Appendix-11.4 Obstacles on Navigation in Alexandria/Cairo IW

Obstacles on navigation are summarized in this Appendix. These obstacles are basically outlined in accordance with the past survey report "Navigation and Infrastructure for RTA" by G.E.M. Consultants B.M., 1994. In addition, results of the cross-sectional sounding survey by the Study are also considered. Consequently, noteworthy obstacles can be summarized in the following Table.

Table A11.4-1 Summary of obstacles

<table>
<tr><th colspan="5">Sunken Units</th></tr>
<tr><th>Stretch</th><th>Km</th><th>Nr.</th><th>Location</th><th>Priority</th></tr>
<tr><td>End lock</td><td>120</td><td>1</td><td>In front of beans factory (Alexandria) at the left bank</td><td>B</td></tr>
<tr><td></td><td></td><td>2,3</td><td>2 units in front Nor El Dien shipyard at the right bank</td><td>C</td></tr>
<tr><td></td><td></td><td>4</td><td>In front of Abou Taleb shipyard at the right bank</td><td>A</td></tr>
<tr><td>Nahada lock</td><td>92</td><td>5</td><td>Nearly at km 92 at the left bank</td><td>B</td></tr>
<tr><td>Sharbat bridge</td><td>90</td><td>6</td><td>In front of El Snoosy village near Sharbat bridge</td><td>B</td></tr>
<tr><td>El Naudia bridge</td><td>75</td><td>7</td><td>Submerged small unit in front of El Sunawy village</td><td>C</td></tr>
<tr><td>Ghanaklis bridge</td><td>62</td><td>8</td><td>Submerged ferry at the left bank</td><td>B</td></tr>
<tr><td>Daowd bridge</td><td>52</td><td>9</td><td>Partly sunken unit 300 m upstream of the bridge at the left bank</td><td>B</td></tr>
<tr><td>Khatatba</td><td>42</td><td>10</td><td>Partially submerged unit at the zone called Al Khaam</td><td>A</td></tr>
<tr><td></td><td>21</td><td>11</td><td>Sunken ferry which was overrun by a barge</td><td>*</td></tr>
<tr><th colspan="5">Unused Irrigation Water Source</th></tr>
<tr><td>Nahada lock</td><td>101</td><td>1</td><td>At the left bank, nearby km 91.5</td><td>B</td></tr>
<tr><td></td><td></td><td>2</td><td>At the right bank, nearby km 91</td><td>B</td></tr>
<tr><td>Shabat bridge</td><td>90</td><td>3</td><td>At about 0.5 km from the end of the first bend upstream of the bridge (stretches out about 8-10 m in the waterway)</td><td>A</td></tr>
<tr><td>El Kreom bridge</td><td>65</td><td>4</td><td>Irrigation water source (still in use) extending about 4 m into the waterway at about 0.4 km downstream El Kroom bridge at the left bank. Another "round " shape concrete structure will be constructed.</td><td>A</td></tr>
<tr><th colspan="5">Various Types of Obstacles</th></tr>
<tr><td>End lock</td><td>119</td><td>1</td><td>Sunken bitt downstream the lock (left bank)</td><td>A</td></tr>
<tr><td>Nahada lock</td><td>100.6</td><td>2</td><td>Sunken bitt (left bank)</td><td>A</td></tr>
<tr><td>R. E. Teraa bridge</td><td>81</td><td>3</td><td>Submerged big stones at the end of the first bend upstream of the bridge</td><td>A</td></tr>
<tr><td>El Mahdia bridge</td><td>75</td><td>4</td><td>Submerged heaps of stones coming from collapsed bank protection at approx. 2 km upstream of the bridge</td><td>A</td></tr>
</table>

continued

Various Types of Obstacle

Stretch	Km	Nr.	Location	Priority
El Mahdia bridge	75	5 6	Submerged stones on both sides just downstream of the bridge Submerged long concrete slab at about 150 m downstream of El Kroom bridge	A
	65.2	7	Steel or concrete pipe extending 10m into waterway at about 200 m downstream of El Kroom bridge on left bank	A
	64.5	8	Drainage pipes cause sedimentation at about 3 km downstream Ghanaklis lock on left bank	B
	64	9	Remains of a bridge and civil structures under water level , at Khemeza area	A
	?	10	Irrigation pipe extends 4 m into waterway at 200 m downstream of Nikla bridge on right bank	A
	28.5	11	Sunken bitt in the middle of waterway	A

Hazardous Shoals

Nr.	Location	Priority	Nr.	Location	Priority	Nr.	Location	Priority
1	132	B	23	158	A	45	180	A
2	137	A	24	159	B	46	181	A
3	138	A	25	160	A	47	182	A
4	139	B	26	161	A	48	183	B
5	140	A	27	162	B	49	184	A
6	141	A	28	163	A	50	185	B
7	142	B	29	164	A	51	186	A
8	143	A	30	165	A	52	187	A
9	144	B	31	166	A	53	188	A
10	145	A	32	167	A	54	189	A
11	146	A	33	168	A	55	190	A
12	147	A	34	169	A	56	191	B
13	148	B	35	170	A	57	195	A
14	149	A	36	171	A	58	197	A
15	150	A	37	172	A	59	198	A
16	151	A	38	173	A			
17	152	A	39	174	A			
18	153	A	40	175	A			
19	154	A	41	176	A			
20	155	A	42	177	A			
21	156	A	43	178	A			
22	157	A	44	179	A			

Appendix-11.5 Requirements of IW (Width and Depth)

This appendix summarizes careful considerations to width or depth of IWs which were examined in the master plan.
As for width or depth, the following standards are outlined and its requirements are examined by Alexandria/Cairo IW and Damietta/Cairo IW, respectively.

- ✓ Existing standard by RTA
- ✓ International standard by PIANC

1. Existing standard (Physical Requirements) by RTA.

At present, RTA has following physical requirements of 1st class waterways in Table A11.5-1.

Table A11.5-1 Physical Standards of 1st class waterways

· River Nile (mainstream of Aswan to Cairo) · Two Branches (Damietta and Rosetta Branch) · El Baheira/El Noubaria canal · Ismaelia canal	
Water Depth	**Width of Navigational Way**
● The maximum draft 1.8 m ● The minimum water depth 2.5 m	●The width of the navigable cross-section not less than 35 m or two lanes (open space) with each one width is 12 m.
Air Clearances	
● The air clearness on the water level under bridges not less than 6 m (excluding movable bridges) Note) In case of Nile mainstream, not less than 13 m (excluding movable bridges)	

Source : Navigation Guide (1999) by RTA (Details are refer to Section 6.2)

Actually, with difference from above Table, RTA has been made IW improvement plans taking account of each site's physical conditions. For example, "Damietta Branch Rehabilitation Project" adopted the following requirements of water depths and width of IW.

- ➤ Design water depth of Damietta Project
  2.3 m (This depth is determined taking account of some clearances which can permit barge's draft of 1.80 m.)
- ➤ Design width of Damietta Project
  Minimum 40 m (This width varies on the basis of bend radii and can permit two-way operation with beam of 7.5 m..)

- ➤ Alexandria/Cairo IW
  Target requirements are depth of 2.3 m and width of 35 m. However, a lot of cross-sections cannot meet these requirements, and it is difficult to largely dredge without decrease in WL as described Chapter 11. These targets can also permit two-way operation with beam of 7.5 m, draft of 1.8 m.

2. Required water depth

In this section, with comparison of the international standard by PIANC and Egyptian standard, water depth of Alexandrai/Cairo IW is examined.

In general, international organization such as PIANC recommended the following design method of water depth.

Table A11.5-2 Estimation Factors of Channel Water Depth by PIANC

Depth is estimated from :

- At-rest draft of design ship
- Tide height throughout transit of channel
- Squat
- Wave-induced motion
- A margin depending on type of bed bottom
- Water density and its effect on draught

All the above values for draft, squat, wave action and margin are additive.

Source : "Approach Channels a Guide for Design (June 1997)" ,Final Report of the Joint PIANC and IAPH, at Working Group II-30.

PIANC : Permanent International Association of Navigation Congresses

IAPH : International Association of Ports and Harbours

As above estimation factors by PIANC, some of factors are unnecessary to be considered in case of Egyptian IW in the Delta. Because these IWs are located in area of fresh water and have a little part of estuary.

The following Table indicates the needed factors by PIANC and compare with designed values of Damietta Project.

Estimation Factors by PIANC	In case of waterways in the Delta (Damietta Branch)
At-rest draft of design ship (ΔDkc)	In case of Damietta project, keel clearance = 0.10 m
Tide height throughout transit of channel	- almost negligible-
Squat (ΔDs)	In case of Damietta project, 0.15 m
Wave-induced motion	- negligible-
A margin depending on type of bed bottom (ΔDb)	In case of Damietta project, 0.15 m
Water density and its effect on draft	- almost negligible-

In case of Damietta Project, total clearance is estimated at 0.50 m which value is ΔDkc + ΔDs + ΔDb = 0.40 m added to other margin 0.10 m as above table.

In the master plan, core system of future IWT will be new type barge. Consequently, important factor is design draft of barge and required water-depth is estimated by the ratio of depth to draft.

This estimation method is simple, in case of Damietta Project, the depth/draft ratio is indicated as follows.

- Depth/Draft Ratio Methods
  - Depth/Draft Ratio in case of Damietta Project

    Approx. 1.28 as below equation

$$\text{Depth/Draft Ratio} = \frac{\text{Required water depth 2.3 m}}{\text{Designed Draft 1.8 m}} \quad \text{(=Max. Draft 1.8 m + Total Clearances 0.5 m)}$$

On the other hand, PIANC indicated Depth/Draft Ratio as below table A11.5-3.

Table A11.5-3 Depth/Draft Ratio by PIANC

In the absence of other information,
minimum values of depth/draft ratio should be taken as :
1.10 in sheltered water
1.3 in waves up to one meter in height
1.5 in higher waves with unfavorable periods and directions

Source : "Approach Channels a Guide for Design (June 1997)" ,Final Report of the Joint PIANC and IAPH

One of major strategies is enlargement of barges to the maximum extent that the physical conditions of improved IW facilities will permit. According to this strategy, draft of new- type barge will be determined by the permissible Depth/Draft Ratio.
In general, Depth/Draft Ratio should be estimated at the minimum, in order to minimize a dredging work and to maximize size of barge.

In the master plan, Depth/Draft Ratio of Alexandria/Cairo IW is applied as more than 1.10 and less than 1.28 for the following reason.

Such Depth/Draft Ratio = 1.28 is the case of "Damietta Project", and Alexandria/Cairo waterway is likely to be superior to the Damietta Branch in aspects of navigational conditions as follows:

Table A11.5-4 Summary of Comparison between Alex./Cairo IW and Damietta Branch

	Alexandria/Cairo waterway	Damietta Branch
Type	Manmade Canal	Natural River
Alignment	Almost straight except for two sharp bends	There are a large number of meanders. There are some islands and sand bars
Current Velocity	It is almost certain smaller than Damietta Branch	about 1 m/sec (high discharge period) 0.1m/sec (low discharge period)
Bottom Conditions	Sand or Silt	Sand or Silt

Estimated by JICA team

As shown in above table, Alexandria/Cairo waterways is composed of Baheria and Noubaria canals which have more better navigational conditions such as alignment than Damietta Branch. Thus, the Depth/Draft Ratio of Alexandria/Cairo waterway is applied as the highest value = 1.28. Moreover, above ratio = 1.10 is the lowest value as the minimum standard of PIANC.

However, with applying smaller ratio of depth/draft, it is necessary to consider bottom resistance due to limited KC (Keel Clearance). Needless to say, the bottom resistance generally depends on shape of the bottom of barges and KC.

Meanwhile, the enlargement of laden capacity has led to the increase in bottom resistance. Because a hull of barge is becoming almost rectangular in shape, in order to enlarge of laden capacity, thus bottom resistance is increasing compared with a rounded hull.

In consideration of above aspects, the master plan proposes that KC = 40 cm, target depth = 2.0 m and draft of new barge = 1.6 m, namely Depth/Draft Ratio = 1.25.

3. Required Width

As described in Chapter 11, minimum width of Alexandria/Cairo IW is estimated at 35 or 36 m. because large amount of widening will cause decrease in WL and dredging is not necessarily effective countermeasure without increase in water-discharge. Consequently, maximum width of barge is determined at 12 m corresponding to above-mentioned 35 or 36 m.

In this section, trial estimation by international standard (PIANC) is carried out for reffernce.

In general, PIANC recommended the following design method regarding widths of channels.
The bottom width w of the waterway (see Figure V-1) is given for a one-way canal by:

$$w = w_{BM} + \sum_{i=1}^{n} w_i + w_{Br} + w_{Bg} \qquad \text{-Eq (V-1)}$$

and for a two-way canal by:

$$w = 2w_{BM} + 2\sum_{i=1}^{n} w_i + w_{Br} + w_{Bg} + \sum w_p \qquad \text{-Eq(V-2)}$$

Source : "Approach Channels A Guide for Design (June 1997)" ,Final Report of the Joint PIANC and IAPH

Where, as shown below Figure, W_{Br} and W_{Bg} are the bank clearances on the "red" and "green" side. ΣW_p is passing distance and the W_i are additional widths as given Table V-8. The basic maneuvering width W_{BM} is given following Table V-5.

