3.10.5 DETAILED DESIGN

(1) UNLOADER

The detailed design of the unloader is made based on the design conditions and the results of the preliminary design. The basic dimensions determined are as follows ;

1. Type	Continuous mechanical	
2. Number of set	2	sets
3. Capacity	630	t/h
4. Outreach from sea side rail center (1)	24.5	m
5. Lift (h)		
a. Above sea side rail surface (h1)	16	m
b. Below sea side rail surface (h2)	14	m
6. Maximum reach from sea side rail center (R)	35	m
7. Wheel base	12	m
8. Swing angle (working)	20 and 30	Degree
9. Revolution angle	each 90	Degree
10. Portal clearance		
Between horizontal stags and top of side rail surface	5.5	m
11. Portal clearance		
Between sea side leg and land side leg	6.0	m
12. Distance	4.0	m
Between land side rail center and belt conveyor center		
13. Conveyor capacity (in unloader)	700	t/h
(630 t/h x 1.1 700 t/h)		
14. Rail clamp	Automatic and manual	
15. Unloader stopper	manual type	
16. Power supply	Cabtire cable system	
17. Removal device for foreign material	magnetic system	
18. Dust collection apparatus	1	set
19. Lifting device for bulldozer	12	t
20. Height of berth conveyor	7	m

(2) CONVEYOR FROM UNLOADER TO MACHINERY TOWER

(a) Type of conveyor

Belt conveyor is the most suitable type from the viewpoint of the purpose of handling and arrangement of equipment. Therefore belt conveyor type is selected.

(b) Capacity of belt conveyor

The rated capacity of the unloader is 630 t/h . However, the actual cargo volume to be unloaded by unloader is more than the rated capacity sometimes. Therefore the rated capacity of the belt conveyor to be designed must be lager than that of the unloader. The rated capacity of the belt conveyor is determined as 700 t/h (630 t/h x 1.1 = 700 t/h).

(c) The angle of inclined belt conveyor

The allowable maximum angle of the inclined belt conveyor will be determined by the kind of cargo to be handled. A larger angle is favourable for general arrangement. The allowable max. angle of the inclined belt conveyor is nine (9) degree for wheat, which is employed in this design. The basic dimensions are as follows :

REFERENCE MATERIAL NO.3

Belt Conveyors

1. Capacity

$Q = 1.1 \times Qu$

Qu: Unloader capacity

$Q = 1.1 \times 630 = 693$

700 t/h each

2. Main Dimensions

2-1.	Belt width	1,200 m/m (1,050)
2-2.	Angle of Trough	30 degrees
2-3.	Angle of Surcharge	10 degrees
		(Angle of repose : 20 - 30 degrees)
2-4.	Area of Load Cross Section	
	A = 0.13146 m2 (0.0991)	
2-5.	Bulk apparent specific gravity	0.75
2-6.	Coefficient of Conveyor slope	0.95
		(Conveyor slope : 9 degrees)

2-7. Velt velocity

1) Berth conveyor : V

$$v = \frac{700}{0.13146(0.0991) \times 0.75 \times 60} = 118.3(156.97)$$

120 m/min (160)

2) Inclined conveyor : vi

$$vi = \frac{118.3}{0.95} = 124.55(165.2)$$

125 m/min (165)

2-8. Required horse power (HP)

The required horse power : N(HP) is obtained by the following formula ;

$$N(HP) = \frac{0.06fxwxv(l+lo)}{270} + \frac{f \cdot Q(l+lo)}{270} + \frac{QH}{270}$$

f = 0.022

w = 88 kg/m (B = 1,200)

lo = 66 (f = 0.022)

1) Berth conveyor

L = 260

$$N = \frac{0.06 \times 0.022 \times 88 \times 120(260+66)}{270} + \frac{0.022 \times 700(260+66)}{270}$$

= 16.83 + 18.6

= 35.42

$$Kw = \frac{N}{1.341} \times \frac{1.1}{Ef}$$

= Driven efficiency = 0.7 (Ef)

$$Kw = \frac{35.42}{1.341} \times \frac{1.1}{0.7}$$

= 41.5 45 Kw

2) No.1 Inclined conveyor

L = 40 m H = 6.3 m

$$N = \frac{0.06 \times 0.022 \times 88 \times 125(40+60)}{270} + \frac{0.022 \times 700(40+66)}{270}$$

$$+ \frac{700 \times 6.3}{270}$$

= 5.7 + 6.5 + 16.3

= 28.5

$$Kw = \frac{28.5 \times 1.1}{1.341 \times 0.7} = 33.4 : 37Kw$$

3) No.2 Inclined conveyor

L = 148 H = 23.1

$$N = \frac{0.06 \times 0.022 \times 88 \times 125(148+66)}{270} + \frac{0.022 \times 700(148+66)}{270}$$

$$+ \frac{700 \times 23.1}{270}$$

$$= 11.51 + 12.21 + 59.9 = 83.62$$

$$Kw = \frac{83.62 \times 1.1}{1.341 \times 0.7} = 97.9 = 100\ Kw$$

(d) Berth Conveyor

1) Capacity	each	700	t/h
2) Number of conveyor's line		2	lines
3) Length of conveyors	each	260	m
4) Elevation of conveyors EL		9.683	m
5) Clearance between belt conveyor and ground		5.0	m
6) Detailed Dimensions			
a) Belt width		1,200	m/m
b) Belt velocity		120	m/min
c) Drive unit with fluid coupling			
d) Angle of trough		30	Degree
e) Arrangement of idlers			
Carrying idler	approximately	1.2	m
Return idler	approximately	2.4	m
f) Arrangement of guide rollers or training idlers to minimize belt off line	approximately	24	m
7) Take-up unit	Gravity type		

(e) No.1 Inclined conveyor

1)	Capacity		each	700	t/h
2)	Number of conveyor's line			2	lines
3)	Length of conveyors		each approximate	40	m
4)	Inclined angle		approximate	9	Degree
5)	Elevations of conveyor				
	Lower end		approximate E.L	7.863	m
	Higher end		approximate E.L	14.031	m
6)	Detailed dimensions				
	a)	Belt width		1,200	m/m
	b)	Belt velocity		125	m/min
	c)	Other items are not different from berth conveyor			

(f) No.2 Inclined conveyor

1)	Capacity	each	700	t/h
2)	Number of conveyors line		2	
3)	Length of conveyor	approximate	148	m
4)	Inclined angle	approximate	9	Degree
5)	Height of conveyor			
	Lower end	approximate 12.032	m	
	Higher end	approximate 33.390	m	
6)	Other items are not different from No.1 inclined conveyor.			

(3) CONVEYOR AND ELEVATOR IN THE MACHINERY TOWER

(a) Type of conveyor

1) Horizontal

The grain on the horizontal conveyor in the machinery tower have to be stop overed in sometimes. Chain conveyor is suitable type in such cases, thus this type is selected.

2) Vertical

The most recommendable type on vertical handling for grain in the machinery tower is bucket elevator type.

(b) Principle particulars

1) Chain conveyor for receiving line in the machinery tower.

	Installed location	Type	Capacity (t/h)	Overall Length(m)	Number of set
RC-1	Machinery tower 4th floor	Horizontal	Approx. 700	10	1
RC-2	Machinery tower 1st floor	Horizontal (flow rate adjustable)	Approx. 700	8	2
RC-3	Machinery tower 8th floor	Horizontal	Approx. 700	45	2
RC-4	Silo upper part	Horizontal	Approx. 700	94	2
RC-5	Silo upper part	Horizontal	Approx. 700	83	2

a) Detailed Dimensions

1) Conveying chain speed 50 m/min
2) Effective sectional area approx 0.36 m^2

b) Accessories: Drive assembly

1) Vent for dust-explosion prevention
2) Motor driven slide gates
3) Supporting frame works
4) Maintenance passageways for overhead conveyors
5) Temperature detectors

2) Chain conveyor for discharge and/or recycle line in machinery tower

	Installed location	Type	Capacity (t/h)	Overall Length(m)	Number of set
DR-1	Silo lower part	Horizontal (flow rate adjustable)	Approx. 300	97	4
DR-2	Silo lower part	Horizontal (flow rate adjustable)	Approx. 300	87	4
DR-3	Machinery tower in the pit	Horizontal	Approx. 300	45	1
DR-4	Machinery tower 5th floor	Horizontal	Approx 300	40	1

1) Detailed Dimensions

a) Conveying chain speed 50 m/min
b) Effective sectional area approx 0.16 m2

2) Accessories

a) Derive assembly
b) Vent for dust-explosion prevention
c) Motor driven slide gate
d) Supporting frame works e) Maintenance passageways for overhead conveyor
f) Temperature detectors

3) Bucket elevator for receiving line in the machinery tower

a) Capacity :		700	t/h
b) Type : Vertical type belt method			
c) Number of sets :		2	sets
d) Conveying height :	Approx	55	m
e) Belt speed :	Max.	210	m/min
f) Drive unit :	Drive assembly with fluid coupling		

g) Accessories:

1. Speed detectors
2. Weaving detectors
3. Head pulley bearing temperature detectors
4. Vents for dust-explosion prevention
5. Inspection drive devices
6. Intermediate supporting devices
7. Temperature detectors

4) Bucket elevator for discharge line and/or recyle line in the machinery tower

a) Capacity:		300	/h
b) Type:	Vertical type belt method		
c) Number of sets:		5	sets
d) Conveying height:	Approx.	45	m
e) Belt speed:	Max.	210	m/min
f) Drive unit:	Drive assembly with fluid coupling		

g) Accessories:

1. Speed detectors
2. Weaving detectors
3. Head pulley bearing temperature detectors
4. Vents for dust-explosion prevention
5. Inspection drive devices
6. Intermediate supporting devices
7. Temperature detectors

REFERENCE MATERIAL NO.8

BUCKET ELEVATOR

1. Bucket elevator for receiving line

1-1. Capacity

$$Q = 60 \times S \times A \times E1 \times g$$

Q : Capacity (t/h) = Min. 700
S : Conveying belt speed (m/min.) = Max. 210
A : Effective conveying volume (m3/m) = 0.09
E1 : Conveying efficiency = 0.85
g : Apparent specific gravity = 0.75

$$Q = 60 \times 210 \times 0.09 \times 0.85 \times 0.75 = 722 > 700 \text{ --- OK}$$

1-2. Actual tension of conveying belt

$$T1 = (M + W) \times V + K$$
$$T2 = W \times V$$
$$T3 = T1 - T2$$
$$T4 = M \times V$$

T1 = Actual tension of conveying side (kg)
T2 = Actual tension of return side (kg)
T3 = Actual tension of drive (kg)
T4 = Actual tension of reverse (kg)
M = Weight of grain (kg/m) = 56
W = Weight of bucket and belt (kg/m) = 53
V = Conveying height (m) = 55
K = Friction of feed to bucket (kg) = 220

$T1 = (56 + 53) \times 55 + 220 = 6215$

$T2 = 53 \times 55 = 2915$

$T3 = 6215 - 2915 = 3300$

$T4 = 56 \times 55 = 3080$

1-3. Required moter power

$$N = \frac{T3 \times S}{6120 \times s \times r \times f}$$

T3 : Actual tension of drive (kg) = 3300

S : Conveying belt speed (m/min.) = 210

s : Efficiency of sprocket wheel = 0.9

r : Efficiency of reduction gear = 0.9

f : Efficiency of fluid coupling = 0.95

$$N = \frac{3300 \times 210}{6120 \times 0.9 \times 0.9 \times 0.95} = 147\ 160 \text{ kw}$$

1-4. Safety factor of conveying belt

$$Sf = \frac{Tb}{T1}$$

Sf : Safety factor of conveying belt = Min. 20

Tb : Tensile strength of conveying belt (kg) = 141000

T1 : Actual tension of conveying side (kg) = 6215

$$Sf = \frac{141000}{6215} = 22.6 > 20 \text{ --- OK}$$

1-5. Safety factor of back stop

$$Sfb = \frac{V}{T4 \times R} = 2.05$$

Sfb :	Safety factor of back stop = Min. 1.5
V :	Allowable torque of back stop (kg-m) = 3800
T4 :	Actual tension of reverse (kg) = 3080
R :	Radius of pulley (m) = 0.6

$$Sfb = \frac{3800}{3080 \times 0.6} = 2.05 > 1.5 \text{ --- OK}$$

2. Bucket elevator for discharging and/or recycle line

2-1. Capacity

$$Q = 60 \times S \times A \times E1 \times g$$

Q :	Capacity (t/h) = Min. 300
S :	Conveying belt speed (m/min.) = Max. 210
A :	Effective conveying volume (m3/m) = 0.04
E1 :	Conveying efficiency = 0.85
g :	Apparent specific gravity = 0.75

$$Q = 60 \times 210 \times 0.04 \times 0.85 \times 0.75 = 321 > 300 \text{ --- OK}$$

2-2. Actual tension of conveying belt (Calculated based on the formula 1.2)

T1 = (24 + 25) x 45 + 95 = 2300

T2 = 25 x 45 = 1125

T3 = 2300 - 1125 = 1175

T4 = 24 x 45 = 1080

2-3. Required moter power (calculated based on the formula 1-3.)

$$N = \frac{1175 \times 210}{6120 \times 0.9 \times 0.9 \times 0.95} = 52.4 < 60 \text{ kw}$$

2-4. Safety factor of conveying belt (calculated based on the formula 1-4.)

2-5. Safety factor of back stop

$$Sfb = \frac{1600}{1080 \times 0.6} = 2.47 > 1.5 \text{ --- OK}$$

(4) CONVEYOR (DISCHARGE LINE) FROM MACHINERY TOWER TO LOADING FACILITIES AND/OR BAGGING FACILITIES

(a) Type

Chain conveyor type.

(b) Principal particulars

	Installed location	Type	Capacity (t/h)	Overall Length(m)	Number of set
DR-5	From Machinery tower 3rd floor to rail way	Horizontal	300	Approx. 125	1
DR-6	Horizontal		300	Approx. 120	1
DR-7	Railway	Horizontal	300	Approx. 100	1
DR-8	Horizontal		300	Approx. 95	1
DR-9	Along the road	Horizontal	300	Approx. 100	2
DR-10	Machinery tower 3rd floor	Tilting (8 deg.)	300	Approx. 47	2
DR-11	Machinery tower 3rd floor	Horizontal	300	Approx. 35	1
DR-12	Machinery tower 3rd floor	Horizontal	300	Approx. 35	1

a) Detailed Dimensions

1) Conveying chain speed 50 m/min
2) Effective sectional area approx. 0.16 m2

b) Accessories

1) Derive assembly
2) Vent for dust-explosion prevention
3) Motor driven slide gate
4) Supporting frame works
5) Maintenance passageways for overhead conveyor
6) Temperature detectors

REFERENCE MATERIAL NO.4

Conveyor capacity and line for delivery

1. Delivery line

1-1. Number of branch lines for delivery

The each line of wagon loading, truck loading and bagging line shall be provided two (2) sets (total six (6) sets) considering a feasible number of lines for the each line.

1-2. Necessary number of trunk lines for delivery

To simultaneously operate two (2) kinds of operation in the total three (3) kinds of operation . Four (4) trunk lines will be provided.

2. Capacity of each delivery line

The capacity of each line (four trunk lines and six branch lines) shall be same because it has to be capable to change from each trunk line and to each branch line. The cargo volume in each operation is as follow.

in 2000	Rail	910,000	(1,300,000 x 0.7)
	Truck (Bulk)	312,000	(1,300,000 x 0.24)
	Truck (Bag)	78,000	(1,300,000 x 0.06)
in 2010	Rail	1,260,000	(1,800,000 x 0.7)
	Truck (Bulk)	540,000	(1,800,000 x 0.3)
	Truck (Bag)	Nil	

The largest cargo volume in the above operation is 1,260,000 t/y in rail. The capacity required to cope with the cargo volume to be handled in 2010 shall be estimated by the following formula:

for Rail

$$Qv = \frac{N}{D \times B \times H \times Y1 \times Y2 \times Ne}$$

Qv	: Required capacity	(t/h)
N	: Cargo volume	(1,260,000 t/y)
D	: Workable days	(295 days/y)
B	: Wagon loading facility occupancy	(0.6)
H	: Workable hours	(24 hours/day)
Y1	: Working time efficiency	0.7
Y2	: Operation efficiency	0.7
Ne	: Number of lines	2

$$Qv = \frac{1,260,000}{295 \times 0.6 \times 24 \times 0.7 \times 0.7 \times 2} = 302.66$$

for Truck (Bulk)

$$Qv' = \frac{V'}{1/2D\ B'\ H1xY1'xY2'xQe'+1/2D\ B'\ H2xY1'xY2'xQ2'}$$

$$= \frac{V'}{1/2D\ B'\ (H1+H2)xY1'xY2'xQ2'}$$

Qv'	: Required capacity	(t/h)
V'	: Cargo volume	(540,000 t/y)
D	: Workable days	(295 days/Y)
B'	: Truck loading facility occupancy	(0.6)
H1	: Workable hours in summer	(12 hours/day)
H2	: Workable hours in winter	(8 hours/day)
Y1'	: Working time efficiency	0.8
Y2'	: Operation efficiency	0.7
Ne'	: Number of lines	2

$$Qv' = \frac{540{,}000}{1/2(295) \times 0.6 \times (12+8) \times 0.8 \times 0.7 \times 2}$$

$$= 272.3$$

Therefore, the line capacity on each delivery conveyor is determined as 300 t/h. The flow diagram of delivery line is shown in Figure 3.10-5-4..

REFERENCE MATERIAL NO.7

CHAIN CONVEYOR

1. Chain conveyor for receiving line

1-1. Capacity

$$Q = 60 \times S \times A \times E1 \times g$$

Q	: Capacity (t/h) = 700
S	: Conveying chain speed (m/min) = 50
A	: Effective sectional area of conveyor casing (m2) = 0.36
E1	: Conveying efficiency = 0.95
g	: Apparent specific gravity = 0.75

$$Q = 60 \times 50 \times 0.36 \times 0.95 \times 0.75 = 769 > 700$$ ------ OK

1-2. Actual tension of conveying chain

$$T = (Mh + Wh) \times H + M \times V$$

T	: Actual tension of conveying chain (kg)
Mh	: Required force to move grain horizontally (kg/m)
Wh	: Required force to move conveying chain with freight horizontally (kg/m)
H	: Horizontal conveying length (m)
M	: Weight of grain (kg/m)
V	: Vertical conveying length (m)

1-3. Required moter power

$$N = \frac{T \times S}{6120 \times s \times r \times f}$$

N : Required moter power (KW)

T : Actual tension of conveying chain (kg)

S : Conveying chain speed (m/min.)

s : Efficiency of sprocket wheel = 0.9

r : Efficiency of reduction gear = 0.9

f : Efficiency of fluid coupling = 0.95

1-4. Safety factor of conveying chain

$$Sf = \frac{Tb}{T}$$

Sf : Safety factor of conveying chain = Min. 6.0

Tb : Average strength of conveying chain (kg)

T : Actual tension of conveying chain (kg)

1-5. Results of calculation

		RC-1	RC-2	RC-3	RC-4	RC-5
Q	t/h	716	716	716	716	716
H	m	10	8	45	94	83
V	m	0	0	0	0	0
g	t/m3	0.75	0.75	0.75	0.75	0.75
S	m/min	52	52	52	52	52
A	m2	0.36	0.36	0.36	0.36	0.36
	-	0.85	0.85	0.85	0.85	0.85
Mh	kg/m	91.7	91.7	91.7	91.7	91.7
Wh	kg/m	12.6	12.6	12.6	19.3	19.3
M	kg/m	229	229	229	229	229
T	kg	1043	834	4693	10434	9213
s	-	0.9	0.9	0.9	0.9	0.9
r	-	0.9	0.9	0.9	0.9	0.9
f	-	-	-	0.95	0.95	0.95
N	kw	10.9	8.7	51.8	115.2	101.7
N'[1)]	kw	15	15	75	132	132
Tb	kg	32000	32000	53000	69500	69500
Sf	-	30	38	11.2	6.7	7.5

Note 1) Out put of N' is the moter standard and more than 1.15 times as much as N.

2. Chain conveyor for discharging and/or recycle line

2-1. Capacity

$$Q = 60 \times S \times A \times E1 \times g$$

Q : Capacity (t/h) = Min. 300

S' : Conveying chain speed (m/min.) = 50

A : Effective sectional area of conveyor casing (m2) = 0.16

E1 : Conveying efficiency = 0.85

g : Apparent specific gravity = 0.75

$$Q = 60 \times 50 \times 0.16 \times 0.85 \times 0.75 = 306 > 300 \text{ --- OK}$$

2-2.Actual tension of conveying chain

Calculated based on the formula 1-2.

2-3.Required moter power

Calculated based on the formula 1-3.

2-4.Safety factor of conveying chain

Calculated based on the formula 1-4.

2-5.Results of calculation

		DR-1	DR-2	DR-3	DR-4	DR-5	DR-6	DR-7 DR-9	DR-8	DR-10	DR-11 DR-12
Q	t/h	306	306	306	306	306	306	306	306	306	306
H[2)]	m	97	87	45	40	125	120	100	95	47	35
V	m	0	0	0	0	0	0	0	0	6.6	0
g	t/m3	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
S	m/min	50	50	50	50	50	50	50	50	52	50
A	m2	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
	-	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.82	0.85
Mh	kg/m	38.9	38.9	38.9	38.9	38.9	38.9	38.9	38.9	38.9	38.9
Wh	kg/m	9.14	6.74	6.74	6.74	9.14	9.14	9.14	9.14	6.74	6.74
M	kg/m	102	102	102	102	102	102	102	102	102	102
T	kg	4660	3970	2053	3388	6005	5765	4804	4564	2818	1597
s	-	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
r	-	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
f	-	0.95	0.95	-	0.95	0.95	0.95	0.95	0.95	0.95	-
N	kw	49.5	42.2	20.7	36.0	63.8	61.2	51.0	48.5	31.1	16.1
N'[1)]	kw	75	55	30	45	75	75	75	75	45	22
Tb	kg	39500	28500	19000	28500	45000	45000	39500	39500	28500	19000
Sf	-	8.4	7.1	9.2	8.4	7.4	7.8	8.2	8.6	10.1	11.8

Note
1) Out put of N' is the moter standard and more than 1.15 times as much as N.
2) Indicate double trough conveyor.

(5) REMOVAL DEVICES FOR FOREIGN MATERIAL

Two (2) types of separator will be prepared to cope with any accident and trouble caused by foreign material. The location that they are to be installed is at the upper stream of the grain as close as possible. Magnet separator for ferrous materials will be installed on the unloader and the most up stream of the receiving line in the machinery tower.

The net separator for large size foreign materials will be installed close to magnetic separator in the machinery tower (Refer to the drawing for cargo flow).

The basic dimensions are as follows :

(a) Magnetic Separators

a)	Type	: Motor driven rotary drum, permanent magnet type
b)	Capacity	: 700 t/h
c)	Accessories	: Iron chip discharge chute, Iron chip receiving box.
d)	Number of sets	: each 2 sets (on unloaders and in machinery tower)

(b) Net Separators

1)	Type	: Net type
2)	Screen	: The diagonal size of metal screening conveyor grid shall be under 40 x 50 mm, and diameter of metal grid wire shall be above 3 mm.
3)	Capacity	: 700t/h
4)	Accessories	: Foreign materials discharge chute, Foreign materials receiving box.
5)	Number of set	: 2 sets

(6) WEIGHING DEVICES

(a) Receiving line

1) Location of hopper scale

There are two ideas that can be envisaged on the location of hopper scale. One is to locate in the machinery tower and the other is in the cargo flow between the unloader and machinery tower. The largest merit of the latter is to reduce the time lag caused by the flow of cargo between the unloaders. From the results of the detailed study, it is recommended to locate in the machinery tower since the merit of the latter is not so large and the demerits of the system are higher initial cost and lower flexibility on operation.

2) Principal particulars

a) Supply hopper

1. Effective volume of hopper	: 90 m3
2. Structure	: Steel plate
3. Number of set	: 2 sets
4. Accessories	: Level switch (Upper and Lower) Supporting frame

b) Automatic hopper scale

1. Capacity	: 700 t/h (8 ton/batch)
2. Type	: Load cell type automatic hopper scale
3. Number of set	: 2 sets
4. Operation	: Automatic and manual operation
5. Accuracy	: +/- 0.1 % for full scale
6. Accessories	: Local control panel Supporting frame Connecting chute

c) Discharge hopper

1. Effective volume	: 20 m3
2. Structure	: Welded steel plate
3.Number of set	: 2 sets
4.Accessories	: Level switch (Upper) Supporting frame

(b) Discharge line for business

1) Type of scale

Truck scale and Wagon scale are prepared taking into consideration user's requests.

2) Principle particulars

a) Truck Scale

1. Number of Scale	: 2 sets
2. Capacity	: 100 t
3. Type	: Combined type (Mechanical and Load cell)
4. Accuracy	: 0.1 % of full scale
5. Platform	: 18 x 3 m
6. Accessories	: Remote Digital Indicator Automatic Printing Device

b) Wagon Scale

1. Number of Scale	: 1 set
2. Capacity	: 200 t
3. Type	: Load cell type
4. Accuracy	: 0.1 % of full scale
5. Length of rail for scale	: 14 m
6. Accessories	: Remote Digital Indicator Automatic Printing Device

(c) Discharge line for silo bins operation not business

1) Type of scale

The type of scale for silo bins operation of discharge line and recycle line will be a hopper scale type which is popular.

