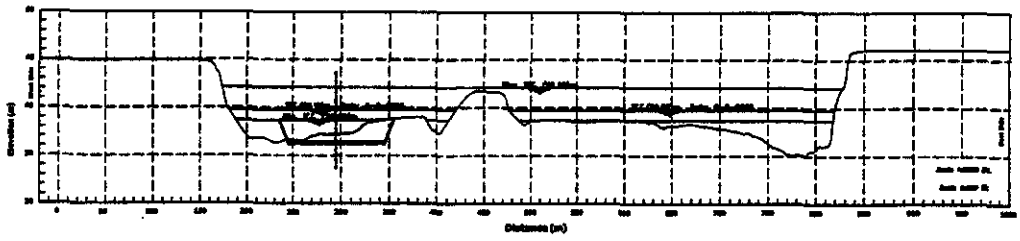
Cross Section No.1 (312.995) Km



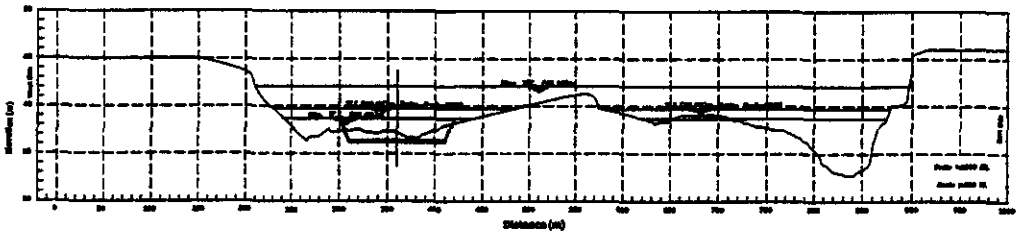
Cross Section No.2 (312.542) Km



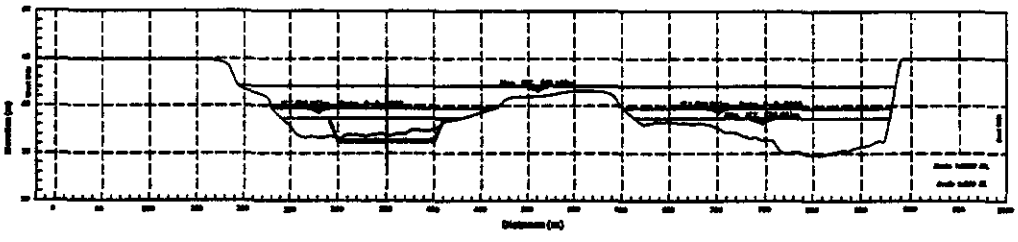
Cross Section No.3 (312.180) Km



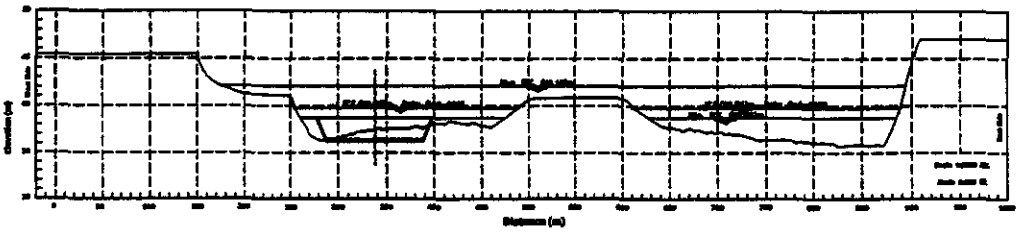
Cross Section No.4 (312.660) Km



Cross Section No.5 (311.848) Km

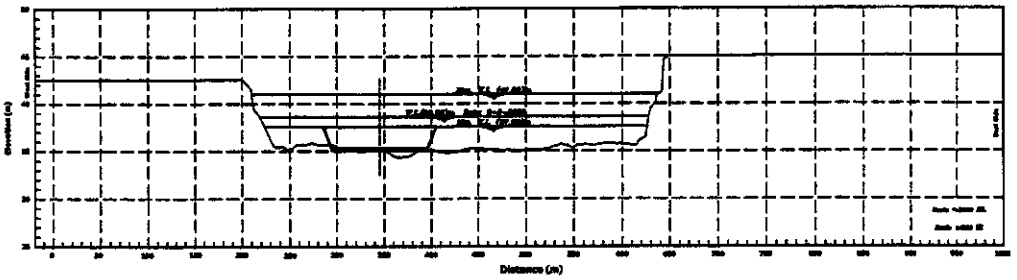


Cross Section No.6 (311.988) Km

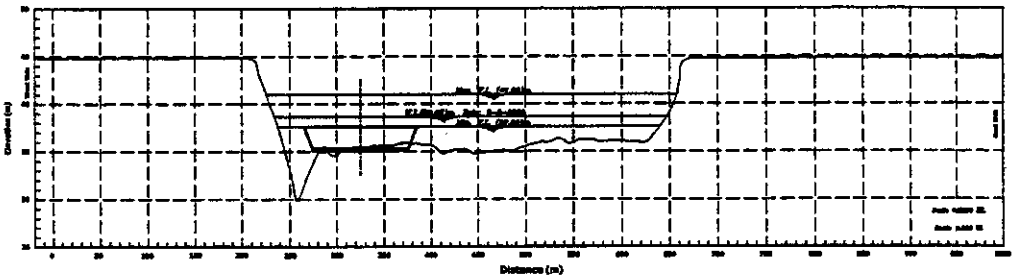


S10 : SAWADA SITE (Km. 299.000 From EL-Roda)

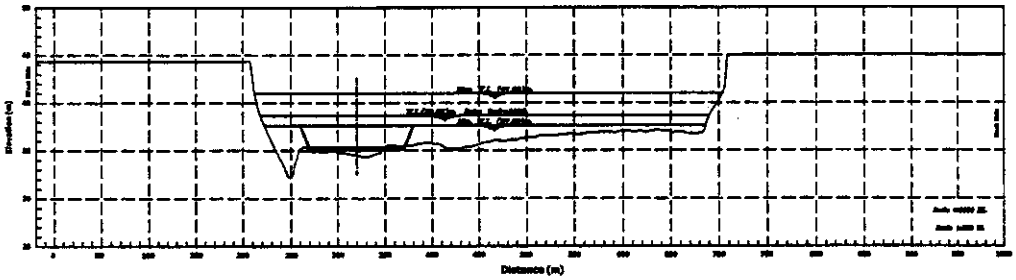
Cross Section No.1 (299.591) Km



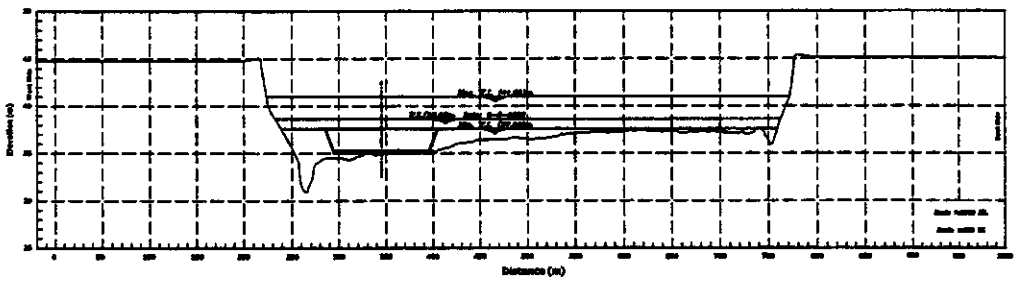
Cross Section No.2 (299.415) Km



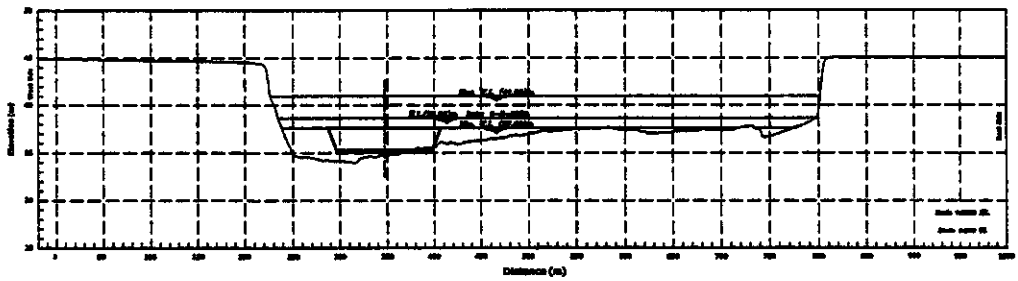
Cross Section No.3 (299.200) Km



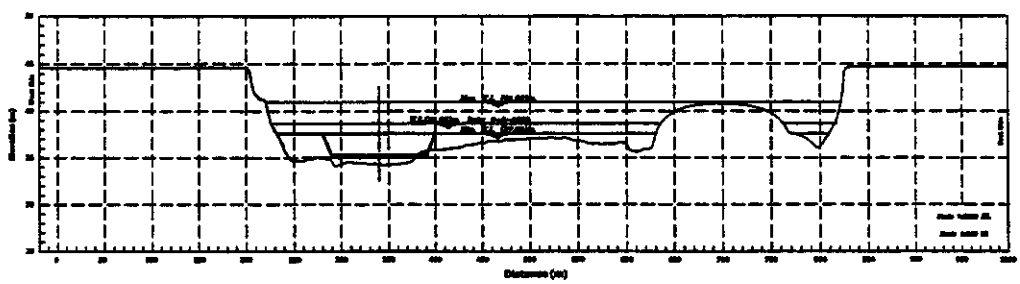
Cross Section No.4 (299.000) Km



Cross Section No.5 (298.839) Km

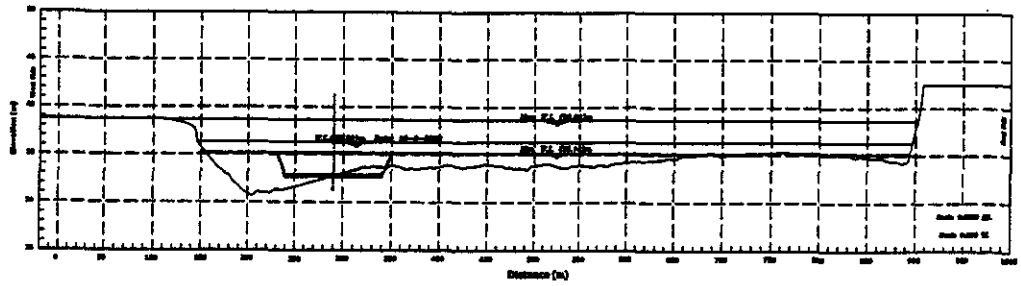


Cross Section No.6 (298.578) Km

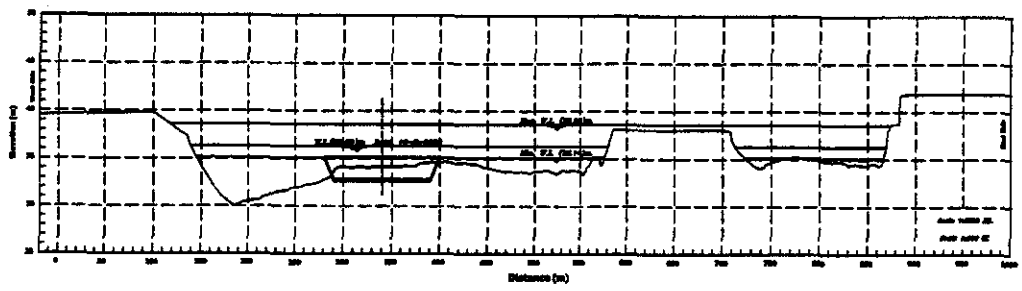


S11 : EL-SHEIKH NEMR ISLAND SITE (Km. 271.000 From EL-Roda)

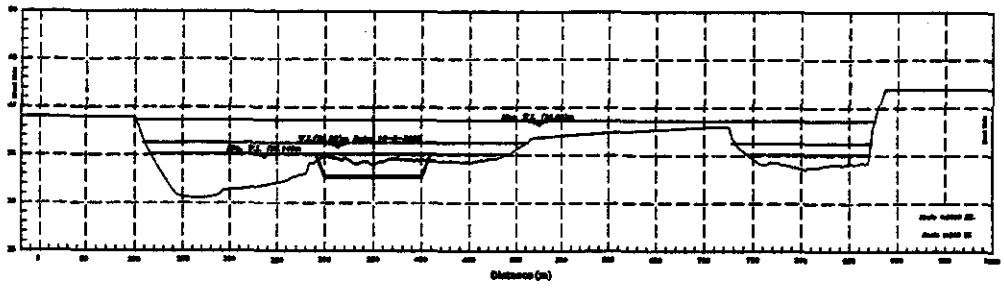
Cross Section No.1 (271.635) Km



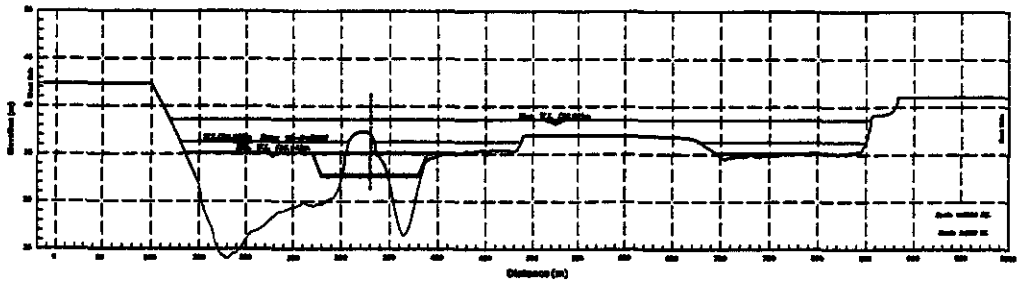
Cross Section No.2 (271.440) Km



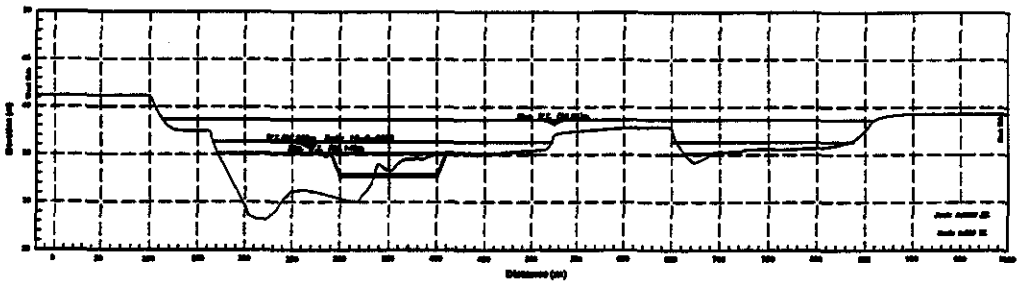
Cross Section No.3 (271.210) Km



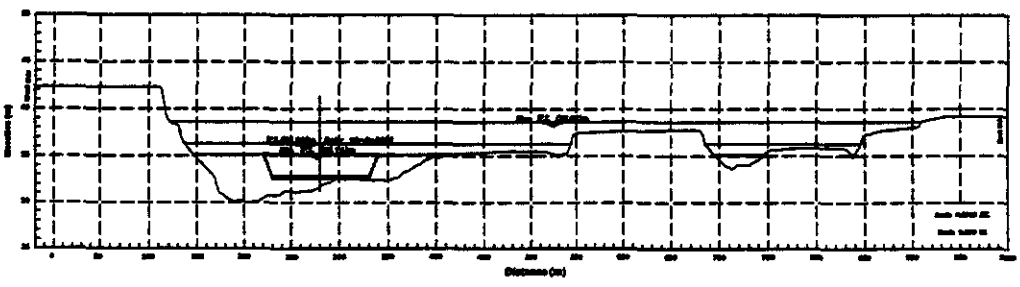
Cross Section No.4 (271.000) Km



Cross Section No.5 (270.780) Km

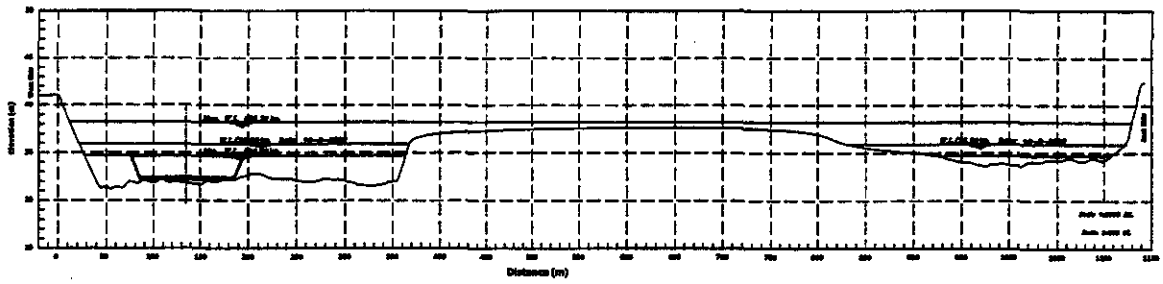


Cross Section No.6 (270.546) Km

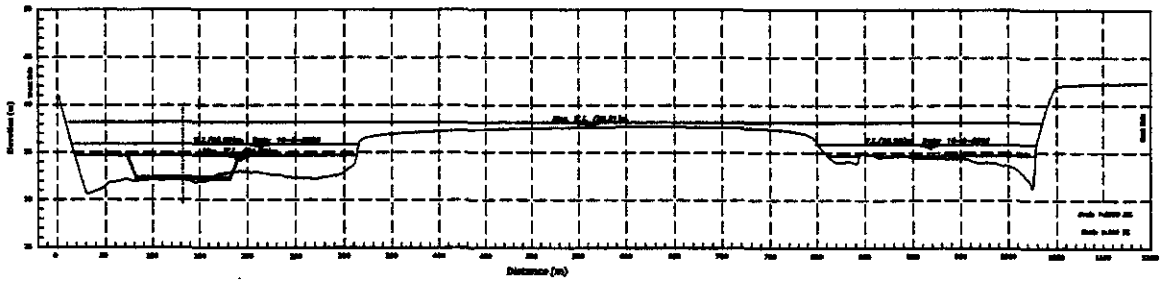


S12 : BNI HASSAN EL-SHOROUK SITE (Km. 266.000 From EL-Roda)