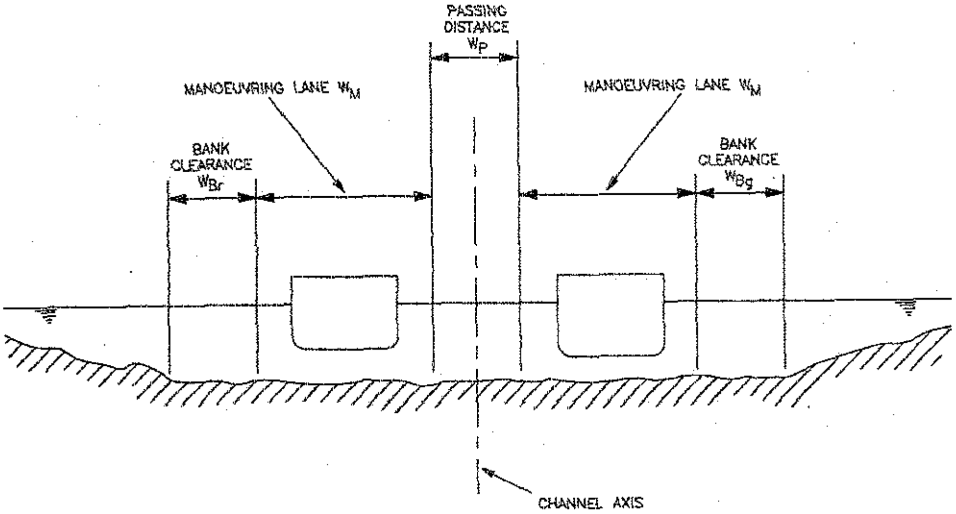


Figure A11.5-1 Elements of Canal Width

Following tables from Table V-5 to Table V-8 indicate each required elements of Alex./Cairo waterway based on PIANC's Guideline Tables and estimation JICA study team.

Table A11.5-5 Basic Maneuvering Lane

Ship Manoeuvrability	**good**	**moderate**	**poor**
Basic Manoeuvring Lane, w_{BM}	1.3 B	1.5 B	1.8 B

Note : referring to design barge : B = Beam

estimation by JICA study team

Table A11.5-6 Passing Distance in Two-way Traffic

PASSING DISTANCE w_P	**Outer Channel exposed to open water**	**Inner Channel protected water**
Vessel speed (knots)		
- fast > 12	2.0 B	-
- moderate > 8 - 12	1.6 B	1.4 B
- slow 5 - 8	1.2 B	1.0 B
Encounter traffic density		
- light	0.0	0.0
- moderate	0.2 B	0.2 B
- heavy	0.5 B	0.4 B

Note : referring to design barge : B = Beam

estimation by JICA study team

Table A11.5-7 Width for Bank Clearance

WIDTH for BANK CLEARANCE (w_{Br} or w_{Bg})	**Vessel Speed**	**Outer Channel exposed to open water**	**Inner Channel protected water**
Sloping channel edges and shoals :			
	fast	0.7 B	-
	moderate	0.5 B	0.5 B
	slow	0.3 B	0.3 B
Steep and hard embankments, structures :			
	fast	1.3 B	-
	moderate	1.0 B	1.0 B
	slow	0.5 B	0.5 B

Note : referring to design barge : B = Beam

estimation by JICA study team

Consequently, required width of Alexandria/Cairo Waterway is estimated using aforementioned equations (V-1) or (V-2) as follows:

- Required Width of Alexandria/Cairo waterways
  - Required width is estimated at 2.6 B (in case of one-way canal)
    $W_{BM} + \Sigma W_i + W_{Br} + W_{Bg} = 1.5B + 0.5B + 0.3B + 0.3B = 2.6\ B$
  - Required width is estimated at 5.6 B (in case of two-way canal)
    $2W_{BM} + 2\Sigma W_i + W_{Br} + W_{Bg} + \Sigma W_p$
    $= 2\times 1.5B + 2\times 0.5B + 0.3B + 0.3B + 1.0B = 5.6\ B$

Where, important notices are that required width depends on beam (B) of design barge, and depth (H) of waterway. Especially, later one indicates that additional width is estimated at 0.2B in case of ($1.15 < H/T < 1.5$) as shown in Table V-8 (here, T is draft of design barge).

In each case of barge types or waterway conditions, Table V-10 shows required widths of Alex./Cairo waterway. Each case is set up based on barge types and waterway sections as Table V-9.

As a result of PIANC method, estimated minimum width of IW is about 2 times design minimum width (36 m) in the master plan. However, other countermeasures such as semi-two operation, supplemental navigation aids are proposed in the master plan. In addition, according to hearing from badge operators or crews, there are no hindrances in case of 36 m wide when its design width and depth are certainly secured by improvement works.

Table A11.5-8 Additional Width for Straight Canal Sections

WIDTH w_i	Vessel Speed	Outer Channel exposed to open water	Inner Channel protected water
(a) Vessel speed (knots)			
- fast > 12		0.1 B	0.1 B
- moderate > 8 - 12		0.0	0.0
- slow 5 - 8		0.0	$\boxed{0.0}$
(b) Prevailing cross wind (knots)			
- mild ≤ 15 (≤ Beaufort 4)	all	0.0	$\boxed{0.0}$
- moderate > 15 - 33	fast	0.3 B	-
(> Beaufort 4 - Beaufort 7)	mod	0.4 B	0.4 B
	slow	0.5 B	0.5 B
- severe > 33 - 48	fast	0.6 B	-
(> Beaufort 7 - Beaufort 9)	mod	0.8 B	0.8 B
	slow	1.0 B	1.0 B
(c) Prevailing cross current (knots)	almost negligible in case of Alex./Cairo Waterway		
(d) Prevailing longitudinal current (knots)			
- low ≤ 1.5	all	0.0	$\boxed{0.0}$
- moderate > 1.5 - 3	fast	0.0	-
	mod	0.1 B	0.1 B
	slow	0.2 B	0.2 B
- strong > 3	fast	0.1 B	-
	mod	0.2 B	0.2 B
	slow	0.4 B	0.4 B
(e) Significant wave height H_S and length λ (m)	negligible in case of Alex./Cairo Waterway		
(f) Aids to Navigation			
- excellent with shore traffic control		0.0	0.0
- good		0.1 B	0.1 B
- moderate with infrequent poor visibility		0.2 B	$\boxed{0.2 B}$
- moderate with frequent poor visibility		≥ 0.5 B	≥ 0.5 B
(g) Bottom surface			
- if depth ≥ 1.5T		0.0	0.0
- if depth < 1.5T then			
- smooth and soft		0.1 B	$\boxed{0.1 B}$
- smooth or sloping and hard		0.1 B	0.1 B
- rough and hard		0.2 B	0.2 B
(h) Depth of waterway			
- ≥1.5T		0.0	≥1.5T 0.0
- 1.5T - 1.25T		0.1 B	<1.5T-1.15T $\boxed{0.2 B^*}$
- <1.25T		0.2 B	<1.15T 0.4 B
(i) Cargo hazard level			
- low		0.0	$\boxed{0.0}$
- medium		~ 0.5 B	~ 0.4 B
- high		~ 1.0 B	~ 0.8 B

Note : referring to design barge : B = Beam, T=Draft

$\boxed{}$: estimation by JICA Study Team.

* is estimated for Baheria and Noubaria Canal

Source of Table V-5 to V-8 is "Approach Channels a Guide for Design (June 1997)", Final Report of the Joint PIANC and IAPH

Table A11.5-9 Rough Estimation of H/T in Alex./Cairo Waterway

(H is actual depth of each site)

Barge type Canal Section	**Existing Barge (Twin Type)** **Max. Draft (T) is 1.8 m** **Beam is 7.5 m, Length is 100 m**	**Proposed New Barge (Twin Type)*** **Max. Draft (T) is 1.6 m** **Beam is 12.0 m, Length is 100 m**
Baheria Canal	Rough estimation is 1.15 < H/T < 1.5 **	Rough estimation is 1.15 < H/T < 1.5
Noubaria Canal	Rough estimation is H/T < 1.15 **	Rough estimation is 1.15 < H/T < 1.5

Note : * Proposed New-generation Barge is described in Section 11.6.1.

** Detailed estimations of each section's depth are indicated in Next Section 11.5.

Table A11.5-10 Required Width of Alex./Cairo Waterway (based on above Table A11.5.8)

Barge type Canal Section	**Existing Barge (Twin Type)** **Max. Draft (T) of 1.8 m** **Beam (B) of 7.5 m, Length is 100 m**	**Proposed New Barge (Twin Type)*** **Max. Draft (T) of 1.6 m** **Beam (B) of 12.0 m, Length is 100 m**
Baheria Canal	42 m (is 5.6B) for two-way canal 20 m (is 2.6B) for one-way canal	68 m (is 5.6B) for two-way canal 32 m (is 2.6B) for one-way canal
Noubaria Canal	45 m (is 6.0B) for two-way canal 21 m (is 2.8B) for one-way canal	68 m (is 5.6B) for two-way canal 32 m (is 2.6B) for one-way canal

Appendix-11.6 Estimation of Lock Capacity

In this Appendix, the capacity of Alexandria/Cairo IW is estimated at the number of daily passable units (barges) in 2020. Regarding Damietta/Cairo IW, the later half of this Appendix similarly indicates its estimated passable traffic volume in the view of lock capacity.

1. Lock Capacity of Alexandria/Cairo IW

Assumptions for estimating the number of daily passable units are as follows.

- Improvement of operational cycle-time of the Nahda lock
- Number of barge traffic on the basis of demand forecast in 2020

1-(1) Operational cycle-time of the lock

Existing operational cycle-time of the each lock are as follows:

Lock	Difference between WLs of Up-/Down-stream	Operational Cycle-Time				
		Total Cycle Time for Water-charge and-discharge		Total 10 min for Gate operation & Enter/Leave of Barge	Total Time for Upward/Downward	
		Upstream ward	Downstream ward			
Kanater	1.7 to 0.4 (m)	10 min	10 min		20 min	20 min
Khataba	1.2 to 0.1 (m)	20 min	15 min		30 min	25 min
Boulin	0.8 to 0.2 (m)	15 min	12 min		25 min	22 min
Busstan	0.4 to 0.0 (m)	10 min	10 min		20 min	20 min
Janaklees	0.5 to 0.1 (m)	12 min	10 min		22 min	20 min
Nahda	5.6 to 5.3 (m)	45 min	35 min		55 min	45 min
End lock	2.5 (m)	15 min	15 min		25 min	25 min

Source) Estimation by the Study Team

Among these locks, the Nahda lock has the longest operational cycle-time due to the largest WLs' difference.

In order to meet increase in barge traffic in 2020, it is needed that operations of water-charge/ discharge will be improved by introduction of mechanical system such as pumping system. In the master plan, it is considered that discharge-time is expected to be shortened by about 10 min with above pumping system. Consequently, it is assumed that total operational cycle-time of Nahda Lock should be reduced from a maximum 55 min to a maximum 45 min.

1-(2) Number of barge traffic volume in 2020

The number of barge traffic through Alexandria/Cairo IW is shown in Table A11.6-1, and this traffic volume is estimated by the following assumptions.

- **Size of barges and its loading capacities**

In 2020, it is assumed that large barges will enter services between GCR and Alexandria, and existing standard type units (width of 7.5 m) will navigate the Central Delta such as Rosetta branch (Kafr El Zayat) and will continuously transport from Upper Egypt to GCR.

Large Barge (width of 12 m): laden capacity is 1,378 MT (1,450 DWT) or 96 TEU (88 TEU*)

*Coastal barge between Dekheila and GCR has a capacity of 88 TEU

Existing standard type (width of 7.5 m): laden capacity is 713 MT (750 DWT)

- **Number of units (barges) per day**

The number of units per day (N) is estimated using the following equation. As a result, daily traffic is estimated at 32 units in all, in consideration of some congestion due to seasonal or daily fluctuations of barge traffic (see Table A11.6-1).

$N = Ny/T \times \lambda$ -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.

Table A11.6-1 Traffic Volume in 2020 via Alexandria-Cairo IW (Noubaria Canal)

IW Route		Cargo Item	Cargo Volume Allocated to IWT (2020)		Number of Barges (units)		Eq. (A)		Peaking Factor (λ)
					(Cargo volume per units)	(Number of units per year)	(Number of units per day)		
Up-stream (Alexandria to GCR)		Wheat	326	'000MT	/1378 MT=	237	1.0		1.4
		Maize	432	'000MT	/1378 MT=	314	1.3		
		Coal	675	'000MT	/1378 MT=	491	1.9		1.3
		Timber	342	'000MT	/1378 MT=	249	1.0		1.3
		Cement	62	'000MT	/1378 MT=	46	0.2		1.3
		Iron/Steel Products	68	'000MT	/1378 MT=	50	0.2		1.3
		Containers (TEUs)	120	'000TEU	/96 (or 88) TEU=	1,327	5.1		1.3
Down-stream (GCR to Alexandria)		Mollases	233	'000MT	/1378 MT=	170	0.9		1.8
		Coke	300	'000MT	/1378 MT=	218	0.8		1.3
		Containers (TEUs)	120	'000TEU	/96 (or 88) TEU=	1,327	5.1		1.3
Down-stream (Upper Egypt to Alex.)		Mollases	257	'000MT	/713 MT=	361	1.9		1.8
Up-stream	(between Alexandria and Kafr El Zayat)	Sulfur	131	'000MT	/713 MT=	184	0.7		1.3
		Grease	30	'000MT	/713 MT=	43	0.2		1.3
Down-stream		Super Phosphate	130	'000MT	/713 MT=	183	0.7		1.3
		Total number of units per year (Up-stream)				3,873	16.0	units per day	
		Total number of units per year (Down-stream)				3,873	16.0	units per day	

In Equation (A), T=335 days/year, namely blockade period of IW is estimated at 1 month although one of strategies of the conceptual plan is to shorten blockade's period as much as possible. In order to avoid to underestimating daily traffic, it is assumed that such closing period is 1 month in consideration of existing blockade period of IWs.