2) Principal particulars

a) Supply hopper

1. Effective volume of hopper	: 35 m3
2. Structure	: Welded steel plate
3. Number of set	: 4 sets
4. Accessories	: Level switch (Upper and Lower) Supporting frame

b) Automatic hopper scale

1. Capacity	: 300 t/h (3 ton/batch)
2. Type	: Load cell type automatic hopper scale
3. Number of set	: 4 sets

(7) FUMIGATION FACILITIES

The both systems (gas system and tablet system) are introduced based on user's requests.

The principal particulars of the main devices are as follows :

(a) Blowers

1) Capacity	: 100 m3/min x 3,000 mm Aq.
2) Type	: Turbo blower type
3) Number of set	: 6 sets
4) Accessories	: Temperature detector Vibration - proof joint Pressure measurement manometer

Note : This blower is available for methyl bromide fumigation, hydrogen phasphide fumigation and aeration.

(b) Gas-vaporizers

1) Capacity	: 120 Litters (Water volume)
2) Type	: Warm water type vaporizer
3) Number of set	: 6 sets
4) Accessories	: Heater with thermostat Water level gauge Thermometer

(c) Dust collectors

1) Type	: Cyclone type
2) Number of set	: 6 sets
3) Accessories	: Dust box

(d) Gas distributors

1) Type	: Cross-shaped (Attached to hopper of silo)
2) Structure	: Steel plate
3) Number of set	: 56 sets (1 set/bin)

(e) Pipings and valves

1) Design pressure	: 5 kg/cm2
2) Material	: Carbon steel or cast iron
3) Size	: 300 Dia.
4) Number of set	: 6 sets

(f) Hydrogen phashide tablet feeder

1) Type	: Perforated plate feeder type
2) Tablet hopper	: Approx. 3 L.
3) Number of set	: 2 sets
4) Accessories	: Motor revolution adjuster Grain flow detector Timer

(g) Miscellaneous equipment

The miscellaneous equipment includes such measuring instruments as necessary for fumigation operations; they include a gas detector, gas density measuring instruments, platform scales, insect detection devices, gas masks and gas absorption cans, emergency medicine, fumigation markings.

REFERENCE MATERIAL NO.9

Fumigation system including aeration system

(1) Required numbers of fumigation line

1) Calculation based on the annual handling volume.

$$NA = \frac{V \times f1}{S \times C \times W \times f2}$$

NA : Required number of fumigation lines based on the annual handling volume

V : Cargo volume (t/y) = 1,800,000

f1 : Ratio of fumigation (%) = 50 (Assumption)

S : Number of fumigation bin (bin/day) = 1

C : Storage capacity of a bin (t/bin) = 1800

W : Workable days (day/y) = 295

f2 : Operation factor = 0.85

$$NA = \frac{1,800,000 \times 0.5}{1 \times 1800 \times 295 \times 0.85} = 1.99 = 2 \text{ lines}$$

2) Calculation based on the unloading capacity

$$Nu = \frac{Q \times n \times T \times f3}{S \times C \times f4}$$

Nu : Required number of fumigation linesbased on the unloading capacity

Q : Unloading capacity (t/h) = 700

n : Number of unloaders = 2

T : Working hours of unloaders (h/day) = 24

f3 : Working time efficiency (%) = 0.7

S : Number of fumigation bins (bin/day) = 4

C : Storage capacity of a bin (t/bin) = 1800

f4 : Operation factor = 0.85

$$Nu = \frac{700 \times 2 \times 24 \times 0.7}{4 \times 1800 \times 0.85} = 3.85 = 4 \text{ lines}$$

(2) Required number of aeration lines

Aeration will be carried out when the grain temperature becomes high. Fresh air will be pressed into the silo bin from its bottom using the fumigation equipment. Consequently, to carry out methyl bromide fumigation and aeration at a time, another (2 - 4) fumigation lines are required. After all the required number of fumigation lines is 6.

(3) Required blower capacity

1) In case of methyl bromide fumigation

The required blower capacity for methyl bromide fumigation is calculated by using the formula below.

$$QBf = \frac{V}{30}$$

QBf : Required blower capacity (m3/min.)

V : Geometric silo bin volume (m3) = Approximate 2900

$$QBf = \frac{2900}{30} = 96$$

2) Required blower capacity for aeration

Required blower capacity for aeration is calculated by using the formula below.

QBa = Veff x R

QBa : Required blower capacity for aeration (m3/min.)
Veff : Effective silo bin volume (m3) = Approximately 2400
R : Air flow rate (m3/min/m3) = 0.026 - 0.078
QBa : 2400 x (0.026 - 0.078) = 62 - 187

Consequently, the capacity of blower shall be 100 m3/min x 3,000 mmaq.

REFERENCE MATERIAL NO.11

Quality control of grain

Control of grain quality is an indispensable function of grain handling equipment. In this connection, grain stored in silo bins shall be monitored in order to prevent quality damage by any cause. There are two (2) methods for the monitoring grain in silo bins -

(i) Measurement of grain temperature and
(ii) Measurement of grain respiration quantity, that is, carbon dioxide (CO_2) contents.

Grain temperature is measured by resistance temperature detectors at nine (9) points per silo bin. This system consists of a sensor, remote scanner units and temperature controller. Carbon dioxide content is measured by "GAS TESTER." The grain temperature measuring system has been selected in the Design by the following reasons ;

(1) By the use of the grain temperature measuring system,the temperature not only of grain but also vacant room of silo bins can be measured, rgardless of quantity of grain in silo bins. It is, therefore, possible to monitor changes in grain and vacant room temperature during and after fumigation, aeration and rotation of grain. While the carbon dioxide measuring system is used, the numerical values obtainedby the measurement vary depending on the grain quantity stored. Therefore, it is difficult to monitor the accurate carbon dioxide contents bred by grain.

(2) Operation and maintenance of the temperature measuring system is easier having least wear and failure of parts and mechanical troubles, since the system consists of no moving rotating parts such as a sensor, cable, scanner, and display unit. While, the carbon dioxide measuring system, which consists of drain pot, gas filter, pump analyzer and amprifier, necessitates thorough maintenance and considerable supply of spare parts.

(8) SAMPLING DEVICES

Imported grain have to be inspected at the unloaded area. Sampling devices will be prepared to make above inspection securely and easily. Sampling devices include sampler, sample divider, equipment for quality inspection and related facilities. The samplers will be installed between net separator and hopper on the reaceving lines. The samples which are picked-up by sampler will be transported to sampling room by gravity through pipe.

The principal particulars of main devices are as follows :

(a) Automatic samplers

a)	Type	: Full width cut type, powered by compressed air
b)	Sampling quantity	: 400 g/once
c)	Accessories	: Sample collecting box, Chute and gate
d)	Number of set	: 2 sets

(b) Sample dividers

a) Type : Japan Food Agency type
b) Capacity : 3.6 L.
c) Accessories : Supporting frame
Chute and gate
d) Number of set : 2 sets

(c) Inspection equipment (Number of set : 1 set)

1) Sample dividers

a) Cargo type divider
b) Heavy-duty grain divider

2) Main inspection equipment (A)

a) Test weight
b) Moisture meter
c) Dockage tester
d) Strand sizer shaker
e) Official grain dockage sieves for strand sizer shaker
f) Electronic balance (6 mg)
g) Electronic balance (3 mg)
h) Double beam scale
i) Engineer scope
j) Hydro-thermometer
k) Grain thermometer
l) Grain triers (grain Probes)
m) Grain sample pan
n) Seed Counter

3) Rotary Pulverizer system

Equipped with Conical Feed Hopper for granulates

4) Main inspection equipment (B)

a) Test weight
b) Grain hardness
c) Protein
d) Ash
e) Falling number
f) Screenings
g) Bag sealers
h) Grain probe
i) In unbator

(9) DUST COLLECTION DEVICES

Dust collecting system will be installed in order to prevent air pollution and to protect the facilities from explosion. Unit dust collector will be arranged in the places where dust occurrs respectively. The collected dust in the unit dust collectors which are installed above the yard will be discharged to outside by dust track directly. On the other hand, the collected dust in the unit dust collectors which are installed in the machinery tower will be collected to dust tank by the dust cleaning equipment again. The dust in the dust tank will be removed to outside by dust truck.

(a) Unit dust collectors

The unit dust collector will be composed of dust collector, fan, compressed air device, duct, regulating valve, dust box and related facilities.

1) Dust collectors

a) Type	: Bag filter
b) Bag	: Antistatic electricity treatment bag
c) Dust removing	: Automatic reverse air cleaning system
d) Accessories	: Explosion panel
	Rotary valve
	Manometer

2) Fans

a) Type	: Turbo fan
b) Total head	: 450 mm Aq.
c) Accessories	: Damper
	Vibration-Proof duct
	Temperature detector

3) Ducts, regulating valves and dust box

a) Ducts	: Dia. 150 mm - Dia. 450 mm
b) Regulating valves	: Dia. 150 mm - Dia. 450 mm
	Manual operate adjustable valve

4) Principal particulars of Dust collecting systems

	Installed location	Area of bag filter (m2)	Capacity (t/h)	Comp.air Length(m)	Number of set
DR-1	Belt conveyor for receiving Line	Approx. 25	60	Approx. 300	2
DR-2	Belt conveyor for receiving Line	Approx. 25	60	Approx. 300	2
DR-3	Receiving Line in Mach. tower	Approx. 70	160	Approx. 800	2
DR-4	Receiving Line in Mach. tower	Approx. 25	60	Approx. 300	4
DR-5	Discharging Line in Mach. tower	Approx. 40	100	Approx. 500	2
DR-6	Truck loading Station	Approx. 25	60	Approx. 300	2
DR-7	Bagging devices	Approx. 25	60	Approx. 300	1
DR-8	Chain conveyor for Discharging line	Approx. 25	60	Approx. 300	1
DR-9	Wagon loading Station	Approx. 70	160	Approx. 800	1

REFERENCE MATERIAL NO.12

Dust Collection System

Required Air Volume

The required air volume at a spot is calculated using the following formula. The coefficient on this formula will be considered based on the installed interval of the suction spot.

$$Qa = \frac{Qg}{60} * C$$

Qa	: Required air volume	M3/min
Qg	: Cargo Volume	M3/h
C	: Coefficient	

For Receiving line

$$Qa = \frac{700}{60 * 0.75}$$

$$= 15.6 \text{ m3/min}$$

C	: Long span interval	3 - 4
	Medium	2 - 3
	Close	1 - 2

(b) Dust cleaning equipment

The dust cleaning equipment will be composed of dust collectors and related facilities.

1) Blowers

a)	Type	: Roots blower
b)	Pressure	: +150 mm Aq, - -5,000 mm Aq.
c)	Air volume	: 5 m3/min.
d)	Accessories	: Delivery silencer,
		: Pressure gauge
		: Safety valve

2) Dust collectors

a)	Type	: Bag filter (Antistatic electricity treatment bag)
b)	Dust removing	: Automatic reverse air cleaning system
c)	Air volume	: 5 m3/min.
d)	Design pressure	: - 5,500 mm Aq.
e)	Accessories	: Explosion panel, Rotary valve, Manometer

3) Auxiliary equipment

a)	Dust tanks	: Approx. 5 m3
b)	Hoses, etc.	: Nozzle hose, extension hose, suction pipe, floor brush and others

4) Number of set : 2 sets

(10) AIR COMPRESSING

Compressed air will be used for hopper scales, sampling devices, dust collections and general use.

a) Type of compressor : Screw type motor driven

b) Rated pressure : 5 - 7 kg/cm2

c) Cooling method : Air cooled

d) Capacity and number of set

	Installation Site	Capacity (l/min)	Number of set
CA-1	Belt conveyor for receiving line	Min. 1,400	1 set
CA-2	Machinery tower 4th floor	Min. 3,200	3 sets
CA-3	Bagging room	Min. 500	1 set
CA-4	Wagon loading Station	Min. 1,400	1 set

e) Accessories : Receiver tank,
Drain separator,
Pipe line and valves,
Necessary instruments

REFERENCE MATERIAL NO.10

Air Compressing equipment

	Applications	Air consumption (l/min.) Unit	Air consumption (l/min.) Total	Required Cap. of Comp. (l/min.)	Number of set
CA-1	DC-1	600			
	DC-2	600			
	General use for belt conveyor	200	1400	Min. 1400	1 set
CA-2	Hopper scale for receiv. line	1200			
	DC-3	1600			
	DC-4	1200			
	DC-5	2000			
	Hopper scale for disch. line	1300			
	DC-6	600			
	Sampling system	600			
	General use for M/T	1100	9600	Min. 3200	3 sets
CA-3	DC-7	300			
	General use for Bagging room	200	500	Min. 500	1 set
CA-4	DC-8	300			
	DC-9	800			
	General use for wagon loading station	300	1400	Min. 1400	1 set

(11) LOADING FACILITIES

(a) Wagon Loading Facility

Two rail way lines are arranged at the behind of the grain terminal. The loading facility will be arranged above the one(1) rail way. The loading facility will be composed of hopper with telescopic loading chute, platform for control house and related facilities, wagon scale and other related facilities. The hopper will be filled with the grain from silo bin through chain conveyors. The stored grain momentary in the hopper will be loaded to wagon through gate and telescopic chute. The full loaded wagon will be moved to just one (1) wagon length by locomotive. The grain volume loaded into wagon will be calculated from the total wagon weights before and after loading weighed by the wagon scale which is installed below the rail way.

The principal particulars are as follows :

1) Number of loading line	: 1
2) Hopper capacity (effective)	: 400 m3
3) Loading chute	
a) Number	: 3 sets
b) Type	: Electrical telescopic type
c) Stroke	: 3 m
4) Gate for chute	
a) Number	: 3
b) Type	: Remote control type
5) Loading capacity	: 200 t/h x 3
6) Receiving conveyor from silo	: 300 t/h x 2
7) Weighing system	: Wagon scale
a) Capacity	: 200 t
b) Accuracy	: +/- 0.1 % of full scale
c) Length of rail for scale	: 14 m
d) Control house	: 1 set

(b) Loading Facility for Truck

Two (2) loading lanes for trucks will be arranged in the space between machinery tower and rail way, and required loading facilities will be arranged above the loading lanes. The loading facilities will be composed of hoppers with telescopic loading chute, platform for control house etc. and other related facilities.

The hopper will be filled with the grain which is taken out on the way of the chain convveyors. The stored grain momentary in the hopper will be loaded to truck through gate and telescopic chute. The loaded volume will be mesured by the truck scale which is installed at the gate.

The principal particulars are as follows :

1) Number of loading lines	: 2
2) Hopper capacity (effective)	: 240 m3
3) Loading chute	
a) Number	: each 1 set
b) Type	: Electrical telescopic type
c) Stroke	: 3 m
4) Gate for chute	
a) Number	: each 1 set
b) Type	: Remote control type
5) Loading capacity	: 200 t/h x 3
6) Receiving conveyor from silo	: 300 t/h x 2
7) Weighing system	: Truck scale (at entrnace gate)

REFERENCE MATERIAL NO.5

The required effective volume of the loading facilities.

The required effective volume of loading facilities is calculated using the following formula.

$$Ve = \frac{1}{g} \left(V + \frac{Qc \times T}{60} \right)$$

$$V = V1 * K * C$$

Ve	: Effective volume of the hopper	(m3)
V	: Maximum holding capacity in normal operation	(t)
V1	: Wagon or truck capacity	(t)
C	: Coefficient	(3)
K	: Number of loading line per hopper	
Qc	: Total conveyor capacity	(600 t/h)
T	: Time lag from Silo to loading facility	(min)

1. Hopper for wagon

$V1 = 65t$

$C = 3$

$n1 = 1$

$$T = \frac{97}{50} + \frac{45}{50} + \frac{45}{210} + \frac{125}{50} + \frac{47}{50} = \frac{314}{50} + \frac{45}{210} = 6.2 + 0.2 = 6.4$$

say = 7

$$Ve = \frac{1}{0.75}\left(65 \times 3 + \frac{600 \times 7}{60\ 0}\right) = \frac{1}{75}(195 + 70)$$

= 353 say 400 m3

2. Hopper for truck

$V1 = 10t, 20t, 40t$

$n1 = 2$

$C = 3$

$$T = \frac{97}{50} + \frac{45}{50} + \frac{45}{210} + \frac{60}{50} = \frac{202}{50} + \frac{45}{210} = 4.04 + 0.2 = 4.24$$

= 5

$$Ve = \frac{1}{0.75}\left(20 \times 2 \times 3 + \frac{600 \times 5}{60}\right) = \frac{1}{0.75}(120 + 50)$$

= 227 say 240 m3

(12) TRUCK SCALE

Two (2) sets of truck scale will be arranged at the front of entrance gate of the port area. These scales will be used for official business for the loaded grain on the truck.

The principal particulars are as follows :

1) Capacity	: 100 t
2) Type	: Combined type (Mechanical and Load cell)
3) Accuracy	: 0.1% of full scale
4) Platform	: 18 x 3 m
5) Accessories	: Remote Digital Indicator Automatic Printing Device

(13) BAGGING DEVICE

The bagging devices shall be arranged in the bagging store. The grain to be bagged will be sent from silo bin through chain conveyor and others. Some bagged grain will be delivered to outside by truck directly and the remained one will be stored temporarily. The bagging devices will be composed of supply hoppers, automatic packer scales, sewing machines attached with conveyor and bag transfer conveyors.

The principal particulars are as follows :

(a) Supply hopper

1) Effective volume	: 40 m3 (Each)
2) Structure	: Steel plate structure
3) Number of set	: 2 sets
4) Accessories	: Level switch (Upper and Lower)

(b) Automatic packer scale

1) Capacity : Max. 25 t/h (for 100 kg/bag)
2) Adjustable range : 50 - 100 kg/bag
3) Type : Load cell type automatic packer scale
4) Accuracy : +/- 0.1% for full scale
5) Power source : AC 220 V, 50 Hz
6) Air source : 5 - 7 kg/cm2
7) Number of set : 4 sets
8) Accessories : Local control panel

(c) Sewing machines with conveyors

1) Capacity : 250 bags/h
2) Seam width : 7 - 10 mm
3) Conveyors : Belt type, Feeding speed : Approx. 10m/min
4) Number of set : 4 sets

(d) Bag transfer conveyors

1) Capacity : 30 t/h
2) Type : Portable belt conveyor type
3) Length : Approx. 10 m
4) Number of set : 4 sets

REFERENCE MATERIAL NO.6

Bagging Devices

1. Required capacity of bagging devices:

The capacity is calculated based on the following formula.

$$Qm = \frac{Qy \times Rb \times f1}{Dy \times Hd \times f2 \times n}$$

Qm : Required capacity of bagging devices (t/h)

Qy : Annual handling volume in 2000 (t/y) = 1,300,000

Rb : Rate of bagging in 2000 (%) = 6

f1 : Assumed peak ratio = 2

Dy : Working days (d/y) = 295

Hd : Average working hours (h/d) = 10

f2 : Operation factor = 0.6

n : Number of set = 4

$$Qm = \frac{1,300,000 \times 0.06 \times 2}{295 \times 10 \times 0.6 \times 4} = 22 \text{ t/h} \qquad 25 \text{ t/h}$$

2. Required effective volume of supply hopper

The effective volume is calculated by using the following formula.

$$Ve = \frac{V}{g} + \frac{Qc \times T}{60 \times g \times n}$$

Ve : Effective volume of supply hopper (m3)

V : Needed holding capacity of supply hopper (t) = 0.3

g : Apparent specific gravity = 0.75

Qc : Capacity of transfer conveyor (t/h) = 300

T : Average conveying time from silo to supply hopper (min.) = Approximately 10

n : Number of supply hoppers = 2

$$Ve = \frac{0.3}{0.75} + \frac{300 \times 10}{60 \times 0.75 \times 2} = 0.4 + 33.4$$

$$= 33.8 \text{ m3} \qquad \text{say} \qquad 40 \text{ m3}$$

(14) GATES AND CHUTES

(a) Slide gates

1) Silo discharging gates

a) Type : Motor driven slide gates, manually operating airtight type
b) Installation site : Below the silo bins
c) Limit switches will be provided
d) Number of set : 56 sets

2) Slide gates

a) Type : Dustproof structure with no leakage of grain, Motor driven slide gate type
b) Installation site : Chain conveyors and hopers
c) Limit switches will be provided
d) Number of set : As required

(b) Two-way gates

a) Type : Dustproof structure with no leakage of grain, motor driven two-way gate
b) Installation : At the branches of chutes
c) Limit switch and inspection hole will be provided
d) Number of set : As required

(c) Chutes

1) The inner diameter and thickness of chutes will be as follows:

a) 770 t/h Dia. 700 mm, 9 mm thickness lined with teflon sheets
b) 350 t/h Dia. 400 mm, 9 mm thickness lined with teflon sheets

2) The shape of chutes will be round in principle

3) The angle of inclination of the chutes should be not less than 45 deg.

4) Number of set : As required

(15) SILO BINS

(a) Location of silo bins group

It is desirable that the silo bins be located as close as possible to the berth line, because the behind zone of the silo bins group can be more useful than the front zone of the silo bins group. However, the minimum distance will be determined by the allowable angle of the belt conveyor. Thus, the location of them is decided from the above viewpoint.

(b) Number of silo bins (Capacity of each silo bin)

The items to be considered in determing the number of silo bins are as follows :

1) Total storage capacity
2) The size of each silo bin
3) Silo operation and Fumigation
4) Construction cost
5) Symmetrical arrangement
6) Number of silo bin row
7) Maximum length of the chain conveyor
8) Total area to be required

Based on the examination of the above items, the finally estimated number of the silo bins which is recommendable in the project is 56 bins using multiplier 8.

(c) The principal particulars are as follows :

1) Shape : Independently self-standing cylindrical shape

2) Type : Reinforced concrete

3) Effective Capacity : 1,870 metric tons

4) Number of silo bins : 56 bins

5) Total Effective Capacity : 104,720 metric tons

6) Silo bin

a) Wall (cylindrical type)

Inner Diameter : 11.000 m
Height of wall : 26.800 m
Thickness of wall(top) : 250 mm
Thickness of wall(bottom) : 500 mm

b) Hopper (conical type of steel)

Height of hopper : 5.000 m
Hopper angle : 45 degree

c) Roof & Ceiling

The roof & ceiling is of T-shaped square slab which is designed of reinforced insitu concrete.

Length of slab -right square- : 12.350 m
Thickness at edges : 250 mm
Thickness at center of cylinder : 250 mm
Thickness at silo bin wall : 300 mm

7) Silo bin support

- Cylindorical reinforced concrete type

Inner diameter :	: 9.000 m
Thickness of wall :	: 800 mm
Number of openning :	: 4 nos
Height of openning :	: 2.000 m
Width of openning :	: 3.000 m

8) Silo bin foundation

- Reinforced in-situ concrete

Scale	Total area	50.0m x 87.5m x 2 = 8,750 sq.m
	Area of a bin	12.5m x 12.5m = 156.25 sq.m

- Pile foundation

Pile : Prestressed concrete pile

Size of pile

Length	1 m
Three (3) piles (L=8-12m) may be joined	
Diameter	600 mm
Thickness cylindrical	100 mm
Number of piles 4 x 4 =	16 nos per bin
Total 16 x 56 =	896 nos

9) Elevation of silo bin facilities

Top level of foundation	: EL +3.300 m
Tip level of pile	: EL -28.200 m
Top level of silo bin support	: EL +11.300 m
Top level of roof & ceiling	: EL +38.100 m

Note: Calculations of silo bin wall are presented in the Design Calculation Sheets Volume III (6. Grain Handling Equipment).

10) Facility Layout Plan

As shown on the Figures 3.10-5-1 to 3.10-5-3

(16) MACHINERY TOWER

A machinery tower will be installed between the silo bin group. A dust cleaning equipment room and a power room will be housed on the 1st floor of the tower.

A central control room, an electric switch room and receiving line automatic hopper scale will be housed on the 2nd floor. Transportation equipment, screening devices, sampling system, discharging line automatic hopper scale, dust collecting system and compressed air equipment will be housed on the 3rd floor and above. The machinery tower will also include an elevator for man and instruments, a stair way and machine hatch equipped with a hoist.

(a) Principal particulars of the machinery tower

1) Tower area	: Approx. 600 m2 (Approx 575 m x 10 m)
2) Total floor area	: Approx. 4,700 m2
3) Height of tower	: Approx. EL + 64.6 m
4) Structure	: 1st to 3rd floor Steel framed reinforcement concrete 4th floor and above Reinforced concrete
5) Foundation	: Reinforced concrete, pile foundation
Pile length	: Approx. 20 m

(b) Finish areas

1) Central control room

a) Floor	: Free access floor, P-tile finish
b) Wall	: Concrete placing, painting finish
c) Celling	: Concrete placing gypsum board finish

2) Other areas

a) Roof : Tamped concrete, asphalt water proofed, Protection mortar
b) External wall : Concrete placing, Spray tile,
c) Window : Aluminum sash
d) Door : Steel sash

3) Machinery and electric rooms

Placing concrete to floor, wall and celling.