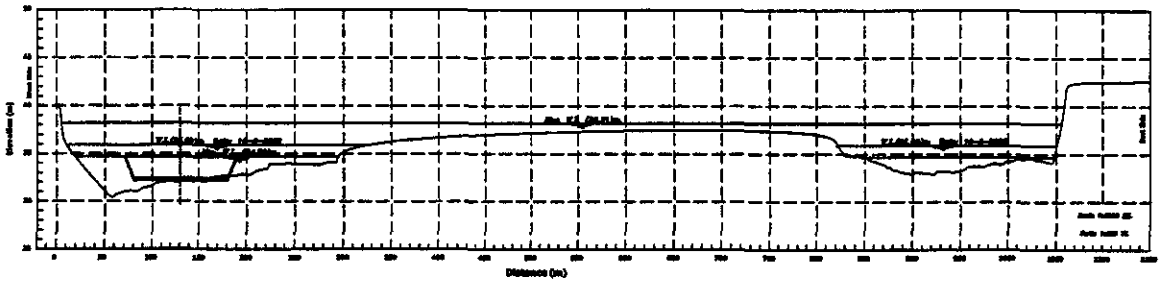
Cross Section No.1 (266.573) Km



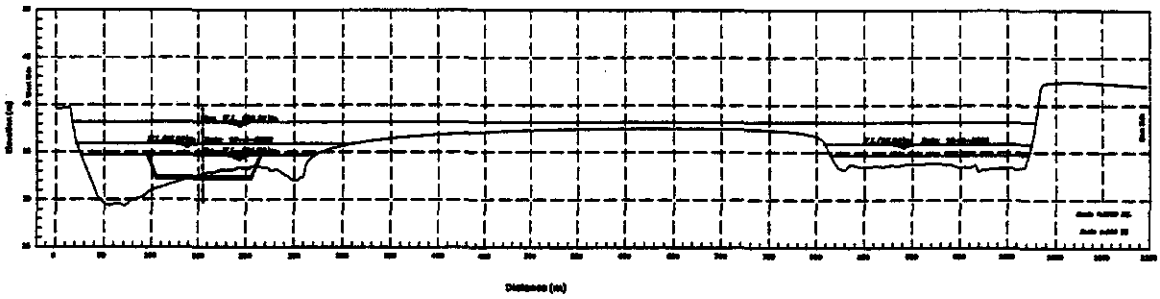
Cross Section No.2 (266.383) Km



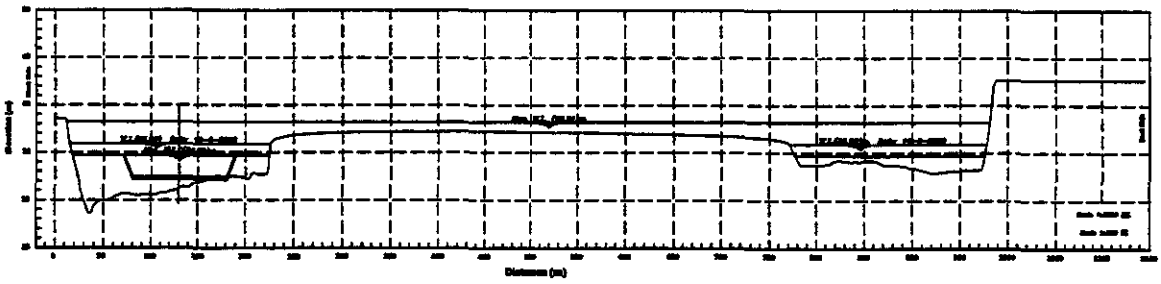
Cross Section No.3 (266.213) Km



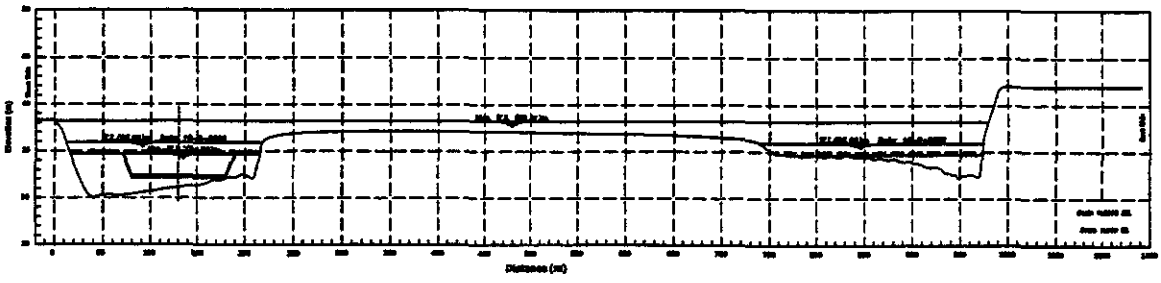
Cross Section No.4 (266.000) Km



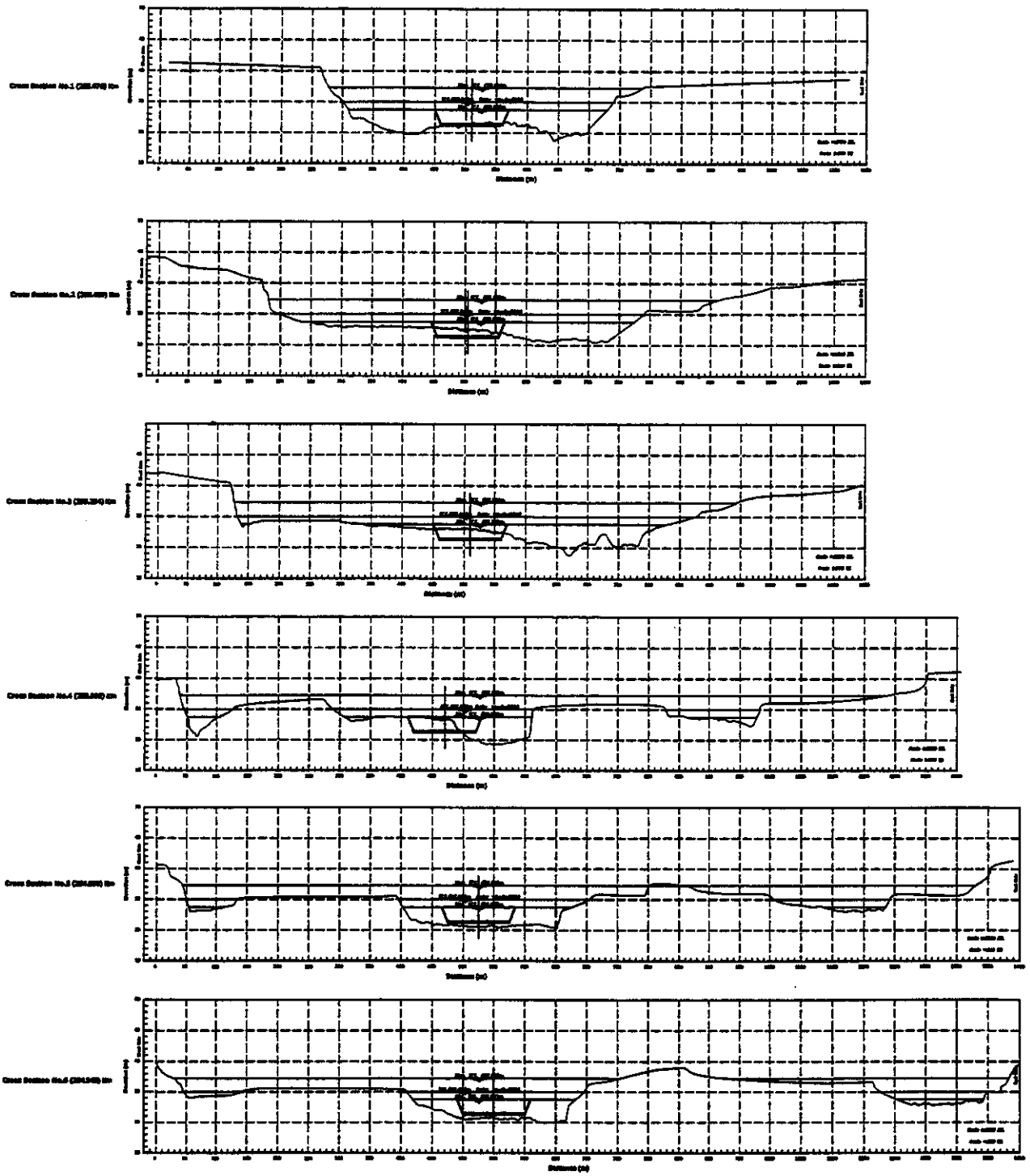
Cross Section No.5 (265.760) Km



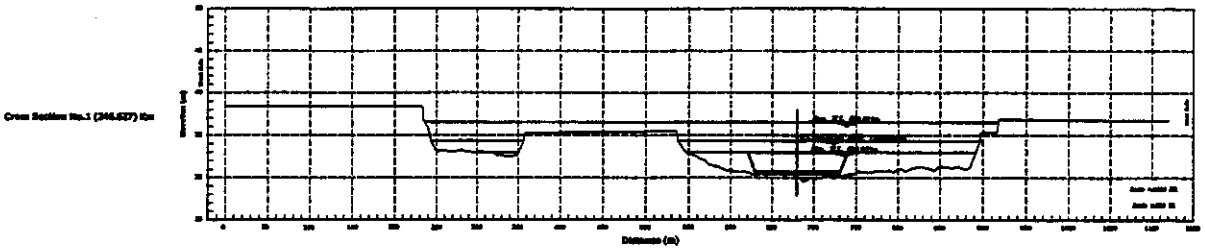
Cross Section No.6 (265.569) Km

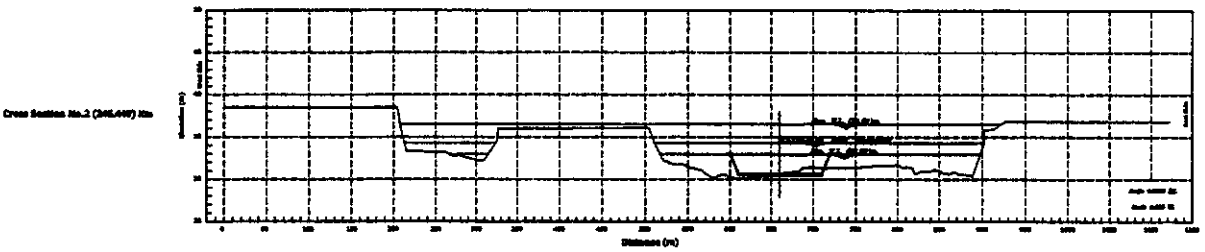


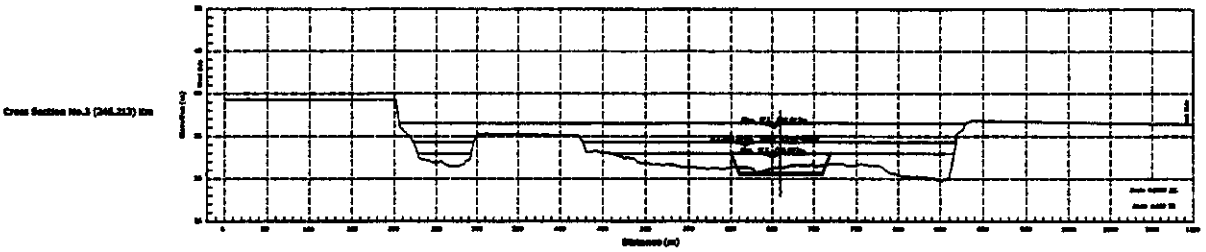
S13 : BNI MOHAMED SHARAWY SITE (Km. 255.000 From EL-Roda)

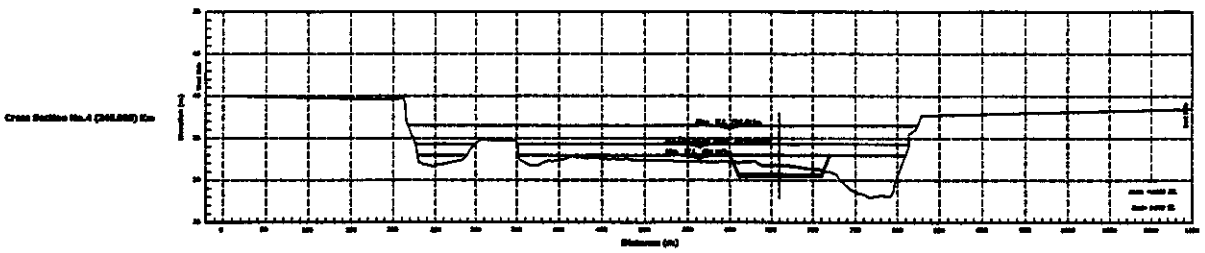


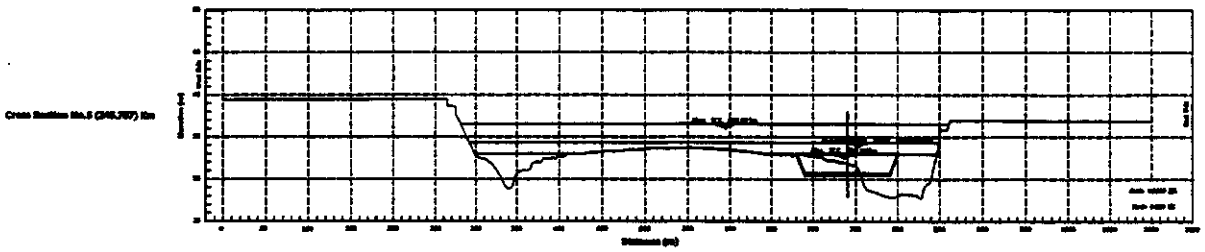
S14 : EL-ZAWIAH SITE (Km. 246.000 From EL-Roda)

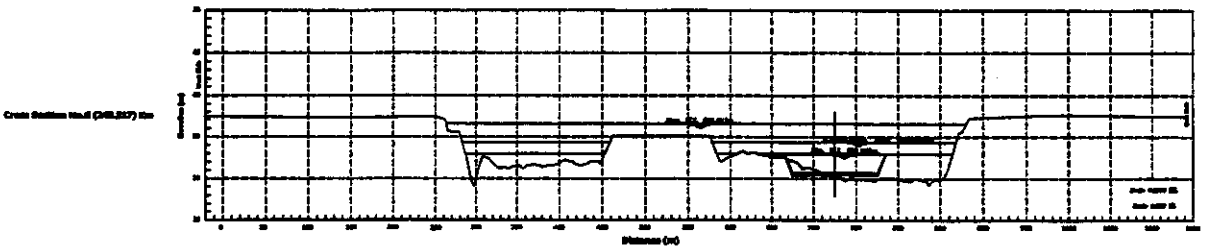






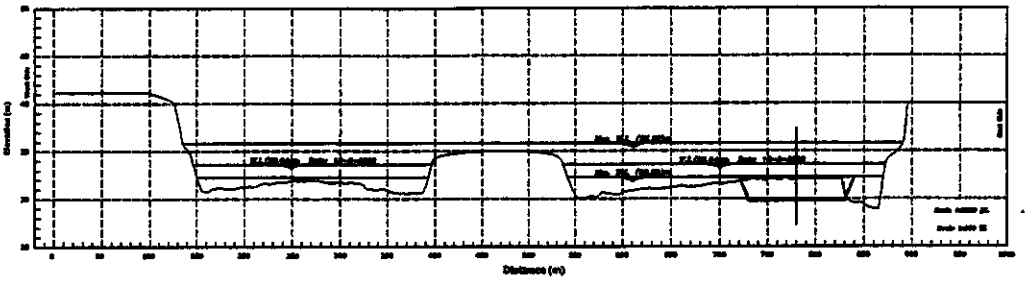




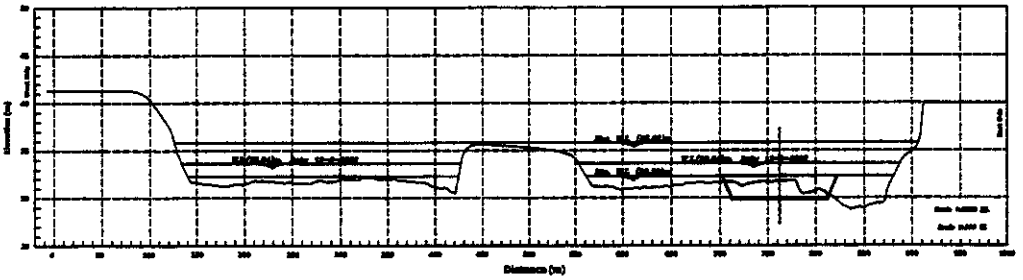


S15 : DAMARIES SITE (Km. 238.000 From EL-Roda)