As for peaking factor λ, existing barge traffic pattern seems to indicate considerable fluctuations (seasonable congestion), namely barge operation during summer is generally more active than winter period. In future, IWT sector will make an effort to secure "regular service all round year" in order to attract mass-transportation users, thus, such fluctuations will be reduce in 2020. As a result, peaking factor is applied at λ =1.3 except for agricultural cargoes. As for grain cargoes such as maize (summer crops in Egypt) and wheat (winter crops), λ =1.4 is assumed because such imported grain cargoes are mainly transported to supply the deficit of local production. λ =1.8 is assumed for molasses because volume of its transportation strongly depends on the crop of sugar cane (summer crops).

The applicability of the "λ (peaking factor)" used in above table is expected to be verified by using actual statistics of barge traffic after IWT will be more active due to "regular service all round year" in these commodities such as containers, grain and other goods.

1-(3) Lock Capacity of Alexandria/Cairo IW

As described in the former section 1-(1), total operational cycle-time of Nahda Lock should be improved from a maximum 55 min to a maximum 45 min, by installation of appropriate pumping system.

On this condition, the capacity of Alexandria/Cairo IW is estimated at 32 units per day (see Table A11.6-2). Consequently, capacities of canals can meet increase in the traffic of units for 2020.

Table A11.6-2 Capacities of Nahda Lock

	Nahda Lock (Alex/Cairo IW)
Operational cycle-time	Total cycle time will be 0.75 hour.
Lock Capacity	32 units per day (=24 hours/0.75)

Note: 1) Cycle-time includes open/close time of gates, water-filling/discharge time, and enter/leave time of units.
2) Introduction of 24-hours operation is assumed.

2. Lock Capacity of Damietta/Cairo IW

2-(1) Operational cycle-time of the lock

When "Damietta Project" is completed, three (3) locks are expected to be operated by RTA. Among them, construction works of two locks are well underway. It is assumed that the longest operational cycle-time of these lock will be 0.5 hours:

2-(2) Number of barge traffic volume in 2020

The number of barge traffic through Damietta/Cairo IW is shown in Table A11.6-3. A calculation procedure is the same as previous case of Alexandria/Cairo IW, and resulting traffic volume is estimated by the following assumptions.

- **Size of barges and its loading capacities**

  In 2020, it is assumed that large barges will enter services between GCR and Damietta.

  Large Barge (width of 12 m): laden capacity is 1,378 MT (1,450 DWT) or 96 TEU

- **Number of units (barges) per day**

  The number of units per day (N) is estimated using the following equation. As a result, daily traffic is estimated at 13 units (to be exact, 12.2 units) in all, in consideration of some congestion due to seasonal or daily fluctuations of barge traffic (see Table A11.6-4).

$N = Ny/T \times \lambda$ -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.

Table A11.6-3 Traffic Volume in 2020 via Damietta-Cairo IW

IW Route	Cargo Item	Cargo Volume Allocated to IWT (2020)		Number of Barges (units)		Eq. (A)		Peaking Factor (λ)
				(Cargo volume per barge)	(Number of barges per year)	(Number of barges per day)		
Up-stream (Damietta to GCR)	Maize	285	'000MT	/1378 MT=	208	0.9		1.4
	Wheat	417	'000MT	/1378 MT=	303	1.3		
	Timber	86	'000MT	/1378 MT=	63	0.2		1.3
	Containers (TEUs)	92	'000TEU	/96 TEU=	955	3.7		1.3
Down-stream (GCR to Damietta)	Containers (TEUs)	92	'000TEU	/96 TEU=	955	3.7		1.3
	Total number of barges per year (Up-stream)				1,529	6.1	units per day	
	Total number of barges per year (Down-stream)				1,529	6.1	units per day	

2-(3) Lock Capacity of Damietta/Cairo IW

As described in the former section 2-(1), total operational cycle-time of lock along this IW is estimated at 30 min.

On such condition, the capacity of Alexandria/Cairo IW is estimated at 48 units per day (see Table A11.6-4). Consequently, capacities of canals can meet increase in the traffic of units for 2020.

Table A11.6-4 Capacities of Lock in Damietta Branch

	Damietta/Cairo IW
Operational cycle-time	Total cycle time will be 0.50 hour.
Lock Capacity	48 units per day (=24 hours/0.50)

Note: 1) Cycle-time includes open/close time of gates, water-filling/discharge time, and enter/leave time of units.

2) Introduction of 24-hours operation is assumed.

Appendix-11.7 Width of Damietta/Cairo IW

The bases of dimension of Damietta/Cairo IW at planning/design stages are summarized in this Appendix. How to determine width and depth of IW in "Damietta Project" has a great importance for the master plan, because a review of "Damietta Project" is needed to examine a possibility of introduction new-wider barge in Damietta/Cairo IW.

This appendix mainly quotes the following study (hereinafter referred to as "Damietta Study"):
Volume III A -Feasibility Study, Technical Development-, "Proposed Damietta/Cairo Inland Waterway Rehabilitation Project", February 87.

According to above Damietta Study, the bases of determination of this IW width are quoted as follows:
The necessary canal width is contingent on:

- Size of the foreseen barges
- Bend radii of IW
- Type of traffic, one-way traffic or oncoming traffic (Two-way)
- Speed of barges
- Flow velocity of IW
- Required safety distances,
- Discharge volume and IW depth
- Traffic density.

Besides, the bases of determination of this IW depth are indicated in Appendix-11.5.

Above bases are almost same with the approach of PIANC (see Appendix-V for detail). As the conclusion of Damietta Study, required minimum wide is estimated at 40 m in the case of oncoming (Two-way) traffic with barge's beam of 7.5 m. Another major reason of its determination is bend radii as 1,500 m, namely, a maximum bend radius of Damietta Branch is estimated at 1,500 m (see Figure A11.7-1 in next page). Moreover, "Damietta study" suggested that minimum required width is approximately 50 m in the case of oncoming traffic with barge's beam of 11.6 m. These cases assume that both oncoming barges pass each other at normal speed.

However, the master plan proposes that new operation methods will be applied in case of new wider barge. According to this new operation, when wider barges moving in opposite directions encounter each other, one barge should stop and safe navigation will be secured even though increase in traffic of wider barges. Therefore, design width of Damietta Project is adequate for navigation of new wider barges.

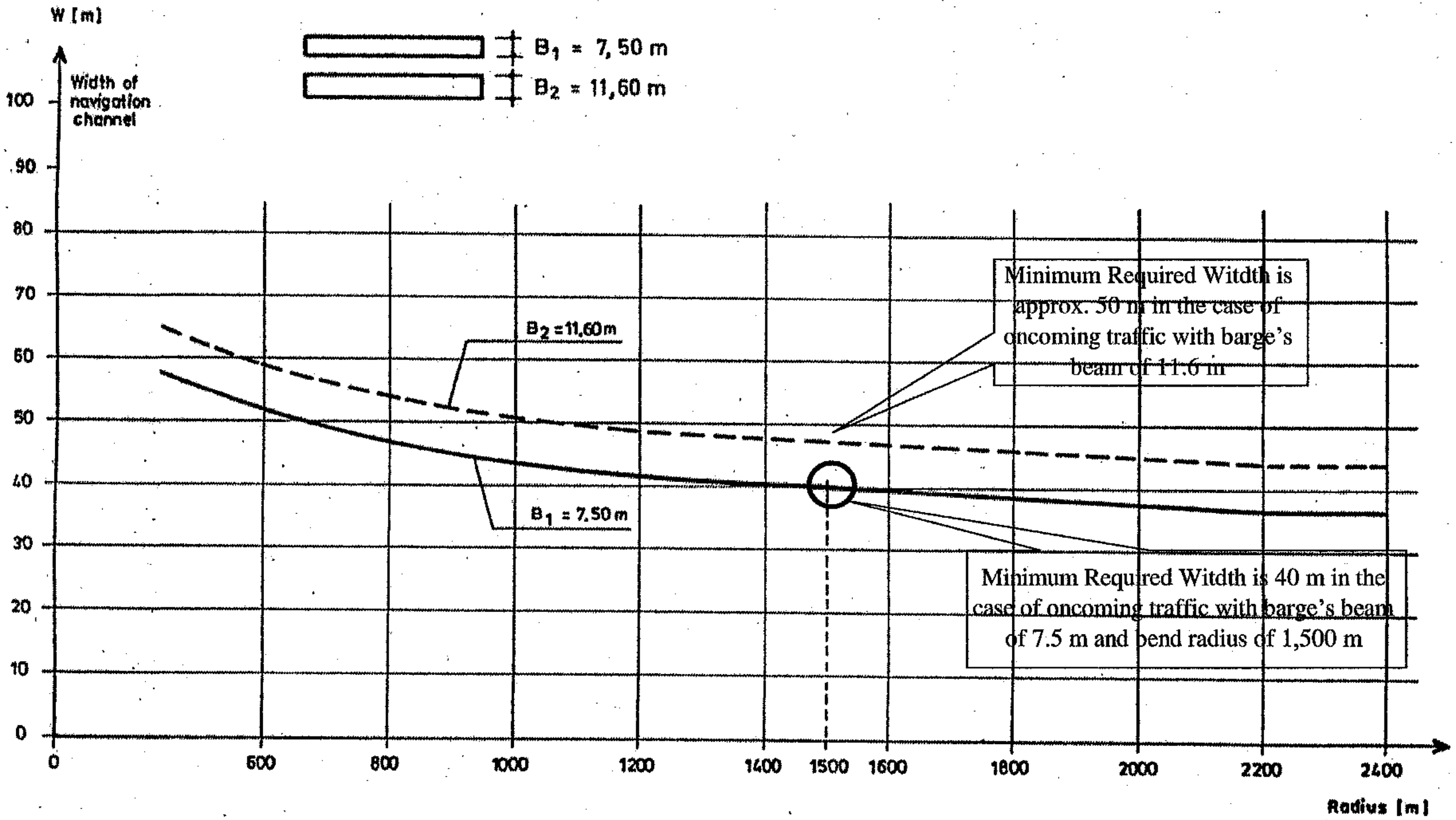


Figure A11.7-1 Required Width of IW source) Damietta Study 1987

Appendix- 11.8 (Long-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 2020 are as follows:

Working Time per Day:	24 hours
Actual Working Days per Year:	335 days
Number of Calling Container Barges per Year:	2,286 barges (910 barges for Dekheila)
Number of Loading / Unloading Containers per Barge:	192 TEUs (176 TEUs 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 2020 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 1,376 (barges) + 4.5 (hours) x 910 (barges)) / 24 hours / 335days / 0.7

= 1.9 → <u>2 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:	4,417 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

= 4,417 (TEUs / week) / 2.25 (tiers) x 1.0 x 0.5 (/week) = <u>982 TEUs</u>

(Outbound Containers)

Outbound Containers:	4,417 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

= 4,417 (TEUs / week) / 3.0 (tiers) x 1.2 x 0.35 (/week) = <u>618 TEUs</u>

(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

= 423 (000 TEUs / year) x 0.2 / 48 (week) / 4.0 (tiers) x 1.1 = <u>485 TEUs</u>

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

Total Required Number of Ground Slots

Container Status	Required Number of Ground Slots (TEU)
Inbound Container Stacking Slots	982
Outbound Container Stacking Slots	618
Empty Container Stacking Slots	485
Total Required Number of Ground Slots	2,085

(3) Required Number of General Cargo Berths

Assumptions for obtaining the required number of general cargo berths in 2020 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:	317 barges
Cement:	47 barges
Iron/Steel Products:	51 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 2020 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 317 (barges) / 16 hours / 335 days / 0.7 = 1.1

Berthing Time / Barge (Cement) = 1,378 (MT) / 30 (MT) + 1 (hour) = 46.9 hours

Required Number of Berths (Cement)

= 46.9 (hours) x 47 (barges) / 16 hours / 335 days / 0.7 = 0.6

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 51 (barges) / 16 hours / 335 days / 0.7 = 0.3

Total Required Number of General Cargo Berth = 2.0 → <u>2 berths</u>

(4) 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.

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

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).

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 2,000 m2 based on the conditions below.

$$A\text{-shed} = (\lambda \times \delta \times V/T) / (\mu \times \xi\varepsilon)$$

$$= (1.6 \times 7 \times 64{,}000 / 335) / (3.0 \times 0.5 \times 0.75)$$

$$= 1{,}902\ (m2)$$

2) Open Yard

Required area of open yard is calculated at 16,000 m2 based on the conditions below.

$$A\text{-open yard} = (\lambda \times \delta \times V/T) / (\mu \times \xi\varepsilon)$$

$$= (1.3 \times 7 \times 436{,}000 / 335) / (2.5 \times 0.5 \times 0.75)$$

$$+ (1.6 \times 7 \times 70{,}000 / 335) / (2.0 \times 0.5 \times 0.75)$$

$$= 12{,}633 + 3{,}120$$

$$= 15{,}753\ (m2)$$

(4) 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:

$$Nqc = A / (T \times \mu 1 \times P \times Pqc \times \mu 2 \times E)$$

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 2020)

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 423 thousand TEUs for the port, the required number of quay side movable cranes is calculated at four (4) units as below.