(c) Building facilities

1) Elevator for man and instruments : 6 persons
(Approx. 500 kg). Speed : 45 m/min

2) Fire alarm and fire fighting equipment
(See close (24) FIRE FIGHTING)

3) Communication and telephone facilities
(See close (21) ELECTRIC DEVICES AND FIXTURES)

4) Water supply and drainage : on the 2nd floor

5) Air conditioning equipment : central control room,electric room and sampling room
(See close (22) AIR-CONDITIONER AND VENTILATOR)

6) Hoist

a) Type : Electric hoist
b) Hoisting capacity : 5 tons
c) Hoisting height : Approx. 56 m
d) Hoisting speed : Approx. 8 m/min
e) Number of set : 1 set

(17) ANCILLARY FACILITIES

(a) Bulldozer

During the final stage of unloading work, the work efficiency (of the unloading) goes down. To cope with this matter, a bulldozer for each unloader is requested for a raking work in the ship hold and making the work more efficient at that stage. The bulldozer will be put into the hold by the unloader with lifting device.

The principal particulars are as follows :

Number of set	2 sets
Capacity	3 t

(b) Wheel loader

Wheel loaders will be provided as necessary for cleaning and collecting the spilled grain that may occur due to some troubles of the loading facilities.

The principal particulars are as follows :

Number of set	2 sets
Capacity	0.25 c.u.m

(c) Return equipment for spilt grain

(d) Others

(18) POWER SUPPLY

(a) Power source

Electric power to operate the grain handling facilities and equipment will be supplied to the 1st floor of the machinery tower for distribution in the complex as required.

The power source design conditions for supply of AC 380v, 3 phase, 50 Hz, 4-wire are stated in Chapter 10.2 Design Conditions (General) and Chapter 10.3 Design Criteria.

(b) The rated voltage of various equipment

1) Power system :

AC 380 v, 3 phase, 50 Hz, 4-wire
AC 220 v, 2 phase, 50 Hz, 3-wire

2) Control and measuring circuit, and communication system :

AC 220 v, 2 phase, 50 Hz, 2-wire
AC 110 v, 2 phase, 50 Hz, 3-wire
DC 24 v, or necessary-----------

3) Lighting system :

AC 220 v, single phase, 50 Hz, 2-wire

4) maintenance and repair circuit :

AC 380, 220 v, 3 phase, 50 Hz, 4-wire

(19) OPERATION SYSTEM

The operation system will be composed of two (2) receiving lines and four (4) discharging lines, including truck loading, wagon loading, bagging device and a recycling line. The two (2) receiving lines will be connected with two (2) unloaders and operated simultaneously. Each receiving line can be connected with either unloader. The four (4) discharging lines can be operated simultaneously. Two (2) lines each of truck loading, wagon loading and bagging device are available. The recycling line is used to improve efficiency of storage and control the quality stored grain. The operation system is same as those of the receiving and discharging lines.

(a) Receiving line

The system controls the operation of loading silo bins through unloaders. Unloaders are operated by unloader operators. The system operator selects silo bins and respective quantities to be loaded and informs unloader operators of his decision. A maximum of three(3) silo bins and respective quantities for each line can be selected without suspension of the operation. Upon the orders by the system operator to start the operation, an alarm rings and the system starts running from the down-stream side. Upon the orders by the system operator to stop the operation, the system stops running in due sequence.

(b) Truck loading line

The system controls the operation of truck loading through supply hoppers for grain discharge from silo bins The system operator selects silo bins and respective quantities to be discharged and informs of his decision. A maximum of three (3) silo bins and respective quantities per each line can be selected without suspension of the operation. Upon the orders by the system operator to start the operation an alarm rings and the system starts running from the down-stream side. Upon the orders by the system operator to stop the operation, the system stops running in due sequence. Truck loaders will be operated at the site.

(c) Wagon loading line

The system controls the operation of the Wagon loading through supply hoppers for grain discharge from silo bins. The system operator selects silo bins and respective quantities to be discharged and informs of his decision. A maximum of three (3) silo bins and respective quantities per each line can be selected without suspension of the operation. Upon the orders by the system operator to start the operation, an alarm rings and the system starts running from the down-stream side. Upon the orders by the system operator to stop the operation, the system stops running in due sequence. Wagon loaders shall be operated in the wagon loader operating room.

(d) Bagging device

The system controls the operation of loading bagging devices through supply hopper. The system operator selects silo bins and respective quantities to be discharged and informs of his decision. A maximum of three (3) silo bins and respective quantities for each line can be selected without suspension of the operation. Upon the orders by the system operator to start the operation, an alarm rings and the system starts running from the down-stream side. Upon the orders by the system operator to stop the operation, the system stops running due sequence. Bagging is carried out by bagging devices at site.

(e) Sampling system and fumigation system

Two (2) lines of the sampling system and six (6) lines of the fumigation system can be operated individually when necessary. The sampling will be operated by the sampling panel installed in the sampling room. The fumigation system will be operated by the fumigation panel installed in the fumigatin room.

(f) Temperature measuring system

The temperature measuring system will be devided into two (2) areas. The 1st area shall be for grain temperature in the silo bin and the 2nd for bearings. These measurements will be made in order to maintain original quality of stored grains and to protect the facilities from explosions by controling the temperature.

1) Grain temperature

The measurement of grain temperature in the silo bin shall be excecuted by temperature detectors (RTD). Nine (9) points per silo bin will be measured. The system consists of remote scanner units, temperature monitor controllers, etc.

2) Bearing temperature

Coveyor bearing (including motors and others) will be measured. Abnormal temperature will be alarmed on the control panel in the central control room and related facilities will be interlocked at set temperature limit to protect facilities from overheating and explosion. The tepertures will be measured on the following facilities:

Belt conveyor
Bucket elevator
Chain conveyor
Blower and fan

(20) CONTROL SYSTEM

Receiving, discharging, sampling and fumigation facilities are separately operated by the respective control systems.

(a) Operation mode of the grain receiving and discharging line

Operation modes are selected by a switch box installed at the motor in the site. The three(3) operation mode- " loacl 1," " local 2" and "remote"- are made available, and the function and the usage of each mode are as described below.

1) Local 1 mode

This mode is applied for testing and maintenance of motors of the equipment. In MCC the "local 1" operation mode is switched on, then the operation is carried out by the switch box installed at the motor in the site. Control is performed by circuits (i.e. hardware)

2) Local 2 mode

This mode is applied for testing and maintenance of devices of the equipment. In MCC the "local 2" operation mode is switched on, then the operation is carried out by the switch box installed at the motor in the site. Control is performed by circuits (i.e. hardware), and a protective interlocking device which equips the machinery to suspend the operation automatically in case of abnormal occurrence.

3) Remote mode

This mode is applied for the usual operation. In MCC the "remote" operation mode is switched on, and the operation is carried out by the operation desk panel installed in the central control room. Control is performed by circuits of PLC (programable sequence controller), and a protective interlocking device equips the machinery to level the mechanical functions.

(b) Sampling system operation mode

Operation modes are selected by the operation box in the site. The two(2) operation modes-"local" and "remote"- are available, and the function and the usage of each mode are as described below.

1) Local mode

This mode is applied for the operation at site. The operation is carried out by the operation box at site. Control is performed by circuits (i.e. hardware), and a protective interlocking device equips the machinery to suspend the operation automatically in case of abnormal occurrence.

2) Remote mode

This mode is applied for the usual operation. The operation is carried out by the sampling panel in the sampling room. Control is performed by circuits of PLC, and a protective interlocking device equips the machinery to suspend the operation automatically in case of abnormal occurrence.

(c) Fumigation system operation mode

Operation modes are selected by the operation box provided at site fumigation panel. The two(2) operation modes-"local" and "remote"- are available, and the function and the usage of each mode are as described below.

1) Local mode

This mode is applied for the operation at site. The operation is carried out by the operation box at site. Control is performed by circuits (i.e. hardware)< and a protective interlocking device equips the machinery to suspend the operation automatically in case of abnormal occurrence.

2) Remote mode

This mode is applied for the usual operation. The operation is carried out by the fumigation panel in the fumigation room. Control is performed by circuits (i.e. hardware), and a protective interlocking device equips the machinery to suspend the operation automatically in case of abnormal occurrence.

(d) Main devices of each panel board

1) Power panel in the machinery tower

A panel, made of MCC (motor control center) type dustproof steel panel, will be installed in the electric switch room on the 2nd floor to control the power facilities.

Main devices

Molded case circuit breaker
Electric contactor
Overcurrent relay
Auxiliary relay
Signal lamp
Ammeter
Operating switch

2) Switch panel in the machinery tower

A panel, made of dustproof steel panel, will be installed in the electric switch room on the 2nd floor to supply the auxiliary facilities in the machinery tower with power.

Main devices

Molded case circuit breaker
Volt meter
Ammeter
Illuminating lamp inside the panel
(dustproof, explosion-proof type)

3) Switch panel in the bagging site

A panel, made of dustproof steel panel, will be installed in the bagging workshop to supply each equipment in the shop with power.

Main devices

Molded case circuit breaker
Volt meter
Ammeter
Illuminating lamp inside the panel

4) AC 110v swich panel

A panel, made of dustproof panel, will be installed in the electric switch room on the 2nd floor to supply each equipment with control power.

Main devices

Molded case circuit breaker
Volt meter
Ammeter
Insulating transformer
Illuminating lamp inside the panel

5) Desk type operation panel

A panel,made of dustproof steel pnel, will be installed in the central control room on the 2nd floor to operate receiving and discharging.

Main devices

Operating switch
Emergency switch
Digital switch
Signal lamp

6) Monitor panel

A panel, made of dustproof steel panel, will be installed in the central control room on the 2nd floor to observe operation, suspension and failure of the facilities.

Main devices

Graphic display
Signal lamp
Ammeter
Illuminating lamp inside the panel

7) Desk type wagon and truck loading panel

A panel, made of dustproof steel panel, will be installed in the wagon loader operating room and truck loader operating room to operate loading wagons and truck.

Main devices

- Graphic display
- Operating switch
- Emergency switch
- Signal lamp

8) PLC (programable sequence controller) panel

A panel, made of dustproof steel panel, will be installed in the electric switch room on the 2nd floor to control the equipment.

Main devices

- Molded case circuit breaker
- PLC (programable sequence controller)
- Insulating transformer
- Illuminating lamp inside the panel

9) Interface panel

A panel, made of dustproof steel panel, will be installed in the electric switch room on the 2nd floor to control the equipment.

Main devices

- Molded case circuit breaker
- Remote in/out
- Auxiliary relay
- Illuminating lamp inside the panel

10) Hopper scale panel

A panel, made of dustproof steel panel, will be installed on the 4th floor to control discharging hopper scales, and same panel be installed on the 2nd floor to control receiving hopper scales. Simultaneous operation of discharging and receiving is controlled by the panel on the 2nd floor in the central control room.

Main devices

Molded case circuit breaker
Insulating transformer
PLC (programable sequence controller)
Scale controller
Illuminating lamp inside the panel

11) Packer scale panel

A panel, made of dust proof steel panel, will be installed in the bagging workshop to control packer scales.

Main devices

Molded case circuit breaker
Insulating transformer
PLC (programable sequence controller)
Scale controller
Graphic display
Illuminating lamp inside the panel.

12) Sampling panel

A panel, made of dustproof steel panel, will be installed in the sampling room on 3rd floor to extract and inspect samples automatically.

Main devices

- Molded case circuit breaker
- Insulating transformer
- PLC (programable sequence controller)
- Auxiliary relay
- Graphic display
- Operating switch
- Signal lamp
- Illuminating lamp inside the panel

13) Fumigation panel

A panel, made of dustproof steel panel, will be installed in the fumigation room located under the silo to control fumigation facilities.

Main devices

- Molded case circuit breaker
- Electric contactor
- Overcurrent relay
- Ammeter
- Volt meter
- Auxiliary relay
- Graphic display
- Operating switch
- Signal lamp
- Illuminating lamp inside the panel

(21) ELECTRIC DEVICES AND FIXTURES

(a) Motor

Motors are explosion-proof and enclosed (IP56) with cooling fans and of the three(3) phase induction motor squirrel cage rotor type.

Insulation	: Class B
Applied voltage	: AC 380 v
	: AC 220 v

(b) Cable

Cables with crimp style terminals at edges are laid in cable racks and pipes.

1) Cable size

Power supply cables	: 600 v CV 2 sq.mm minimum
Control cables	: CVV 1.25 sq.mm minimum
	: CVV-S 1.35 sq.mm minimum

2) Cable color

First phase	: R phase black
Second phase	: S phase white
Third phase	: T phase red
Neutral phase	: N phase green

3) Cable rack

Cable racks are adequately protected against damages by briny air. All cable racks are covered with rackcovers. Power supply cables, control cables and other cables are laid separately in a cable rack.

4) Conduit pipe

Thick steel pipes are used outdoors and also for power systems. Thin steel pipes are used indoors, except for power systems. Pipes and fixtures are connected with flexible tubes.

(c) Industrial television (ITV) system

The system consists of two(2) 16 inch mono-chrome television monitors installed in the central control room and four(4) ITV cameras installed at :

Unloading site at wharf
Truck loading site
Wagon loading site
Bagging workshop

Angles and focuses are adjusted and cameras selected in the central control room. ITV cameras are specifically durable for use in rain and briny air.

(d) Lighting

The lighting system is divided into the following local panels to supply the respective systems with power.

Indoor lighting system
Outdoor lighting system
Emergency lighting system
Lighting system to secure evacuation
Aerial beacon lighting system

1) Location of the local lighting operation panels

Indoor panels are made of dustproof steel panels and outdoor panels are of waterproof steel panels.

Machinery room in machinery tower
Outdoor belt conveyor
Outdoor chain conveyor
Wagon loader building
Truck loader building
Bagging workshop

2) Intencity of illuminations

Standard intensities of illuminations are as follows:

Central control room 150 lux
Wagon loader operating room 150 lux
Truck loader operating room 150 lux
Sampling room 150 lux
Electric switch room 100 lux
Power supply room 100 lux
Fumigation room 100 lux
Outdoor conveyor passage 10 lux
Machinery room in machinery tower 40 lux
Upper and lower silo 50 lux
Stairway in machinery tower 30 lux
Truck loading site 50 lux
Wagon loading site 50 lux
Bagging workshop 50 lux

3) Emergency lighting

Each room shall be equiped with an emergency lighting device to work in case of failure of power supply. Emergency lighting is of a quarter intensity of the usual lighting and to stay on for 30 minutes.

4) Lighting to sequre evacuation

A light indicating "EXIT" is fixed above door(s) in each room, the machinery tower exit and stairway to secure speedy evacuation in case of emergency.

5) Aerial beacon lighting

Red lighting for aerial beacons is fixed on the top of the machinery tower and turned on and off automatically and/or manually.

(e) Communication and telephone fixtures in the complex

A communication panel is installed in the central control room.

1) Broadcasting fixtures

Announcements are broadcasted from the central control room to the whole complex. Announcements are broadcasted from the central control room to any particular area in the complex.

2) Telephone fixtures

Calls are made between the trunk line and extension lines. The trunk line can interrupt calls between extension lines, if necessary.

3) Locations of speakers and telephones

Speaker and telephone fixtures are installed in protective panels against rain and briny air at the following places.

Central control room
Electric switch room
Sampling room
Wagon loader operating room
Fumigation room
Truck loader operating room
Machinery tower (every floor)
Unloader operating room
Upper & lower silo
Truck & wagon loading sites
Bagging workshop
Gate house
Port authority building
Administration building
Maintenance workshop
Service building

(f) Equipment for maintenance and repair

A maintenance panel, with sockets of 380v/220v(with plugs), is installed at the following places. In addition, several terminals of 380v/220v are attached inside the panels.

Machinery room in machinery tower
Upper and lower silo
Outdoor belt conveyor
Truck loading structure
Wagon loading structure
Bagging workshop

(22) AIR-CONDITIONER AND VENTILATOR

(a) Air-conditioner

An air conditioner-cooler and heater- is installed in the following rooms.

Central control room	(15- 22 degrees C)
Electric switch room	(30 degrees C maximum)
Sampling room	(15- 28 degrees C)
Wagon loading room	(15- 28 degrees C)
Truck loading room	(15-28 degrees C)

(b) Ventilator

A ventilator is installed in the following rooms.

Fumigation room
Elevator machinery room

(23) LIGHTNING ROD

(a) Lightning Rod and Grounding system

The following buildings are equiped with a lightning rod.

Machinery tower
Silo bin
Wagon loader operating house
Truck loader operating house

(b) Grounding System

All the electric devices are grounded away from the terminals of lightning rods.

Grounding resistance

Low voltage grounding	: 4 ohms maximum
Lightning rod grounding	: 4 ohms maximum

Grounding cables are coloured in green.
Material of grounding cables are IV.

(24) FIRE FIGHTING

(a) Automatic Detector

The most effective precautionary measures against fire is to defect the incipient of fire or the circumstances before fire to begin. Therefore, automatic detectors (thermal type) are installed in the following places. (excluding buildings)

a. Unloader
   Electric panel room, Machinery room
b. Machinery Tower
   All closed space
c. Loading facilities
   Each control room

Note : Required member of detector will be calculated according to the area.

Two sets of fire-alarm panel are prepared (one is installed in the central room and another one is installed in the central fire office).

(b) Fire Hydrant

Fire hydrants are arranged at the yard. The detail is shown on the relevant drawings. They will be used for fire-fighting of the surrounding of each facility and at the grain terminal yard.

(c) Portable fire extinguisher

Portable fire extinguishers are installed at the following places (exclude Building).

a. Unloader
   Control room, Electric panel room, Machinery room.
b. Conveyor
   At least every 50 m length
c. Machinery Tower
   Central control room, Sampling room, Electric panel room, Machinery room, Fumigation room, and other rooms, and at least one will be installed on each floor outside room.
d. Loading Facilities
   Each control room

(25) SAFETY MEASURES

(a) Anti-explosion measures

1) Origin of fire

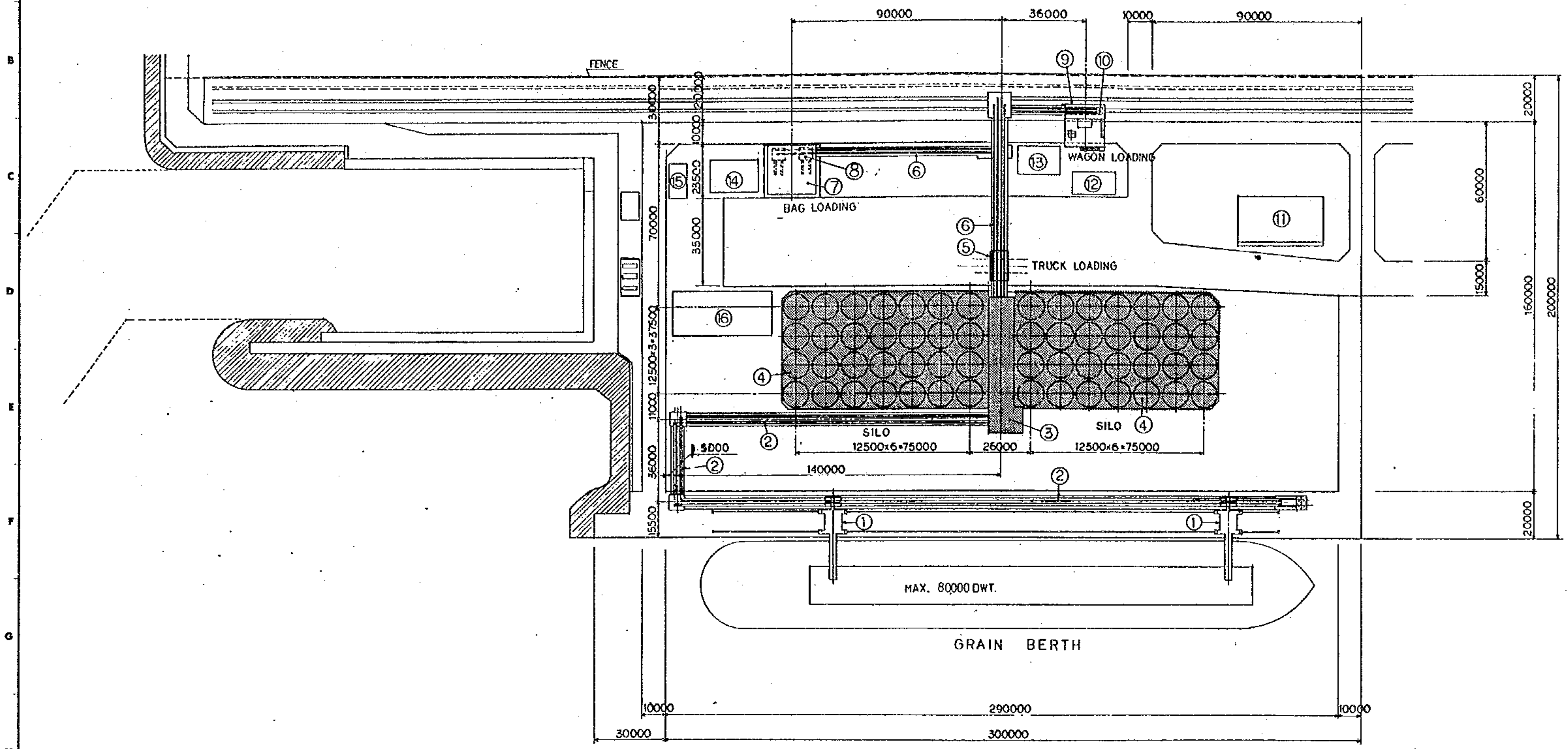
All origin of fire must be excluded in dust mixed air passage or in dust mixed air. All area which may generate statical electricity must be provided with grounding to prevent sparks due to statical electricity. Furthermore, sparks by impact and heat by friction must be avoidable by themself.

2) Dust filter made of anti-electrified cloth

Dust filter in dust separator is made of anti-electrified cloth which is woven of mixed copper wire.

(b) Explosion panel

The explosion panel for the prevention of large disasters will be provided at the places required. The explosion panel has enough area for prevention of large disasters and the panel shall be break-down by small pressure and it will be restored easily.



GENERAL NOTES

MAIN PARTICULARS

ITEM	TYPE	CAPACITY
UNLOADER	CONTINUOUS MECHANICAL	830 T/H × 2 SETS
SILO	REINFORCED CONCRETE	100,000 T (≒ 1,860 t × 58 Bins)
CONVEYOR		
(RECEIVING)	BELT	700 T/H × 2 LINES
(DISCHARGE)	CHAIN	300 T/H EACH

SYMBOL

1. MECHANICAL UNLOADER
2. BELT CONVEYOR
3. MACHINERY TOWER
4. SILO
5. TRUCK LOADING
6. CHAIN CONVEYOR
7. BAG STORAGE
8. BAGGING
9. WAGON LOADING
10. WAGON SCALE
11. SILO'S ADMI. BUILDING
12. SERVICE BUILDING
13. SUB-STATION
14. GRAIN SACKS STORAGE
15. GREASE & OIL
16. MAINTENANCE WORK SHOP

DESCRIPTIONS	DWG. NO.