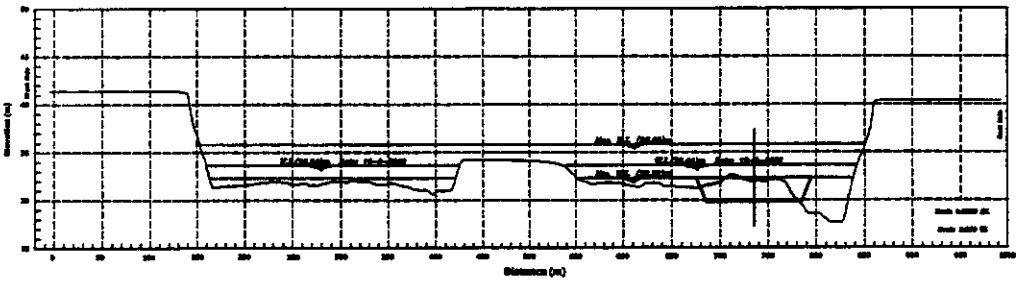
Cross Section No.1 (238.718) Km



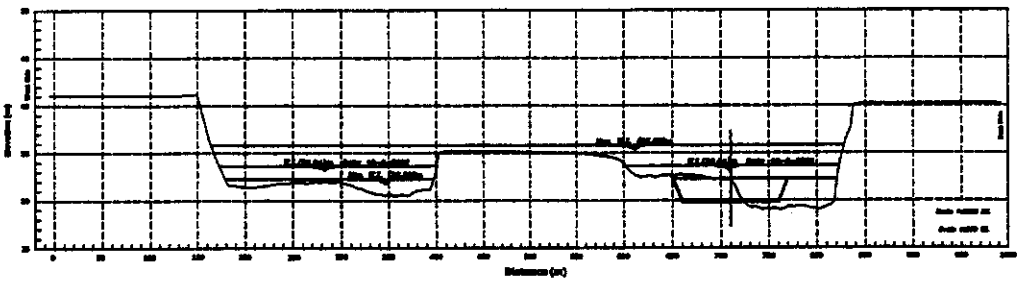
Cross Section No.2 (238.514) Km



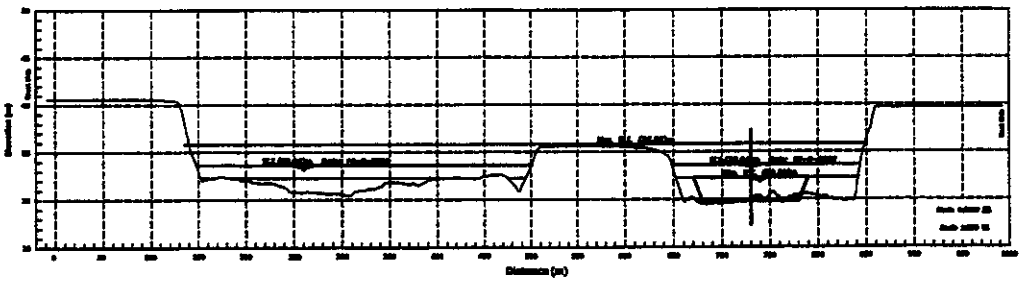
Cross Section No.3 (238.348) Km



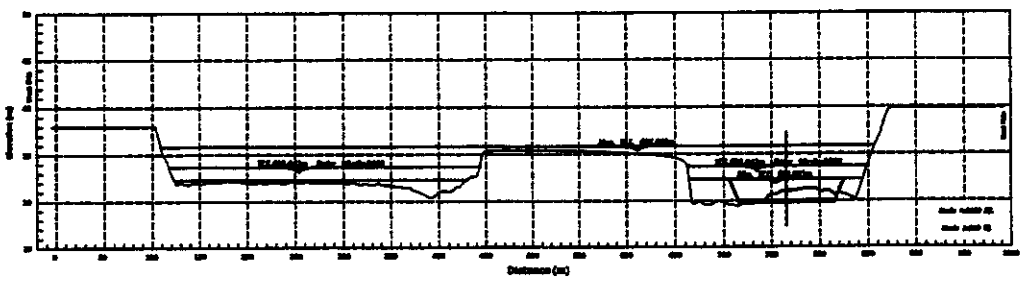
Cross Section No.4 (238.088) Km



Cross Section No.5 (237.734) Km

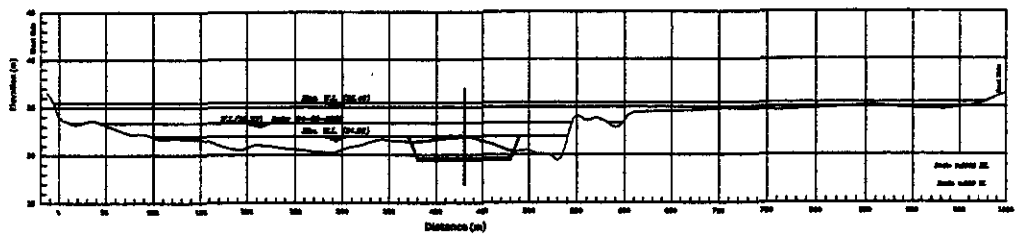


Cross Section No.6 (237.474) Km

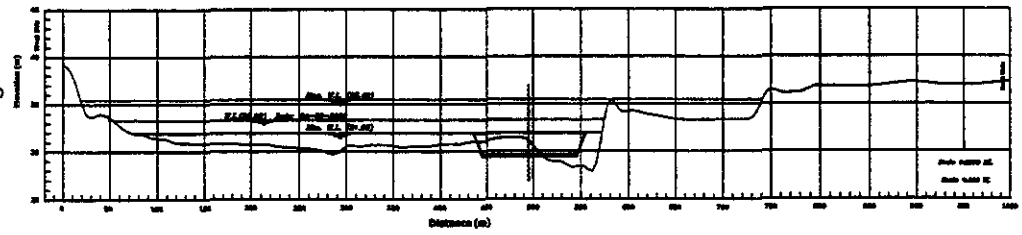


S16 : EL-BERGAY SITE (Km. 233.800 From EL-Roda)

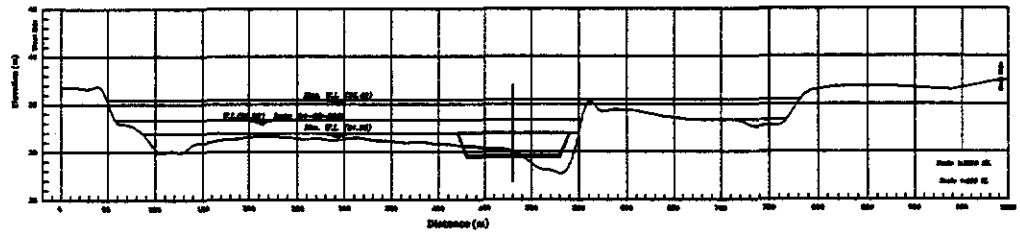
Cross Section No. 1 (234.442 Km)



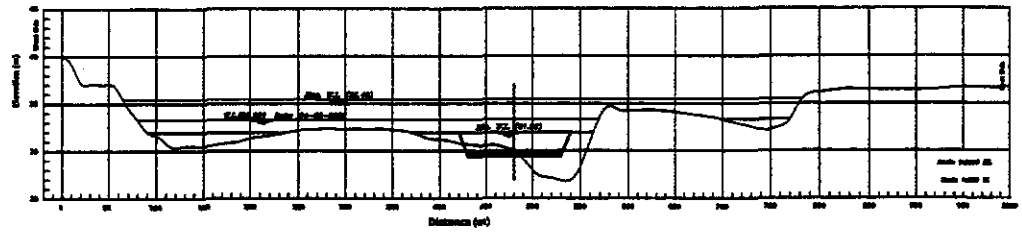
Cross Section No. 2 (234.231 Km)



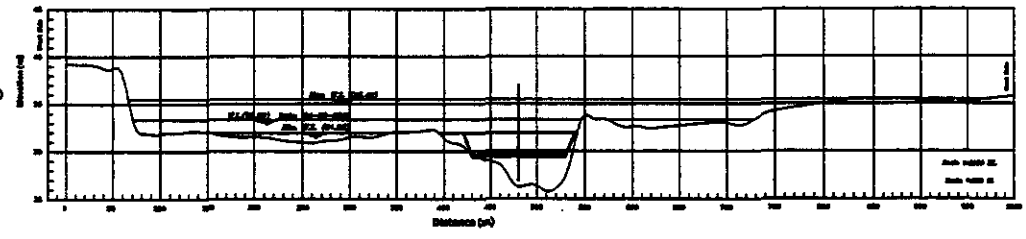
Cross Section No. 3 (234.280 Km)



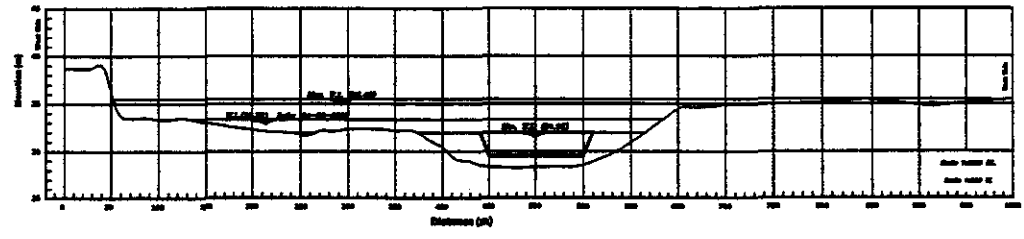
Cross Section No. 4 (233.880 Km)



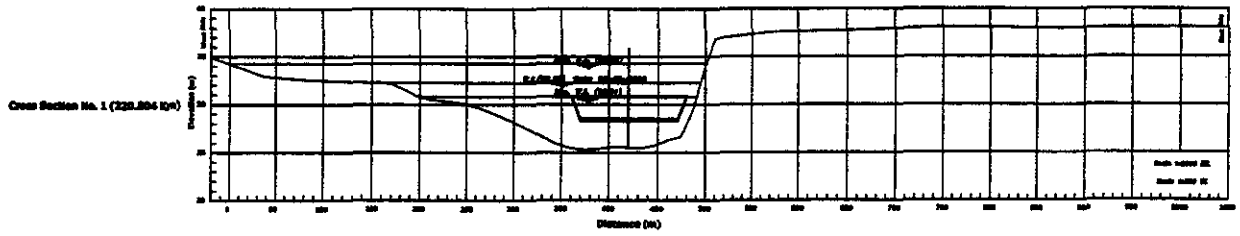
Cross Section No. 5 (233.600 Km)

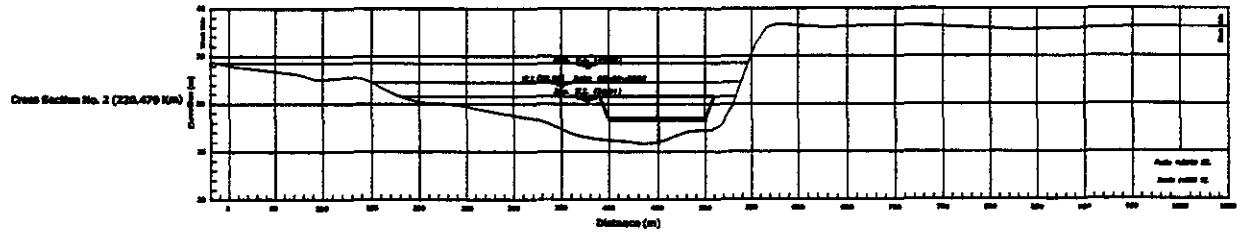


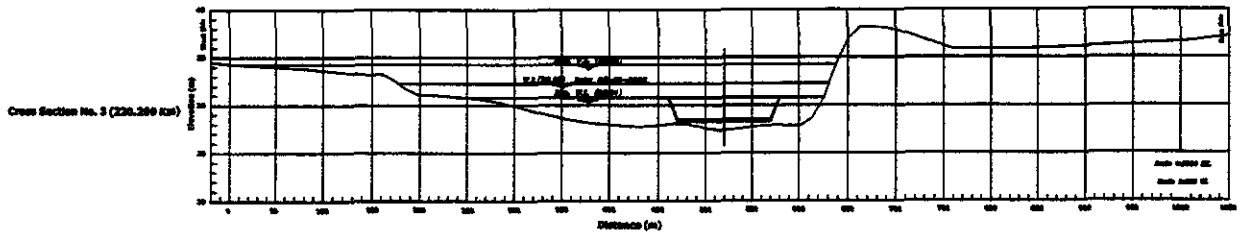
Cross Section No. 6 (233.394 Km)

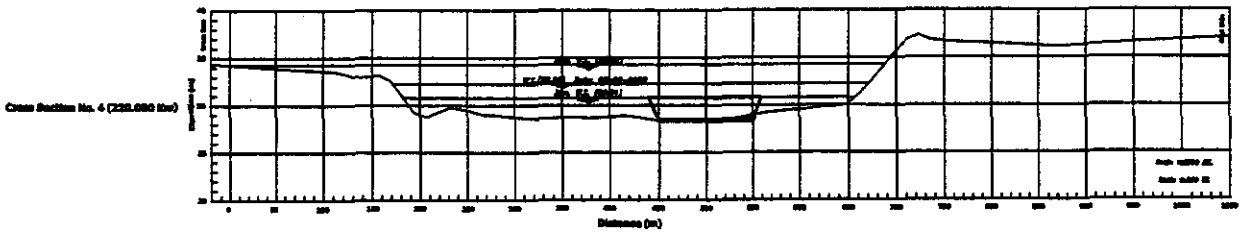


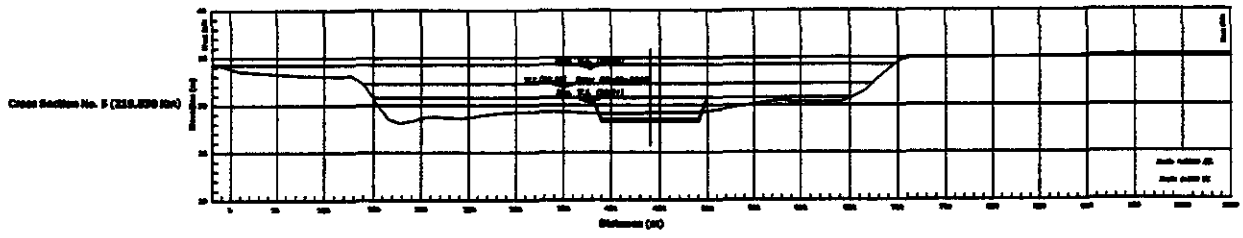
S17 : EL - BEHO SITE (Km. 220.000 From EL-Roda)