Nqc = 423,000 / (8,040 ×0.8 ×0.7 ×20 ×0.8 ×1.67)

= 3.5 → 4 (units)

2) Rubber Tire Mounted Gantry Crane (RTG)

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 (8,040 hours/year)

Nrc3: Stand-by RTGs for immobilization due to repairmen, periodical inspection or other unforeseen circumstances

= (Nrc1 + Nrc2) x 10%

Nrc 1 = 4

Nrc 2 = (423,000 x 3) / 26.9 / 8,040 = 5.9

Nrc 3 = (4 + 5.9) x 0.1 = 0.99

Nrc = 4Units + 6Units + 1Unit = 11Units

Total required number of RTGs in 2020 is 11 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.

$$\text{Nytt} = (3.0 + 0.7 / (15 / 60)) / (3.0 \times 0.7)$$

$$= 5.8 / 2.1 = 2.76 \rightarrow 3 \text{ (units/quay side crane)}$$

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 12 (= 3 x 4) units.

(5) 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) Forklift

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.

Appendix 11-9 Rough Estimate of Dredging Volume along the Upper River Nile

The possible volume of maintenance dredging is estimated based on the results of cross sectional survey which was carried out by the Study Team for 1 km distance at each specified 30 location along the Upper River Nile form Cairo to Asyut. The estimated volume of dredging for each specified location is summarized in the following Table for two cases of water depth requirement, CASE 1: Water Depth of 2.3 m and CASE 2: Water Depth of 2.5 m.

Roughly estimated cost for the above estimated maintenance dredging was obtained at L.E. 33.7 million for 2.4 million cubic meters dredging work (CASE 1: water depth of 2.3 m) and L.E. 39.6 million for 2.8 million cubic meters dredging works (CASE 2: water depth of 2.5 m) respectively as summarized below.

Table A11.9.1 Cost Estimate on Maintenance Dredging from Asyut to Cairo (million L.E.)

			CASE 1	CASE 2
			Min. Depth = 2.3 m	Min. Depth = 2.5 m
			V=2.36 mil m3	V=2.78 mil m3
A	Dredging Cost		28.4	33.4
B	Indirect Cost	(A) x 15%	4.3	5.0
C	Sub Total	(A) + (B)	32.7	38.4
D	Engineering Cost	(C) x 3 %	1.0	1.2
	Total	(C) + (D)	33.7	39.6

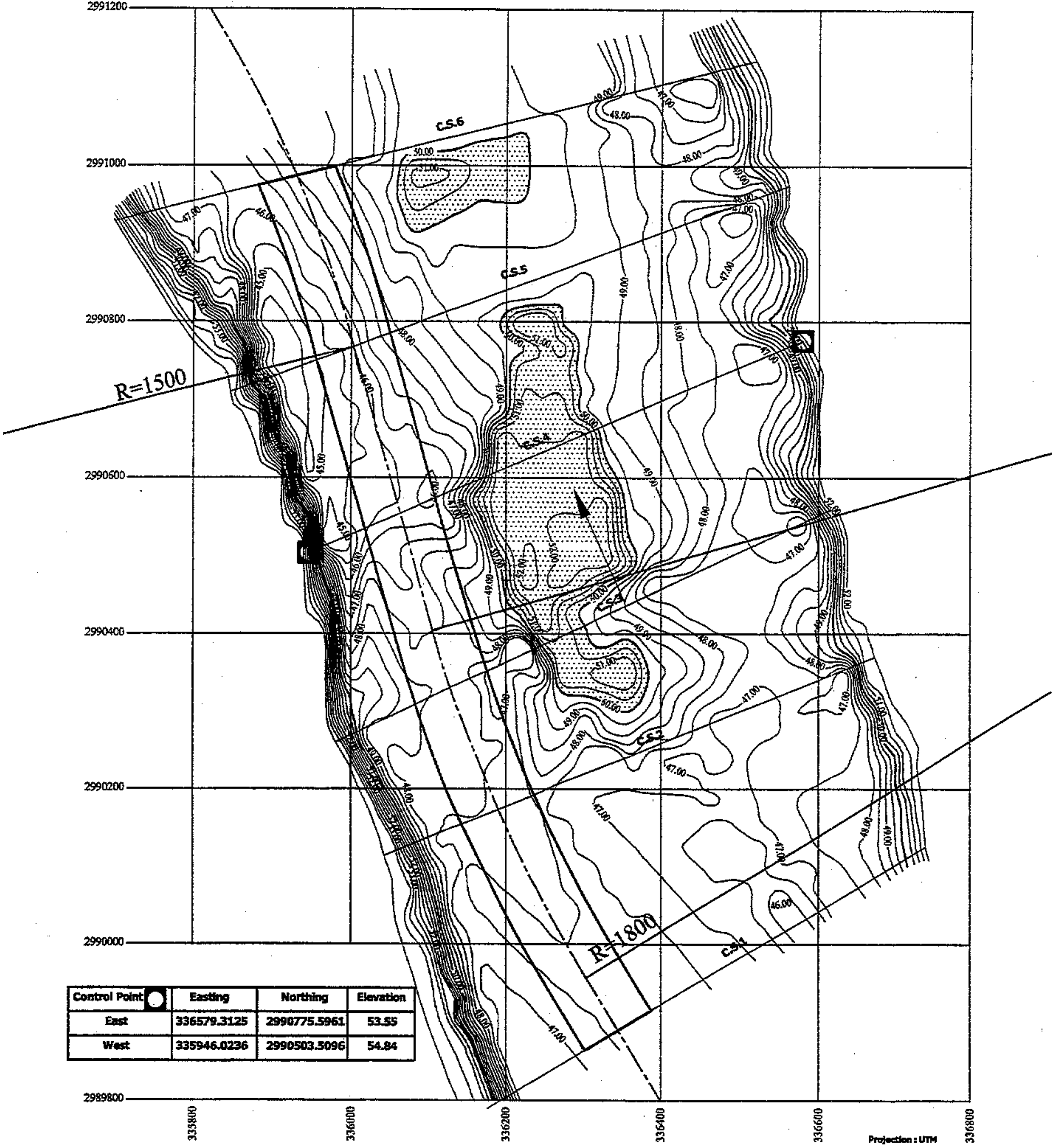
Dredging Volume CASE-1 (Min.Water Depth -2.3m)

Point	Section	Area (m2)	Length (m)	Volume (m3)
S01	1	86.78		
	2	59.98	323	23,730
	3	102.25	168	13,648
	4	0.00	233	11,914
	5	20.32	222	2,254
	6	50.78	230	8,190
	V01			59,737
S02	1	4.27		
	2	10.14	252	1,820
	3	10.61	129	1,340
	4	15.95	199	2,639
	5	1.19	163	1,398
	6	2.10	246	404
	V02			7,601
S03	1	0.00		
	2	0.00	326	0
	3	0.00	240	0
	4	2.30	187	216
	5	26.19	170	2,427
	6	60.89	172	7,491
	V03			10,134
S04	1	95.83		
	2	14.94	185	10,256
	3	25.61	146	2,963
	4	33.08	171	5,021
	5	1.11	177	3,021
	6	8.93	146	732
	V04			21,994
S05	1	0.00		
	2	0.00	158	0
	3	0.00	137	0
	4	36.96	185	3,414
	5	168.49	184	18,936
	6	202.22	209	38,676
	V05			61,026
S06	1	0.11		
	2	18.85	216	2,044
	3	23.12	211	4,431
	4	99.83	189	11,623
	5	251.55	190	33,455
	6	299.85	182	50,137
	V06			101,690
S07	1	38.42		
	2	6.24	296	6,602
	3	56.01	188	5,843
	4	54.20	156	8,598
	5	95.65	175	13,101
	6	93.98	193	18,253
	V07			52,396
S08	1	1.42		
	2	2.06	140	243
	3	38.25	136	2,738
	4	46.80	215	9,136
	5	59.40	114	6,062
	6	191.68	146	18,333
	V08			36,511
S09	1	94.83		
	2	111.72	183	18,863
	3	112.65	150	16,831
	4	89.94	201	20,332
	5	71.40	173	13,968
	6	91.08	192	15,597
	V09			85,591
S10	1	2.37		
	2	20.26	151	1,713
	3	3.59	220	2,624
	4	0.00	209	376
	5	3.34	175	291
	6	2.58	216	639
	V10			5,644
S11	1	27.95		
	2	141.57	208	17,602
	3	172.55	247	38,813
	4	144.91	198	31,442
	5	98.35	229	27,907
	6	0.00	227	11,169
	V11			126,932
S12	1	0.20		
	2	5.81	224	675
	3	3.45	186	863
	4	37.12	216	4,392
	5	0.90	233	4,437
	6	0.00	168	76
	V12			10,441
S13	1	3.87		
	2	104.41	279	15,105
	3	151.85	215	27,576
	4	149.71	230	34,712
	5	0.00	184	13,751
	6	0.00	218	0
	V13			91,144
S14	1	0.00		
	2	20.95	195	2,043
	3	66.53	237	10,383
	4	110.47	220	19,453
	5	107.48	213	23,158
	6	27.73	229	15,510
	V14			70,547
S15	1	219.10		
	2	140.11	203	36,454
	3	186.14	217	35,441
	4	150.28	276	46,416
	5	15.27	267	22,110
	6	72.40	271	11,888
	V15			152,309
S16	1	186.66		
	2	98.53	208	29,621
	3	39.54	182	12,552
	4	45.71	234	9,965
	5	0.18	191	4,390
	6	0.00	183	16
	V16			56,544
S17	1	0.00		
	2	0.00	279	0
	3	0.00	208	0
	4	4.45	226	503
	5	67.93	209	7,558
	6	137.98	202	20,848
	V17			28,909
S18	1	78.47		
	2	0.00	161	6,328
	3	0.15	158	12
	4	57.09	177	5,077
	5	130.22	169	15,850
	6	178.96	176	27,184
	V18			54,452
S19	1	30.23		
	2	6.72	111	2,046
	3	9.40	274	2,211
	4	106.32	213	12,298
	5	68.53	198	17,289
	6	28.96	205	9,986
	V19			43,830
S20	1	14.71		
	2	7.71	199	2,235
	3	0.00	193	742
	4	0.00	190	0
	5	0.00	160	0
	6	0.07	157	6
	V20			2,983
S21	1	8.91		
	2	134.67	301	21,593
	3	234.09	203	37,469
	4	318.77	281	77,739
	5	372.00	210	72,417
	6	265.31	365	116,276
	V21			325,495
S22	1	12.75		
	2	0.00	187	1,193
	3	5.41	208	563
	4	0.00	195	528
	5	0.25	196	24
	6	6.79	191	674
	V22			2,981
S23	1	305.94		
	2	284.10	232	68,326
	3	270.88	202	56,170
	4	281.11	290	79,925
	5	267.52	326	89,346
	6	24.64	224	32,655
	V23			326,422
S24	1	0.00		
	2	0.00	197	0
	3	0.00	213	0
	4	89.78	381	17,095
	5	247.01	237	39,830
	6	342.17	255	75,042
	V24			131,967
S25	1	200.47		
	2	151.08	239	42,017
	3	143.39	209	30,747
	4	135.95	185	25,848
	5	174.66	166	25,782
	6	107.22	207	29,147
	V25			153,542
S26	1	0.00		
	2	0.00	195	0
	3	0.00	237	0
	4	0.00	216	0
	5	10.58	265	1,401
	6	59.80	244	8,569
	V26			9,970
S27	1	0.00		
	2	134.72	259	17,419
	3	198.05	196	32,548
	4	208.69	207	42,004
	5	67.22	329	45,453
	6	177.24	181	22,101
	V27			159,525
S28	1	205.11		
	2	56.80	256	33,589
	3	22.79	230	9,148
	4	59.64	219	9,006
	5	80.30	233	16,300
	6	7.30	214	9,352
	V28			77,395
S29	1	0.00		
	2	0.00	304	0
	3	78.22	278	10,858
	4	73.45	274	20,777
	5	0.00	267	9,817
	6	1.77	296	262
	V29			41,714
S30	1	31.16		
	2	16.14	237	5,609
	3	45.05	208	6,368
	4	75.39	214	12,867
	5	99.02	221	19,295
	6	6.89	205	10,849
	V30			54,987
			Total	2,364,412

Dredging Volume CASE-2 (Min.Water Depth -2.5m)