REFERENCE DRAWINGS

NO.	DATE	DESCRIPTIONS	BY	APP'D

REVISIONS

ARAB REPUBLIC OF EGYPT

MINISTRY OF DEVELOPMENT,
NEW COMMUNITIES, HOUSING AND PUBLIC UTILITIES

THE DETAILED DESIGN ON THE URGENT DEVELOPMENT PLAN
OF
THE SUEZ BAY COASTAL AREA DEVELOPMENT

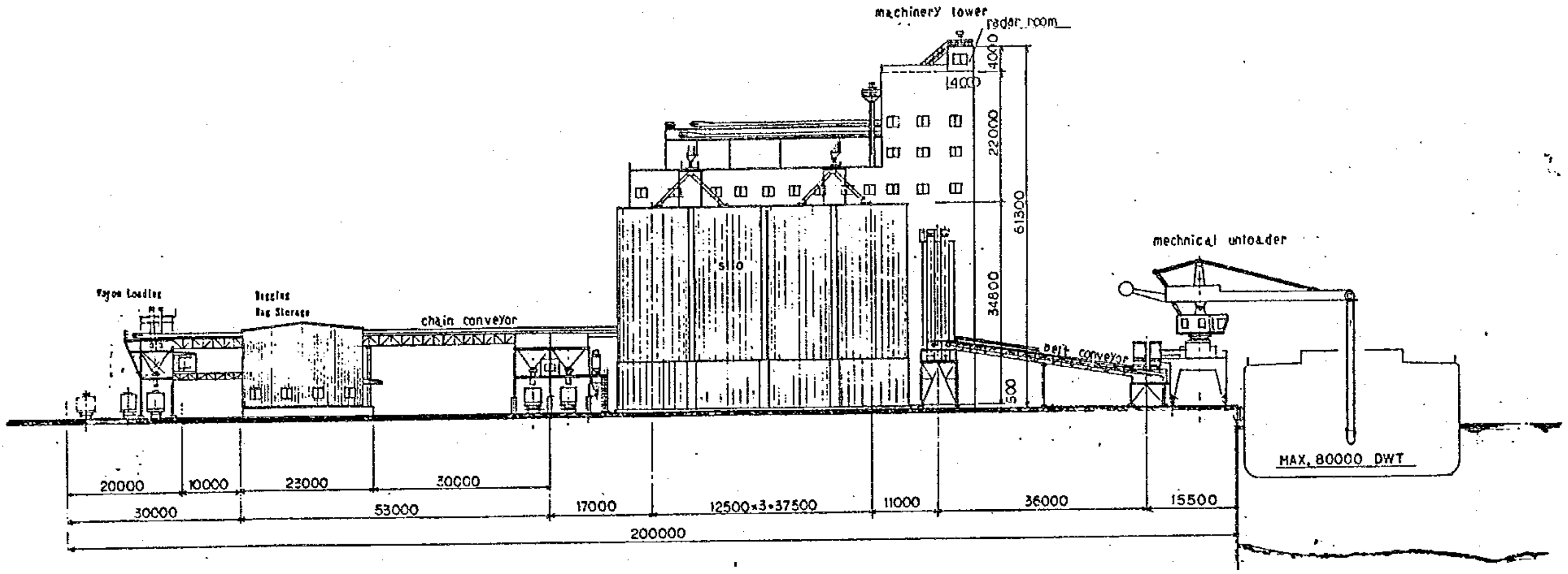
A.5 GRAIN SILO TERMINAL
5.2 MECHANICAL WORKS, ELECTRICAL WORKS AND MACHINERY TOWER

GRAIN HANDLING EQUIPMENT
LAYOUT PLAN

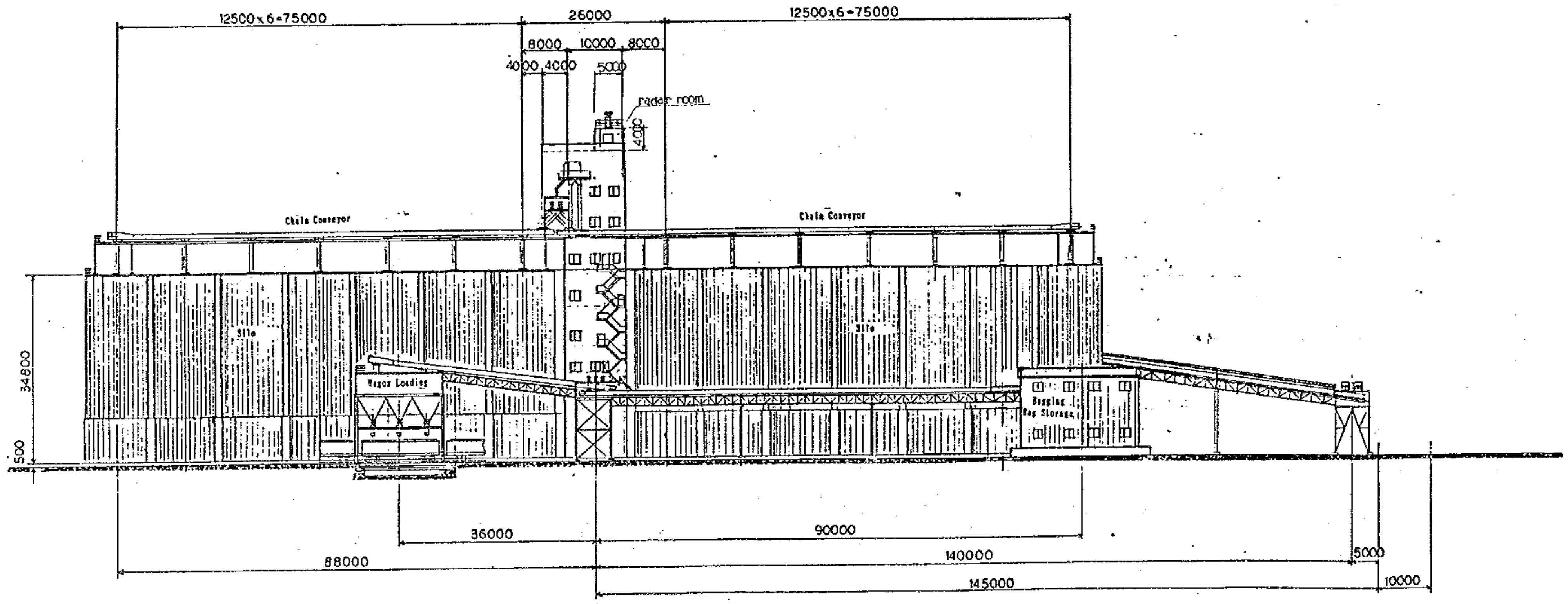
JICA JAPAN INTERNATIONAL COOPERATION AGENCY

SUBMITTED	APPROVED	SCALE	REV. NO.
		1:1000	
DATE October., 1993		DWG. NO. A5-5.2-1-01	

Figure 3.10-5-1 Grain Handling Equipment Layout Plan



SIDE VIEW OF GRAIN TERMINAL



ELEVATION OF GRAIN TERMINAL

Figure 3.10-5-2 Grain Handling Equipment Front View

GENERAL NOTES

REFERENCE DRAWINGS

DESCRIPTIONS	DWG. NO.

REVISIONS

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ARAB REPUBLIC OF EGYPT

MINISTRY OF DEVELOPMENT, NEW COMMUNITIES, HOUSING AND PUBLIC UTILITIES

THE DETAILED DESIGN ON THE URGENT DEVELOPMENT PLAN OF THE SUEZ BAY COASTAL AREA DEVELOPMENT

A.5 GRAIN SILO TERMINAL
5.2 MECHANICAL WORKS, ELECTRICAL WORKS AND MACHINERY TOWER

GRAIN HANDLING EQUIPMENT
FRONT VIEW

JICA JAPAN INTERNATIONAL COOPERATION AGENCY

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		1:500	
DATE October, 1993		DWG. NO.	A5-5.2-1-02

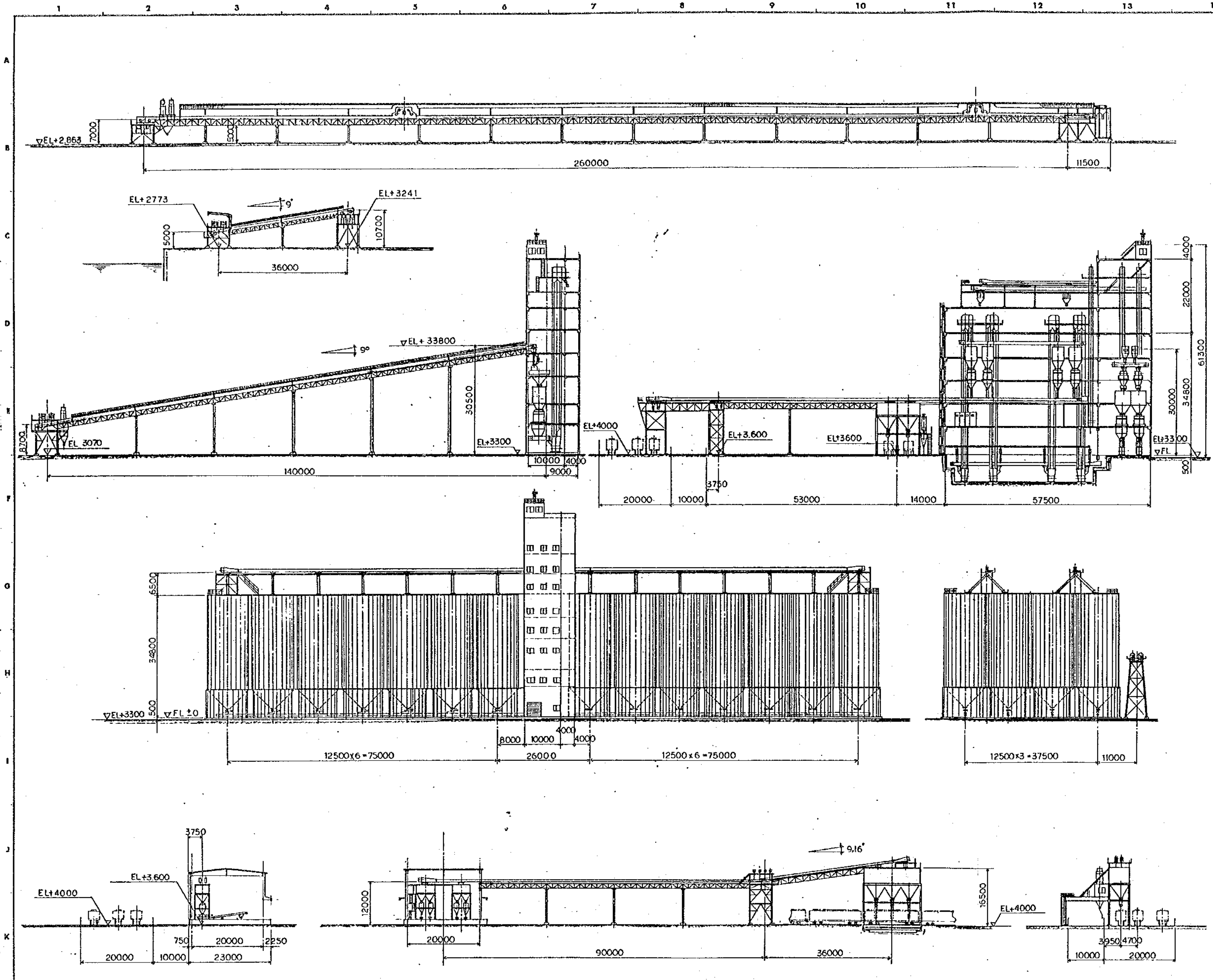

Figure 3.10-5-3 Grain Handling Equipment Side View

FL±0 = EL+4,000

GENERAL NOTES

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A.5 GRAIN SILO TERMINAL
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GRAIN HANDLING EQUIPMENT
SIDE VIEW

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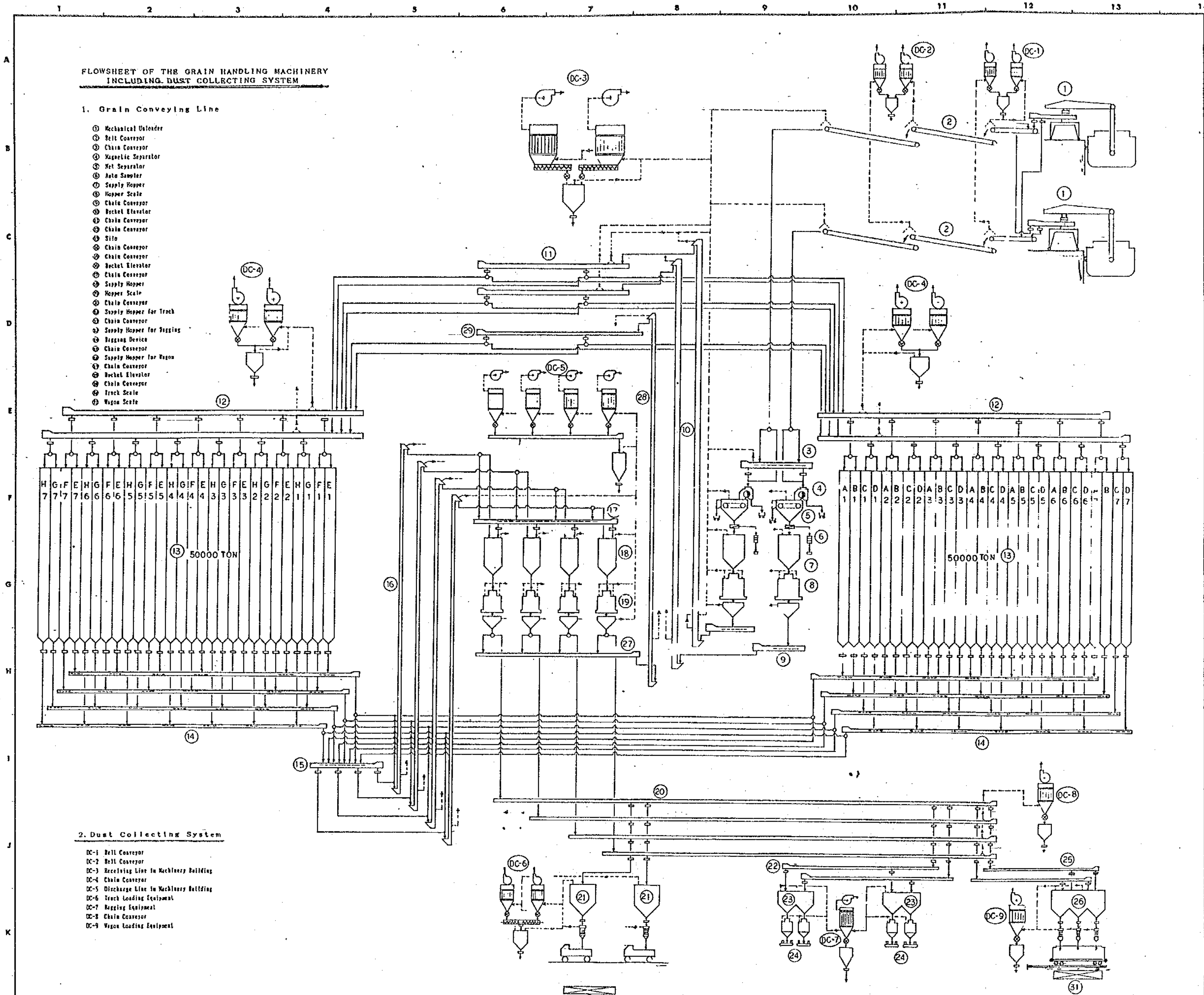
		1:500	
DATE October, 1993		DWG. NO. A5-5.2-1-03	



GENERAL NOTES

DESCRIPTIONS	DWG. NO.
REFERENCE DRAWINGS	

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REVISIONS				

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MINISTRY OF DEVELOPMENT,
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THE DETAILED DESIGN ON THE URGENT DEVELOPMENT PLAN OF THE SUEZ BAY COASTAL AREA DEVELOPMENT

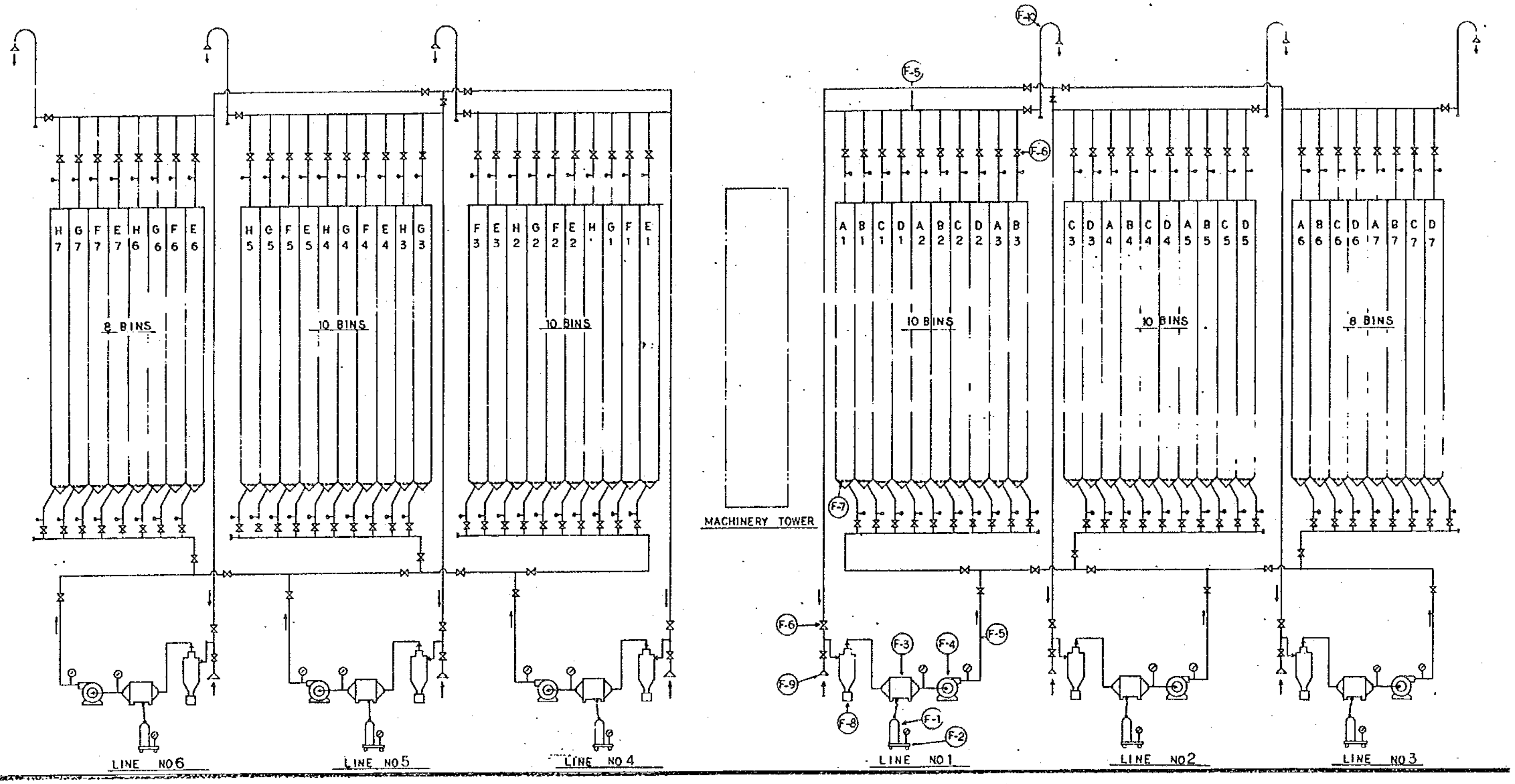
A.5 GRAIN SILO TERMINAL
5.2 MECHANICAL WORKS, ELECTRICAL WORKS AND MACHINERY TOWER

GRAIN HANDLING EQUIPMENT
FLOW DIAGRAM OF GRAIN & DUST

JICA JAPAN INTERNATIONAL COOPERATION AGENCY

SUBMITTED	APPROVED	SCALE	REV. NO.
DATE October, 1993		DWG. NO. A5-5.2-1-04	

Figure 3.10-5-4 Grain Handling Equipment Flow Diagram of Grain & Dust



FLOWSHEET OF THE METHYL BROMIDE FUMIGATING SYSTEM

F-1 Methyl Bromide (gas cylinder)
F-2 Weigher
F-3 Gas Expansion Tank
F-4 Blower
F-5 Piping
F-6 Valve
F-7 Gas Inlet Cover
F-8 Receiver Tank
F-9 New Air Inlet Piping
F-10 Gas Exhaust Piping

Note 1. Six (6) lines can be simultaneously fumigated.
2. Blowers and exhaust pipes to ventilate fumes are available also for Aluminum Phosphide (PH3) fumigation.

GENERAL NOTES

DESCRIPTIONS	DWG. NO.

REFERENCE DRAWINGS

NO.	DATE	DESCRIPTIONS	BY	APP'D

REVISIONS

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THE SUEZ BAY COASTAL AREA DEVELOPMENT

A.5 GRAIN SILO TERMINAL
5.2 MECHANICAL WORKS, ELECTRICAL WORKS AND MACHINERY TOWER

GRAIN HANDLING EQUIPMENT
FLOW DIAGRAM OF FUMIGATION

JICA JAPAN INTERNATIONAL COOPERATION AGENCY

SUBMITTED	APPROVED	SCALE	REV. NO.
DATE October, 1993		DWG. NO. A5-5.2-1-05	

Figure 3.10-5-5 Grain Handling Equipment Flow Diagram of Fumigation

3.11 STORM WATER DRAINAGE

3.11.1 Objectives of the Storm Water Drainage

The proposed industrial estate and its wastewater treatment plant are located at the foot of the mountains, which are facing the Suez Bay with the peak elevation of about 500 m. The ground elevation of the project area varies between 5 m and 100 m approximately with relatively gentle slopes of about 1/500 near the lowest portion and rather steep slopes of about 1/30 near the highest portion.

There are two major rivers (wadi) in the project area. They are the Wadi Alabar and the Wadi Abu-Sayalah as shown in Figure 3.11-1-1. The Wadi Alabar crosses the north-west corner of the project area and flows down along the boundary line between the project area and the proposed wastewater treatment plant area of USAID. The Wadi Abu-Sayalah crosses the central part of the industrial estate.

Although the project area belongs to a semiarid zone, storm rainfall occurs several times a year. The ground and the rivers remain usually dry mostly in a year, but rainfall runoff occurs during the storm rainfall. Furthermore, as there are almost no plants and trees in the mountains and as the ground is covered by silty sand with relatively low permeability, the hydrograph of the rainfall runoff seems to be sharp with high peak discharge.

The catchment area of the project area is about 36 km2 in all. It is composed of four sub-catchment areas as shown in Figure 3.11-1-1. Among these, the catchment areas of the Wadi Alabar and the Wadi Abu-Sayalah are 18.8 km2 and 4.8 km2 respectively. In the event of storm rainfall, flood runoff occurs in these rivers. With relatively large peak discharge of the flood runoff and the steep slopes of the river profile, the stream flow conditions of these rivers are estimated to be strong. Furthermore, as these rivers form alluvial fans, they sometimes cause inundation in the project area.

Therefore, in order to protect the project area from flooding by the rivers as well as the rainfall runoff from other sub-catchment areas, it is necessary to provide storm water drainage facility around the proposed industrial estate and the wastewater treatment plant.

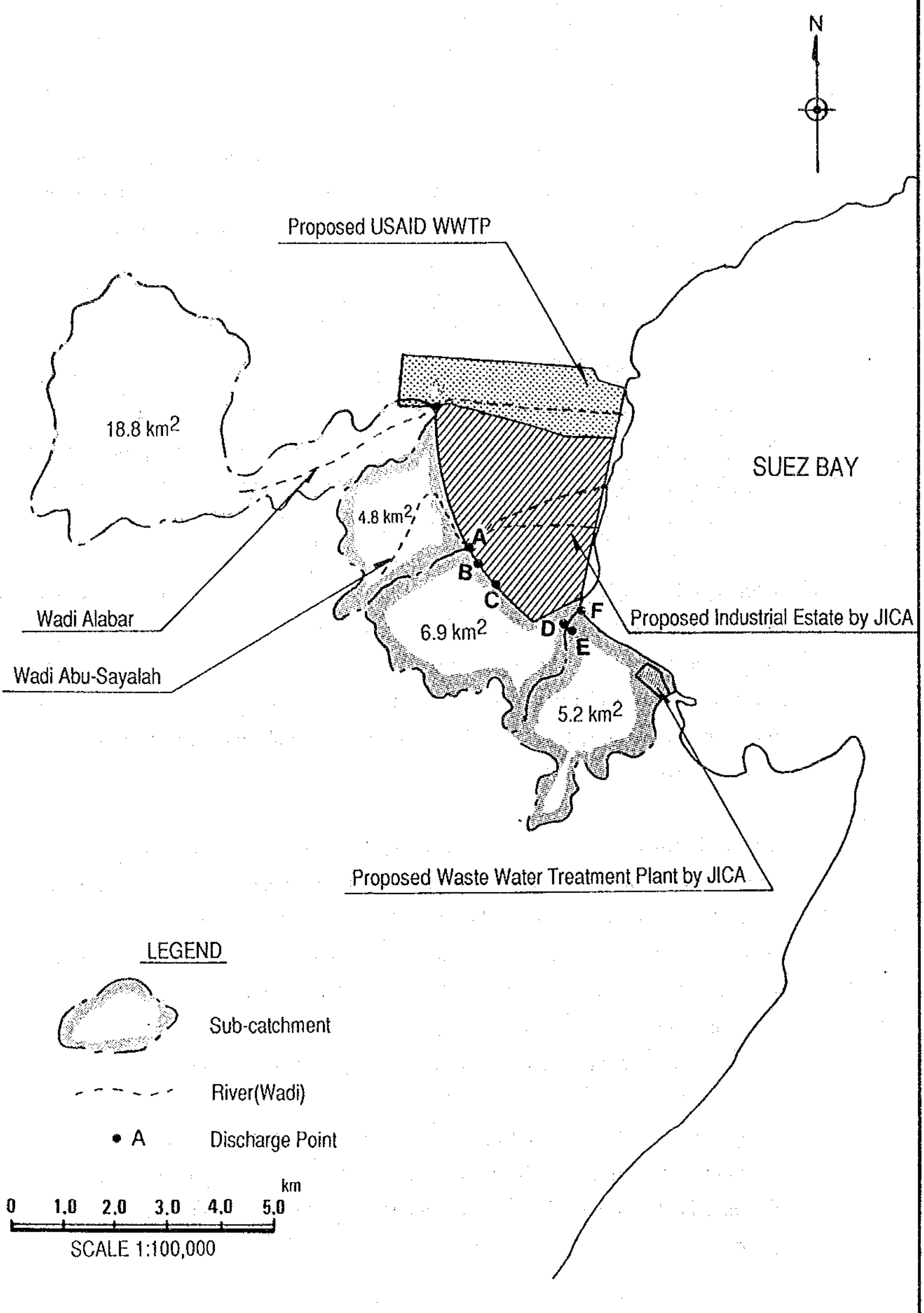


Figure 3.11-1-1 Catchment Area of the Project Area and the Major Rivers (Wadi)

In July 1992 JICA Study Team discussed with MODANC the boundary between this project and US-AID sewerage treatment project. MODANC made a decision that the project boundary of this project should be set back down to the south and that a green belt is to be provided to mitigate possible odorous hazards.

As a result of the MODANC's decision, the drainage for catchment area of 18.8km2 (Wadi Alabar) is now located within premises of the US-AID project. MODANC concluded that the US-AID project will construct the drainage channel since the US-AID project is scheduled to start earlier than the industrial estate development of MODANC.

