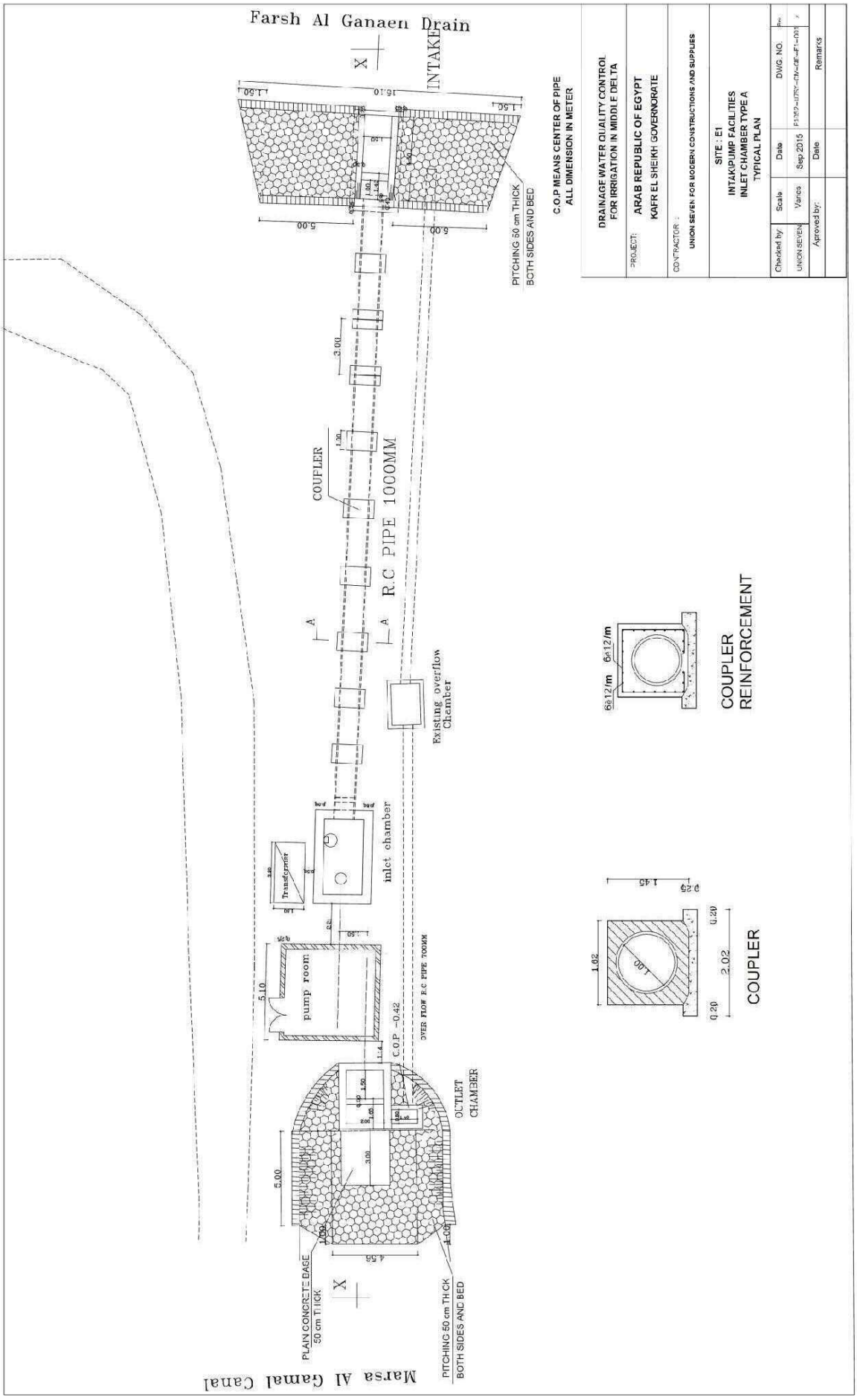
Appendix-L Drawings of Facilities in Pilot Project Sites