Point	Section	Area (m2)	Length (m)	Volume (m3)
S01	1	108.16		
	2	81.32	323	30,639
	3	122.06	168	17,111
	4	1.38	233	14,384
	5	27.07	222	3,156
	6	67.22	230	10,861
	V01			76,150
S02	1	15.34		
	2	24.69	252	5,053
	3	25.44	129	3,236
	4	25.72	199	5,083
	5	7.09	163	2,676
	6	14.11	246	2,609
	V02			18,656
S03	1	0.00		
	2	0.00	326	0
	3	0.00	240	0
	4	7.22	187	675
	5	41.78	170	4,172
	6	81.30	172	10,588
	V03			15,435
S04	1	117.65		
	2	26.74	185	13,369
	3	38.41	146	4,760
	4	44.36	171	7,080
	5	3.49	177	4,227
	6	15.07	146	1,353
	V04			30,790
S05	1	0.00		
	2	0.00	158	0
	3	0.00	137	0
	4	57.06	185	5,270
	5	190.46	184	22,813
	6	224.72	209	43,316
	V05			71,399
S06	1	5.43		
	2	29.29	216	3,744
	3	30.45	211	6,308
	4	121.85	189	14,397
	5	275.00	190	37,783
	6	324.31	182	54,493
	V06			116,725
S07	1	56.84		
	2	16.33	296	10,817
	3	77.25	188	8,783
	4	71.54	156	11,607
	5	117.49	175	16,526
	6	115.84	193	22,460
	V07			70,193
S08	1	4.06		
	2	7.83	140	830
	3	52.19	136	4,076
	4	67.90	215	12,899
	5	78.15	114	8,336
	6	214.35	146	21,357
	V08			47,497
S09	1	114.15		
	2	133.71	183	22,636
	3	134.98	150	20,154
	4	112.37	201	24,823
	5	92.96	173	17,777
	6	112.13	192	19,686
	V09			105,076
S10	1	7.28		
	2	36.28	151	3,297
	3	8.31	220	4,905
	4	1.16	209	991
	5	8.09	175	807
	6	5.12	216	1,428
	V10			11,428
S11	1	38.57		
	2	163.52	208	20,985
	3	195.34	247	44,341
	4	154.24	198	34,623
	5	113.39	229	30,702
	6	0.00	227	12,876
	V11			143,527
S12	1	1.50		
	2	10.04	224	1,295
	3	7.70	186	1,652
	4	50.67	216	6,318
	5	3.50	233	6,321
	6	0.00	168	294
	V12			15,880
S13	1	12.25		
	2	126.02	279	19,291
	3	174.03	215	32,288
	4	166.91	230	39,244
	5	0.00	184	15,331
	6	0.00	218	0
	V13			106,153
S14	1	0.25		
	2	31.57	195	3,103
	3	87.92	237	14,183
	4	132.15	220	24,187
	5	122.44	213	27,052
	6	36.81	229	18,268
	V14			86,793
S15	1	240.99		
	2	161.87	203	40,885
	3	206.63	217	40,032
	4	165.14	276	51,294
	5	26.22	267	25,557
	6	88.68	271	15,579
	V15			173,348
S16	1	208.77		
	2	112.44	208	33,362
	3	52.27	182	14,975
	4	57.92	234	12,882
	5	1.22	191	5,658
	6	0.00	183	112
	V16			66,989
S17	1	0.00		
	2	0.00	279	0
	3	0.00	208	0
	4	11.62	226	1,313
	5	89.21	209	10,528
	6	160.28	202	25,259
	V17			37,100
S18	1	100.04		
	2	0.00	161	8,068
	3	3.72	158	293
	4	77.97	177	7,246
	5	152.11	169	19,470
	6	201.71	176	31,109
	V18			66,186
S19	1	44.69		
	2	12.50	111	3,167
	3	19.93	274	4,447
	4	128.16	213	15,739
	5	85.54	198	21,131
	6	40.57	205	12,919
	V19			57,402
S20	1	25.00		
	2	23.34	199	4,818
	3	0.00	193	2,247
	4	0.00	190	0
	5	0.00	160	0
	6	2.19	157	172
	V20			7,236
S21	1	17.75		
	2	156.97	301	26,276
	3	257.59	203	42,123
	4	343.29	281	84,492
	5	396.93	210	77,602
	6	288.58	365	125,071
	V21			355,564
S22	1	18.62		
	2	0.00	187	1,742
	3	9.48	208	986
	4	0.00	195	925
	5	4.28	196	420
	6	21.74	191	2,490
	V22			6,562
S23	1	330.29		
	2	308.37	232	73,956
	3	294.91	202	61,059
	4	305.14	290	86,884
	5	289.68	326	96,867
	6	31.50	224	35,898
	V23			354,664
S24	1	0.57		
	2	0.00	197	56
	3	0.00	213	0
	4	111.00	381	21,135
	5	270.79	237	45,152
	6	367.06	255	81,241
	V24			147,584
S25	1	223.41		
	2	173.22	239	47,405
	3	166.23	209	35,443
	4	158.13	185	30,014
	5	197.57	166	29,523
	6	128.83	207	33,750
	V25			176,135
S26	1	0.00		
	2	0.00	195	0
	3	1.47	237	174
	4	0.00	216	158
	5	21.45	265	2,840
	6	80.61	244	12,426
	V26			15,598
S27	1	3.32		
	2	156.91	259	20,718
	3	221.00	196	36,963
	4	231.99	207	46,780
	5	89.04	329	52,886
	6	200.20	181	26,149
	V27			183,495
S28	1	225.06		
	2	67.22	256	37,484
	3	42.61	230	12,623
	4	74.93	219	12,843
	5	101.20	233	20,515
	6	15.50	214	12,458
	V28			95,924
S29	1	0.27		
	2	0.44	304	107
	3	99.30	278	13,845
	4	94.53	274	26,553
	5	1.75	267	12,868
	6	3.91	296	837
	V29			54,211
S30	1	44.55		
	2	26.68	237	8,446
	3	56.57	208	8,663
	4	85.87	214	15,216
	5	114.07	221	22,119
	6	15.13	205	13,235
	V30			67,679
			Total	2,781,380

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

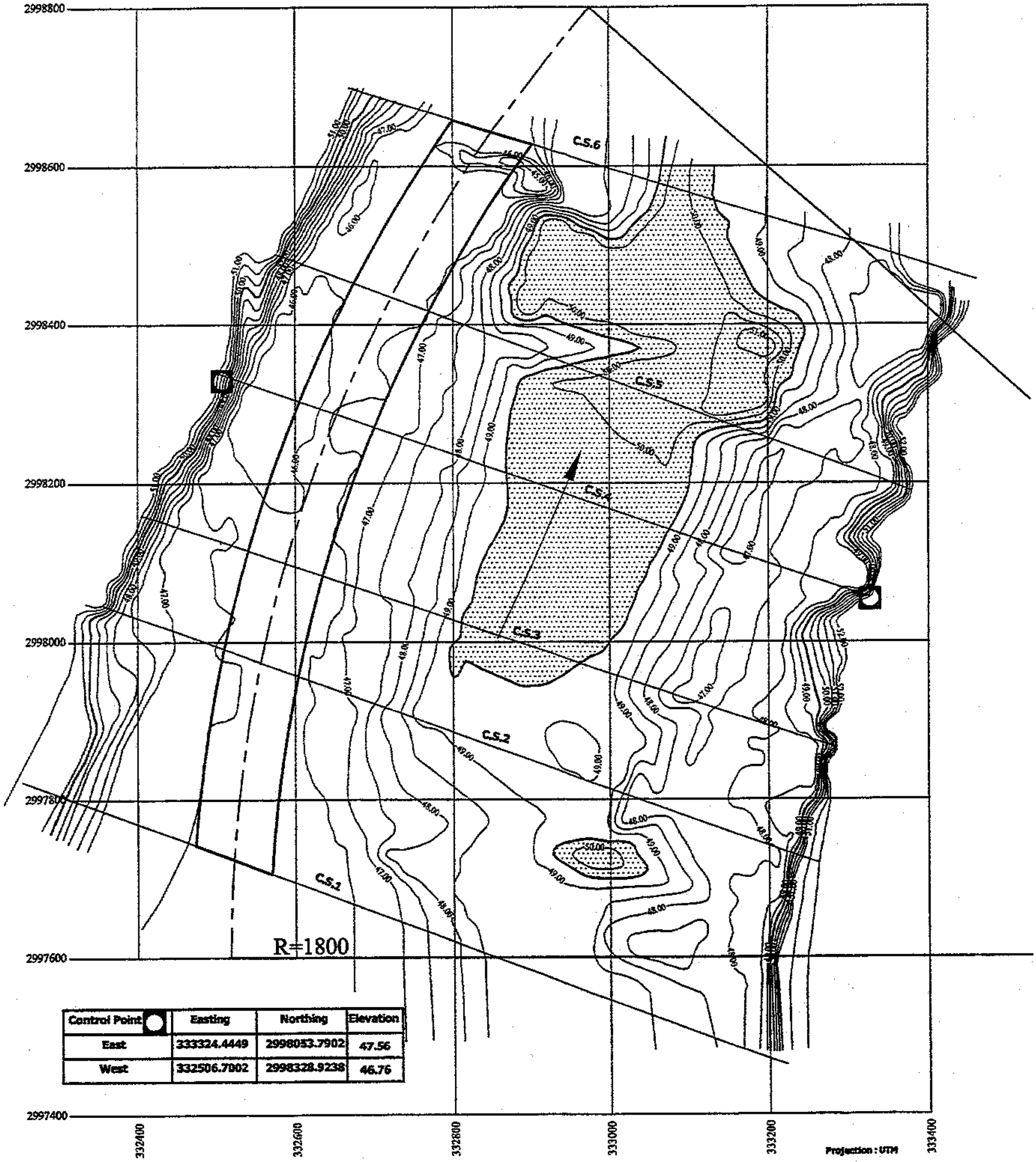


Control Point ○	Easting	Northing	Elevation
East	336579.3125	2990775.5961	53.55
West	335946.0236	2990503.5096	54.84

SCALE 1 : 7,500

Projection : UTM
Elepsiod : WGS84
Date of Survery : 4-2-2002

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

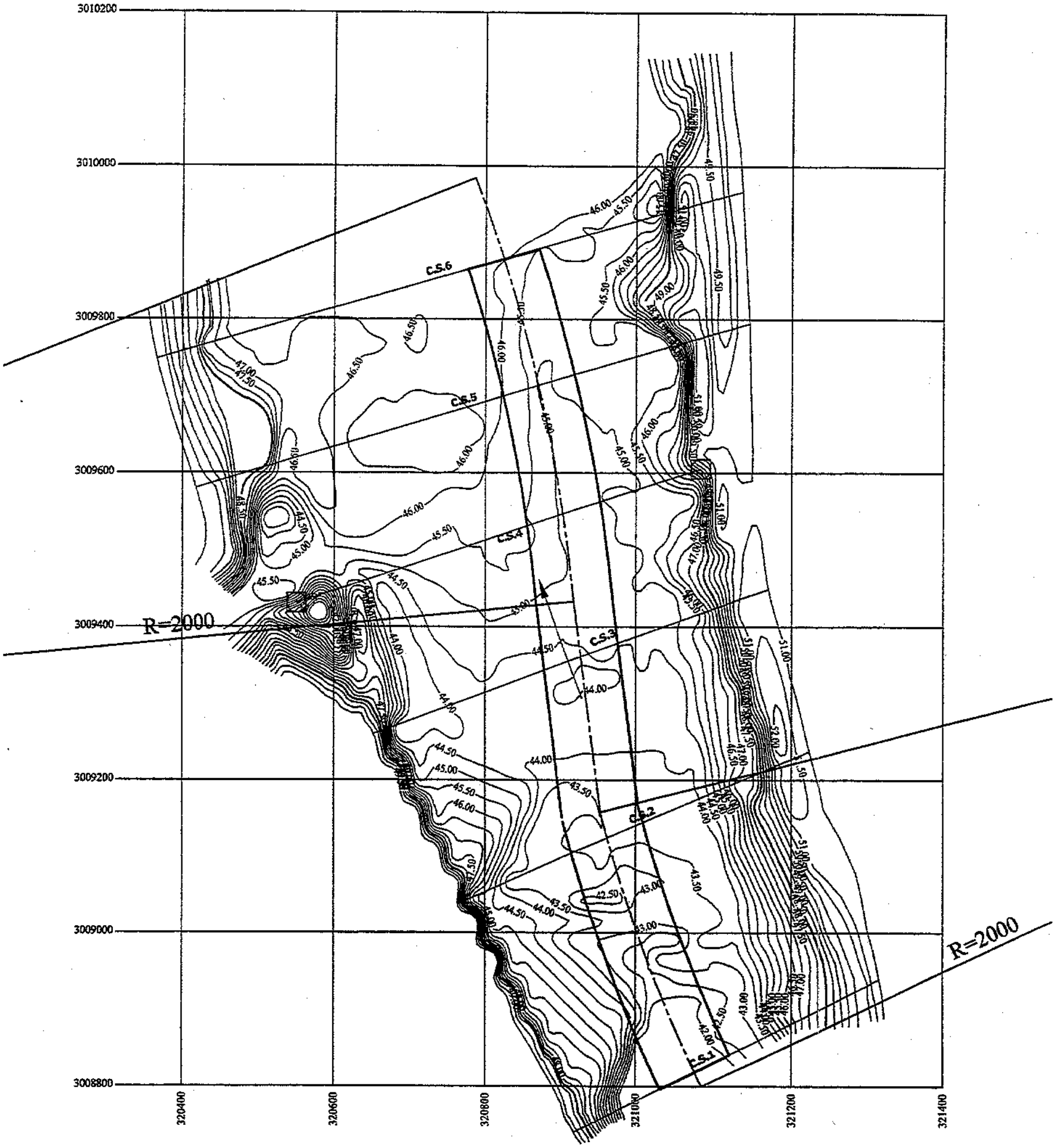


Control Point ○	Easting	Northing	Elevation
East	333324.4449	2998053.7902	47.56
West	332506.7002	2998328.9238	46.76

SCALE 1 : 7,500

Projection : UTM
Elepsiod : WGS84
Date of Survey : 5-2-2002

S03 : ASSUIT LOCK SITE
(Km. 382.700 From EL-Roda)