In this regard, the drainage facilities for this catchment area was excluded in the detail design. A training dike or wall must be considered in the US-AID design, to prevent the Wadi Alabar runoff from entering into the project area.

Therefore, JICA Study Team will not carry out the detailed design of this drainage, and requests MODANC that the information contained in this section be conveyed to US-AID project for the proper storm water control of the area extending over both the projects.

The objectives of this section is to design the necessary storm water drainage system for the project area, based on the above-mentioned conditions.

3.11.2 Design Storm Rainfall

In this sub-section, design storm rainfall intensity for the design of storm water drainage system and the facilities is described.

(1) Available Storm Rainfall Data

The available storm rainfall data are daily rainfall intensity data of Suez City for a period of 10 years. Table 3.11-2-1 shows the monthly maximum daily rainfall and its duration. From the data, it is evident that storm rainfall occurs several times a year.

Figure 3.11-2-1 shows the relation between daily rainfall intensity and its duration. The duration of the storm rainfall is monthly less than 1.5 hours.

(2) Probable Storm Rainfall

Frequency analysis is conducted to get the probable daily rainfall intensity. The adopted method of the frequency analysis is Gumbel-Chow's method. The results of the analysis are as shown in the Table 3.11-2-2 and Figure 3.11-2-2.

Table 3.11-2-2 Probable Storm Rainfall

Return period (year)	Probable Rainfall (mm/day)
2	9.0
3	11.6
5	14.4
10	18.0
20	21.4
30	23.4
50	25.8
100	29.1

The recorded maximum daily rainfall is 22.0 mm/day of Jan. 26, 1990 which corresponds to a return period of about 25 year.

Table 3.11-2-1 Monthly Maximum Daily Rainfall Data of Suez City

YEAR	ITEM \ MONTH	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.	ANNUAL MAX.
1981	Max. Rainfall (mm/day)	0.3	0.1	6.7	-	-	-	-	-	-	-	1.2	-	6.7
	Duration (min)	6	3	13	-	-	-	-	-	-	-	10	-	13
1982	Max. Rainfall (mm/day)	1.5	7.3	0.5	-	0.2	-	-	-	-	0.2	7.7	1.2	7.7
	Duration (min)	15	39	3	-	3	-	-	-	-	3	45	20	45
1983	Max. Rainfall (mm/day)	3.4	2.3	6.3	1.4	-	-	-	-	-	-	-	-	6.3
	Duration (min)	24	23	16	8	-	-	-	-	-	-	-	-	16
1984	Max. Rainfall (mm/day)	0.4	-	1.6	-	-	-	-	-	-	-	9.7	2.7	9.7
	Duration (min)	3	-	40	-	-	-	-	-	-	-	69	17	69
1985	Max. Rainfall (mm/day)	1.5	0.8	16.3	1.5	-	-	-	-	-	-	0.9	7.4	16.3
	Duration (min)	5	19	27	5	-	-	-	-	-	-	13	22	27
1986	Max. Rainfall (mm/day)	-	2.2	-	4.4	-	-	-	-	-	-	3.5	1.2	4.4
	Duration (min)	-	12	-	20	-	-	-	-	-	-	34	10	20
1987	Max. Rainfall (mm/day)	-	1.1	9.3	-	-	-	-	-	-	0.3	-	9.7	9.7
	Duration (min)	-	13	-	-	-	-	-	-	-	15	-	80	80
1988	Max. Rainfall (mm/day)	16.5	2.5	3.0	-	-	-	-	-	-	-	-	4.6	16.5
	Duration (min)	82	16	33	-	-	-	-	-	-	-	-	157	82
1989	Max. Rainfall (mm/day)	0.6	0.8	0.7	-	-	-	-	-	-	-	-	0.2	0.8
	Duration (min)	10	6	6	-	-	-	-	-	-	-	-	12	6
1990	Max. Rainfall (mm/day)	22.0	1.8	0.2	1.1	0.1	-	-	-	-	-	-	-	22.0
	Duration (min)	82	55	3	12	5	-	-	-	-	-	-	-	82

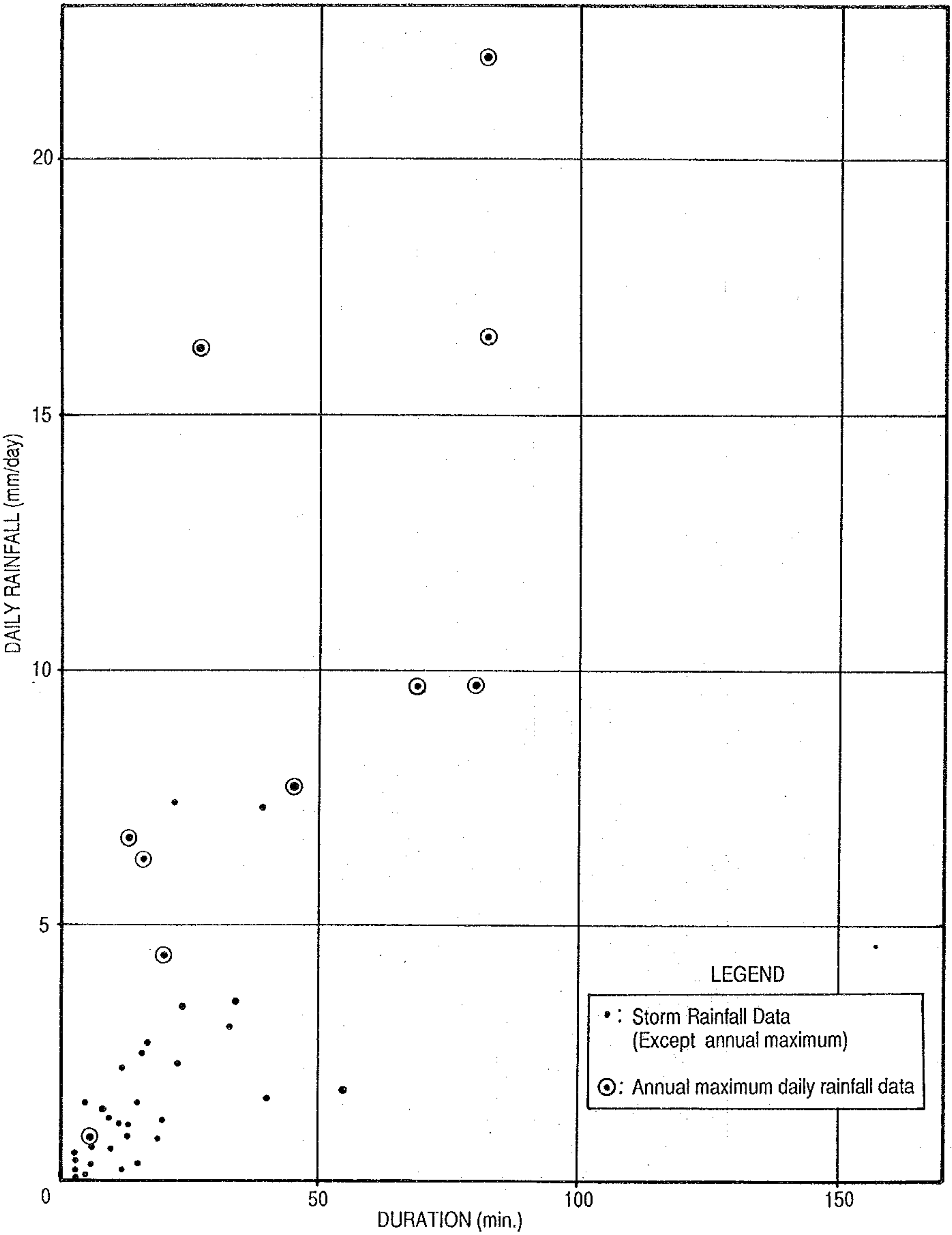


Figure 3.11-2-1 Duration of Storm Rainfall

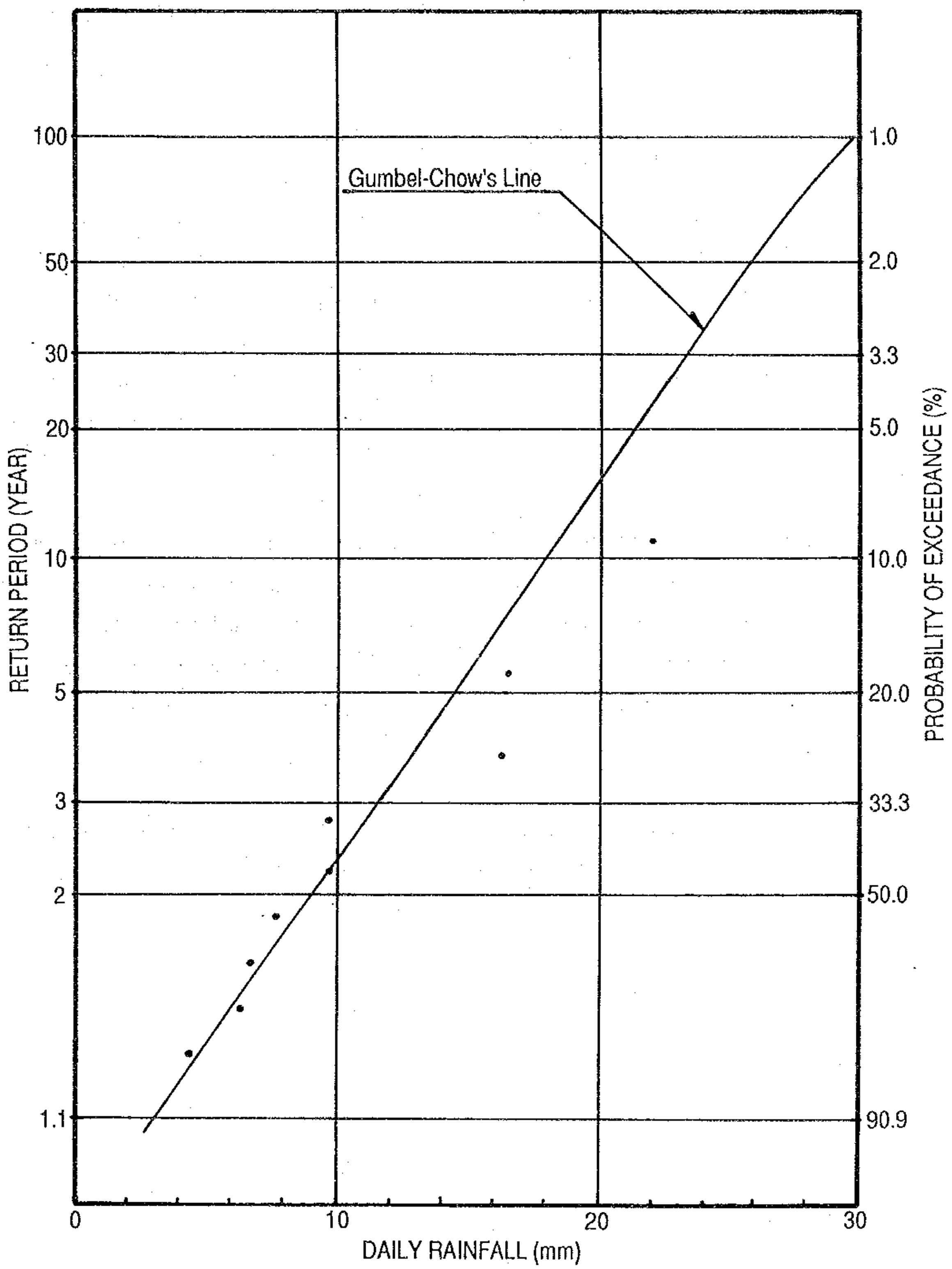


Figure 3.11-2-2 Probable Daily Rainfall

(3) Design Storm Rainfall

Design storm rainfall is selected to be 23.4 mm/day with 30-year return period considering the following aspects.

1) The recorded maximum daily rainfall is 22.0 mm/day with 25 years return period.

2) The accuracy of the frequency analysis generally decreases when the return period exceeds three (3) times the available data period. Therefore, the probable rainfall intensities calculated for the return period of more than 30 years.

As the duration of the recorded maximum rainfall is between 80 and 90 minutes, the duration of the design storm rainfall is estimated to be 90 minutes. Therefore, the design rainfall intensity becomes 15.6 mm/hr.

The time of concentrations of the floods, or rainfall runoff, of the three sub-catchment areas shown in Figure 3.11-1-1, except the catchment area of the Wadi Alabar, are estimated to be between 1.0 and 2.0 hours for a flow velocity of about 1.0 to 2.0 m/sec and inflow time of rainfall runoff of about 20 minutes. In this case, the above rainfall intensity is applicable to the design of drainage system without any modification.

Although the time of concentration of the Wadi Alabar is estimated to be more than 4.0 hours, the above rainfall intensity is applied conservatively.

3.11.3 Storm Water Drainage System

(1) Layout of the Drainage System

The layout of drainage channels and other related facilities are proposed as shown on Figure 3.11-3-1, taking the following into consideration.

(a) The Wadi Abu-Sayalah currently has wide flow courses in the downstream portion forming alluvial fans. This denotes that once the flood occurs due to heavy rainfall, the flood water carries a remarkable volume of sediments, such as sand, silt and gravels, to the downstream area.

(b) It is essential protect the proposed project area from intrusion and deposition of carried sediments as well as from the flood water.

(c) The drainage channel should be composed of one line of main channel (Type M), and subsidiary channels (Type S) be provided as required for areas where the main channel is not available.

(d) The route of the drainage channel should be along the Adabiya-Suez/Cairo road. Unfortunately, in order to avoid deep excavation in the elevated portion where the Adabiya-Suez/Cairo road crosses the Wadi Abu-Sayalah, the drainage channel must pass through the proposed residential area. In this elevated portion, two subsidiary channels (S2 and S3) must be provided to avoid rainfall flooding into the residential area.

(e) Subsidiary channel (S1) is required to avoid rainfall flooding into the waste water treatment plant site.

(f) The following structures and facilities located on or across the routes of proposed drainage channels, should be considered in the design:

1) Roads
- Adabiya-Suez/Cairo road proposed to be constructed
- Existing Suez-Adabiya Coastal road

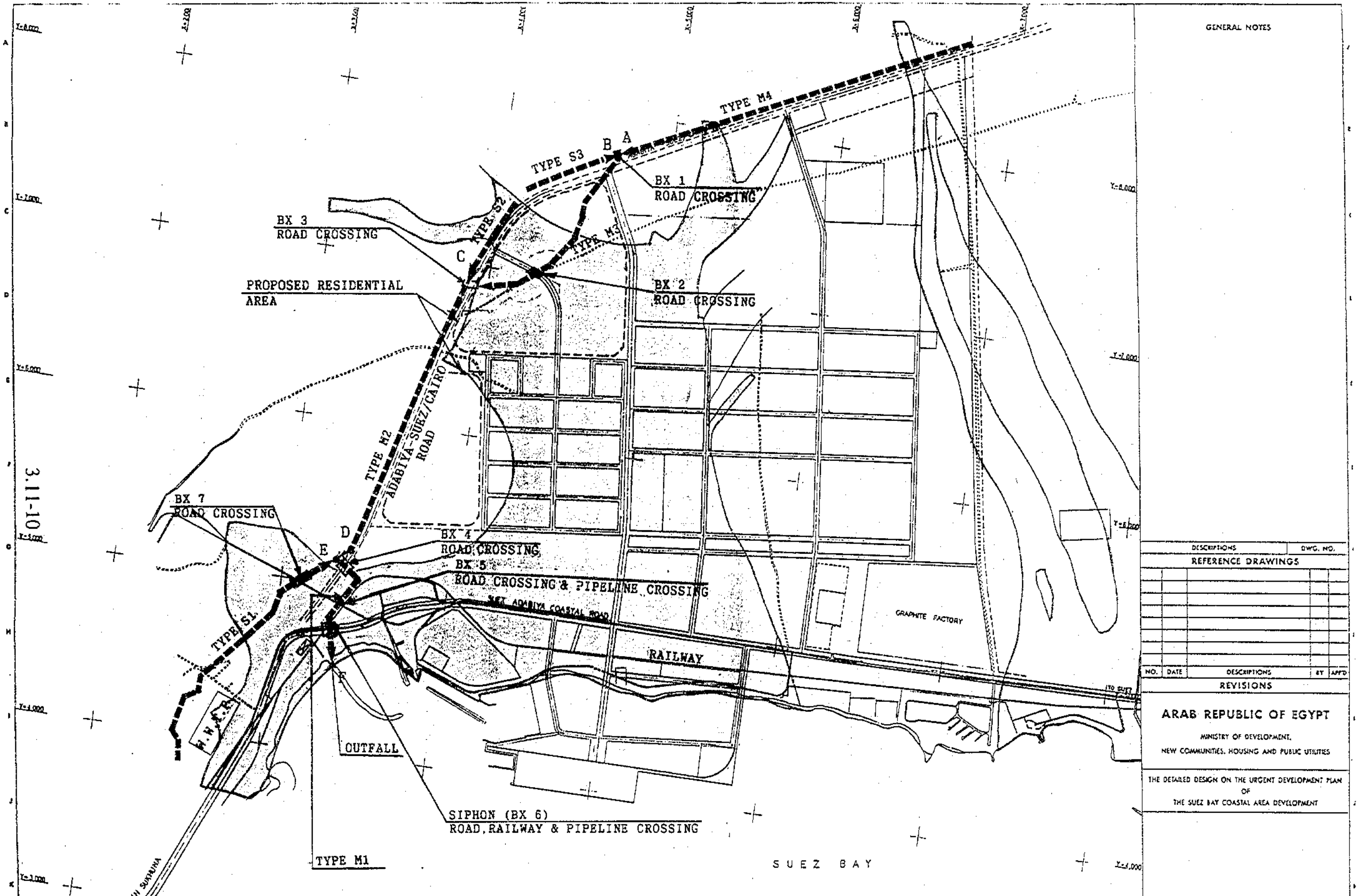


Figure 3.11-3-1 Layout of Storm Water Drainge Ststem

2) Railway

- Existing railway lines running along coast line

3) Pipelines

- Underground oil pipelines running along the coast in parallel to the existing railway and running through the project area from north to south
- Underground gas pipelines running through the project area from north to south
- Underground water pipelines running along the oil pipelines

(2) Design Discharge

The design discharge of each drainage channel is calculated applying the following Rational Formula.

$$Q = \frac{1}{3.6} \times C \times I \times A$$

where;

Q: Peak discharge (m3/sec)
C: Runoff coefficient (C = 0.2)
I: Rainfall intensity (mm/hr)
A: Catchment area (km2)

The design peak discharge for each discharge point of the drainage channel is calculated applying the above formula and summarized in Table 3.11-3-1. The discharge points for the calculation of peak discharges are indicated in Figure 3.11-1-1 and Figure 3.11-3-1.

Table 3.11-3-1Calculated Peak Discharge

Basin and Point	Catchment Area (km^2)	Rainfall Intensity (mm/hr)	Runoff Coefficient	Peak Discharge (m^3/S)
A	4.8	15.6	0.2	4.2
B	1.0	15.6	0.2	0.9
C	1.0	15.6	0.2	0.9
D	11.7	15.6	0.2	10.1
E	5.2	15.6	0.2	4.5
F	16.9	15.6	0.2	14.6

(3) Drainage Channel

A trapezoidal channel section is adopted for the proposed drainage channels in principle. The side slope of channel is proposed to be 1(V):0.5(H) considering the soil property, and concrete block masonry is employed for protecting the slope. The hydraulic studies were conducted using the following Manning's formula to determine the most appropriate size and dimension of each drainage channel.

$$Q = A \times V$$

$$V = \frac{1}{n} \times R^{(2/3)} \times I^{0.5}$$

where;

Q: Discharge (m3/s)
A: Flow area (m2)
V: Flow velocity (m/s)
R: Hydraulic radius (m)
I: Gradient of channel

The results of the study is summarized in Table 3.11-3-2. The maximum gradient of the channel was restricted in such a way that its Froude Number does not exceed 1.0, in order to avoid the creation of super-critical flow condition.

Since gradients of the original ground surface along the proposed drainage channels are measured to be quite steep, ranging from 1/500 to 1/30, while the allowable maximum gradient of the channel is calculated to be about 1/50 as shown in the above table, it is proposed to provide drop structures to stabilize the flow in the channels.

Table 3.11-3-2 Sizes and Dimensions of Drainage Channels

Drainage Type	Design Discharge (m^3/S)	Water Depth (m)	Base Width (m)	Slope (1: m)	Rough Coefficient	Gradient (%)	Flow Velocity (m/s)	Froude Number
Type M1 (Total Length : 629m)								
M1-1	14.6	1.276	4.000	0.5	0.030	0.667	2.468	0.70
M1-2	14.6	1.886	3.000	0.5	0.030	0.333	1.963	0.46
Type M2 (Total Length : 1771m)								
M2	10.1	1.243	2.400	0.5	0.030	1.000	2.690	0.77
Type M3 (Total Length : 1148m)								
M3	6.0	1.196	2.400	0.5	0.030	0.400	1.673	0.49
Type M4 (Total Length : 2380m)								
M4-1	4.2	1.392	1.400	0.5	0.030	0.333	1.439	0.39
M4-2	4.2	1.013	1.400	0.5	0.030	1.000	2.175	0.69
M4-3	4.2	1.945	1.400	0.5	0.030	0.100	0.910	0.21
Type S1 (Total Length : 1642m)								
S1-1	4.5	1.527	2.400	0.5	0.030	0.100	0.932	0.24
S1-2	4.5	1.240	2.400	0.5	0.030	0.333	1.202	0.34
Type S2 (Total Length : 568379m)								
S2	1.8	0.796	0.600	0.5	0.030	2.000	2.268	0.81
Type S3 (Total Length : 647m)								
S3-1	1.8	0.796	0.600	0.5	0.030	2.000	2.268	0.81
S3-2	1.8	0.836	0.600	0.5	0.030	1.667	2.115	0.74

(4) Other Related Facilities

The following facilities are proposed to be provided for the drainage works.

a) Box Culvert and Siphon

The following number of box culverts and siphons are required for crossing roads, railway and pipeline.

Table 3.11-3-3 Required Facilities for Crossing Roads, Railway and Pipeline

Drainage Type	Crossing			Box Culvert	Siphon
	Road	Railway	Pipeline		
M1	●	●	●	2	1
M2	-	-	-	0	0
M3	●	-	-	3	0
M4	-	-	-	0	0
S1	●	-	-	1	0
S2	-	-	-	0	0
S3	-	-	-	0	0
Total				6	1

b) Drop Structure

Drop structures are necessary to avoid the increase of velocity and to stabilize the channel beds. The required number thereof is as listed Table 3.11-3-4.

Table 3.11-3-4 Required Number of Drop Structures

Drainage Type	Required Number of Drop Structures
M1	3
M2	36
M3	1
M4	18
S1	3
S2	10
S3	2
Total	73

The drop structures in the drainage system are of plain concrete with a maximum drop height of 1.0m, in order to reduce deep excavations and large reinforced concrete structures.

c) Junction

Protection works are proposed to be provided at the junction of the drainage channels to prevent the drainage channels from damages caused by erosion, scoring, etc., and the alignments of channel were carefully determined in the design so as to create smooth flow at the junctions.

3.11.4 Design Criteria

Following design criteria are used for the design of the storm water drainage structures.

(1) Materials

a) Concrete

Table 3.11-4-1 Allowable Stress

	Compressive strength S28 (kg/cm2)	Allowable bending Compressive Stress (kg/cm2)	Allowable Shear Stress (kg/cm2)	Allowable Bond Stress (kg/cm2)
Reinforced Concrete	240	90	9.0	16.0
Plain Concrete	180	70	8.0	-

* Bond stress is for deformed bars.

Table 3.11-4-2 Increasing Allowable Stress

	Normal Condition	Earthquake Condition
Reinforced Concrete	1.0	1.5
Plain Concrete	1.0	1.5

Table 3.11-4-3 Unit Weight

	Unit Weight (t/m3)
Reinforced Concrete	2.5
Plain Concrete	2.3

b) Re-Bars

SD30 : Allowable tensile stress = 1,800 kg/cm2

(2) Ground Water Tables

In the soil investigation, ground water was not encountered along the proposed storm water drainage channel. Therefore, no ground water is considered in the design.

3.12 ENVIRONMENTAL IMPACT ANALYSIS

3.12.1 GENERAL

The Suez Bay Coastal Area Development (hereinafter referred to as "the Development") would involve the introduction of new industries into the Ataqa and Adabiya area, which would, in turn, affect the aquatic and the atmospheric environment of the area. The impacts which are likely to be caused by the implementation of the Development have been classified into two main items as follows.

- The impacts on the sea water quality caused by the proposed waste water treatment plant.

- The impacts on the ambient air quality caused by the proposed industrial complex.

The study has been conducted to evaluate the expected impacts of the Development and to recommend necessary measures against the impacts. The study is composed of two major parts; namely understanding of the present state of the sea water quality and the ambient air quality, and prediction and evaluation of the impacts caused by the Development.

3.12.2 STUDY AREA

The Suez Bay is a shallow extension of the Gulf of Suez that is limited between longitudes 32°28'E and 32°34'E, and latitude 29°52' and 29°57'N as shown in Fig. 3.12.2-1. It is roughly elliptical in shape with its major axis running in a NE-SW direction. Its average length along the major axis is 13.2km, while its average width along the minor axis is 8.8km. It has a surface area of about 77.13km^2, and a mean depth of 10m. It is connected to the Gulf of Suez at its southeastern side, and to the Suez Canal at north through a dredged channel of 12m depth.