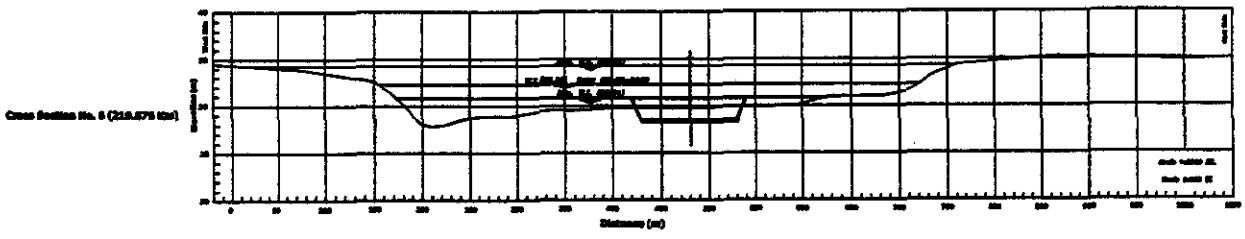




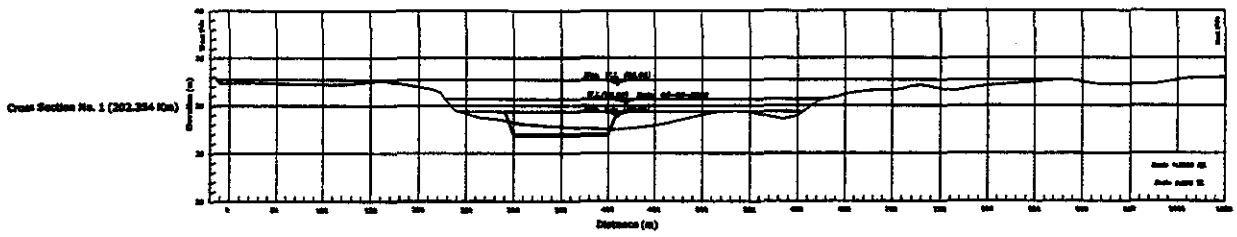


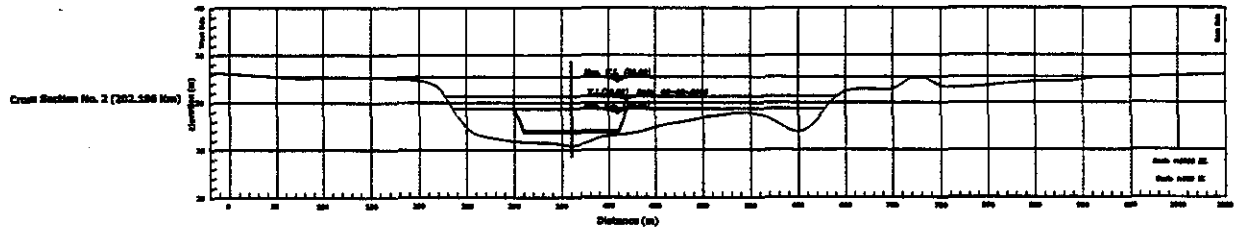


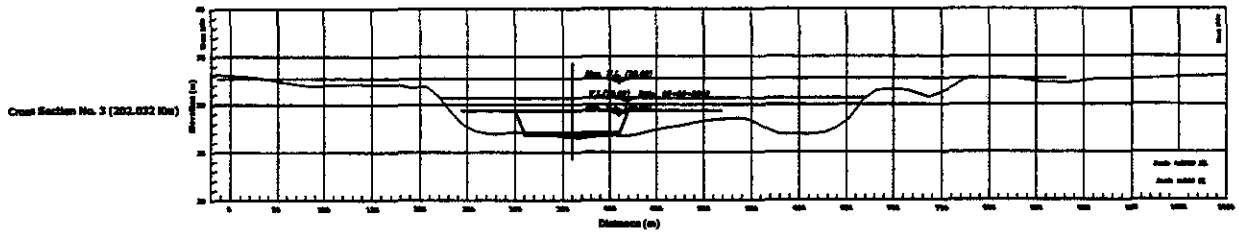


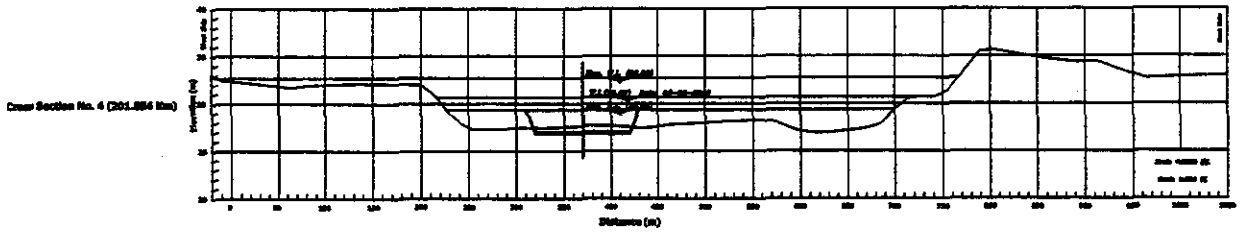


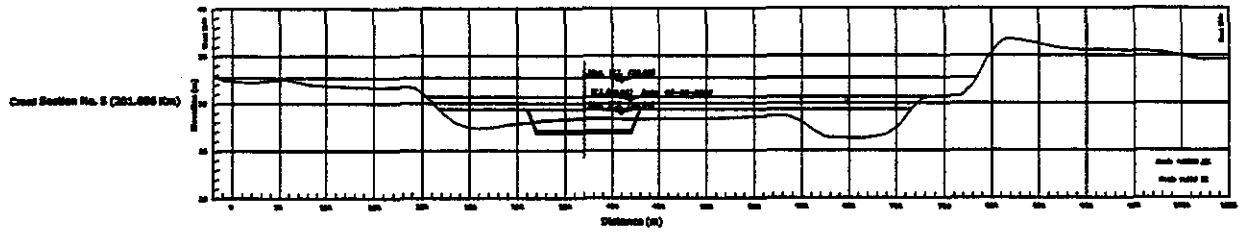
S18 : MATAY SITE (Km. 201.856 From El.-Roda)

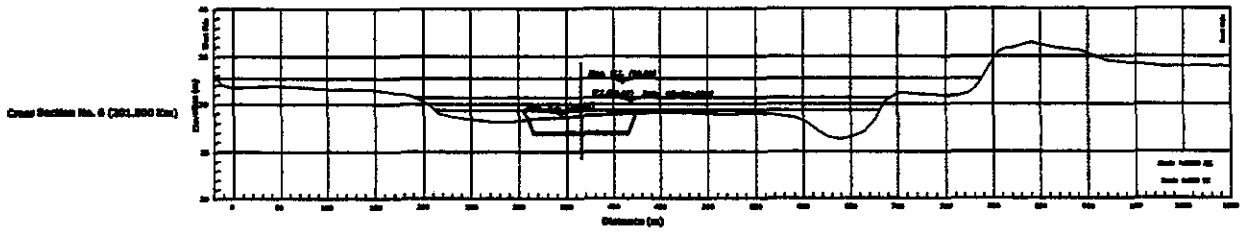




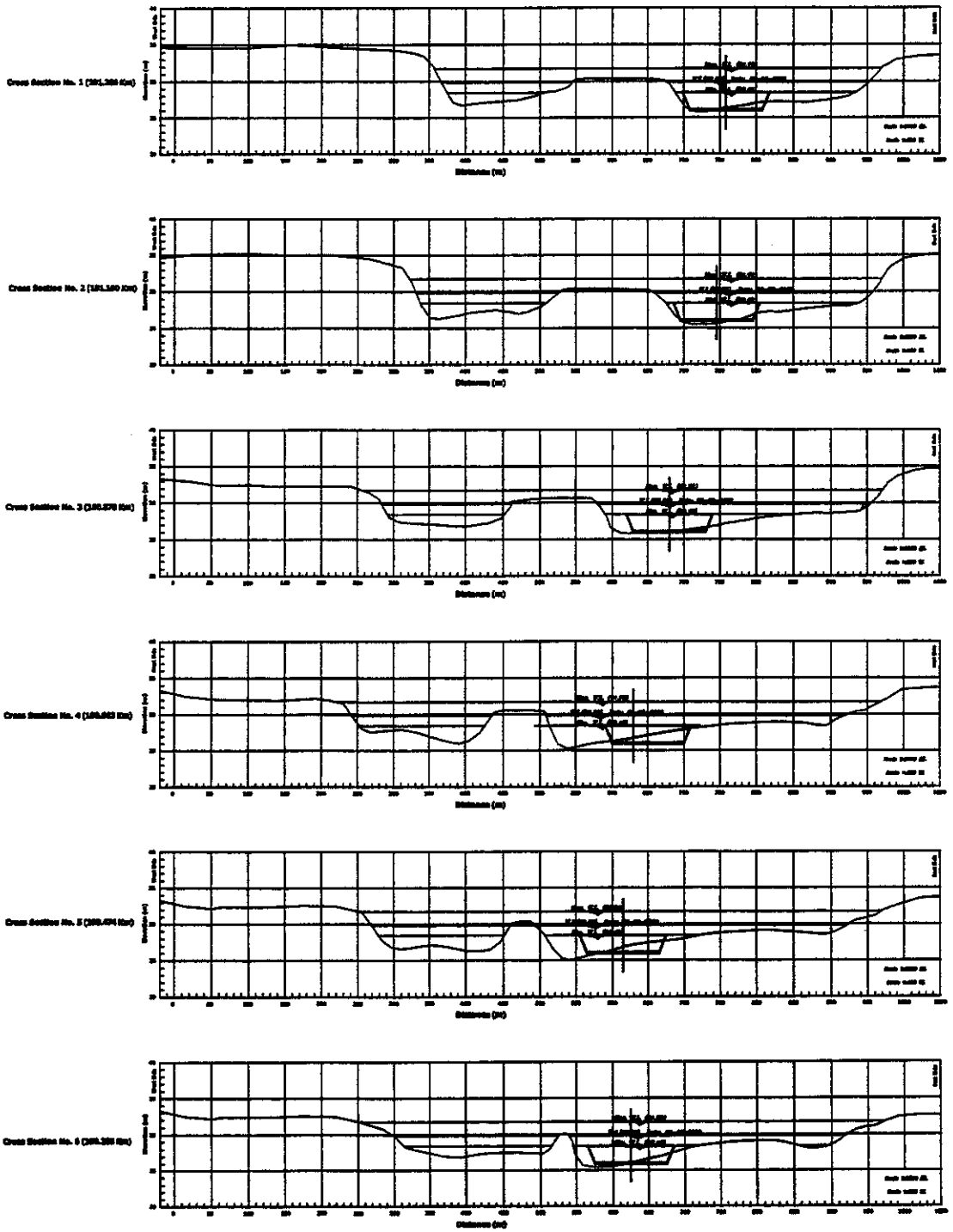




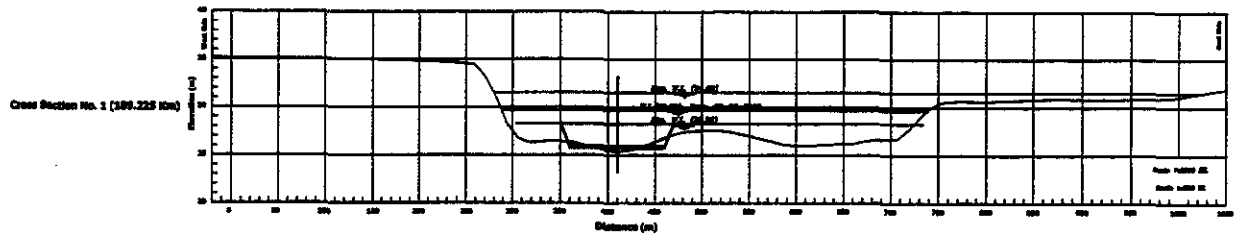


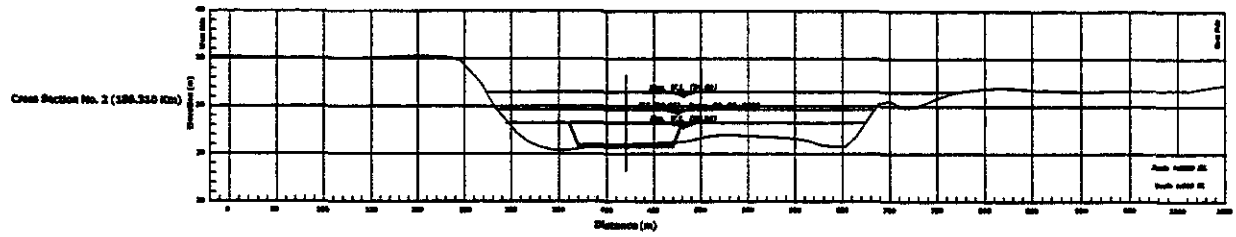


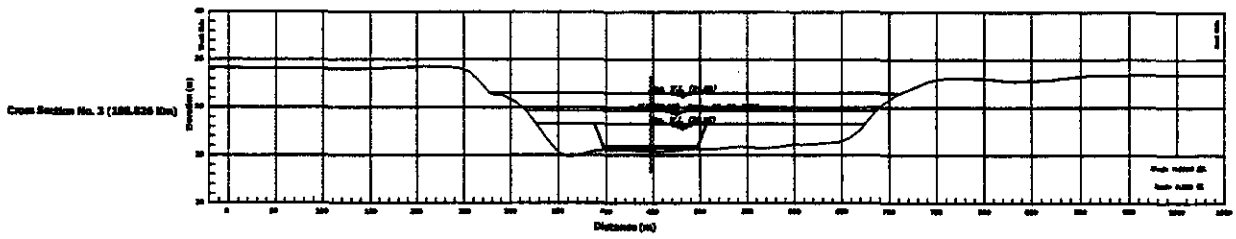
S19 : EL-SHEKH FADL SITE (Km. 190.663 From EL-Roda)

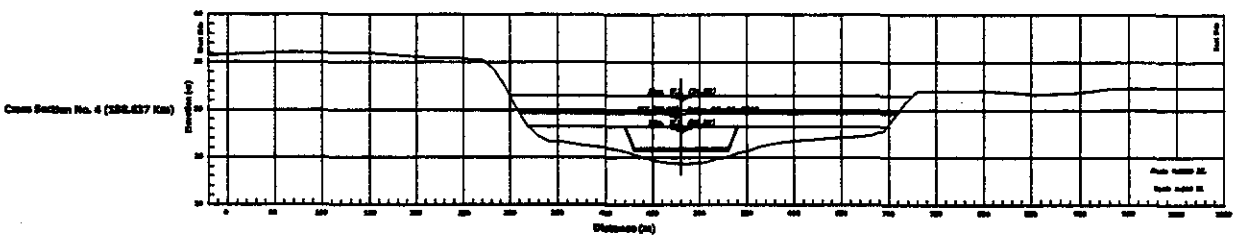


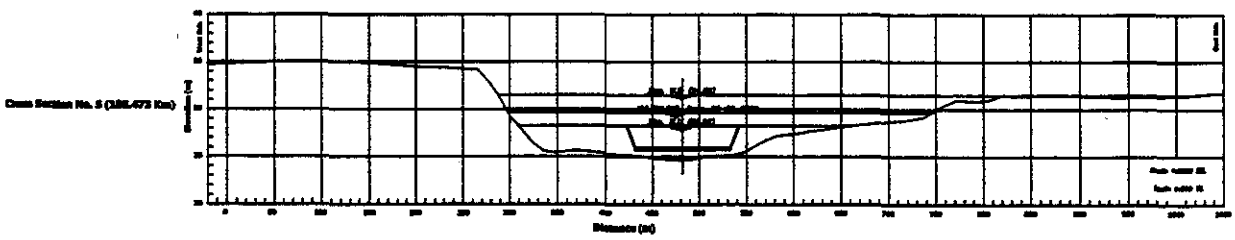
S20 : BENI MAZAR SITE (Km. 188.637 From EL-Roda)

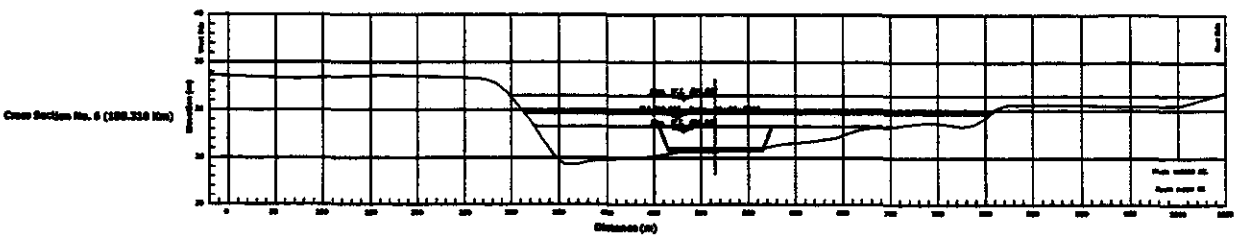




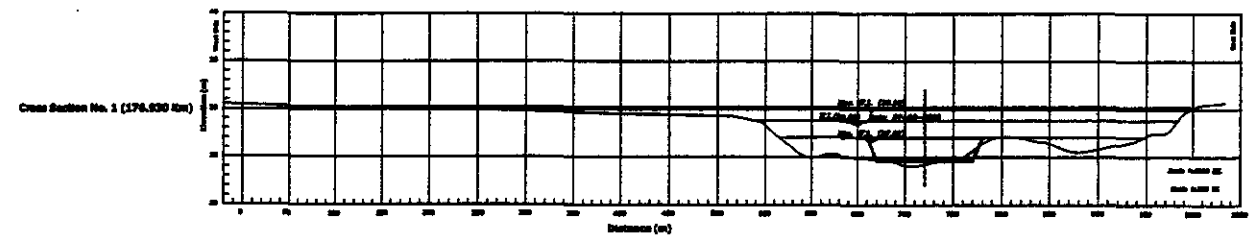


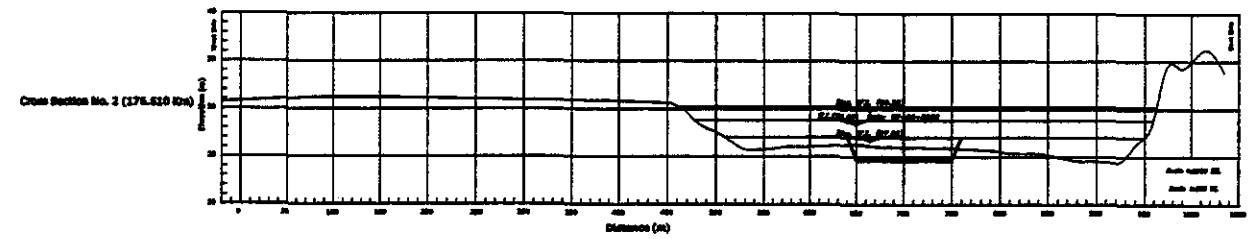


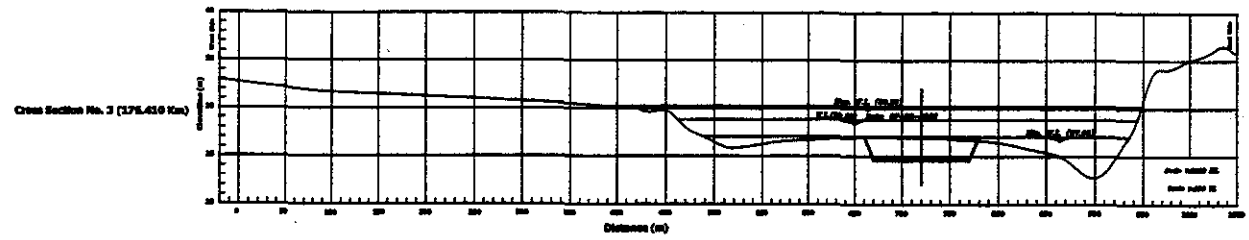


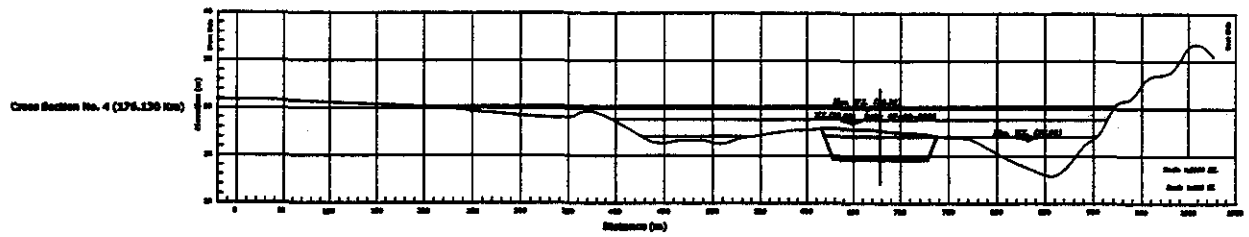


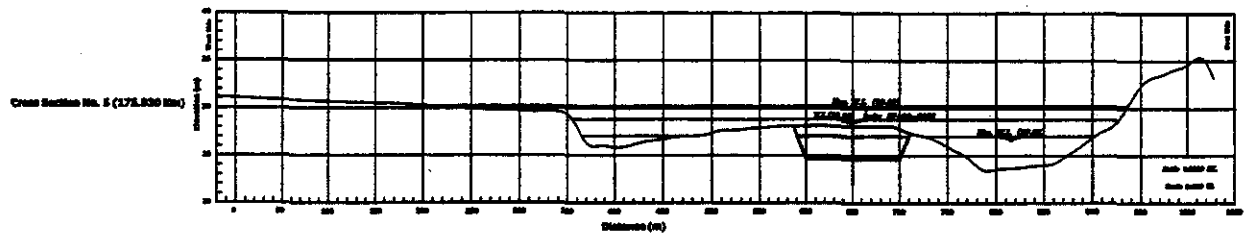
S21 : SHAROUNA ISLAND SITE (Km. 176.130 From EL-Roda)