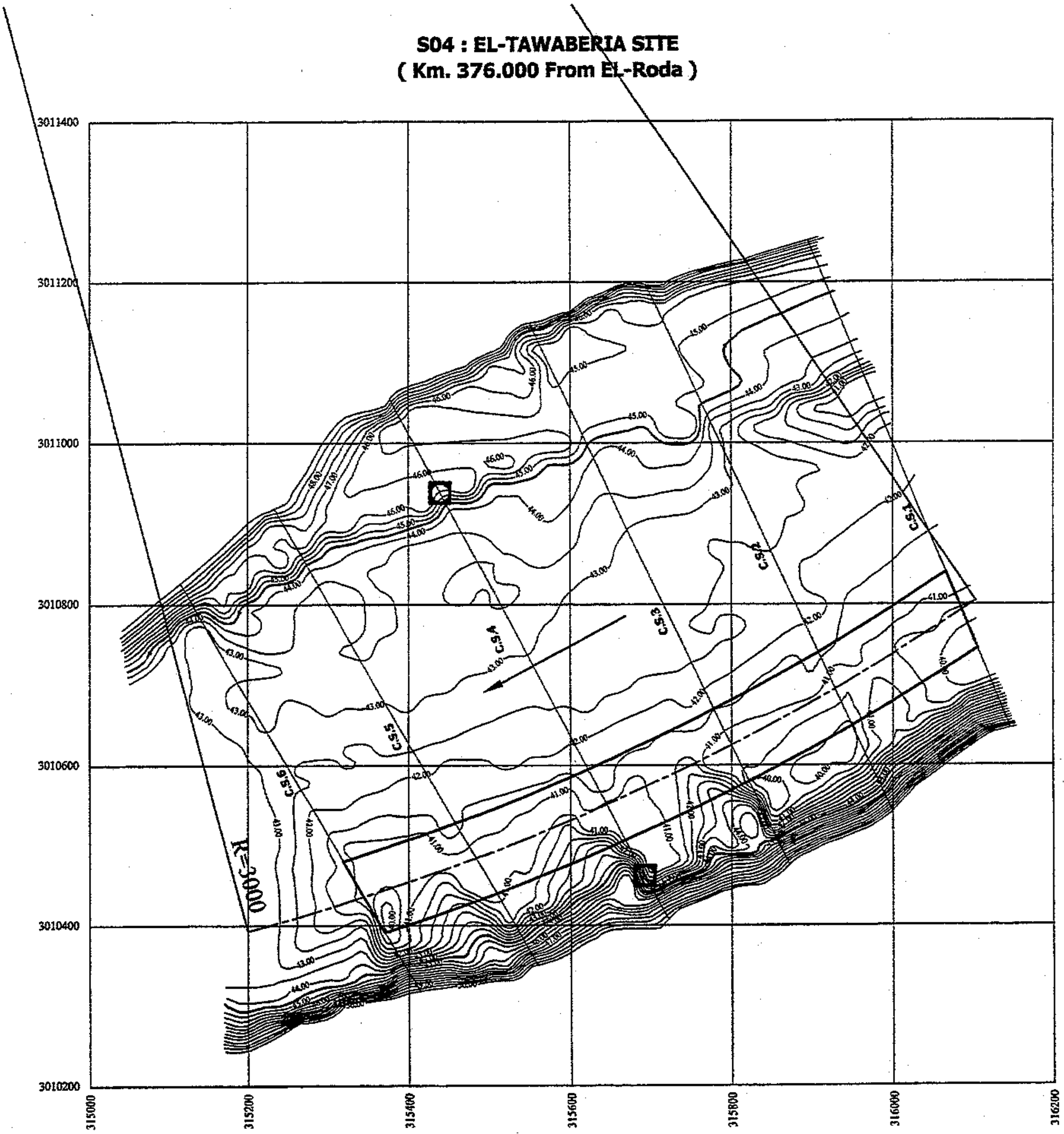


Control Point ○	Easting	Northing	Elevation
East	321083.1409	3009605.3294	50.55
West	320551.8671	3009430.5825	50.872

SCALE 1 : 7,500

Projection : UTM
Elepsiod : WGS84
Date of Survery : 5-2-2002

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

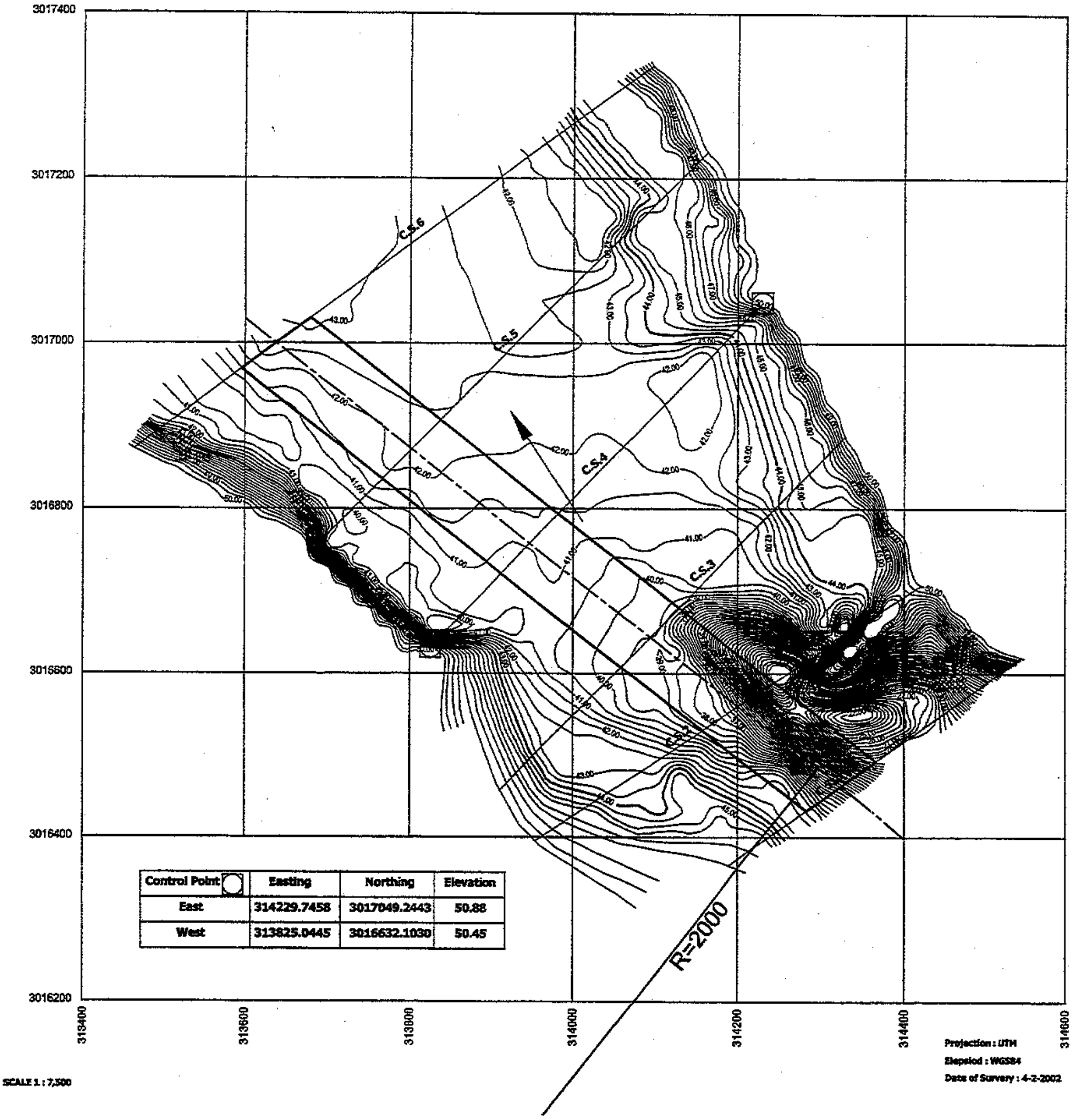


Control Point ○	Easting	Northing	Northing
East	315439.0348	3010935.2791	50.88
West	315693.1948	3010461.7807	50.87

SCALE 1 : 7,500

Projection : UTM
Elepsiod : WGS84
Date of Survery : 5-2-2002

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

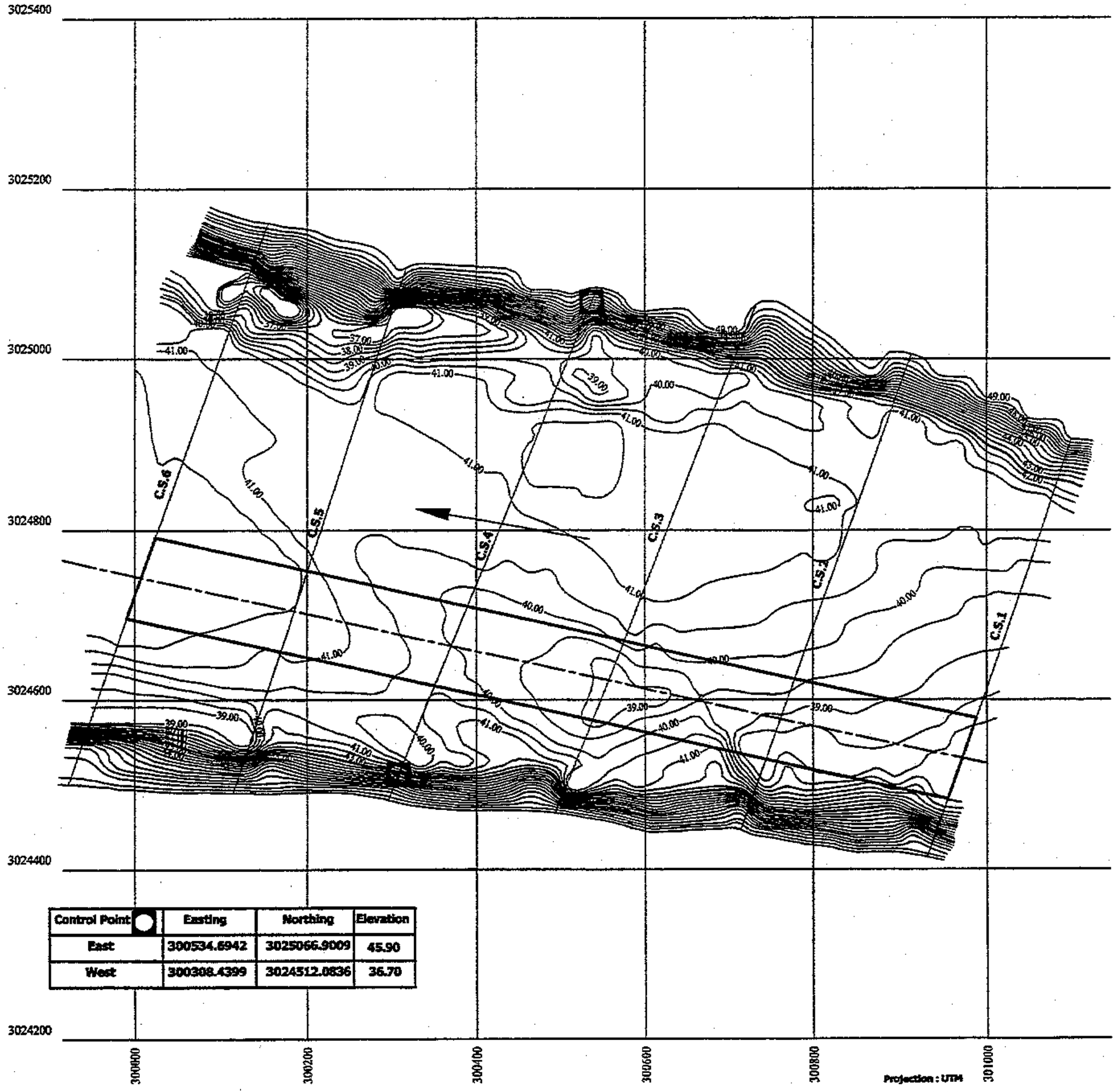


Control Point ○	Easting	Northing	Elevation
East	314229.7458	3017049.2443	50.88
West	313825.0445	3016632.1030	50.45