The Suez Bay receives water from two sources; namely the Suez Canal and the Gulf of Suez. The Gulf waters enter the Bay along its eastern side and flows counterclockwise to leave the Bay at the western side. The water of the Suez Canal is generally deflected to the western coast. Therefore, there is always a persistent counterclockwise circulation pattern in the Bay. Due to the relatively large tidal range in the Bay, the current is dominated by the tidal component. On the other hand, the currents at the entrance of the Suez Canal are always strong due to the constriction at the head of the Bay with their directions confined to that of the Canal; i.e., either into or out of the Canal.

In spite of the location of the Suez Bay in a rapidly developing area as well as its presence at the southern end of one of the most heavily trafficked navigational routes in the world; i.e., the Suez Canal which is crossed by about 20,000 ships every year, very few studies have been made there.

The Bay is currently suffering water pollution to a certain extent. The Bay receives three different types of pollutants. These are as follows;

1) Industrial wastes from 3 oil refineries, a fertilizer factory, and a power plant;

2) Domestic sewage of Suez City; and

3) Ships' wastes, oil spills and refuses.

The total annual landed catch at Suez Landing Center during the period 1987-1990 fluctuated between 14,875 and 28,972 tons (Ref. No.1). However, little fishing activities are practiced in the Suez Bay, because of the deterioration of its environment due to sustained disposal of waste that renders parts of it uninhabitable for fish, and the heavy traffic that affect the distribution of fish. Accordingly the Bay itself does not produce any measurable amount of fish.

The area surrounding the Suez Bay holds a number of industries and activities (as shown in Fig. 3.12.2-1) emitting several components that are considered as pollutants into the atmosphere. A component of interest is sulphur dioxide which is produced from different refineries as a result of burning oil for heating purposes. Oil produced from the Gulf of Suez oil fields is known to have a relatively high content of sulphur. Also, thermal power plants that are fueled by oil products emit considerable amounts of carbon oxides and sulphur oxides into the atmosphere. The fertilizers company invariably produces a variety of nitrogen compounds including ammonia and nitrogen oxides. This company also depends on the quarries distributed around the area to obtain the calcium carbonate required for this industry. Accordingly, it is expected that the ambient air quality in the area is not ideal and may be far from high quality air standards due to the already mentioned production of sulphur dioxide, nitrogen oxides, and dust.

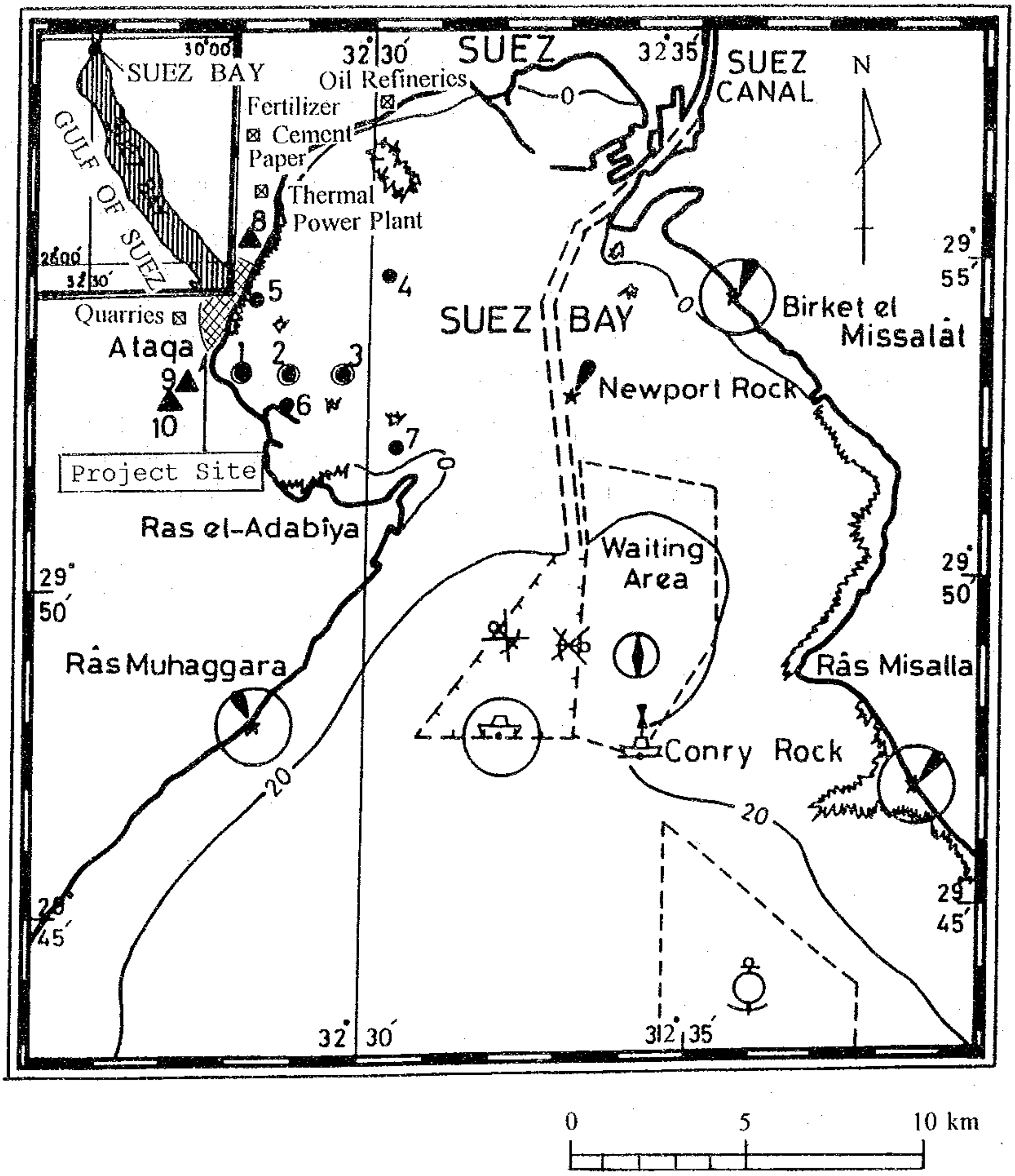


Figure 3.12.2–1 The Suez Bay and The Surrounding

3.12.3 SEA WATER QUALITY

The Suez Bay is an environmentally stressed area that has been subject to pollution from different sources for a long period. At its northern extremity, the Bay receives industrial wastes from oil refineries, fertilizers factory and power plant. Furthermore, it is the crossing route and anchorage area for more than 20,000 tankers and cargo ships that cross the Suez Canal annually. These ships mostly dump their wastes during their stay in the Bay. The Bay also represents the main recipient of the domestic sewage of the city of Suez with a population of about 400,000 persons.

Studies concerning the circulation in this small area are very limited, and the carrying capacity of the Bay had never been assessed. In view of the proposed Development plans in the land areas adjoining the Bay, and despite the fact that most of the proposed industries are not expected to produce measurable, persistent types of pollutants in comparison with the existing major industries, it deemed necessary to investigate the possible impacts of the Development on the aquatic environment of the Bay.

The visual observations indicated that very limited fishing is practiced in the offshore area of the Bay. In fact, the southern part of this area is highly stressed as indicated from the abundance of huge sea urchins which seemed to be constituting more than 90% of the bottom faunae. It seems that the direct disposal of different types of wastes into the marine area of the Bay coupled with the dust particles excited from the quarries and the mountain are considerably affecting the fisheries and the distribution of organisms in the area.

(1) Existing Data

(a) Hydrography and Stratification

The knowledge of the physical conditions in the Suez Bay is primarily owed to the work made by Meshal (Ref. No.6) who has investigated the circulation pattern of the Bay as well as the water characteristics such as temperature and salinity.

The surface water temperature in the Bay reaches its maximum value (28.5°C) in July, while it is at minimum (17.5°C) in February. At the bottom, the water temperature fluctuates between 28.3°C in July and 17.0°C in February. The water temperature decreases away from the shore in general.

The highest salinity values (41.61~42.79‰) of the Bay waters are recorded during summer months (July~September). These high values are affected by the high evaporation during this period of the year as well as the inflow of highly saline water from the Suez Canal into the Bay. The lowest salinity values (40.81~41.95‰) are recorded in winter. During spring and autumn, however, the salinity values vary in the range between the minima and the maxima of winter and summer.

In general, there are four factors that control the water characteristics in the Bay. These factors are as follows:

- Seasonal variations in water level in the Bay;
- High salinity of water in the Suez Canal as a result of the dissolution of salt layers in the bottom of the Bitter Lakes;
- Variation of water level due to tides which vary between 80cm at neap tide and 140cm at spring tide; and
- Prevailing local wind and daily cycle of warming.

In the review of the physical and chemical oceanography of the Red Sea, Morcos (Ref. No.8) has found that there is a latitudinal increase of 2.5‰/2° in the salinity of water in the Gulf of Suez. This latitudinal increase in salinity was ascribed to the increase in evaporation of water going southward across the Gulf as well as the dissolution of salt deposits found in the bottom of the Great Bitter Lake connected to the Gulf through the Suez Canal, and in the bottom of the Gulf as well. El-Sabh and Beltagy (Ref. No.3) have also found that the surface salinity in the shallow waters of the Gulf of Suez varies between a maximum of 42.85‰ in the north of the Suez Bay and a minimum of 40.14‰ in the southern part of the Gulf.

(b) Water Level and Tides

The mean sea level in the Suez Bay reaches its maximum value (12cm) in April, while its lowest values (-21cm~-12cm) occur in summer (July~October). According to Rough (Ref. No.11), the geodetic levelling along the Gulf of Suez indicates that the mean sea level at the northern end of the Gulf; i.e., in the Suez Bay, reaches 15cm higher than that found at the southern end of the Gulf.

The tidal range in the Gulf of Suez is about 1.5m with a time lag of 6 hours between the time of high water at the southern and the northern ends of the Gulf. Thus, the tidal pattern will be that of a standing wave with high water at north when it is low water at south, and the reverse is true. At Suez, the two semi-diurnal cycles are not identical, and the tidal range is relatively great being about 80cm at neap tide and 140cm at spring tide (Ref. No.7). However, the tidal currents are weak and do not exceed 15cm/sec (Ref. No.8).

(c) Pollution

The first study on the water pollution in the Suez Bay was conducted by Meshal (Ref. No.6). He reported the values of 40, 35, 35, 0, 0, and 0ppm for oil in the disposed effluent of the Suez Petroleum Company, Al-Nasr Petroleum Company, Misr Petroleum Company, Fertilizers Company, Kraft Company, and the domestic waste water drainage respectively.

Recently, Tarek (1992) has determined the levels of the dissolved and dispersed petroleum hydrocarbons in the water and sediments of the Bay. He found that the maximum value of dissolved hydrocarbons in the Suez Bay was 10μg/l in the near shore area. This value, however, decreased to 5.7μg/l in the central part of the Bay, and to 4.5μg/l in the offshore part.

On the other hand, Abdel-Fattah (Ref. No.1) has studied the physical and chemical characteristics of the water body in the Bay. He found that in the inshore water the concentration of NH_3-N, NO_2-N, NO_3-N, PO_4-P, copper, zinc, lead, and cadmium were 5.75μg-at./l, 0.77μg-at./l, 2.38μg-at./l, 1.49μg-at./l, 2.44×10^{-2}mg/l, 16.06×10^{-2}mg/l, 0.67×10^{-2}mg/l, and 0.30×10^{-3}mg/l respectively. In the offshore waters, however, the concentrations of NH_3-N, NO_2-N, NO_3-N, PO_4-P, copper, zinc, lead, and cadmium were 0.76μg-at./l, 0.21μg-at./l, 0.57μg-at./l, 0.21μg-at./l, 1.43×10^{-2}mg/l, 11.31×10^{-2}mg/l, 0.30×10^{-2}mg/l, and 0.14×10^{-3}mg/l respectively.

In general, many factories discharge their wastes into the Bay, and Table 3.12.3-1 gives some examples of the amounts and characteristics of these discharged effluent in the area.

Table 3.12.3-1 Characteristics of pollution of effluent discharged from different existing companies in Suez

Company/parameter	Fertilizer Co.	Power Station	Al-Nasr Pet. Co.	Domestic drainage
Temperature (^{o}C)	29	29	27	28
pH	8.46	8.05	8.20	7.55
Salinity (‰)	2.48	36.42	35.59	5.79
Dissolved Oxygen (mg O_2/l)	nil	4.69	0.31	nil
Ammonia (ton/year)	16.68	0.06	14.98	93.76
Nitrite (ton/year)	0.12	0.01	0.65	0.31
Nitrate (ton/year)	0.58	0.03	2.56	0.40
Phosphate (ton/year)	9.42	0.04	8.26	52.93
Copper (ton/year)	0.33	0.01	0.42	0.41
Zinc (ton/year)	1.43	0.01	7.23	3.65
Lead (ton/year)	0.07	0.01	0.66	0.12
Cadmium (ton/year)	0.04	< 0.11	0.05	< 0.11

Source: Ref. No.1

(2) Survey

(a) Data Acquisition and Analysis

A survey covering the sea area adjacent to the proposed site of the Development was carried out to obtain the data on sea water characteristics in the area. In this survey, three stations have been selected to understand the present state of currents and seven stations have been selected to understand the present state of sea water quality. The locations and depths of these stations are shown in Table 3.12.3-2 and Fig. 3.12.3-1.

Table 3.12.3-2 Locations and Depths of Sampling Stations

Station	Latitude (N)	Longitude (E)	Depth (m)
1	29° 53' 34"	32° 27' 59"	5.0 m
2	29° 53' 36"	32° 28' 44"	14.2 m
3	29° 53' 38"	32° 29' 38"	16.7 m
4	29° 54' 57"	32° 30' 14"	12.8 m
5	29° 54' 30"	32° 28' 21"	5.5 m
6	29° 53' 08"	32° 28' 45"	15.5 m
7	29° 52' 33"	32° 30' 29"	4.0 m

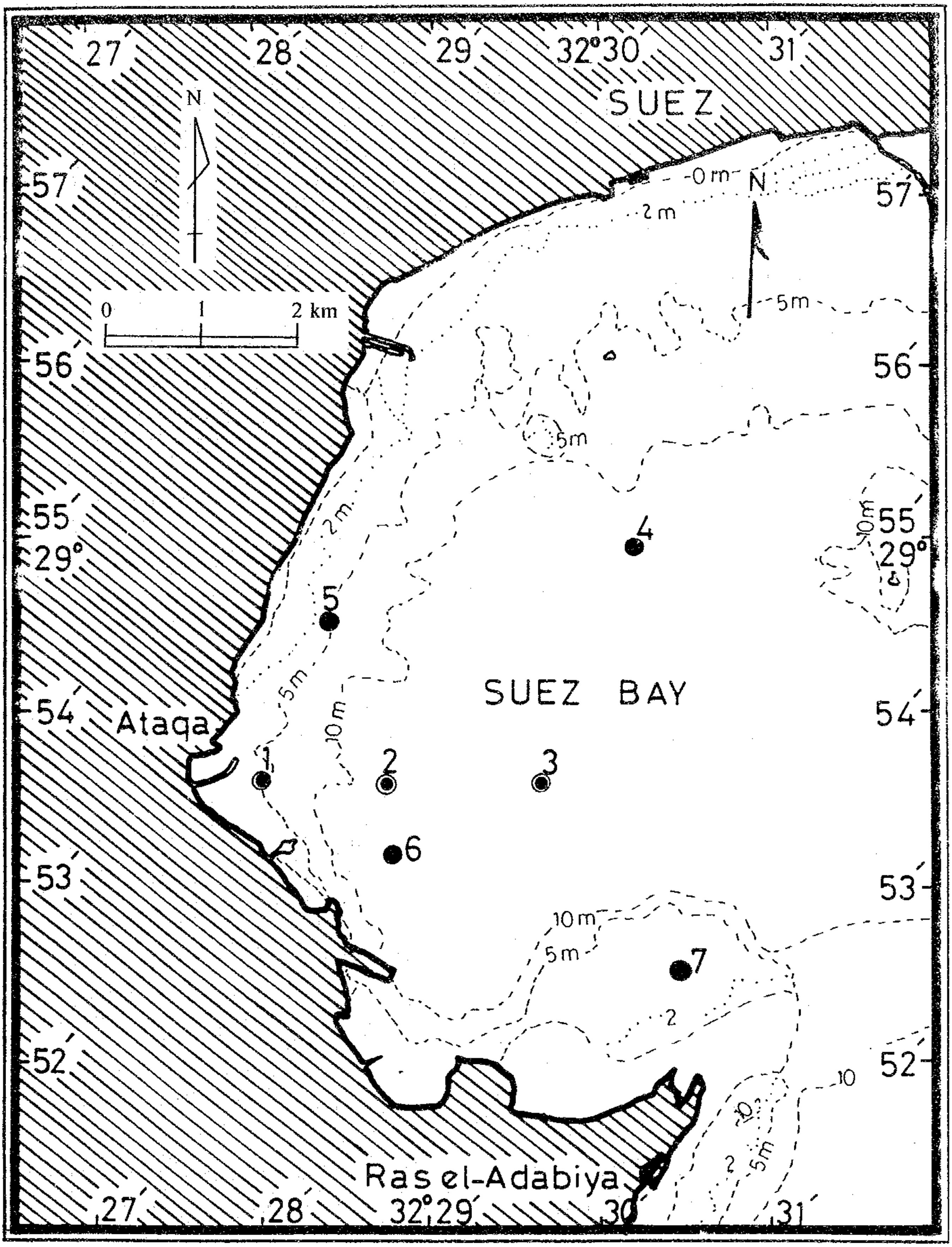


Figure 3.12.3–1 Locations of Currents and Water Quality Survey Points

i) Currents

At stations 1, 2 and 3, current measurements were made for approximately two hours at each station at high and low water periods. These measurements were made using Aanderaa Recording Current Meters Model RCM7 as well as an Aanderaa Recording Water Level Recorder Model 1207 to determine the water level. Floats were also released at each station, but they have not moved more than few meters during 4 hours due to very calm weather conditions. The locations of the survey points were determined using Magellan GPS 1000.

ii) Sea Water Quality

At each station, the following parameters were determined at the depths of 1 meter and 5 meters below the surface of water:

- Air temperature;
- Water temperature;
- SS (suspended solids);
- COD(Mn) ($KMnO_4$ oxidizable organic matter);
- COD(Cr) ($K_2Cr_2O_7$ oxidizable organic matter); and
- HC (Total hydrocarbon content extracted by n-hexane).

The outlines of chemical analysis are shown as follows.

<u>SS</u>

Wet a membrane filter of pore size 0.45μm pore size (diameter 47mm) in a Buchner funnel with distilled water, and apply suction for a few seconds. Remove it carefully and dry it for

1 hour at $105^{o}C \pm 5^{o}C$ in the drying oven. Cool in a desiccator and weigh. Place the weighed filter in the Buchner funnel again, and transfer a vigorously shacked 1 liter sample in portions to the funnel. Continue suction until the filter is almost dry. Remove it carefully from the funnel with tweezers and dry it in the drying oven for 24 hours at $105^{o}C \pm 5^{o}C$. Allow to cool, and weigh as before. Calculate the suspended solids as mg/l.

COD(Mn)

Application of methods of acid dichromate or permanganate can not be directly made for seawater because of its high content of chloride ions. For use in seawater, the permanganate method may be modified by using alkaline oxidation instead of acidic one.

To 50ml sample of seawater, add 10ml 0.01N $KMnO_4$ (or duplicates). Oxidation is interrupted by cooling and the remaining amount of oxidant is acidified, then add KI and determine the used permanganate iodometerically.

The consumption of $KMnO_4$ in mg/l is:

$KMnO_4$ mg/l = 3.16 x N x 100(b-s), or

O mg/l = 0.8 x N x 100(b-s)

where,

N = the normality of thiosulfate

b = ml thiosulfate solution consumed by the blank

s = ml thiosulfate solution consumed by the sample

COD(Cr)

Place 50ml sample in a round water flask, add 25ml standard dichromate solution (0.25N). Carefully add 75ml conc. H_2SO_4, and attach the flask to the condenser and reflux the mixture for 2 hours. Cool and titrate against standardized solution of $FeSO_4(NH_4)_2SO_4$.

The consumption of oxygen in mg/l is:

$$OC = (a\text{-}b) \times \text{Normality of } FeSO_4(NH_4)_2SO_4 \times (8000/\text{ml sample})$$

$$- \text{Cl correction}$$

where,

OC = Oxygen consumed from dichromate

a = ml $FeSO_4(NH_4)_2SO_4$ used for blank

b = ml $FeSO_4(NH_4)_2SO_4$ used for sample

Chloride correction = mg/l Cl x 0.23

HC

1 liter sample is mixed successively with 2 x 50ml of n-hexane (petroleum hydrocarbon grade). The extracts are combined, dried with anhydrous sodium sulfate and rotavapoured at 35°C to 5ml. The dried concentrate is measured fluorometerically against standard Gulf petroleum oil (Regional Organization for the Protection of the Marine Environment, ROPME) supplied from IAEA (International Atomic Energy Agency) Monaco laboratories. Results are expressed as μg/l.

iii) Industrial Waste Water Quality

The quality of waste water discharged from existing food and canning factory in Suez is shown in Table 3.12.3-3. In addition, waste water discharged from other kind of industries in Alexandria are given in Table 3.12.3-4 ~ 3.12.3-7.

Table 3.12.3–3 Waste Water Quality of El-Nasser Company (Food and Canning Factory)

Parameter	concentration
Temperature ° C	24.4
pH	6.9
D.O. (mg/l)	2.6
NH_3-N (mg/l)	0.55
NO_2-N (mg/l)	0.015
NO_3 N (mg/l)	4.27
Phosphates (mg/l)	0.29
Sulphate (mg/l)	81
BOD (mg/l)	739
COD (mg/l)	1110
Chloride (mg/l)	211
T. alkalinity (mg/l)	185
T. hard. (mg/l)	353
Ca Hard. (mg/l)	138
Mg Hard. (mg/l)	215
T.S. (mg/l)	1393
F.S. (mg/l)	452
V.S. (mg/l)	941
D.S. (mg/l)	1031
SS (mg/l)	362
Set. S. (mg/l)	2.14
Oil & grease (mg/l)	20
H_2S (mg/l)	0.07

Table 3.12.3–4 Chemical Composition of the Waste Water of Rakta Paper Factory

Chemical parameter	Concentration
pH	9.15
Chlorosity (mg Cl/l)	3000.00
Dissolved oxygen (ml/l)	0.00
Total alkalinity (mg Ca Co_3/l)	500.00
Total hardness (mg Ca Co_3/l)	879.00
Calcium (mg Ca^{++} /l	0.32
Magnesium (mg Mg^{++}/l)	0.08
Oxidizable organic matter C.O.D.(mg O_2/l	760.0
B.O.D. (mg O_2/l)	1420.00
Total solids (mg/l)	9303.00
Fixed solids (mg/l)	5582.00
Volatile solids (mg/l)	3721.00
Phosphate-P (μg-at/l)	1.66
Nitrite - N (μg-at/l)	16.99
Nitrate-N (μg-at/l)	30.10
Ammonia-N (μg-at/l)	0.94
Silicate-Si (μg-at/l)	133.49
Sulphite (mg Na_2So_4/l)	6.59
Sulphate (mg SO_4 $^{++4}$/l)	379.00
+ Cupper (mg/l)	0.140
+ Zinc (mg/l)	0.138
+ Lead (mg/l)	0.126
+ Oil and grease (mg/l)	37.00

Table 3.12.3--5 Chemical Composition of the Waste Water of El-Ahlia Paper Factory

Chemical parameter	Concentration
pH	7.75
Chlorosity (mg Cl/l)	2290.00
Dissolved oxygen (ml/l)	3.36
Total alkalinity (mg Ca Co_3/l)	156.00
Total hardness (mg Ca Co_3/l)	811.00
Calcium (mg Ca^{++} /l	0.16
Magnesium (mg Mg^{++}/l)	0.01
Oxidizable organic matter C.O.D.(mg O_2/l	283.0
Total solids (mg/l)	2040.00
Fixed solids (mg/l)	590.00
Volatile solids (mg/l)	1450.00
Phosphate-P (μg-at/l)	0.66
Nitrite-N (μg-at/l)	1.03
Nitrate-N (μg-at/l)	1.68
Ammonia-N (μg-at/l)	7.65
Silicate-Si (μg-at/l)	14.97
Sulphite (mg Na_2So_4/l)	3.14
Sulphate (mg SO_4 $^{++4}$/l)	160.00

Table 3.12.3-6 Chemical Composition of the Waste Water of El-Seouf Textile Factory

Chemical parameter	Concentration
pH	7.05
Chlorosity (mg Cl/l)	350.00
Dissolved oxygen (ml/l)	3.42
Total alkalinity (mg Ca Co_3/l)	276.45
Total hardness (mg Ca Co_3/l)	0.21
Calcium (mg Ca^{++} /l	0.05
Magnesium (mg Mg^{++}/l)	0.02
C.O.D. (mg O_2/l)	37.00
Total solids (mg/l)	1520.00
Fixed solids (mg/l)	1140.00
Volatile solids (mg/l)	380.00
Phosphate-P (μg-at/l)	2.87
Nitrite-N (μg-at/l)	14.19
Nitrate-N (μg-at/l)	14.84
Ammonia-N (μg-at/l)	22.94
Silicate-Si (μg-at/l)	19.14
Sulphite (mg Na_2So_4/l)	2.51
+ Cupper (mg/l)	0.092
+ Zinc (mg/l)	0.168
+ Lead (mg/l)	0.112
+ Oil and grease (mg/l)	70.50

Table 3.12.3–7 Chemical Composition of the Industrial Waste Water in El-Amia Drain

Chemical parameter	Concentration
pH	7.20
Chlorosity (mg Cl/l)	630.00
Dissolved oxygen (ml/l)	6.50
Total alkalinity (mg Ca Co_3/l)	28.76
Total hardness (mg Ca Co_3/l)	524.37
Calcium (mg Ca^{++} /l	0.21
Magnesium (mg Mg^{++}/l)	0.00
+ Cadmium (mg/l)	0.0034
C.O.D. (mg O_2/l)	12.20
Total solids (mg/l)	1120.00
Fixed solids (mg/l)	820.00
Volatile solids (mg/l)	300.00
Phosphate -P (μg-at/l)	0.57
Nitrite - N (μg-at/l)	0.50
Nitrate-N (μg-at/l)	1.68
Ammonia-N (μg-at/l)	6.23
Silicate-Si (μg-at/l)	25.25
Sulphite (mg Na_2So_4/l)	2.36
Sulphate (mg SO_4 $^{++4}$/l)	280.00
+ Cupper (mg/l)	0.0116
+ Zinc (mg/l)	0.0793
+ Lead (mg/l)	0.0625
+ Iron (mg/l)	0.0402

(b) Data Analysis

i) Currents

Water temperature recorded at the 7 stations surveyed are fluctuated between 17.2 and 17.5°C and the temperature does not vary with depth indicating well mixing condition despite the calm weather condition prevailing during the survey. The weather condition during the investigated period was so calm that the effect of winds on the current speed is relatively small in comparison with the effect of tides. The air temperature is between 16.5 and 17.3°C.