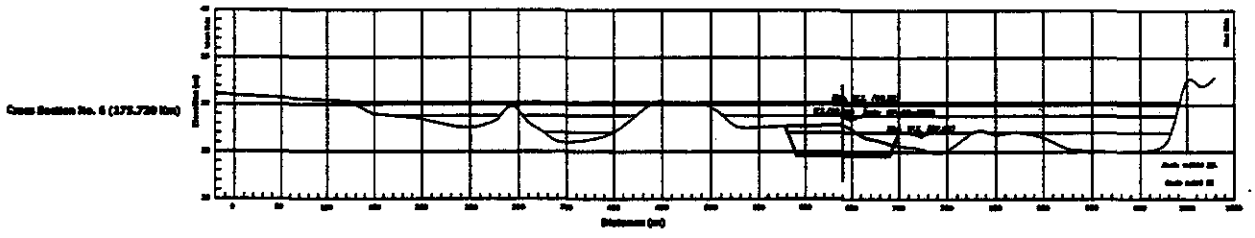




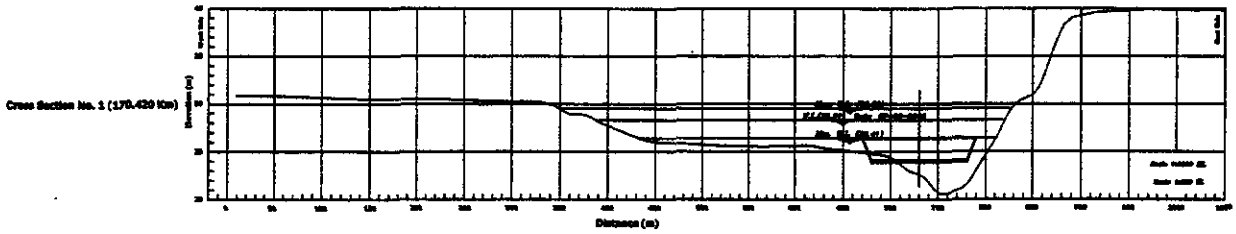


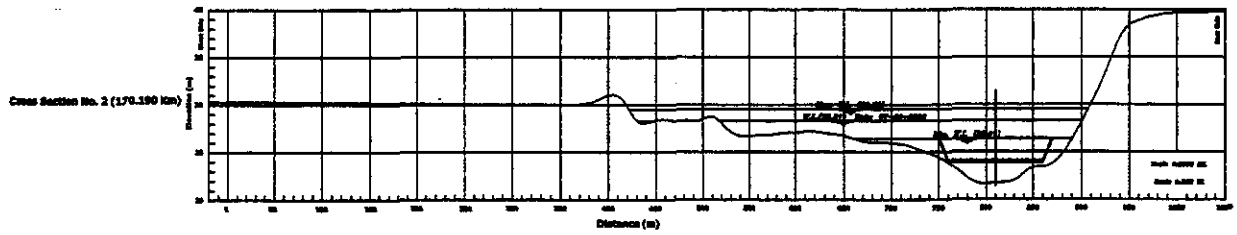


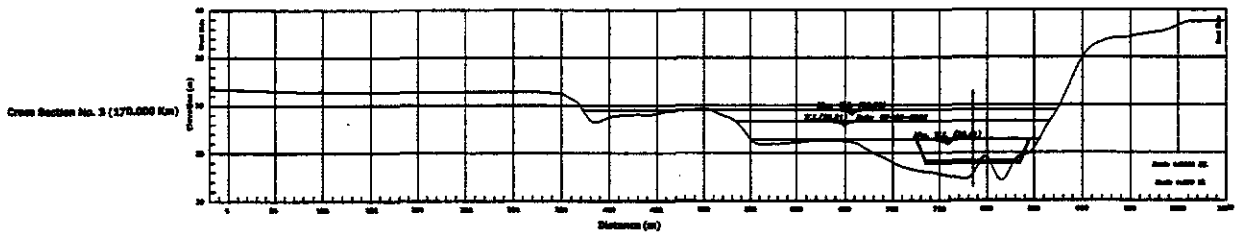


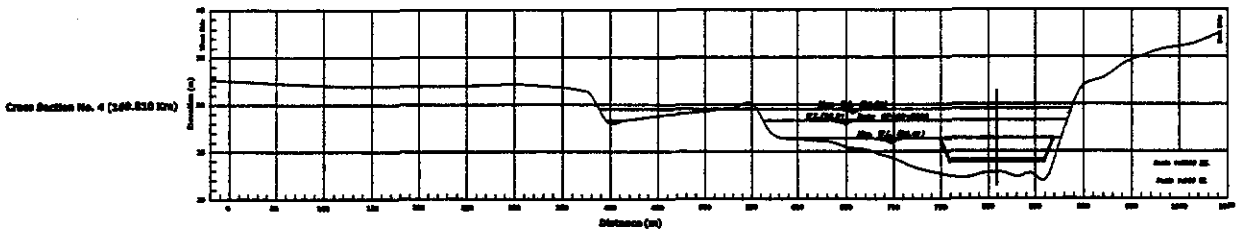


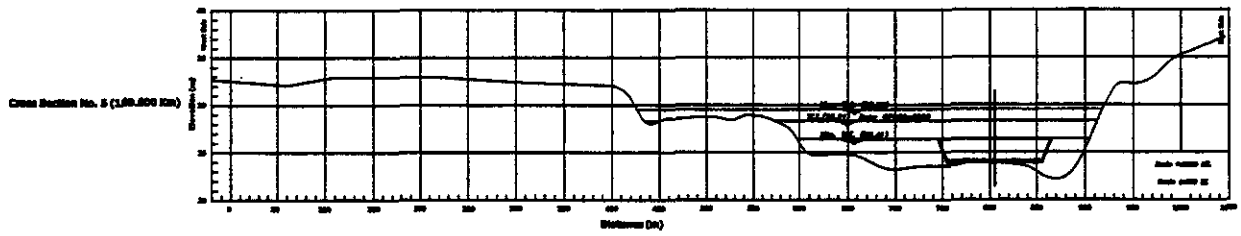
S22 : AWLAD EL-SHEIKH SITE (Km. 169.810 From EL-Roda)

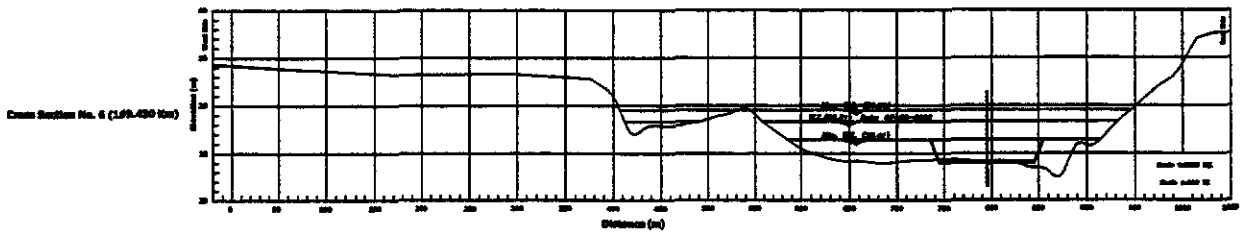




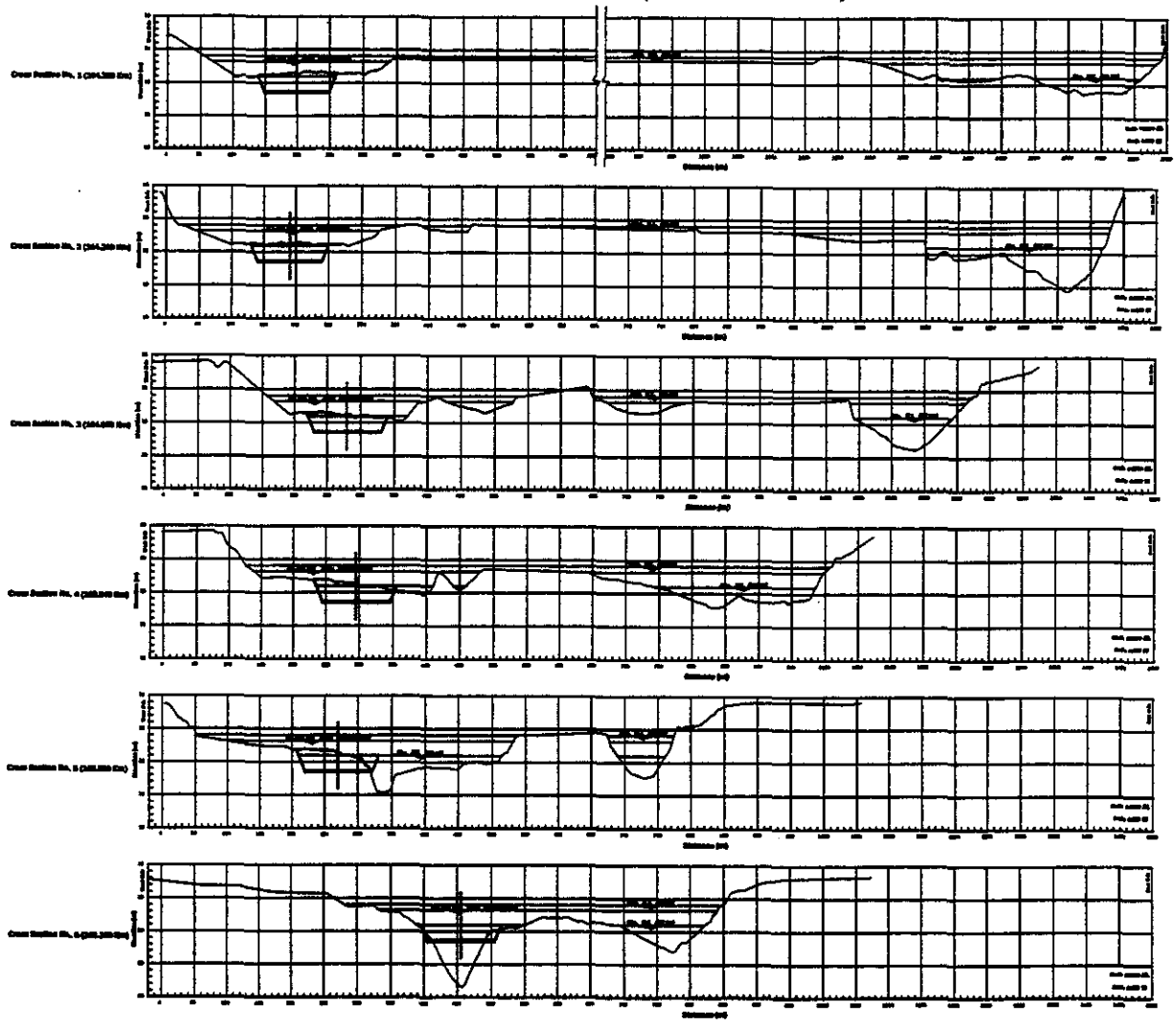




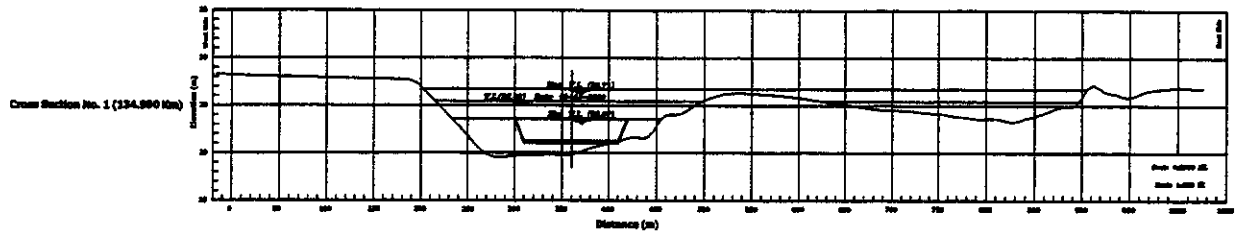


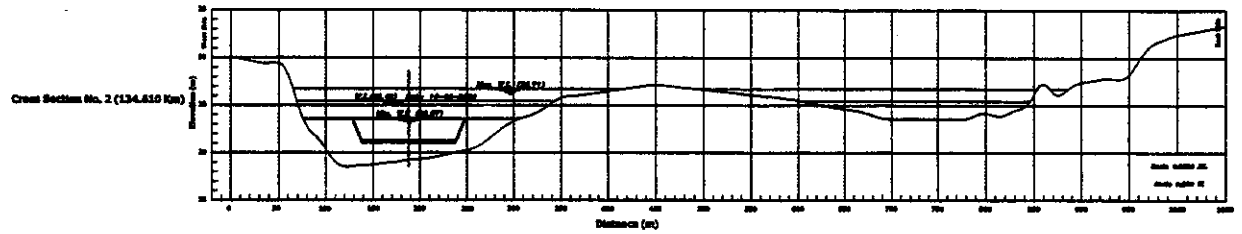


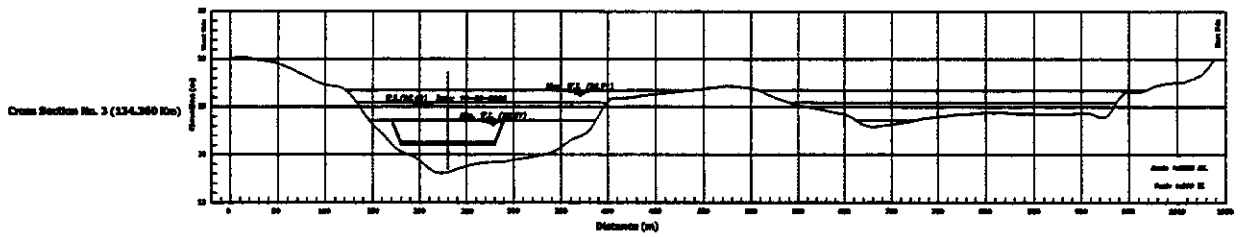
S23 : ZAWIAT EL-GODAMY SITE (Km. 163.840 From EL-Roda)