Projection : UTM
Elepsiod : WGS84
Date of Survery : 4-2-2002

SCALE 1 : 7,500

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

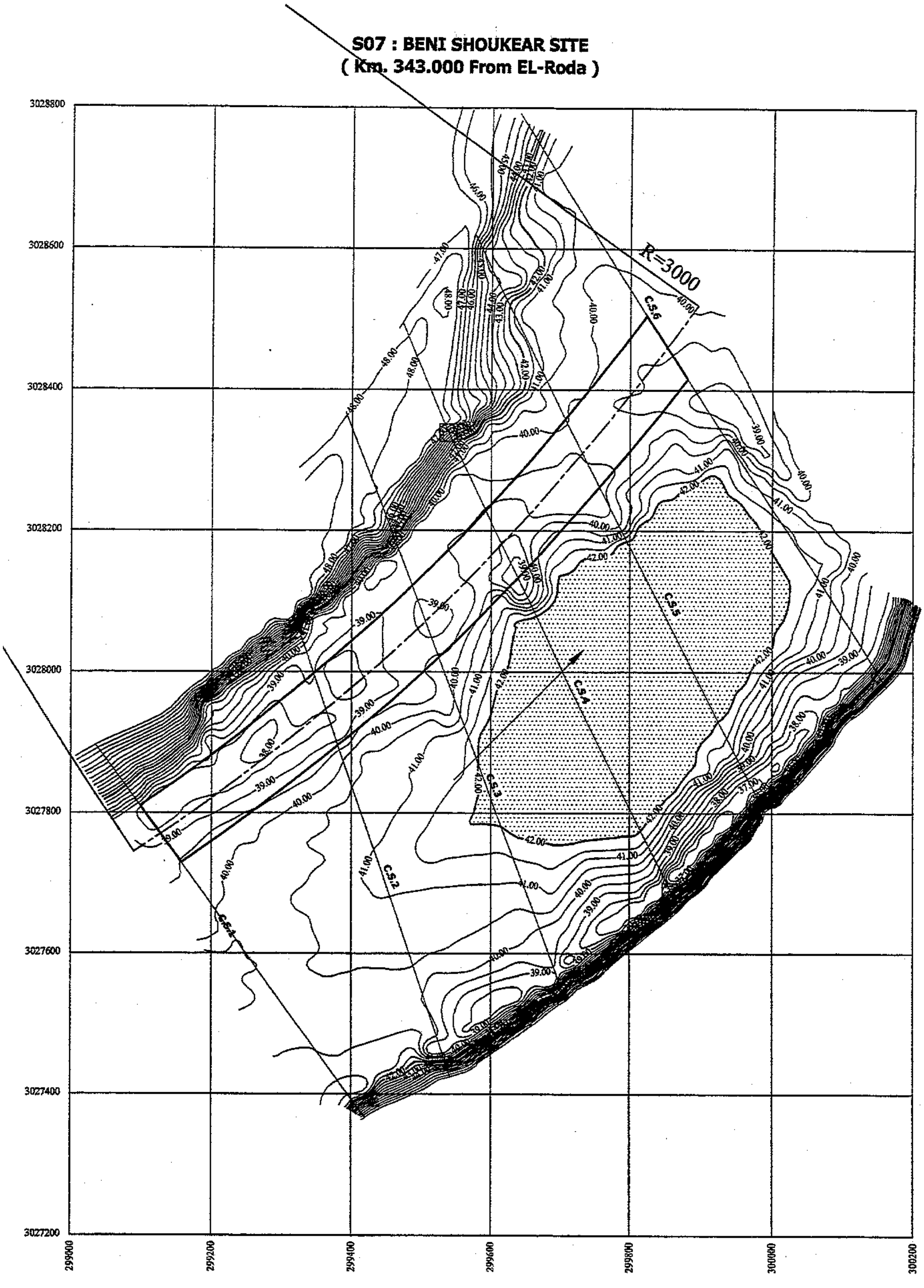


Control Point ●	Easting	Northing	Elevation
East	300534.6942	3025066.9009	45.90
West	300308.4399	3024512.0836	36.70

SCALE 1 : 7,500

Projection : UTM
Elepsiod : WGS84
Date of Survey :6-2-2002

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

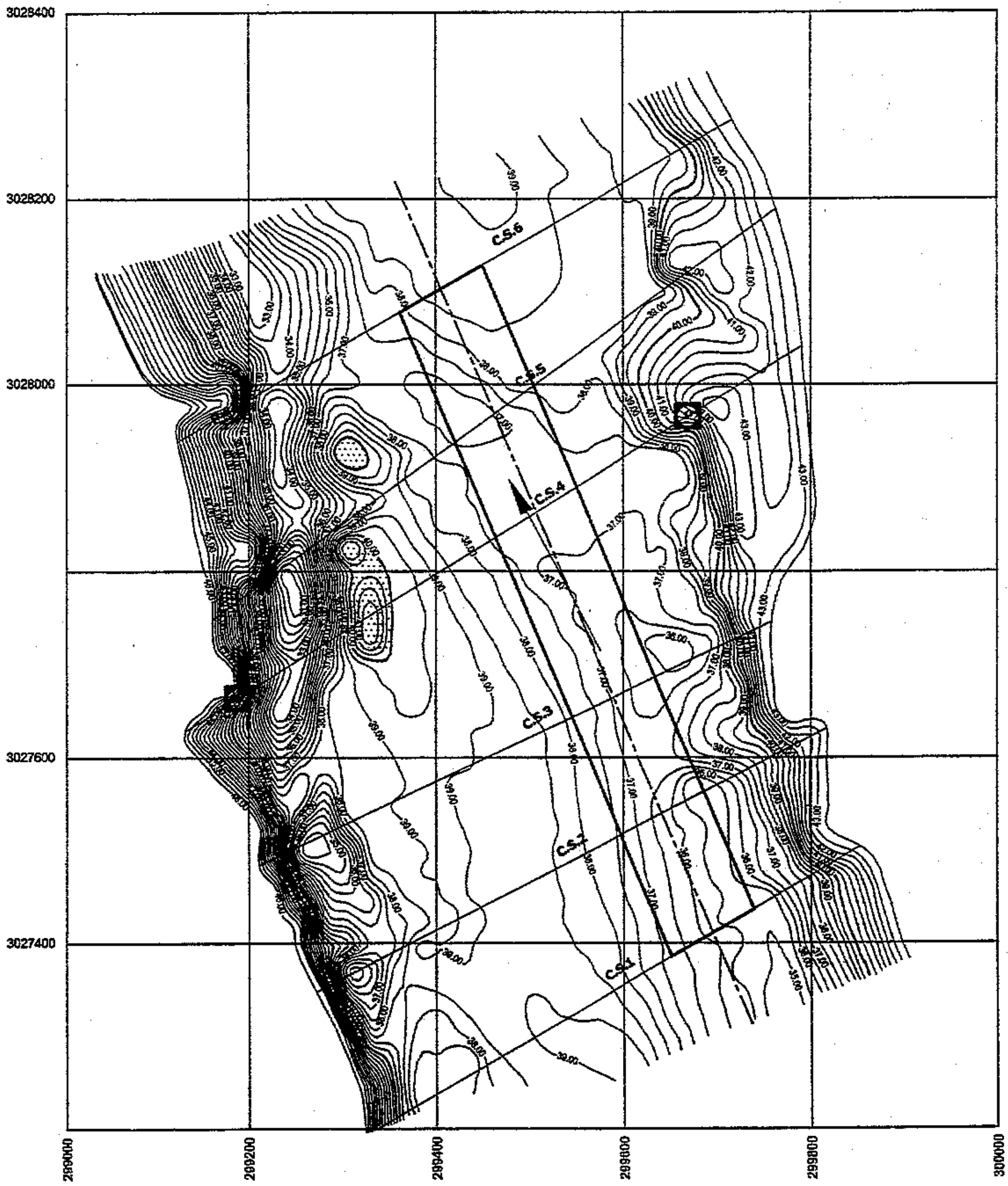


CALE 1 : 7,500

Control Point ○	Easting	Northing	Elevation
East	299859.0305	3027687.9070	48.62
West	299536.9796	3028338.7687	47.99

Projection : UTM
Elepsiod : WGS84
Date of Survery : 7-2-2002

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

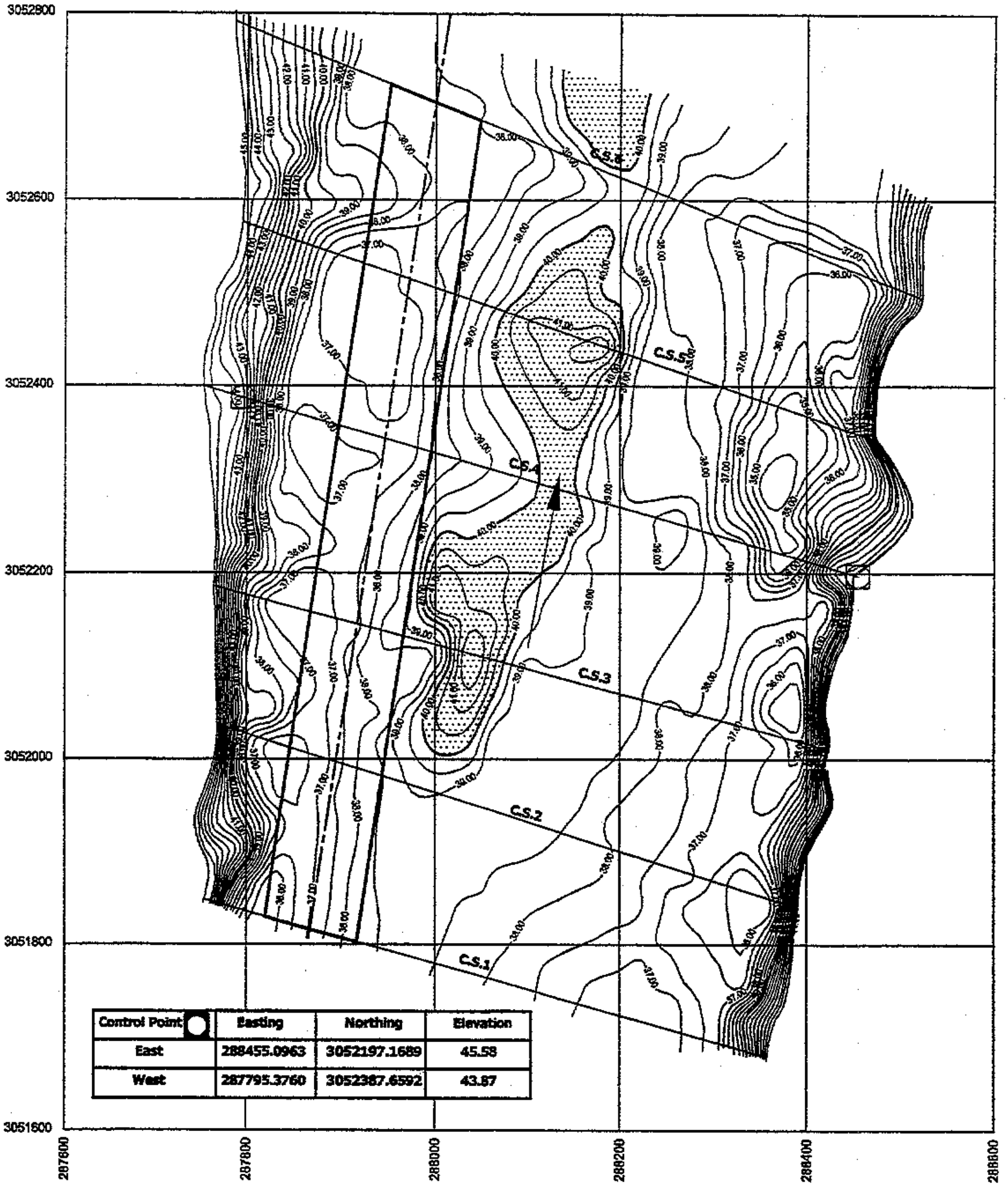


Control Point ○	Easting	Northing	Elevation
East	287469.7827	3048965.9474	35.50
West	286987.9378	3048664.2578	40.00

SCALE 1 : 7,500

Projection : UTM
Elapsied : WGS84
Date of Survery : 7-2-2002

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

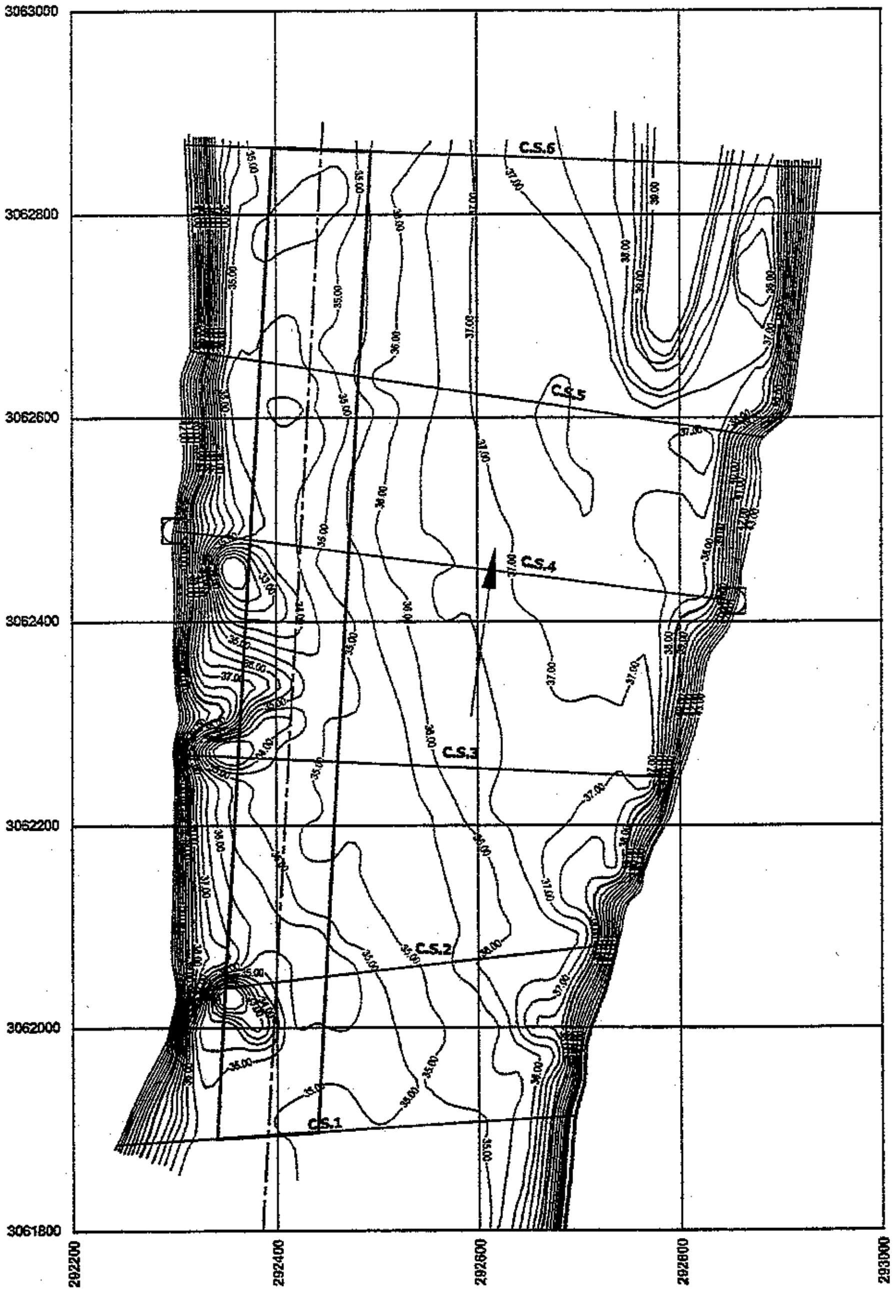


Control Point ○	Easting	Northing	Elevation
East	288455.0963	3052197.1689	45.58
West	287795.3760	3052387.6592	43.87