Current measurements were carried on January 3~5, 1993 at stations 1, 2 and 3 during ebb tide and rising tide. Results are shown in Table 3.12.3-8 ~ 3.12.3-13. The frequency of current at any given direction was calculated and the results are also in these tables. For the purpose of predictive analysis of impacts, the velocity vectors of the current in U (east-direction) and V (north-direction) coordinates were calculated and the results are shown in Fig. 3.12.3-2 ~ 3.12.3-7.

During the fall period, the southeasterly current was the most dominant direction with average velocity of 3.8cm/sec, 3.2cm/sec and 3.2cm/sec at the three sites respectively. While during the rise period, the southeasterly and the northwesterly current with an average speed of 5.2, 7.8 and 3.9cm/sec at the three sites respectively.

ii) Water Quality

The results of the chemical analysis are shown in Table 3.12.3-14.

<u>Visual Observations</u>

The shoreline of the surveyed area was covered by a film of floating oily matter overlaid by dust. This film was directed, thick or thin and wide or narrow according to wind direction. The effect of industrial and sewage disposal activities on the coastal line of the Suez Bay.

Suspended Solids

The results of measurement of suspended solids show a more or less homogeneity of the suspended solids content either at 1m or 5m depths. The range was very narrow and varied between 9.5 to 11.5mg/l with an average of 10.8mg/l.

Petroleum Hydrocarbons

The petroleum hydrocarbons content of the collected samples varies so much from station to station or with depth. The results of 1m depth samples varies between 2.0 and 13.7μg/l, with an average of 5.8μg/l. The samples of 5m varies between 1.1 and 6.6μg/l with an average of 4.5μg/l. The average of surface-bottom is 5.2μg/l. These results show wide variability with the maximum at the surface water of station 5.

COD(Mn)

The results of collected samples varies within a very narrow range. The minimum range is 0.6mg/l and the maximum is 1.8mg/l. Although the area surveyed is receiving organic wastes from different sources, yet the concentrations of COD do not exceed 8mg/l which is the upper limit of the environmental water quality standards (category C) in Japan. The standard is applied for the purpose of the environmental conservation so that no unpleasantness is caused to the people in their daily lives including a walk along the shore.

COD(Cr)

The results of analysis by this method give too high values in comparison with the ordinary COD values of coastal area. The minimum is 71.0mg/l and the maximum is 276.7mg/l. These results show that the permanganate method gives the reasonable values, but the dichrome method gives much higher values. Because, it is considered that the acid dichromate method differentially oxidizes the halogen contents of sea water.

Table 3.12.3-8 Current Data (at Station 1) During the Ebb Tide

Time	Temp. o C	Dir	Speed cm/sec
1019	17.31	323	6.3
1024	17.28	97	3.4
1029	17.31	105	4.9
1034	17.34	99	5.2
1039	17.34	122	2.0
1044	17.31	105	2.6
1049	17.37	98	4.3
1054	17.37	184	1.4
1059	17.37	141	3.4
1104	17.37	89	6.9
1109	17.37	134	2.6
1114	17.37	126	4.3
1119	17.40	82	6.6
1124	17.40	138	2.6
1129	17.40	108	4.6
1134	17.40	95	5.5
1139	17.40	119	3.7
1144	17.40	115	4.0

STATION 1

DIRECTION	FREQUENCY (%)
N	0
NE	5.55
E	16.67
SE	**66.67**
S	5.55
SW	0
W	0
NW	5.55

Table 3.12.3–9 Current Data (at Station 2) During the Ebb Tide

Time	Temp. o C	Dir	Speed cm/sec
1109	17.18	4	2.6
1114	17.21	103	4.9
1119	17.21	156	1.1
1124	17.21	91	2.8
1129	17.21	93	2.3
1134	17.21	25	1.4
1139	17.21	108	2.6
1144	17.21	285	1.7
1149	17.21	209	2.3
1154	17.24	91	3.7
1159	17.21	120	2.0
1204	17.21	104	3.1
1209	17.24	84	2.0
1214	17.21	129	2.6
1219	17.24	108	2.6
1224	17.24	284	3.1
1229	17.24	105	4.0
1234	17.24	265	3.1
1239	17.24	112	5.5
1244	17.24	231	2.6
1249	17.24	120	4.0

STATION 2

DIRECTION	FREQUENCY (%)
N	4.76
NE	4.76
E	14.29
SE	**52.38**
S	
SW	9.52
W	4.76
NW	9.53

Table 3.12.3-10 Current Data (at Station 3) During the Ebb Tide

Time	Temp. o C	Dir	Speed cm/sec
1209	17.09	290	7.2
1214	17.09	99	2.8
1219	17.09	143	1.7
1224	17.09	82	3.1
1229	17.09	123	2.3
1234	17.09	135	2.3
1239	17.09	78	4.0
1244	17.09	170	3.1
1249	17.09	113	2.3
1254	17.09	129	3.7
1259	17.09	121	3.7
1304	17.09	147	3.4
1309	17.09	118	4.6
1314	17.12	138	3.4
1319	17.1w	143	3.4
1324	17.09	138	3.1
1329	17.12	111	5.2
1334	17.09	165	2.6

STATION 3

DIRECTION	FREQUENCY (%)
N	
NE	5.55
E	11.11
SE	77.79
S	
SW	
W	
NW	5.55

Table 3.12.3–11 Current Data (at Station I) During the Rising Tide

Time	Temp. o C	Dir	Speed cm/sec
1304	17.03	271	4.0
1309	17.06	73	10.1
1314	17.06	97	6.0
1319	17.06	88	5.5
1324	17.06	107	4.0
1329	17.06	94	4.9
1334	17.06	107	5.5
1339	17.06	80	5.7
1344	17.06	100	6.3
1349	17.06	93	5.7
1354	17.09	88	6.6
1359	17.09	118	7.2
1404	17.12	129	3.4
1409	17.09	246	2.6
1414	17.09	156	4.0
1419	17.12	181	3.1
1424	17.12	193	2.3
1429	17.12	201	1.4
1434	17.12	216	1.7
1439	17.09	275	1.4
1444	17.12	290	1.4
1449	17.12	255	1.7

DIRECTION	FREQUENCY (%)
N	
NE	13.64
E	
SE	**40.91**
S	
SW	31.81
W	
NW	4.55

Table 3.12.3-12 Current Data (at Station 2) During the Rising Tide

Time	Temp. o C	Dir	Speed cm/sec
1509	17.06	224	4.0
1514	17.09	222	1.4
1519	17.09	302	2.0
1524	17.09	106	1.7
1529	17.18	4	2.6
1534	17.09	286	2.0
1539	17.18	357	3.1
1544	17.21	2	3.7
1549	17.12	339	4.6
1554	17.18	330	6.9
1559	17.40	301	8.1
1604	17.43	301	11.9
1609	17.40	302	10.7
1614	17.40	304	11.3
1619	17.37	310	11.3
1624	17.21	324	5.5
1629	17.43	319	5.7
1634	17.34	311	6.6
1639	17.46	317	8.7
1644	17.46	329	8.7
1649	17.49	328	9.2
1654	17.49	329	11.0
1659	17.46	325	13.9

DIRECTION	FREQUENCY (%)
N	13.64
NE	
E	
SE	4.55
S	
SW	9.09
W	
NW	**72.73**

Table 3.12.3-13 Current Data (at Station 3) During the Rising Tide

Time	Temp. o C	Dir	Speed cm/sec
1354	17.09	331	3.1
1359	17.09	168	2.8
1404	17.09	133	3.1
1409	17.09	178	2.3
1414	17.09	163	2.6
1419	17.09	223	2.3
1424	17.09	230	2.8
1429	17.15	246	3.4
1434	17.12	170	2.0
1439	17.09	192	2.3
1444	17.09	290	2.0
1449	17.12	269	4.0
1454	17.09	271	3.1
1459	17.12	267	4.0
1504	17.09	252	2.0
1509	17.09	286	2.3
1514	17.09	284	3.1
1519	17.09	277	5.2

DIRECTION	FREQUENCY (%)
N	
NE	
E	
SE	27.78
S	
SW	27.78
W	11.11
NW	33.33

Figure 3.12.3–2 Velocity Vectors of the Current in U (East) and V (North) Coordinates (at Station 1) during the Ebb Tide

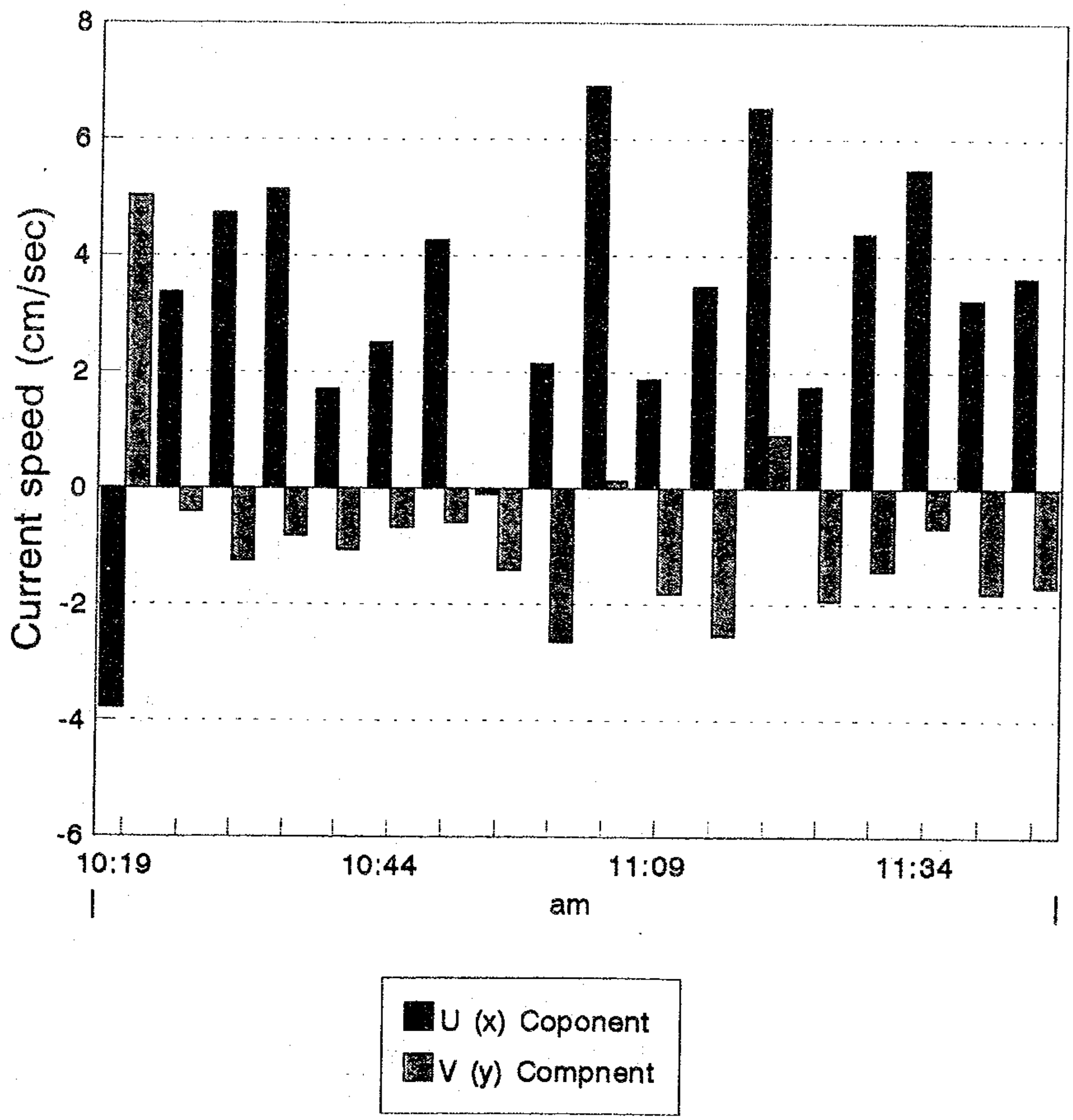


Figure 3.12.3–3 Velocity Vectors of the Current in U (East) and V (North) Coordinates (at Station 2) during the Ebb Tide

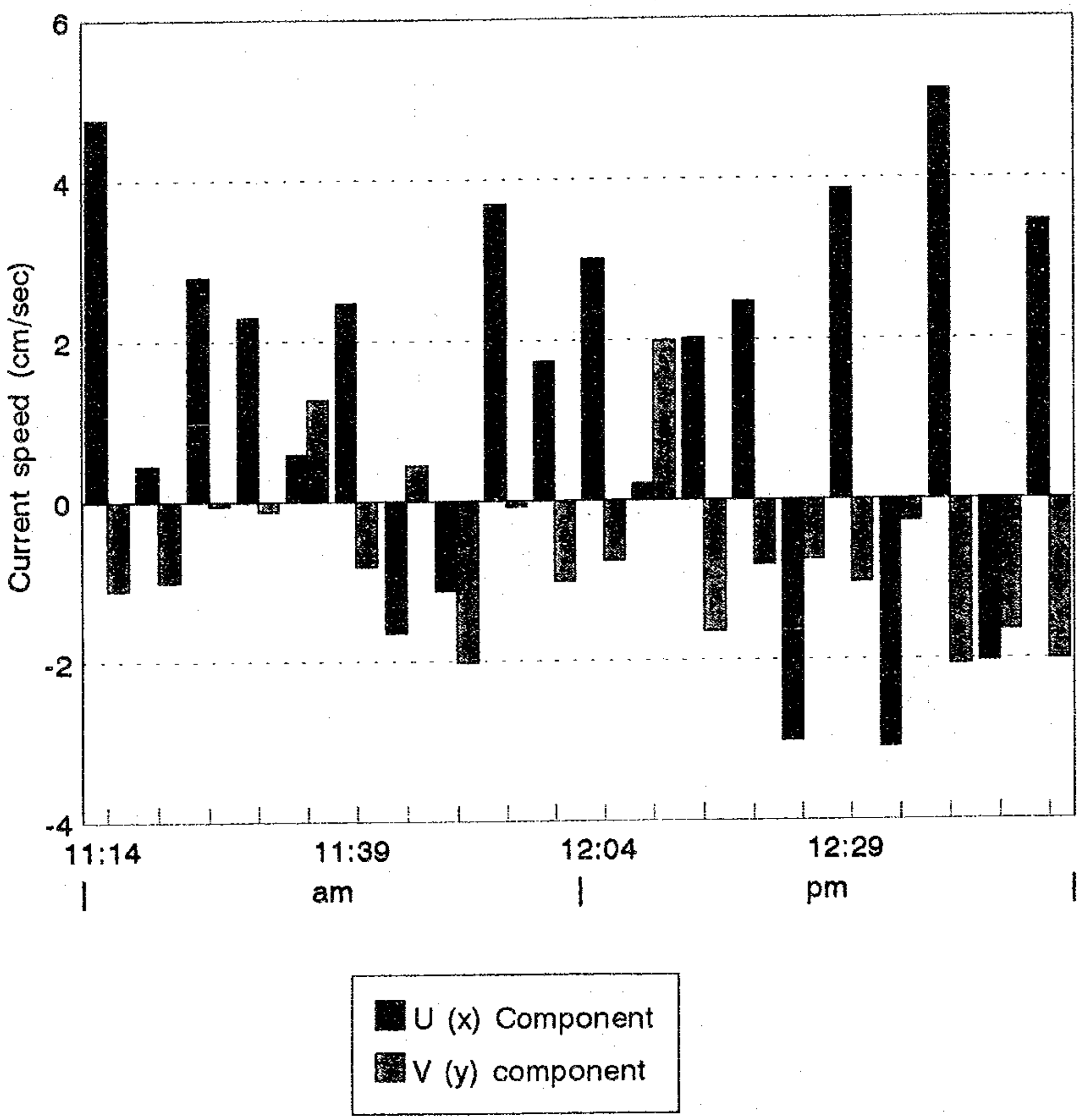


Figure 3.12.3–4 Velocity Vectors of the Current in U (East) and V (North) Coordinates (at Station 3) during the Ebb Tide

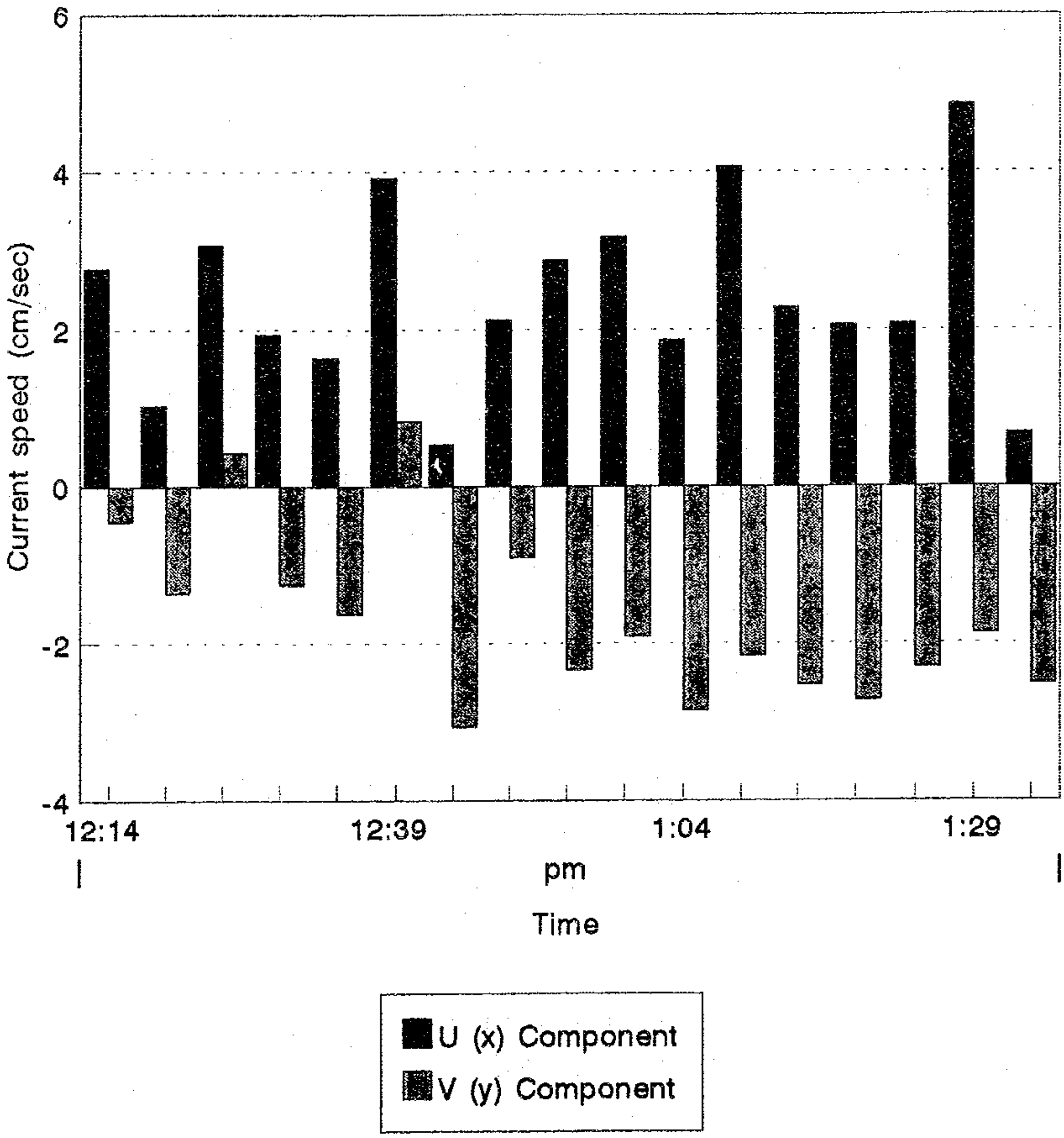


Figure 3.12.3–5 Velocity Vectors of the Current in U (East) and V (North) Coordinates (at Station 1) during the Rising Tide

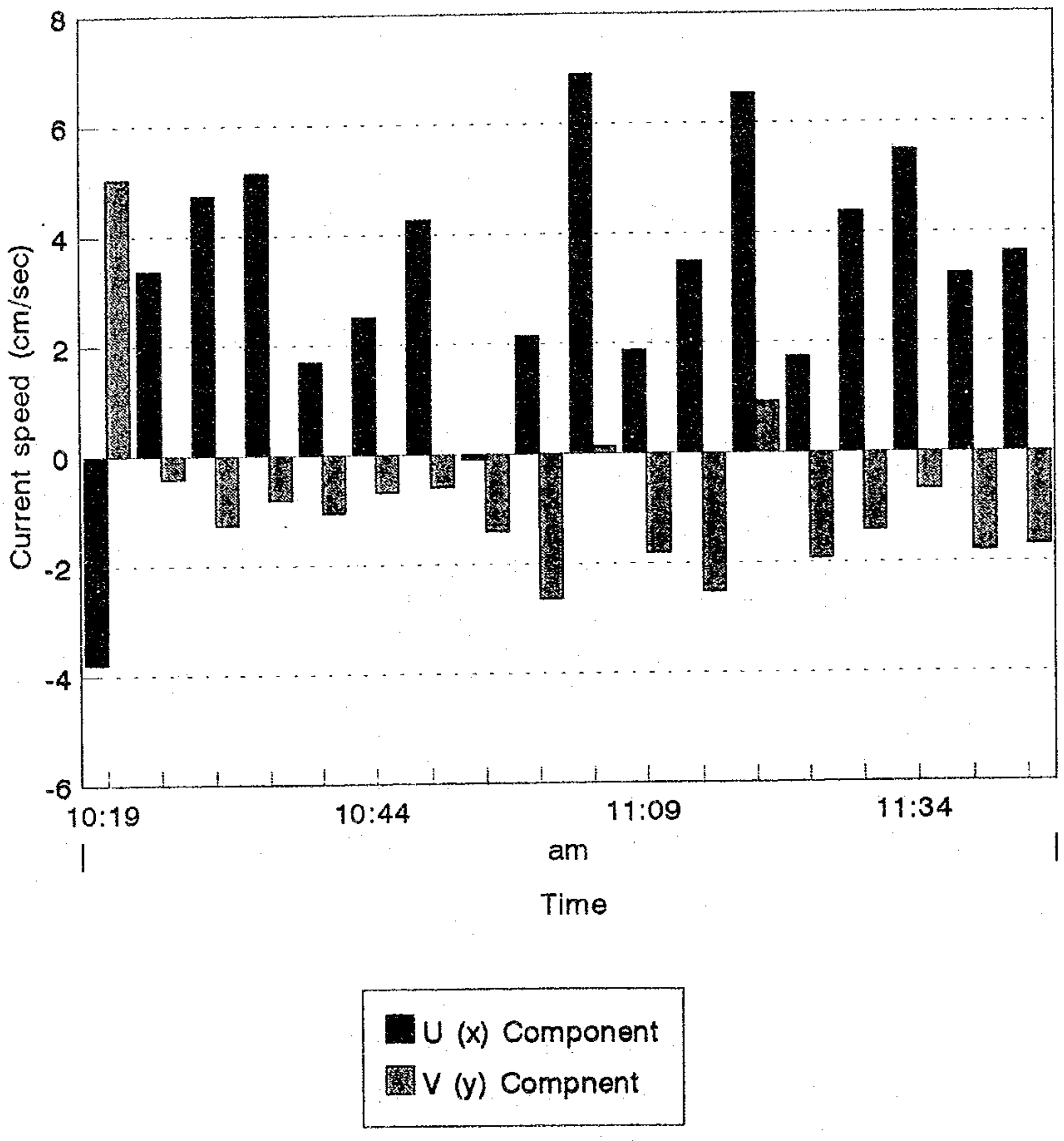


Figure 3.12.3–6 Velocity Vectors of the Current in U (East) and V (North) Coordinates (at Station 2) during the Rising Tide