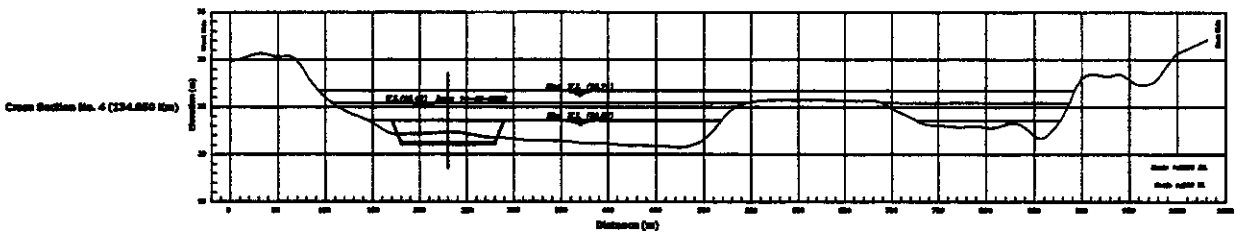


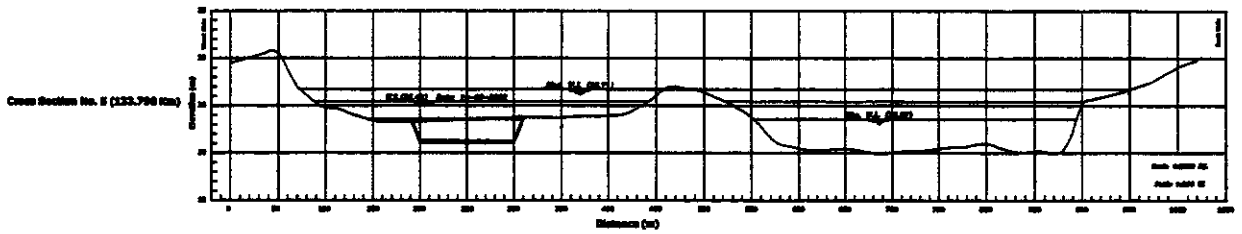
S24 : MAHMOUD EWEAS SITE (Km. 134.040 From EL-Roda)

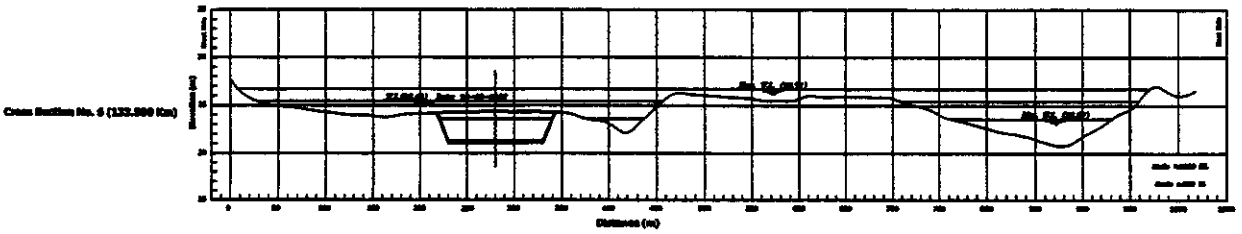




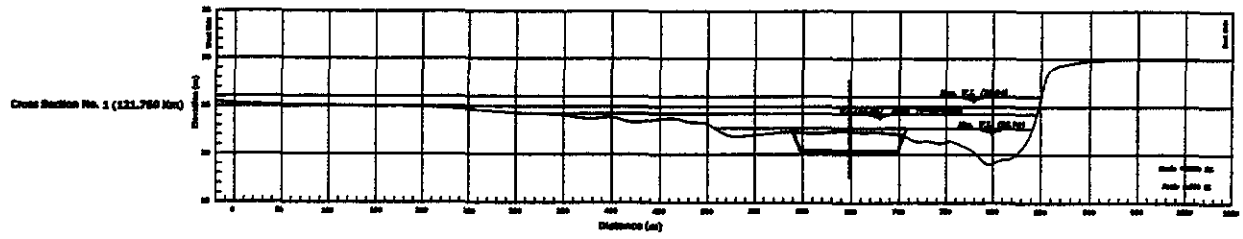


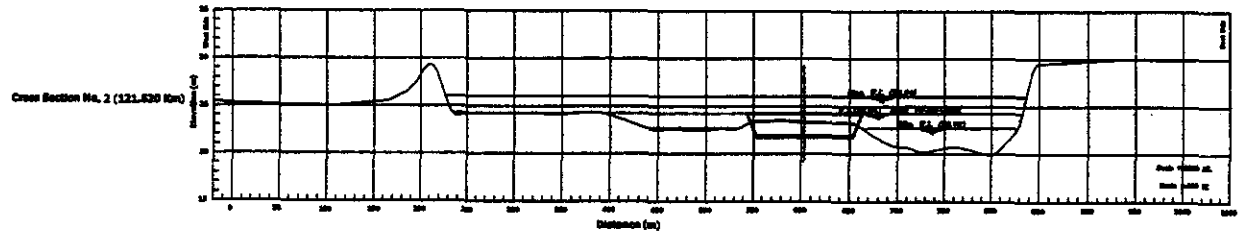


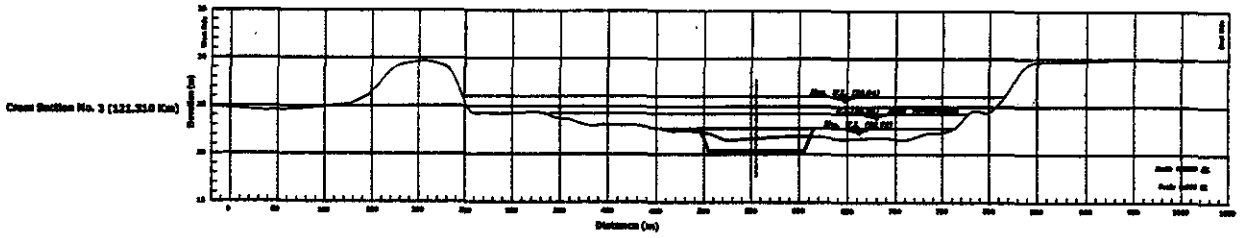


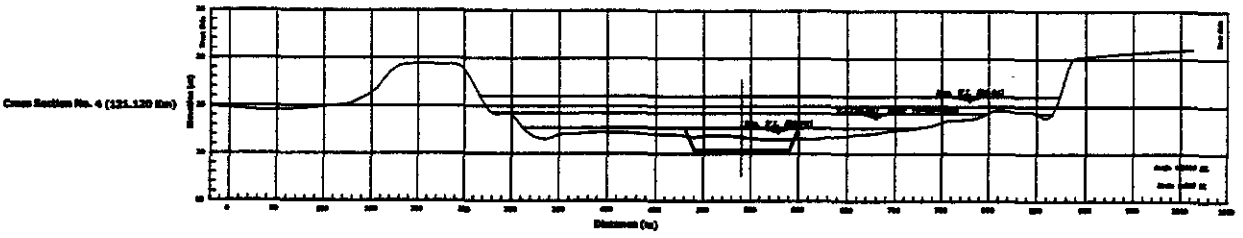


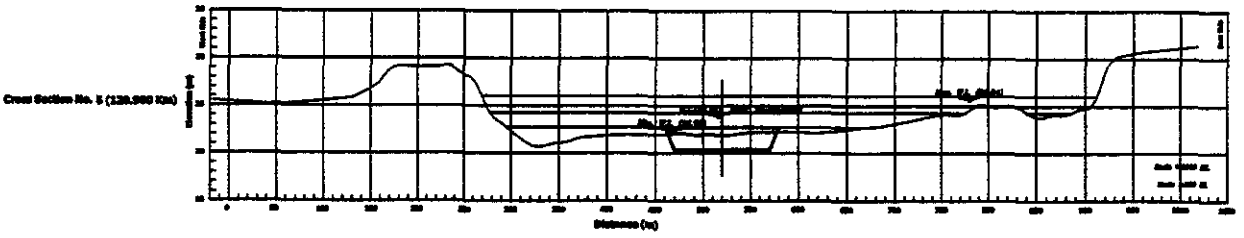
S25 : EL-DAWABA SITE (Km. 121.120 From EL-Roda)

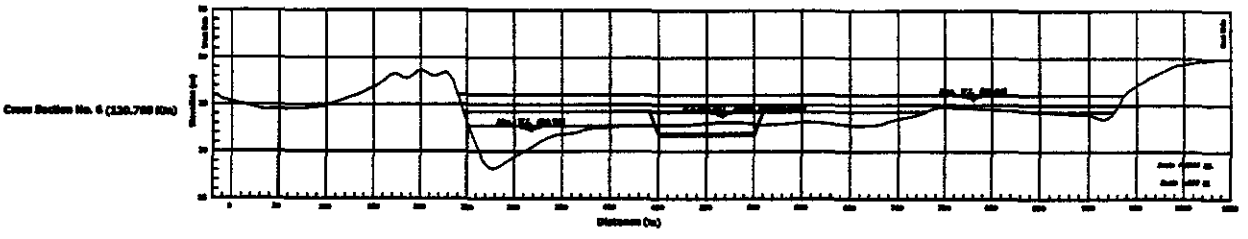




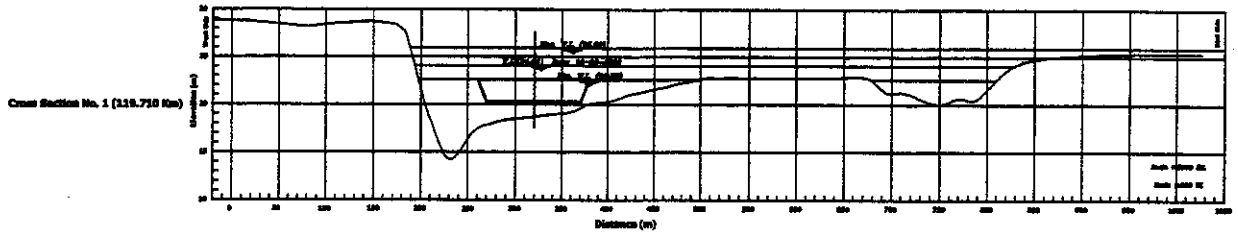


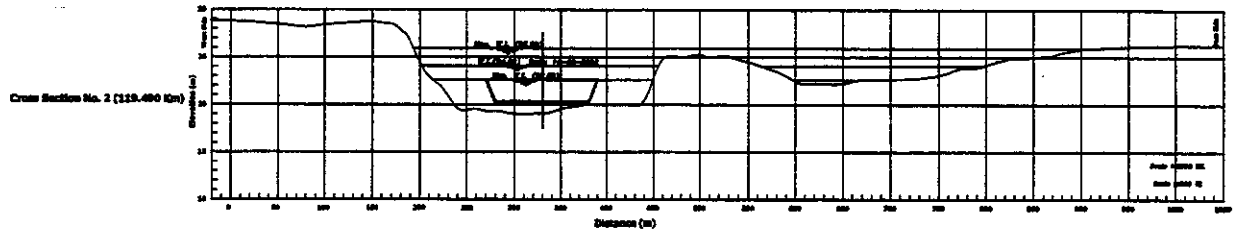


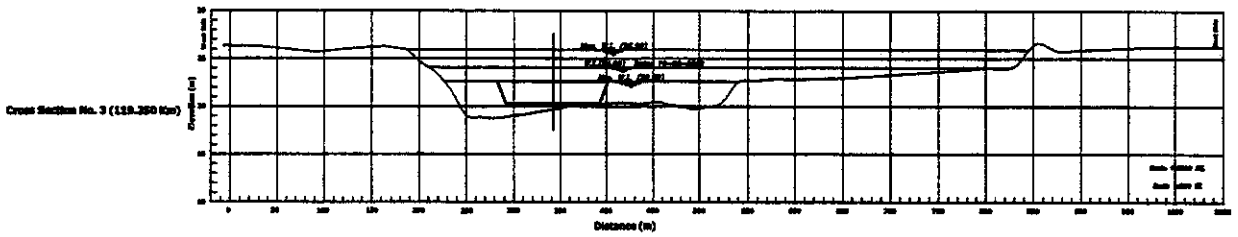


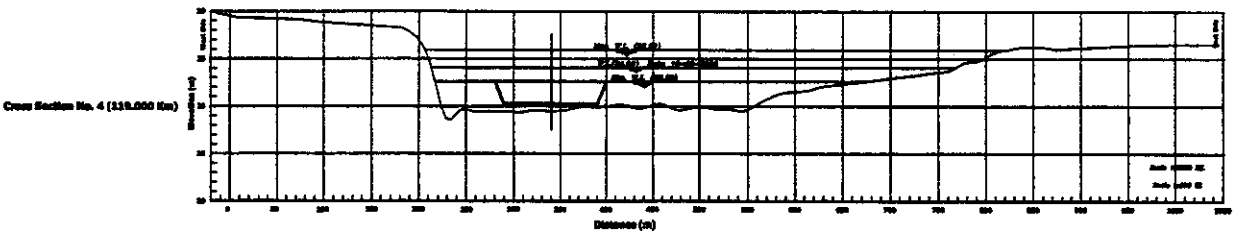


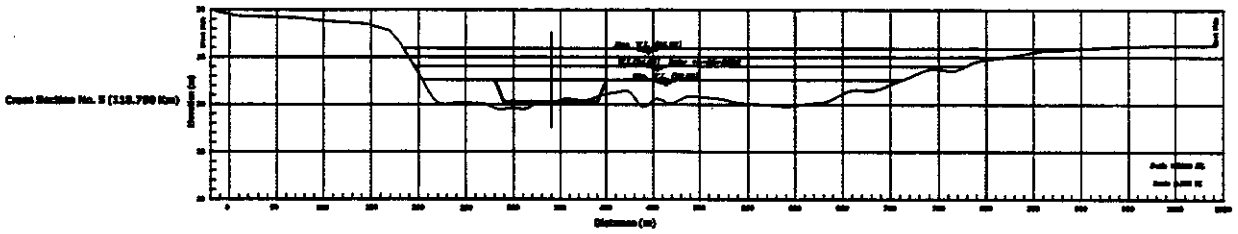
S26 : BENI SWEEF BRIDGE SITE (Km. 119.000 From EL-Roda)

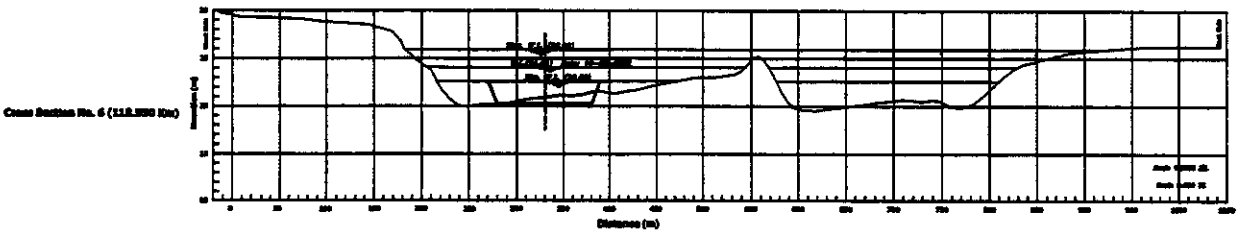




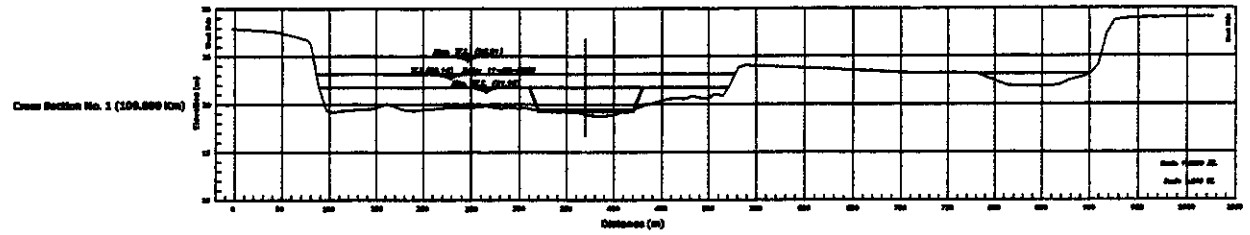


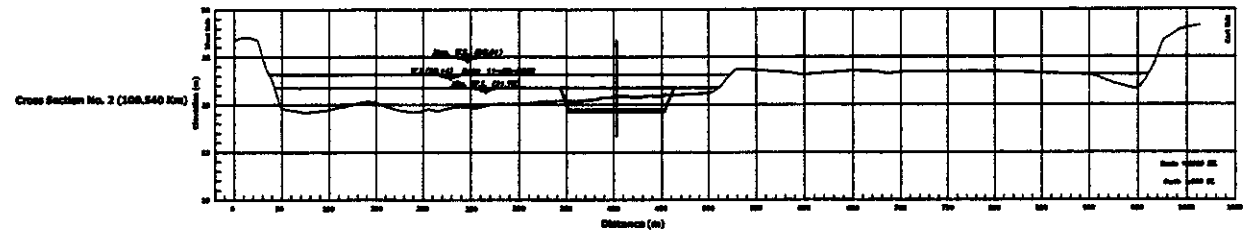


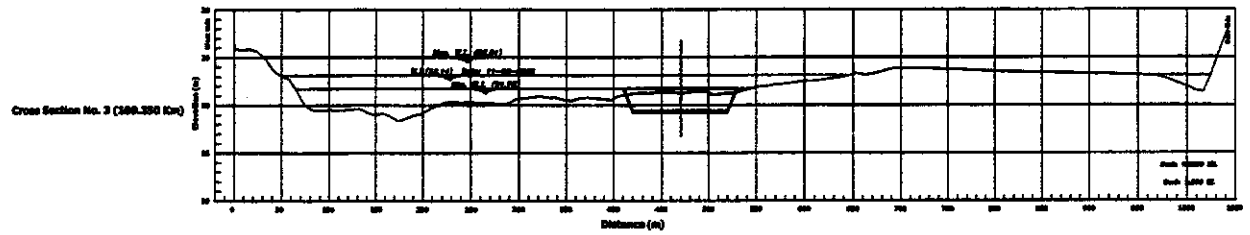


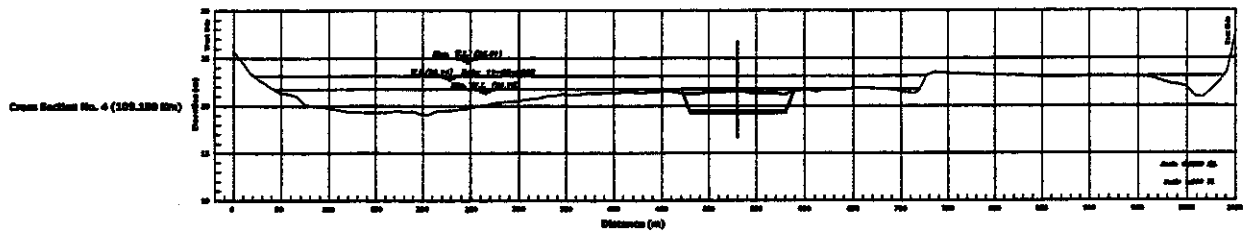


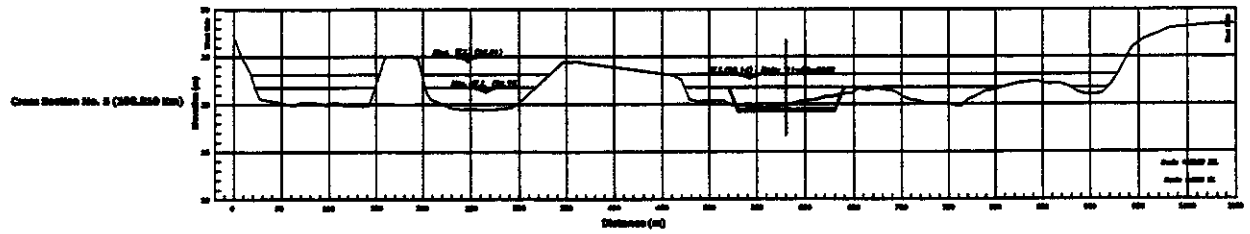
S27 : EL-ALALMA SITE (Km. 109.150 From EL-Roda)