SCALE 1 : 7,500

Projection : UTM
Elipsoid : WGS84
Date of Survey : 9-2-2002

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

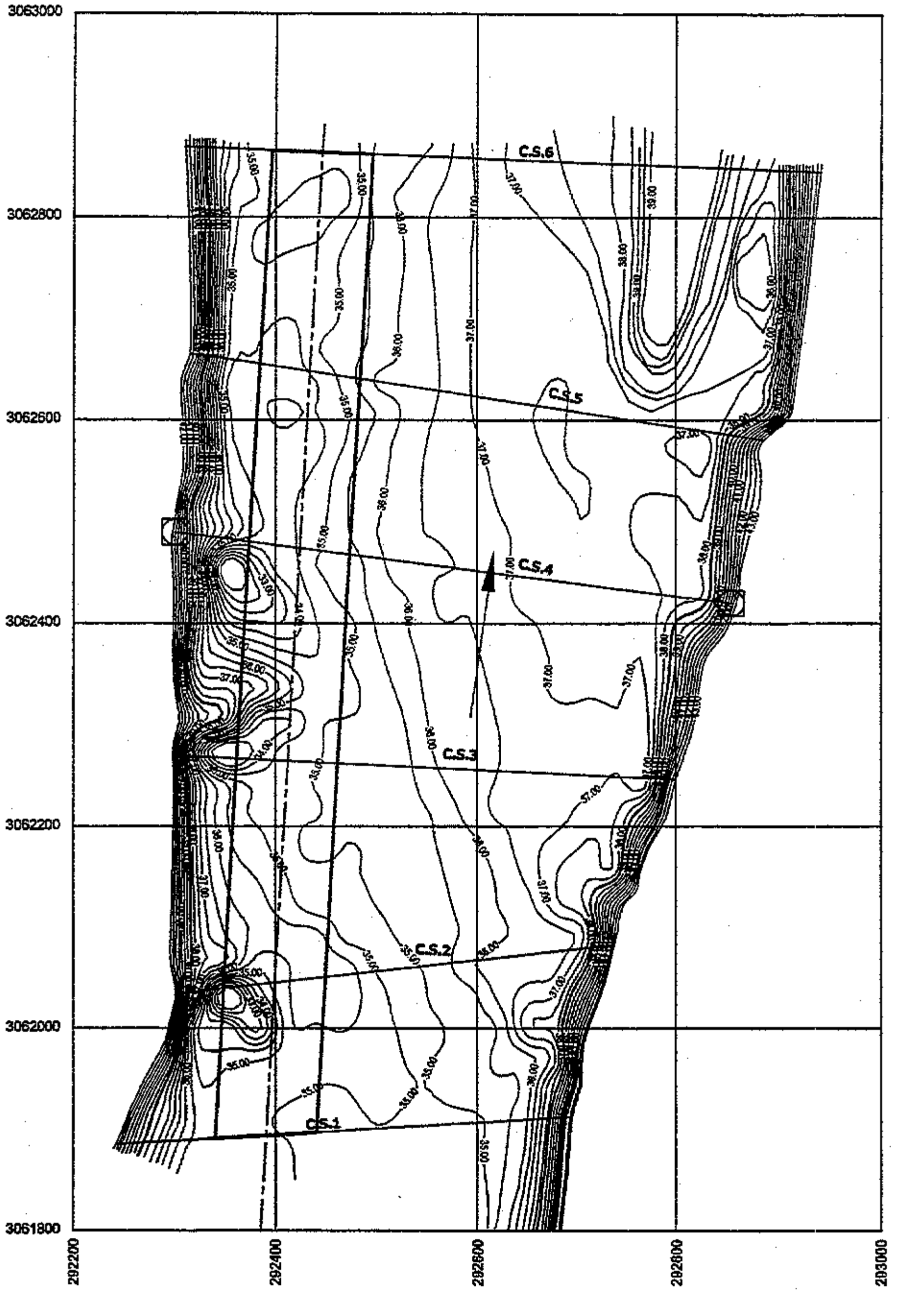


Control Point ○	Easting	Northing	Elevation
East	292853.8842	3062419.6022	45.08
West	292300.6312	3062489.5443	44.78

Projection : UTM
Elepsiod : WGS84
Date of Survery : 9-2-2002

SCALE 1 : 7,500

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

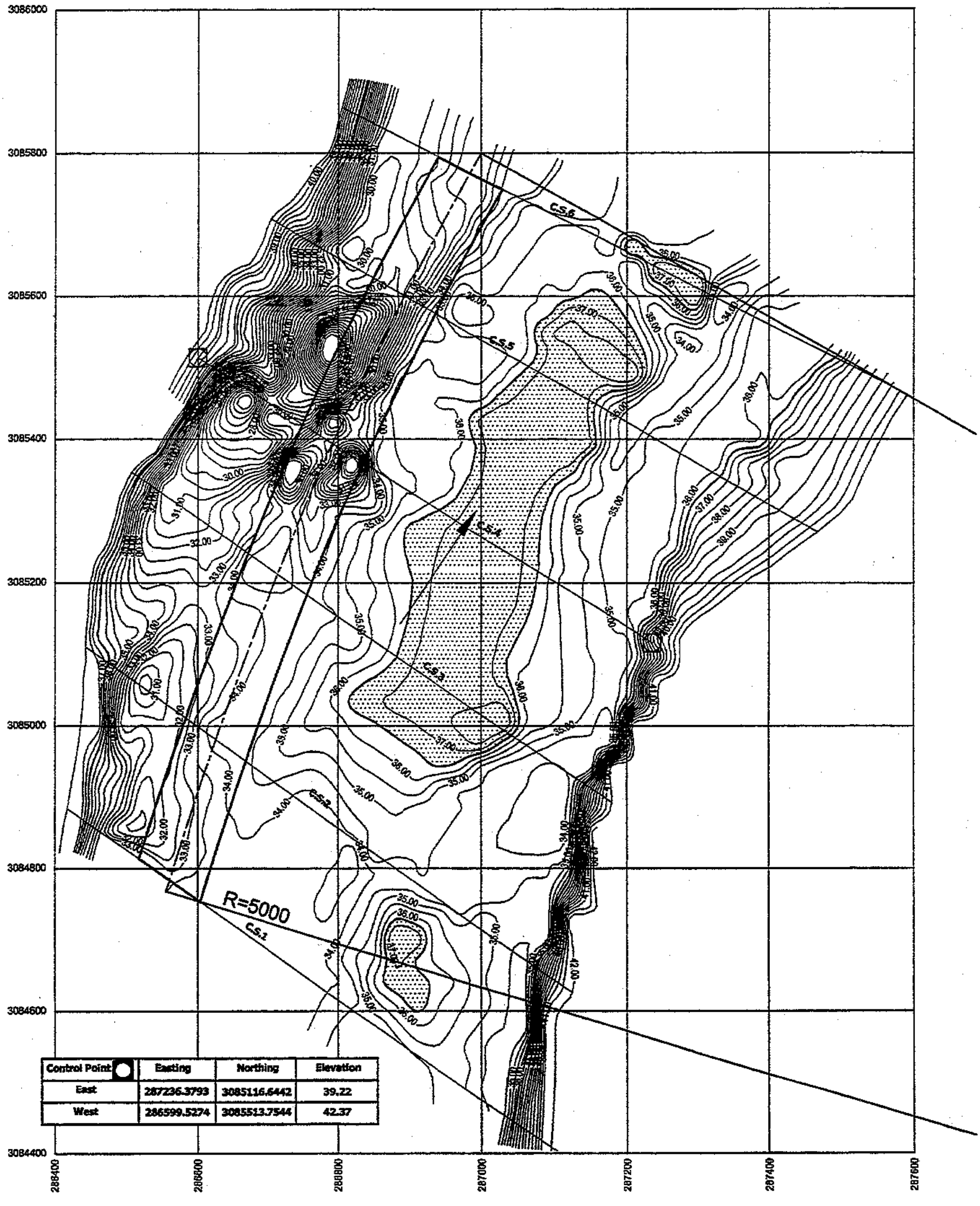


Control Point ○	Easting	Northing	Elevation
East	292853.8842	3062419.6022	45.08
West	292300.6312	3062489.5443	44.78

Projection : UTM
Elepsiod : WGS84
Date of Survery : 9-2-2002

SCALE 1 : 7,500

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

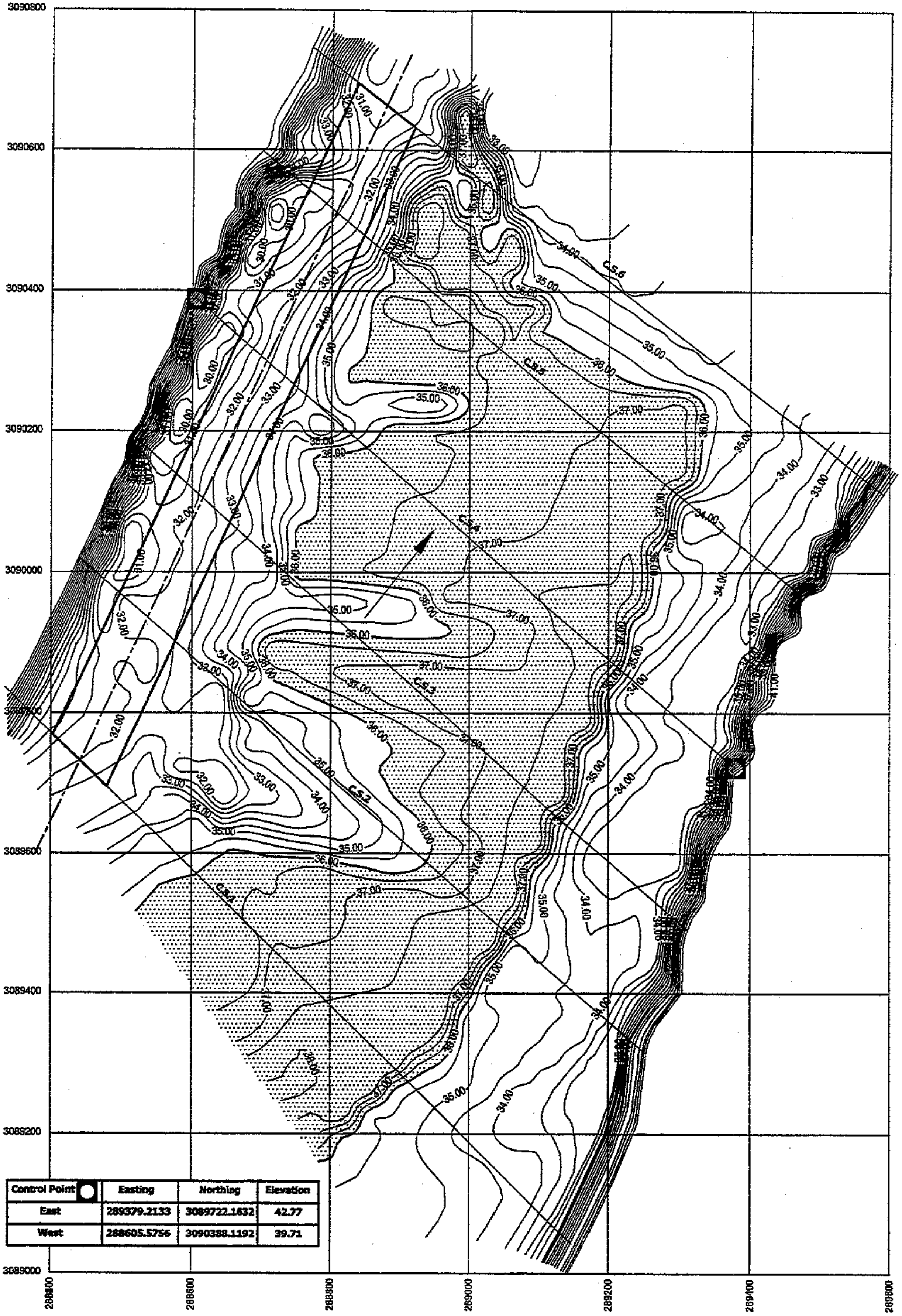


Control Point ○	Easting	Northing	Elevation
East	287236.3793	3085116.6442	39.22
West	286599.5274	3085513.7544	42.37

SCALE 1 : 8,000

Projection : UTM
Elepsoid : WGS84
Date of Survey : 10-2-2002

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



Control Point ○	Easting	Northing	Elevation
East	289379.2133	3089722.1632	42.77
West	288605.5756	3090388.1192	39.71

SCALE 1 : 8,000

Projection : UTM
Elepsiod : WGS84
Date of Survey : 10-2-2002