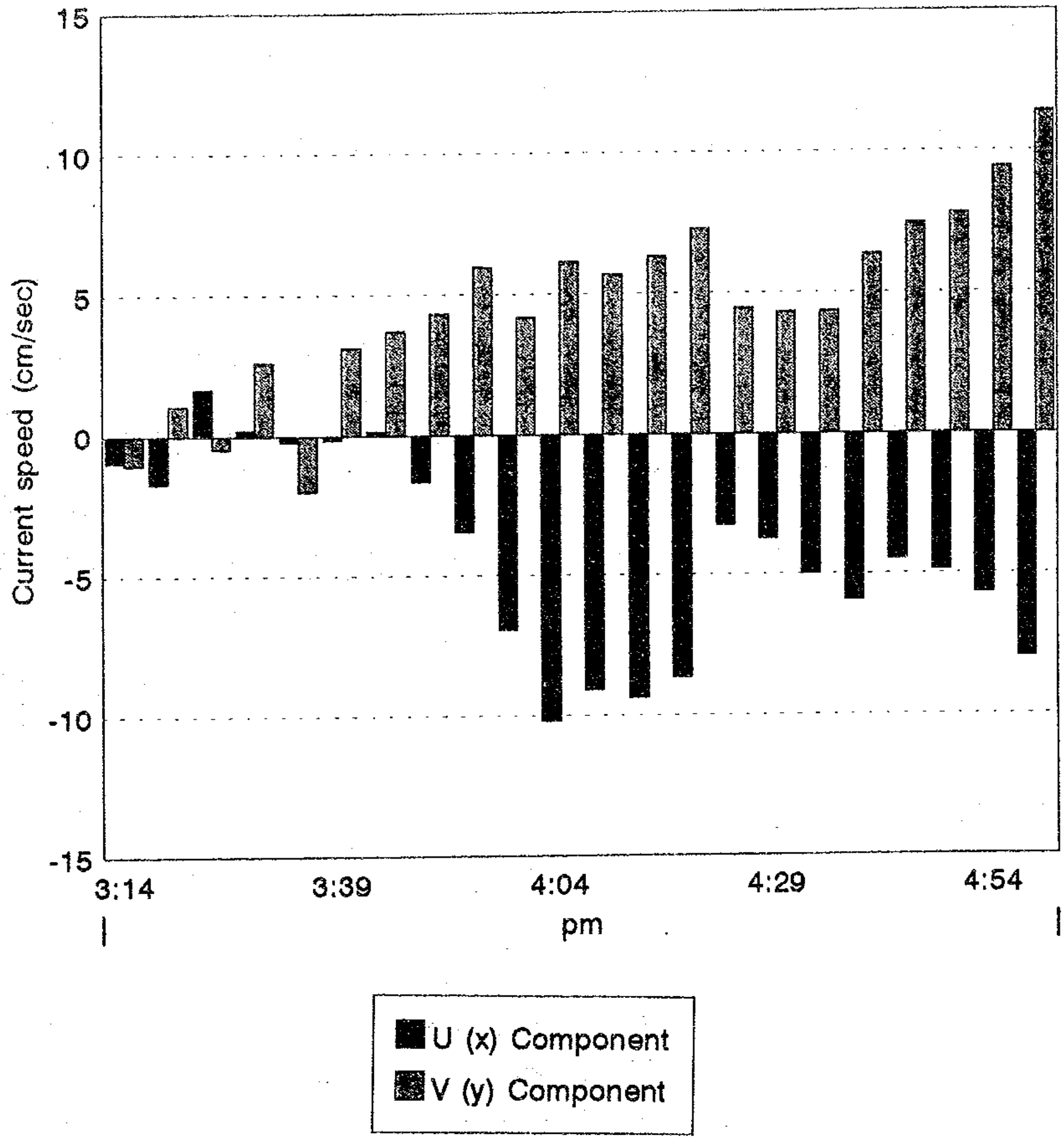


Figure 3.12.3-7 Velocity Vectors of the Current in U (East) and V (North) Coordinates (at Station 3) during the Rising Tide

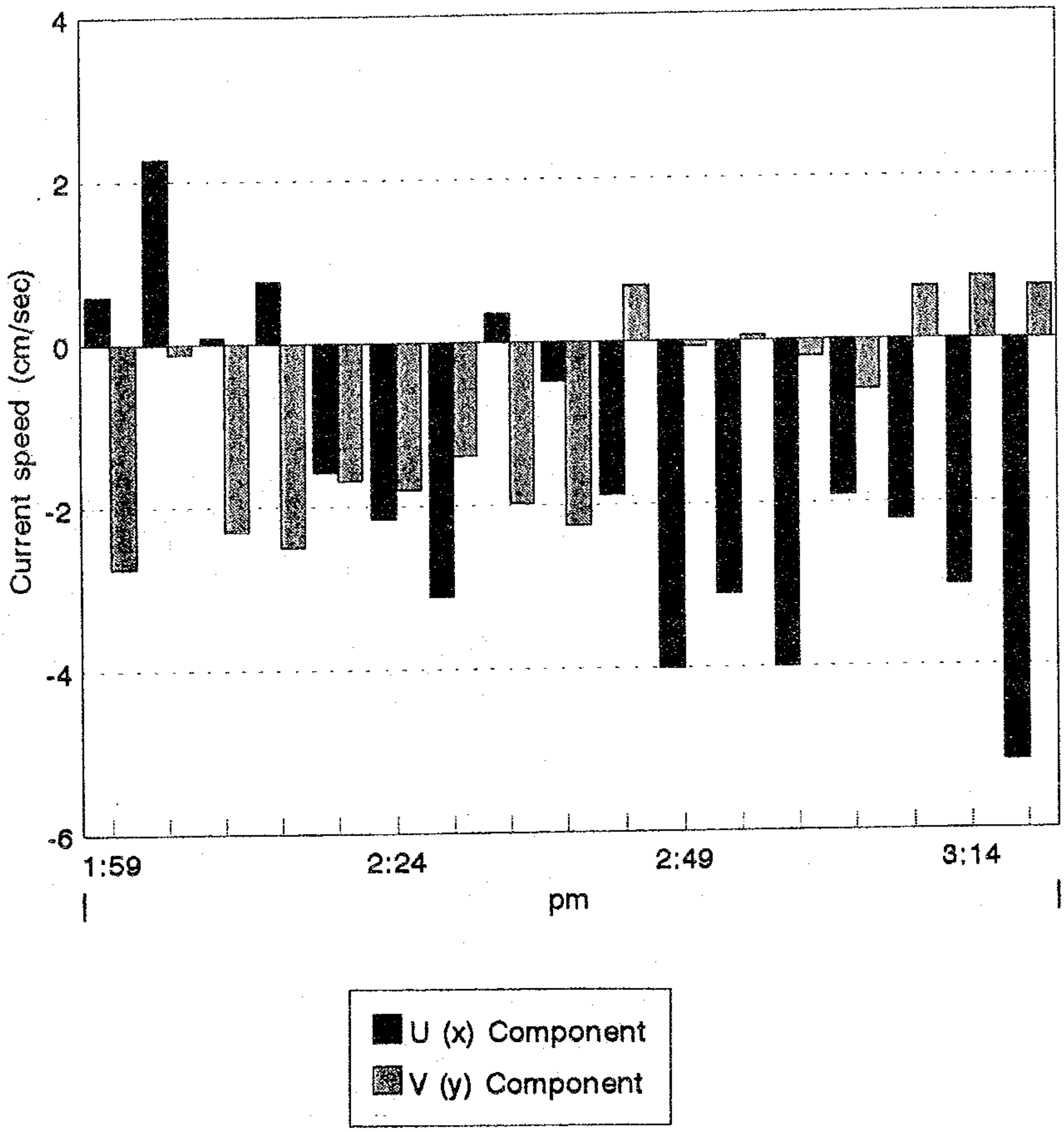


Table 3.12.3-14 The Results of Sea Water Quality Survey in the Suez Bay

Station No.	Depth (m)	THC (μg/l)	SS (mg/l)	COD(Mn) (mg/l)	COD(Cr) (mg/l)
1	1	4.1	10.1	6.2	71.0
	5	5.0	10.9	4.0	135.9
2	1	6.7	11.6	4.6	134.8
	5	5.8	11.1	7.3	107.8
3	1	2.9	10.5	3.5	228.1
	5	2.6	10.8	6.6	175.0
4	1	7.3	10.3	5.7	169.0
	5	6.6	10.5	3.5	200.0
5	1	13.7	10.9	5.1	276.7
	5	6.1	10.5	5.1	242.0
6	1	2.0	11.5	2.4	98.9
	5	1.1	9.5	6.2	190.0
7	1	4.1	11.3	6.5	116.5
	-	-	-	-	-

(3) Prediction of Impacts

(a) Methodology

i) Predictive Model

It is convenient to divide the mixing and dispersion process into two zones. Near the discharging point, the mixing is accomplished in the buoyant jets, a phenomenon governed by the momentum and buoyancy of the discharge. Far from the discharging point, transport and mixing are accomplished by the sea currents and turbulence and relatively insensitive to the exact discharge conditions.

To estimate the initial dilution of the solution for a two dimensional buoyant plume, the following equation can be used when the field of water is uniform and motionless.

$$S = 0.38\, y^{1/3} (d / q)^{2/3}$$

where,

S : centerline dilution

y : $g\, \Delta\rho/\rho$

ρ : density of discharge

$\Delta\rho$: density difference between sea water and discharge

g : gravitational acceleration

d : vertical distance above outlet

q : initial discharge

When the sea water is stratified with a linear density profile, the corresponding plume equation is

$$S = 0.38\, y^{1/3} (d / q)^{2/3}$$

$$y_{max} = 2.84\, (yd)^{1/3} (-g/\rho)\ \{d\rho/(dy)^{-1/2}\}$$

where,

y_{max} : maximum height of rise of jet

Approximate estimates can be made as to the effect of blocking due to the finite thickness of the discharging field. According to the continuity, following equation is obtained.

$$Q_o\, S_{aw} = ubh = ub\, (y_{max} - y_b)$$

where,

h : thickness of the discharging field

b : width of the discharging field (normal to the current)

u : current speed

S_{aw} : average dilution in the discharging field

Q_o : quantity of the discharge

y_b : y coordinate at the bottom of the discharging field

y_{max} : y coordinate at the top of the discharging field

It can be assumed that the average dilution at elevation y is proportional to y. This is nearly true in all buoyant line plume and jet for sufficiently large y. Thus assuming S_{aw} is the same as the average dilution in the plume at $y=y_b$

$$\frac{S_{aw}}{S_a} = \frac{y_b}{y_{max}}$$

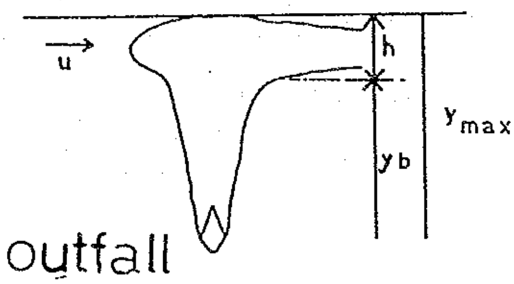
where,

S_b : calculated value at the top of the plume ($y=y_{max}$) disregarding the presence of blocking of the finite thickness of the discharging field

Hence,

$$Q_o\, S_a \approx ub\, \frac{y_{max}}{y_b}\, (y_{max} - y_b)$$

$$\frac{y_b}{y_{max}} = \frac{1}{\left(1 + \dfrac{Q_o\, S_a}{uby_{max}}\right)}$$



Then,

$$S_{aw} = \frac{S_a}{\left(1 + \dfrac{Q_o\, S_a}{uby_{max}}\right)}$$

and the thickness of the discharging field is

$$h = y_{max} - y_b = y_{max}\left(1 - \frac{y_b}{y_{max}}\right)$$

$$h = y_{max} \frac{\dfrac{Q_o S_a}{uby_{max}}}{\left(1 + \dfrac{Q_o S_a}{uby_{max}}\right)}$$

For uniform sea water field, a plume of discharge rises to the surface and an actual average dilution S_{aw} is given from the following equation.

$$S_{aw} = 0.38 \ (yq)^{\frac{1}{3}} \ \frac{y_{max}}{q}$$

And an average dilution S_a in the absence of the blocking is calculated from the following equation.

$$S_a = 0.54 \left((yq)^{\frac{1}{3}} \ \frac{y_{max}}{q} \right)$$

From the above equation the dilution of any chemical parameters can be calculated. Also the thickness and extension of the surface diluted layer can be calculated.

In the case of considering the effluent is discharged from the coastal drain to the surface, the initial dilution of any concentration can be calculated from the following equation.

$$S = 2.25 \ \frac{\Delta\rho_1}{\Delta\rho_2}$$

where,

$\Delta\rho_1$: difference in density between the surface and the bottom of sea water

$\Delta\rho_2$: difference in density between the discharged water and the surface of sea water

To follow up the spreading of any pollutant the above equations are used.

Since water is incompressible, the principal of conservation of mass implies compensation of any random movement of small mass of water within fluid medium by an opposite motion, thus illustrating a swirling flow aspect of turbulence. An immediate effect of turbulent eddies is that they cause rapid propagation in all directions.

The hydrodynamic/thermodynamic equations introducing the overall effect of turbulence in the form of three parameters related to the principal flow reference axis,

i.e.

$$\partial F / \partial t + u\, \partial F / \partial x = \partial \{ Kx\, (\partial F/\partial x) \} / \partial x + \partial \{ Ky\, (\partial F/\partial y) \}/\partial y + \partial \{ Kz\, (\partial F/\partial z) \}/\partial z$$

where,

x,y,z : space coordinate, with ox in the direction of velocity vector and oz vertical

t : time

u : horizontal flow velocity

K_x, K_y, K_z : turbulent diffusion parameters

F : a scaler quantity such as pollutant concentration

In the case of a source points which discharges the mass per unit time of Q (at a point of x=y=z=0), the steady flow can be considered as a series of instantaneous discharges at a specific time intervals. The basic analytical solution available for the differential diffusion equation is as follows ;

$$C\,(x,y,z) = Q \cdot \exp\,[\, \{u / (2K_x)\}\, (x - R\sqrt{K_x})\,] / \{ 4\pi R\, (K_x K_y K_z)^{1/2} \}$$

where,

$$R^2 = x^2 / K_x + y^2 / K_y + z^2 / K_z$$

In many theoretical approaches, usually more or less random distribution is converted into a radially symmetrical one. This assumption is done by determining the area enclosed by the isolines of concentration and by calculating the radius of the circle with an equivalent area. This radius (r) is called an equivalent radius. Then, the above equation can be changed into the following form.

$$C(r, t) = Q \cdot \exp(-r^2/\sigma_r^2) / (\pi \sigma_r^2)$$

where,

σ_r : symmetrical variance

The variance of the horizontal distribution of concentration is the most suitable parameter of the diffusion. The rotationally symmetrical variance as a function of time can be represented by the following form.

$$\sigma_r^2 = K t^n$$

where,

n : = 2.3 (as a mean value)

K : diffusion coefficient { $= (K_x K_y)^{1/2}$ }

ii) Conditions

The following conditions have been applied for the prediction of the impacts on sea water quality.

Effluent from the proposed waste water treatment plant

- Quantity of discharge : 46500 m^3/day

- Density of discharge : 1.0005 g/cm^3

- The diameter of the outlet : 1.35 m

- Quality of discharge : pH = 6 ~ 9

BOD = 20 mg/l

COD = 50 mg/l

SS = 50 mg/l

Sea water

- Density of sea water : 1.031 g/cm^3

(The sea water field is considered to be homogeneous, i.e., there is no density variation)

- Diffusion coefficient : K_x=3.19x10^{-5} cm^2/sec

K_y=7.10x10^{-5} cm^2/sec

- Current velocity and direction

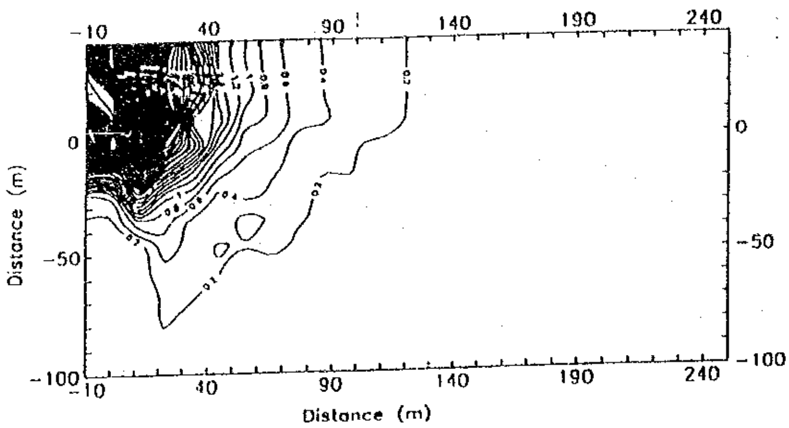
(The observed data at the survey stations 1, 2 and 3 have been applied)

(b) Results of Prediction

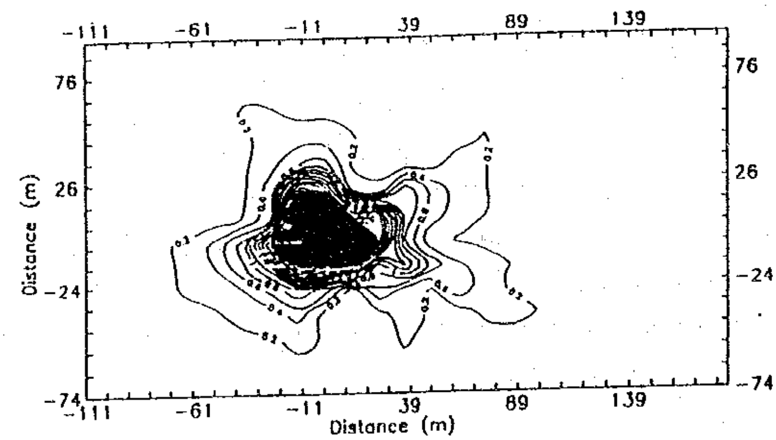
The results predicted for COD during the ebb tide and during the rising tide are shown in Fig. 3.12.3-8 and Fig. 3.12.3-9 respectively.

Currents of SE direction pushes the pollutants offshore and has little effect on the water quality near the coast. This current is dominant during the ebb tide. On the other hand, currents of NW and SW direction carry the pollutants towards the coast. Both of these currents are dominant during the rising tide. As a result, the concentration of pollutants near the coast during the rising tide is predicted to be higher than that during the ebb tide.

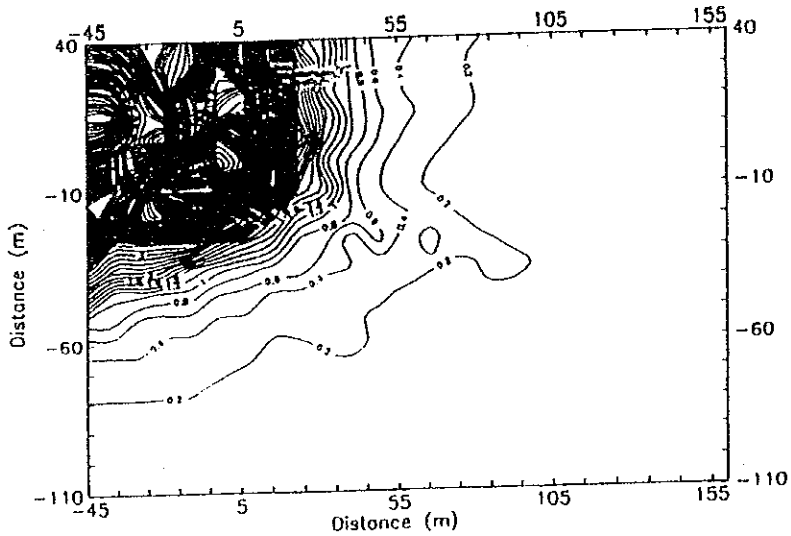
Judging from the results for the currents model of station 1 which represents the coastal currents, the contribution of the effluent to the sea water quality never spread seriously. If the distance from the discharging point exceeds approximately 150 meters, the increased concentration of COD reduces to the level below 0.1 mg/l, namely, below 1~2% of the present concentration of the sea water.



Currents Model (Station 1)

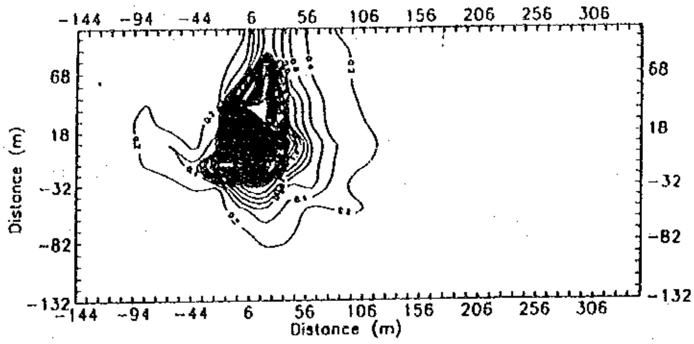


Currents Model (Station 2)

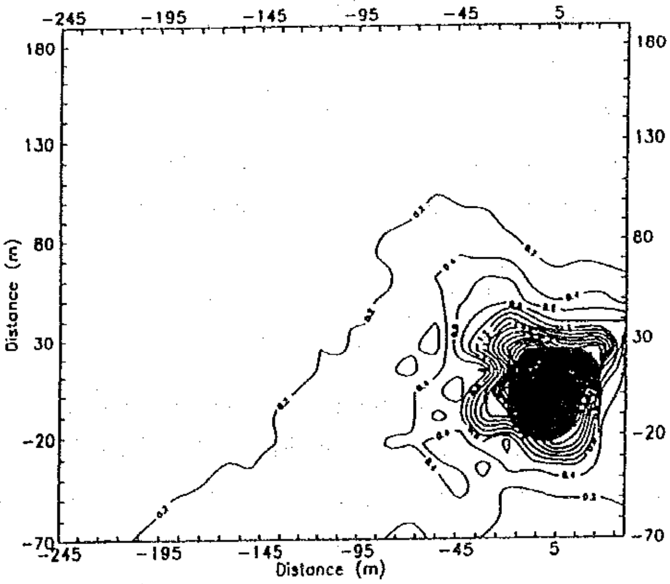


Currents Model (Station 3)

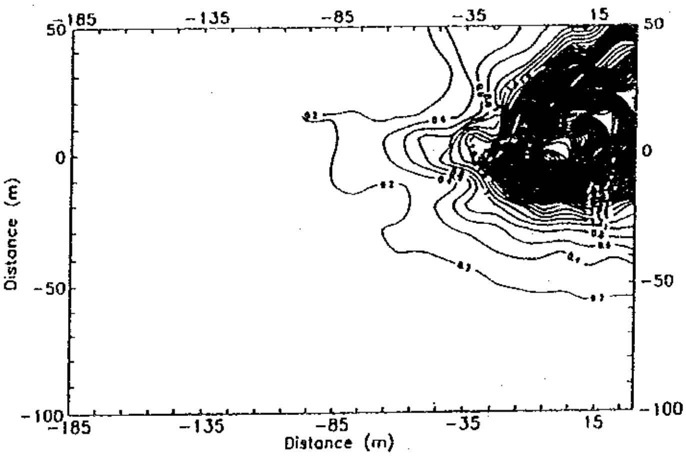
Figure 3.12.3–8 Predicted Distribution Patterns of COD Concentration (unit:mg/ℓ) from the Effluent of the Proposed Waste Water Treatment Plant during Ebb Tide



Currents Model (Station 1)



Currents Model (Station 2)



Currents Model (Station 3)

Figure 3.12.3–9 Predicted Distribution Patterns of COD Concentration (unit:mg/ℓ) from the Effluent of the Proposed Waste Water Treatment Plant during Rising Tide

(c) Evaluation

In general, the effect on the sea water caused by the effluent of the proposed waste water treatment plant is expected to be very limited in extent.

As a long term evaluation, if some projects of coastal reclamation neighboring the Development site will be implemented in future, the sea water area where the effluent are to be discharged will be surrounded by the barriers which prevent the discharge from diluting or diffusing. Such reclamation may accelerate the tendency that the discharged pollutants accumulate along the coastline under the condition of northwesterly or southwesterly currents during the rising tide. In such case, some countermeasure would be necessary.

The industrial waste water shall be primarily treated by each industry before discharging to the public sewer pipe according to the law/regulation. Therefore, hazardous or highly organically polluted waste water is never to flow to the proposed waste water treatment plant nor to discharge into the sea. But, it is recommended to conduct the water quality monitoring. Because, once the plant or the sea is contaminated, it will be quite difficult to recover.