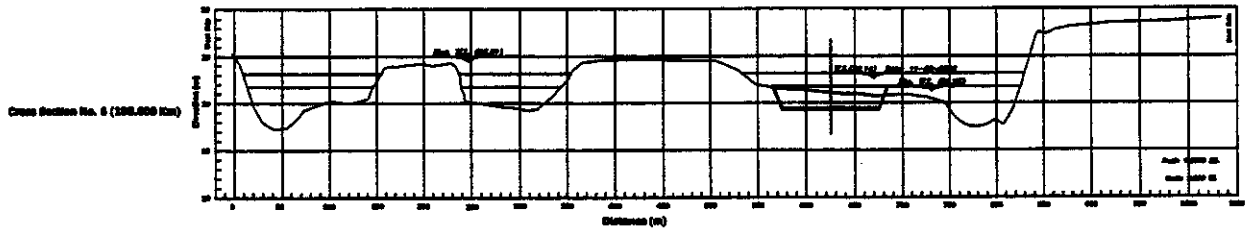




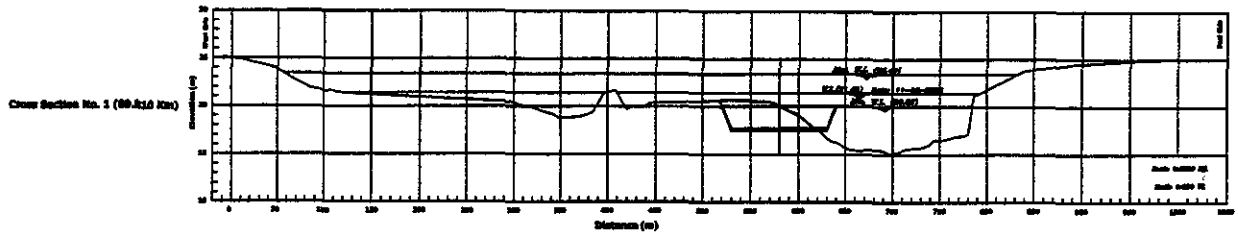


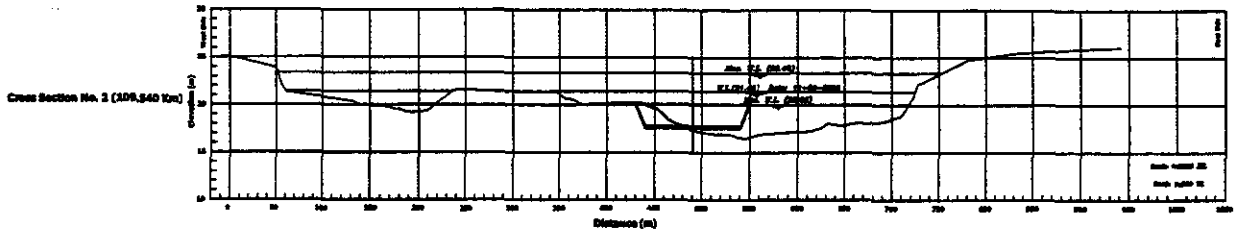


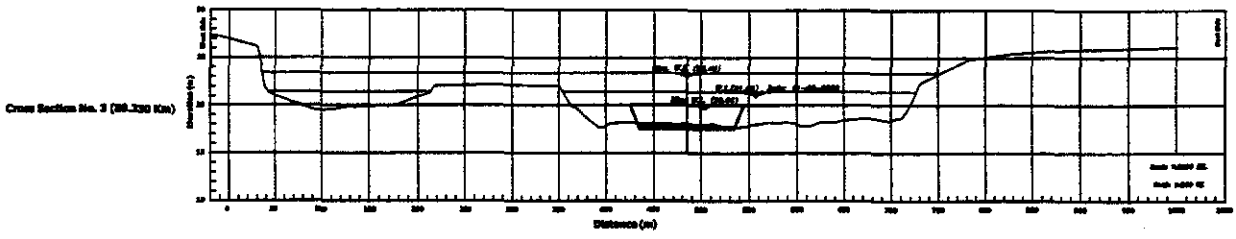


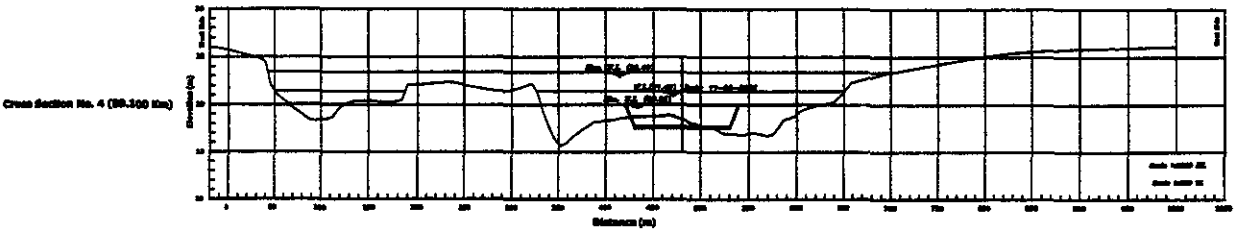


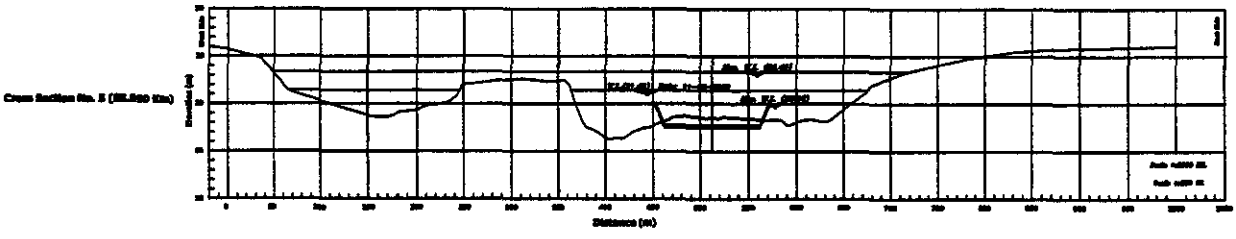
S28 : EL-KOREIMAT SITE (Km. 89.100 From EL-Roda)

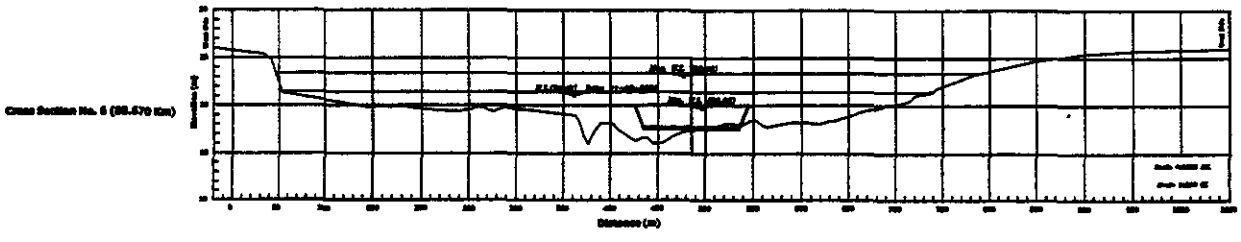




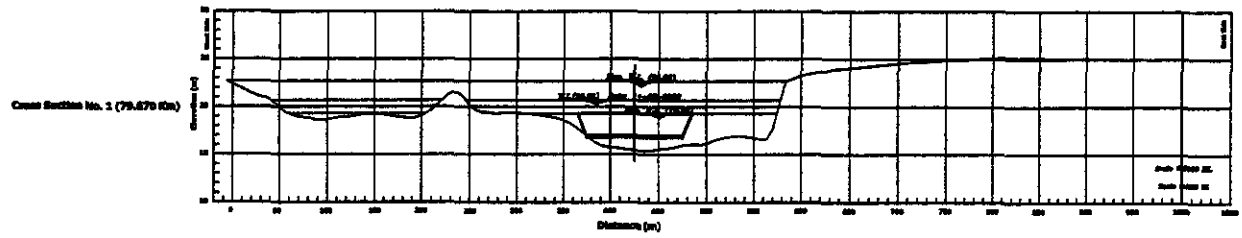


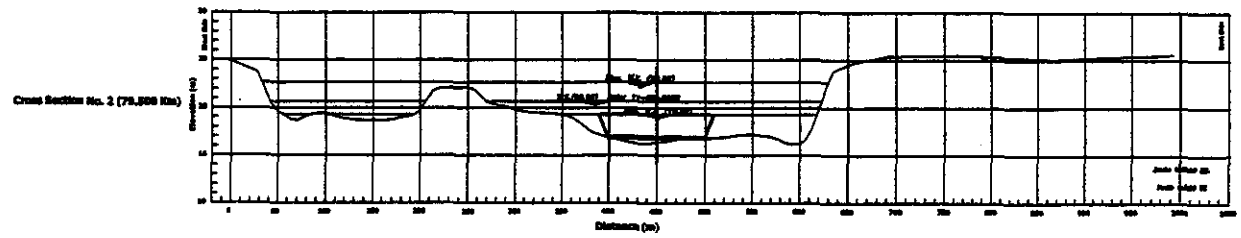


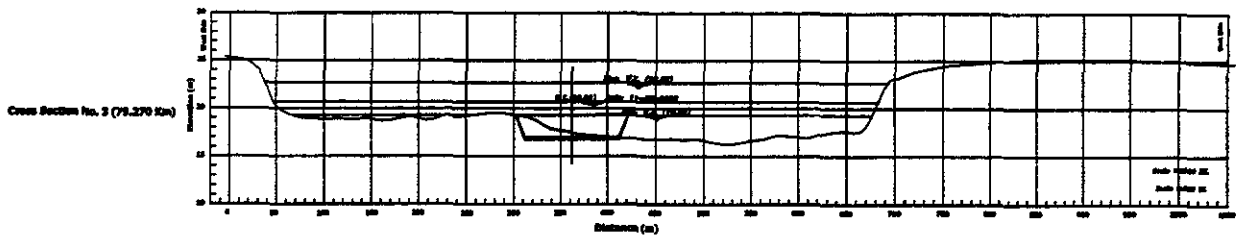


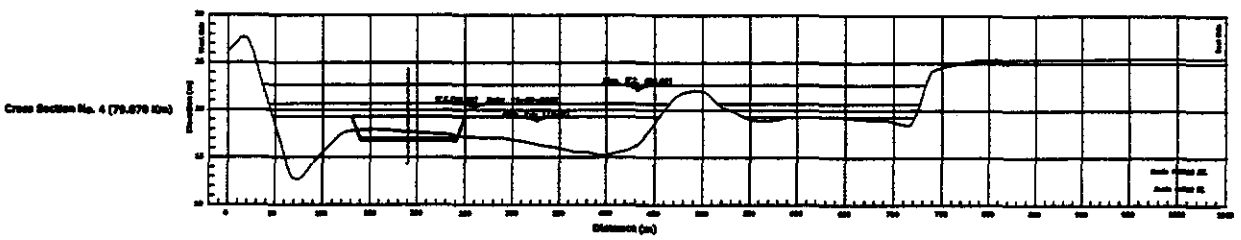


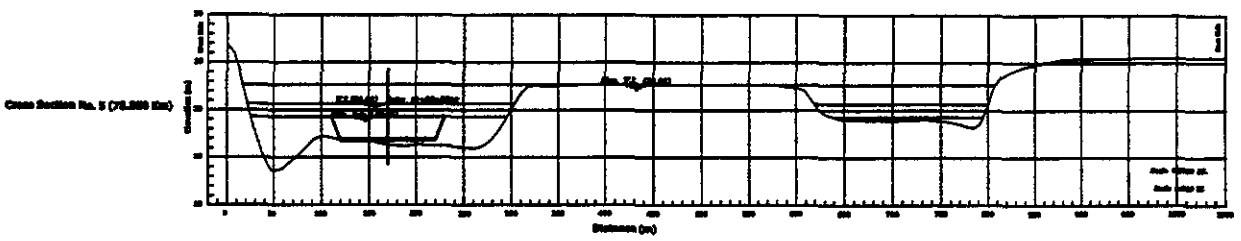
S29 : SOUL SITE (Km. 79.070 From EL-Roda)

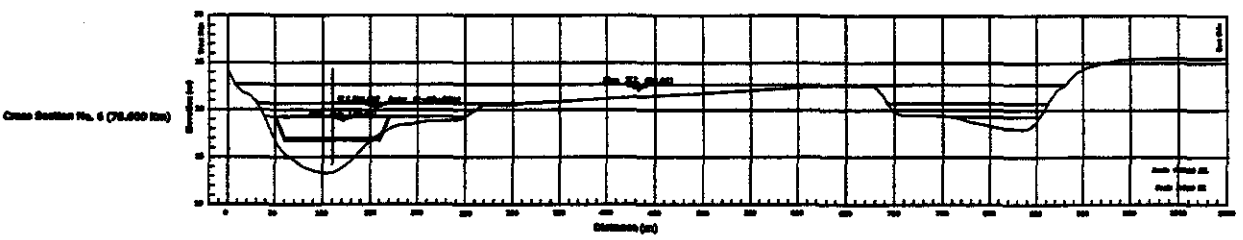












S30 : EL-SAAF SITE (Km. 44.000 From EL-Roda)

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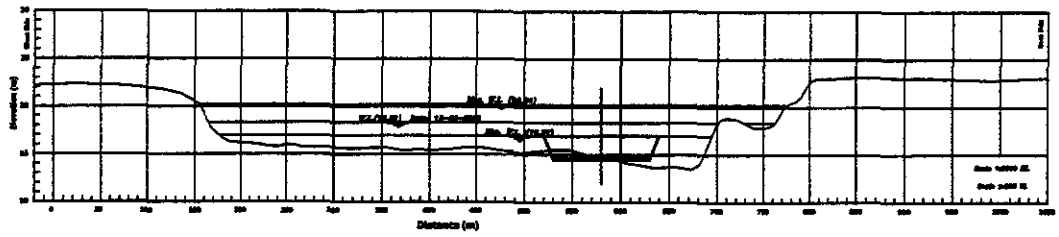
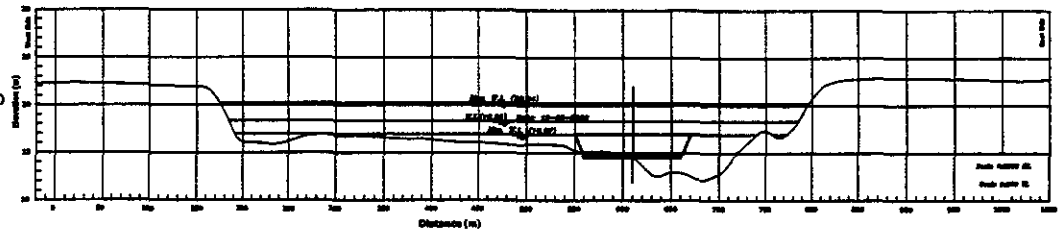


Cross Section No. 2 (44.470 Km)



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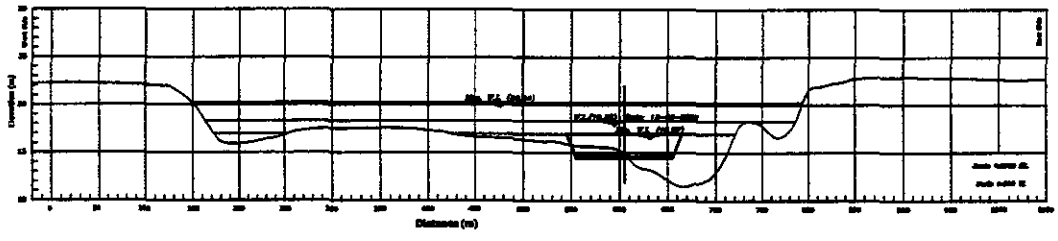
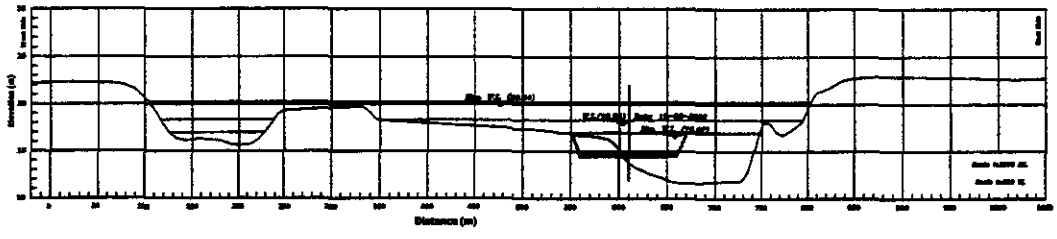
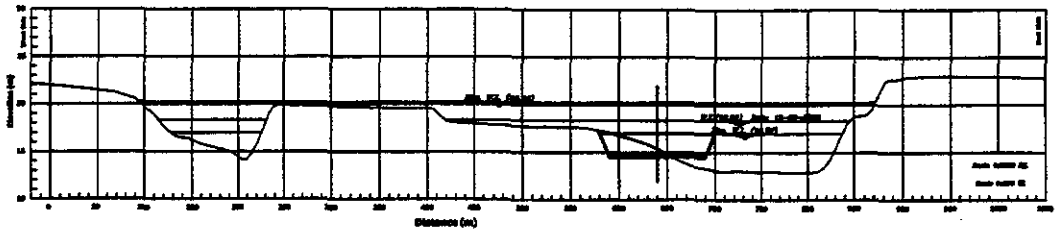


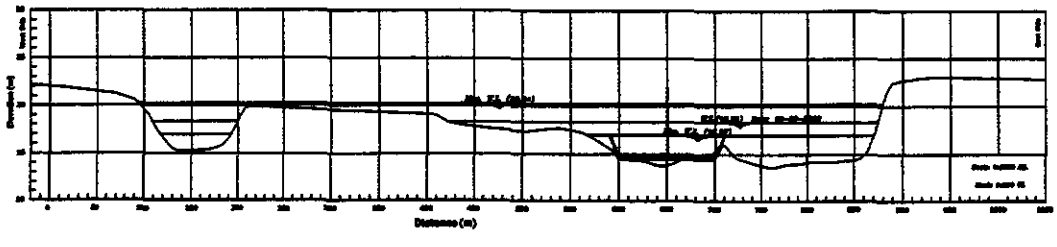
Cross Section No. 4 (44.000 Km)



Cross Section No. 5 (43.760 Km)



Cross Section No. 6 (43.540 Km)



Appendix-13.1 Rough Estimation of Required Number of Aid to Navigation

Table A13.1 Rough Estimation of Number of Beacons

Location	Section	Distribution	Number
Port of Ather El Nabi	Entrance	As appropriate	6
	Exit	As appropriate	6
Nile Mainstream	With City Lights	Every 500 meters	40
	Without City Lights	Every 1,000 meters	20
Beheira Canal	Straight Sections	Every 500 meters	160
	Curving Sections	As appropriate	0
Naobaria Canal	Straight Sections	Every 500 meters	240
	Curving Sections	As appropriate	10
Connecting Point of Both Canals		As appropriate	15
Locks		Four beacons at seven Locks	28
Subtotal			525
Spare Unit		About 4% of subtotal (525)	20
Total			545

Appendix-13.2 Rough Estimation of Number of Barges through Maritime Lock in 2010

Using the same equation with Appendix11-6, the number of units per day (N) is estimated as follows:

$N=Ny/T\times\lambda$ -Eq.(A)

Where, Ny: Annual cargo-wise number of units,

T : Maximum navigable days for year (=335 days/year),

λ : Cargo-wise peaking factor to the daily average traffic.

The forecasted traffic volume in 2010 is annually 60 hundred units from/to the Greater Alexandria Port as shown in the following table.

IW Route		Cargo Item	Cargo Volume Allocated to IWT (2010)	Number of Barges (units) (Cargo volume per barge)	(Number of barges per year)	Eq. (A) (Number of barges per day)	Peaking Factor (λ)
Up-stream (Alexandria to GCR)		Wheat	171 '000MT	/1378 MT=	124	0.5	1.4
		Maize	192 '000MT	/1378 MT=	140	0.6	
		Coal	675 '000MT	/1378 MT=	491	1.9	1.3
		Timber	101 '000MT	/1190 MT=	85	0.3	1.3
		Cement	87 '000MT	/1378 MT=	63	0.2	1.3
		Iron/Steel Products	51 '000MT	/1378 MT=	37	0.1	1.3
		Containers (TEUs)	60 '000TEU	/ 88 TEU=	683	2.7	1.3
Down-stream (GCR to Alexandria)		Mollases	188 '000MT	/1378 MT=	137	0.7	1.8
		Coke	300 '000MT	/1378 MT=	218	0.8	1.3
		Containers (TEUs)	60 '000TEU	/88 TEU=	683	2.7	1.3
Down-stream (Upper Egypt to Alex.)		Mollases	205 '000MT	/430 MT=	477	2.6	1.8
Up-stream	(between Alexandria and Kafr El Zayat)	Sulfur	103 '000MT	/430 MT=	240	0.9	1.3
		Grease	26 '000MT	/430 MT=	61	0.2	1.3
Down-stream		Super Phosphate	102 '000MT	/430 MT=	238	0.9	1.3
		Total number of units per year (Up-stream)			2,994	12.6	units per day
		Total number of units per year (Down-stream)			2,994	12.6	units per day

Appendix -13.3 (Short-Term Plan) Required Facilities and Equipments at a New River Port

(1) Required Number of Container Berths at New River Port

Assumptions for obtaining the required number of container berths in 2010 are as follows:

Working Time per Day:	24 hours
Actual Working Days per Year:	335 days
Number of Calling Container Barges per Year:	758 barges (455 barges for Dekheila)
Number of Loading / Unloading Containers per Barge:	192 TEUs (176TEUs for Dekheila))
Conversion Rate:	1.67 TEU / Box
Berth Occupancy Ratio:	70%
Non-operational Hours at Berthing and De-berthing:	1 hour

The required number of container berths in 2010 is obtained as follows:

Berthing Time / Barge
= 192 (TEUs) / 1.67 (TEU / box) / 30 (box / hour) + 1 (hour) = 4.8 hours
(176 (TEUs) / 1.67 (TEU / box) / 30 (box / hour) + 1 (hour) = 4.5 hours for Dekheila)

Required Number of Container Berths
= (4.8 (hours) x 303 (barges) + 4.5 (hours) x 455 (barges)) / 24 hours / 335days / 0.7
= 0.6 → <u>1 berths</u>

(2) Required Number of Container Stacking Ground Slots

Required number of container stacking ground slots is calculated as follows.

(Inbound Containers)

Inbound Containers:	1,438 TEUs / week
Average Number of Stacking Tiers of Inbound Containers:	2.25 tiers
Yard Stacking Efficiency:	1.0
Container Delivery Efficiency:	0.5 /week

Required Number of Ground Slots for Inbound Containers
= 1,438 (TEUs / week) / 2.25 (tiers) x 1.0 x 0.5 (/week) = <u>320 TEUs</u>

(Outbound Containers)

Outbound Containers:	1,438 TEUs / week
Average Number of Stacking Tiers of Outbound Containers:	3.0 tiers
Yard Stacking Efficiency:	1.2
Container Receiving Efficiency:	0.35 /week

Required Number of Ground Slots for Outbound Containers

= 1,438 (TEUs / week) / 3.0 (tiers) x 1.2 x 0.35 (/week) = 202 TEUs

(Empty Containers)

Empty Container Storage Ratio: 20%

Average Number of Stacking Tiers of Empty Containers: 4.0 tiers

Yard Stacking Efficiency: 1.1 / week

Required Number of Ground Slots for Empty Containers

= 137 (000 TEUs / year) x 0.2 / 48 (week) / 4.0 (tiers) x 1.1 = 157 TEUs

Total required number of ground slots is shown in the following table.

Table XI-1 Total Required Number of Ground Slots

Container Status	Required Number of Ground Slots (TEU)
Inbound Container Stacking Slots	320
Outbound Container Stacking Slots	202
Empty Container Stacking Slots	157
Total Required Number of Ground Slots	679

(3) Required Area for Container Freight Station (CFS)

The required area for the CFS is estimated using the following formula.

$$A = (\lambda \times \delta \times V/T) / (\mu \times \xi \varepsilon)$$

where,

V : Annual handling volume of container cargo through CFS (tons),

T : Maximum available working days for the year (= 335 days/year),

λ: Peaking factor to the daily average handling demand (1.3),

δ: Average dwelling time (=7 days),

μ: Unit load per square meter for storage (1.3t ons/m2),

ξ: Passage ratio (=0.5), and

ε: Operational factor (=0.75).

V = 11.8 (average weight of imported container: ton/TEU)

×69,000 (annual handling volume of imported containers: TEU)

×0.98 (laden container ratio of imported containers)

×0.05 (CFS container ratio of imported laden containers) +

12.6 (average weight of exported container: ton/TEU)

×69,000 (annual handling volume of exported containers: TEU)

×0.29 (laden container ratio of exported containers)

×0.05 (CFS container ratio of exported laden containers)

= 52,502 ton / year

A = (1.3×7×52,502 / 335) / (1.3×0.5×0.75) = 2,925 (m2)

(4) Required Number of General Cargo Berths

Assumptions for obtaining the required number of general cargo berths in 2010 are as follows:

Working Time per Day:	16 hours
Actual Working Days per Year:	335 days
Number of Calling General Cargo Barges per Year:	
Timber:	94 barges
Cement:	65 barges
Iron/Steel Products:	38 barges
Number of Loading / Unloading Cargoes per Barge:	1,378 MT
Berth Occupancy Ratio:	70%
Non-operational Hours at Berthing and De-berthing:	1 hour

Required number of general cargo berths in 2010 is obtained as follows:

Berthing Time / Barge (Timber) = 1,378 (MT) / 110 (MT) + 1 (hour) = 13.5 hours
Required Number of Berths (Timber)
= 13.5 (hours) x 94 (barges) / 16 hours / 335 days / 0.7 = 0.3

Berthing Time / Barge (Cement) = 1,378 (MT) / 30 (MT) + 1 (hour) = 46.9 hours
Required Number of Berths (Cement)
= 46.9 (hours) x 65 (barges) / 16 hours / 335 days / 0.7 = 0.8

Berthing Time / Barge (Iron/Steel Products) = 1,378 (MT) / 70 (MT) + 1 (hour) = 20.7 hours
Required Number of Berths (Iron/Steel Products)
= 20.7 (hours) x 38 (barges) / 16 hours / 335 days / 0.7 = 0.2

Total Required Number of General Cargo Berth = 1.3 → 2 berths

(5) Required Areas of Sheds and Open Yard

The required areas of commodity-wise sheds and open yard are estimated using the following formula on the general cargo storage condition presented in the following table.

$$A = (\lambda \times \delta \times V/T) / (\mu \times \xi \varepsilon)$$

where,

V : Annual cargo-wise throughput of conventional cargo (tons),
T : Maximum available working days for the year (= 335 days/year),

λ: Cargo-wise peaking factor to the daily average handling demand,

δ: Average dwelling time (=7 days),

μ: Cargo-wise unit load per square meter for storage,

ξ: Passage ratio (=0.5), and

ε: Operational factor (=0.75).

Table XI-2 Package-wise Storage Conditions of Conventional Cargo

Commodity	Package Style	Peaking Factor (λ)	Unit Load for Storage (μ; ton/m2)	Storage Place
Timber	Bundle	1.3	2.5	Yard
Cement	Bag	1.6	3.0	Shed
Iron/Steel Products	Bundle	1.8	2.0	Yard

1) Sheds

Required area of sheds is calculated at 2,700 m2 based on the conditions below.

A-shed = (λ×δ×V/T) / (μ×ξ)

= (1.6 × 7 ×89,000 / 335) / (3.0 ×0.5 ×0.75)

= 2,645 (m2)

2) Open Yard

Required area of open yard is calculated at 6,000 m2 based on the conditions below.

A-open yard = (λ×δ×V/T) / (μ×ξ)

= (1.3 × 7 × 128,000 / 335) / (2.5 ×0.5 ×0.75)

+ (1.6 × 7 × 52,000 / 335) / (2.0 ×0.5 ×0.75)

= 3,709+ 2,318
= 6,027 (m2)

(6) Cargo Handling Equipment for Container Cargo

1) Quay Side Crane

The required number of quay side movable cranes for handling containers can be obtained by the following formula:

Nqc = A / (T x μ1 x P x Pqc x μ2 x E)

where,

Nqc: Required number of quay side movable cranes
A : Annual throughput in TEUs
T : Maximum annual available working hours
available working day per year = 335 days
actual working hours = 24 hours per day x 335 = 8,040 hours per year
P : Berth occupancy ratio = 0.7
Pqc : Net productivity of quay side movable crane (20 boxes/hour/unit in 2010)
μ1 : Percentage of availability (0.8)
μ2 : Container operation efficiency ratio (0.8)
E : Conversion ratio of 20'/40' (1.67 TEU / box)

Assuming that the operational conditions above and a forecast annual throughput of 137 thousand TEUs for the port, the required number of quay side movable cranes is calculated at two (2) units as

below.

Nqc = 137,000 / (8,040 ×0.8 ×0.7 ×20 ×0.8 ×1.67)

= 1.2 → 2 (units)

2) Rubber Tire Mounted Gantry Crane (RTGs)

The required number of RTGs used at the marshalling yard is estimated by the following formula on the assumption that containers loading / discharging will be stacked once in the marshalling yard.

Nrc = Nrc1 + Nrc2 + Nrc3

Where,

Nrc: Required number of RTGs

Nrc1: RTGs mainly used for quay side crane operation
= One unit RTG x Number of quay side cranes

Nrc2: RTGs mainly used for container receiving/delivery operation
= Number of annual handling containers / Amy / T
= A x R / Amy / T
A : Annual throughput in TEUs
R : Handling times pre unit (3)
Amy = μ1 x Prc x E
μ1: Percentage of available ratio (0.7)
Prc: Productivity of RTG on the basis of gross (23 boxes/hour/unit)
E: Conversion rate of 20' / 40' (1.67 TEUs / box)
Amy = 0.7 x 23 boxes x 1.67 = 26.9
T: Maximum available working hours per year (8,640 hours/year)

Nrc3: Stand-by RTGs for immobilization due to repairmen, periodical inspection or other unforeseen circumstances
= (Nrc1 + Nrc2) x 10%

Nrc 1 = 2
Nrc 2 = (137,000 x 3) / 26.9 / 8,040 = 1.9
Nrc 3 = (2 + 1.9) x 0.1 = 0.4

Nrc = 2Units + 2Units + 1Unit = 5 Units

Total required number of RTGs in 2010 is 5 units.

3) Prime Mover (Tractor / Trailer)

Yard tractor-trailers with chassis run between the quay side apron and the marshaling yard, and transport containers for loading onto or unloading from the container barges. One job cycle time of the yard tractor-trailers largely depends on the traveling distance between quay side cranes and marshaling yard. The required number of yard tractor-trailers for each quay side crane (Nytt) is estimated based on the conditions below.

Nytt = (3.0 + 0.7 / (15 / 60)) / (3.0 ×0.7)

= 5.8 / 2.1 = 2.76 → 3 (units/quay side crane)

Average travel speed of yard tractor-trailers:	15 (km/hour)
Handling time under quay-side crane:	3 (minute/cycle)
Handling time under RTGs:	3 (minutes/cycle)
Average traveling distance of yard tractors:	0.7 (km/cycle)
Operational factor:	0.7

Therefore, the required number of yard tractor-trailers in total is estimated at 6 (= 3 x 2) units.

(7) Cargo Handling Equipment for General Cargo

1) Quay Side Crane

Considering available working range of truck crane and efficient cargo handling, two truck cranes should be applied for one unit of barges. The required number of truck cranes in total is 4 units (2 cranes x 2 berths).

2) Forklifts

It is essential to introduce a sufficient number of forklifts in order to efficiently handle general cargoes. Forklifts are used for receiving cargoes on the apron and delivering cargoes at the shed and open yard. The required number of forklifts is obtained as follows:

Required number of forklifts for receiving cargoes on the apron
= 1 (unit/crane) x 4 (cranes) = 4 (units)

Required number of forklifts for delivering cargoes at the shed and open yard
= 2 (units/berth) x 2 (berth) = 4 (units)

The required number of forklifts in total is 8 units.