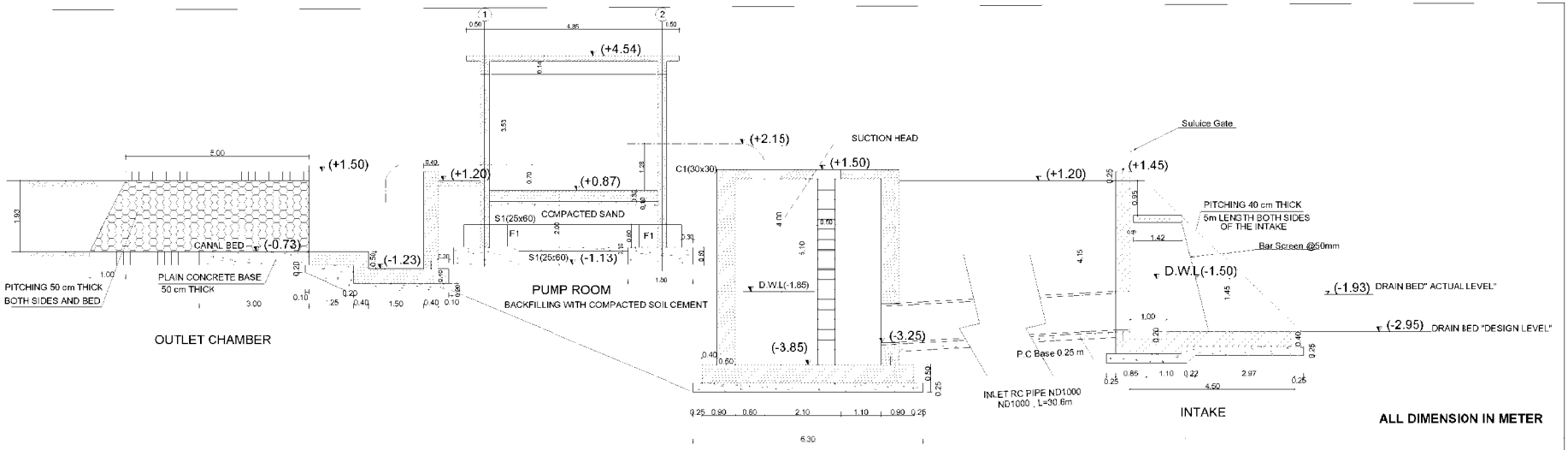
THE PROJECT FOR
DRAINAGE WATER QUALITY CONTROL FOR
IRRIGATION IN MIDDLE NILE DELTA
IN THE ARAB REPUBLIC OF EGYPT

LIST OF DRAWINGS

No.	Name	sheets
1	Reuse Pump Facilities (E1)	4
5	Reuse Pump Facilities (E4)	4
9	Reuse Pump Facilities (W2)	4
13	Reuse Pump Facilities (W4)	4
17	Reuse Pump Facilities (W5)	4
21	Compost Facilities (W5)	2
23	In-stream Treatment Facilities (W5)	5
28	Rural Sewerage Treatment Facilities (W5)	3

1. Reuse Pump Facilities (E1) 1/4





SECTION X-X

ALL DIMENSION IN METER

DRAINAGE WATER QUALITY CONTROL FOR IRRIGATION IN MIDDLE DELTA

PROJECT:

ARAB REPUBLIC OF EGYPT

KAFR EL SHEIKH GOVERNORATE

CONTRACTOR:

UNION SEVEN FOR MODERN CONSTRUCTIONS AND SUPPLIES

SITE : E1

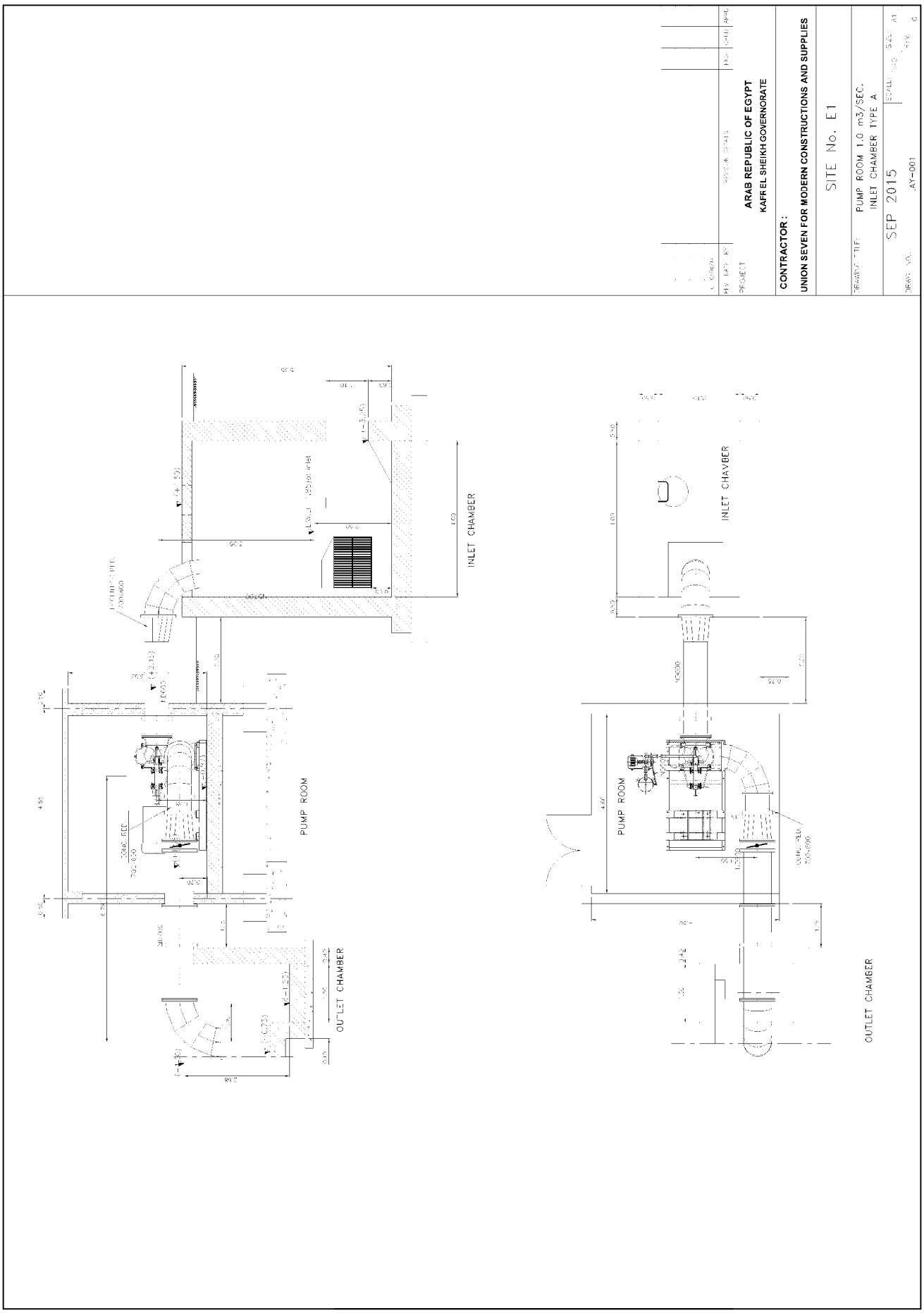
INTAK\PUMP FACILITIES

INLET CHAMBER TYPE A

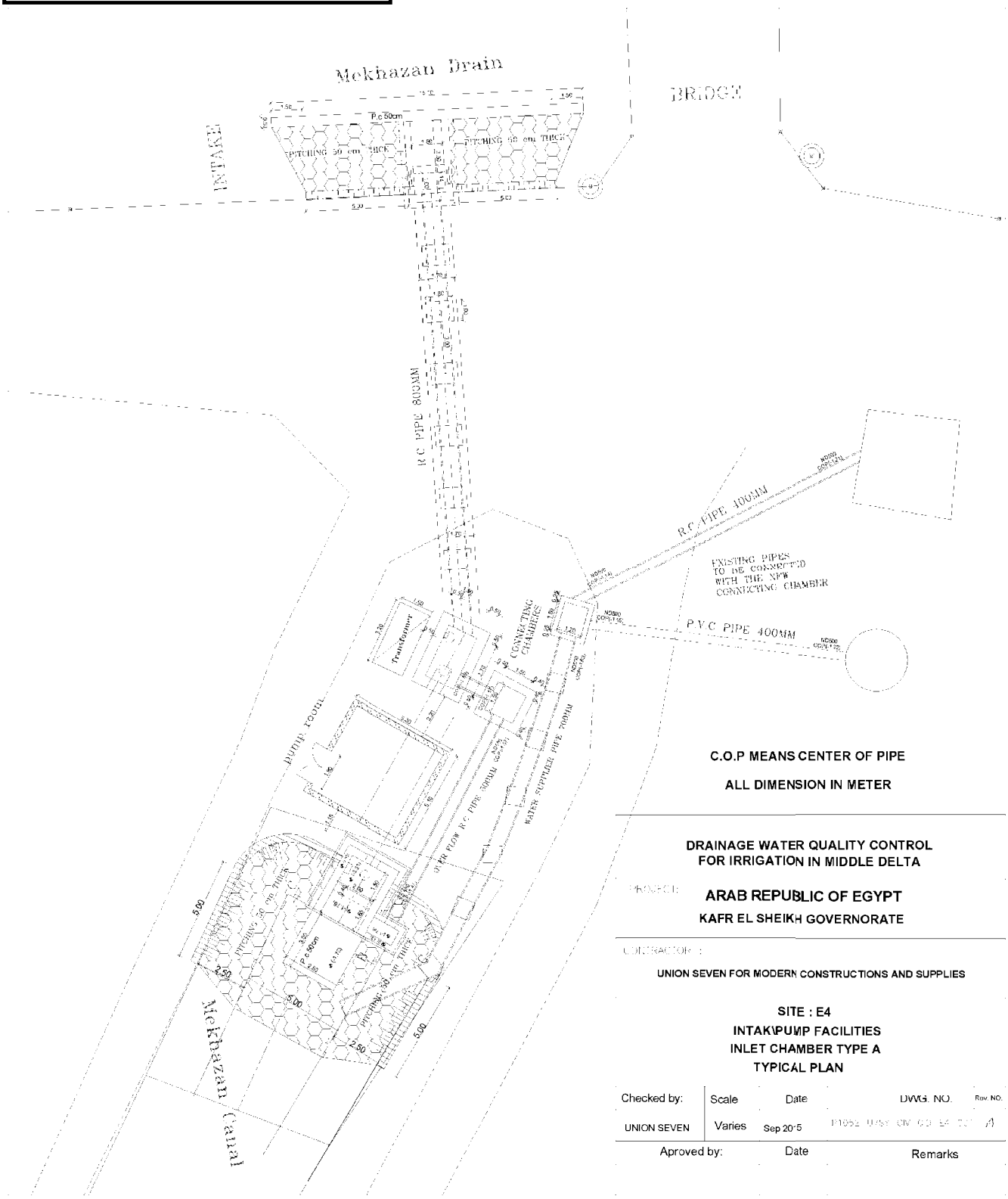
SECTION X-X

Checked by:	Scale	Date	DWG. NO.	Rev. NO.
UNION SEVEN	Varies	Sep 2015	[illegible]	/1
Aproved by:		Date	Remarks	

3. Reuse Pump Facilities (E1) 3/4


ARAB REPUBLIC OF EGYPT
KAFR EL SHEIKH GOVERNORATE
CONTRACTOR :
UNION SEVEN FOR MODERN CONSTRUCTIONS AND SUPPLIES
SITE No. E1
PUMP ROOM 1.0 m3/SEC.
INLET CHAMBER TYPE A
SEP 2015
AY-001
INLET CHAMBER
PUMP ROOM
OUTLET CHAMBER
INLET CHAMBER
PUMP ROOM
OUTLET CHAMBER

5. Reuse Pump Facilities (E4) 1/4



C.O.P MEANS CENTER OF PIPE

ALL DIMENSION IN METER

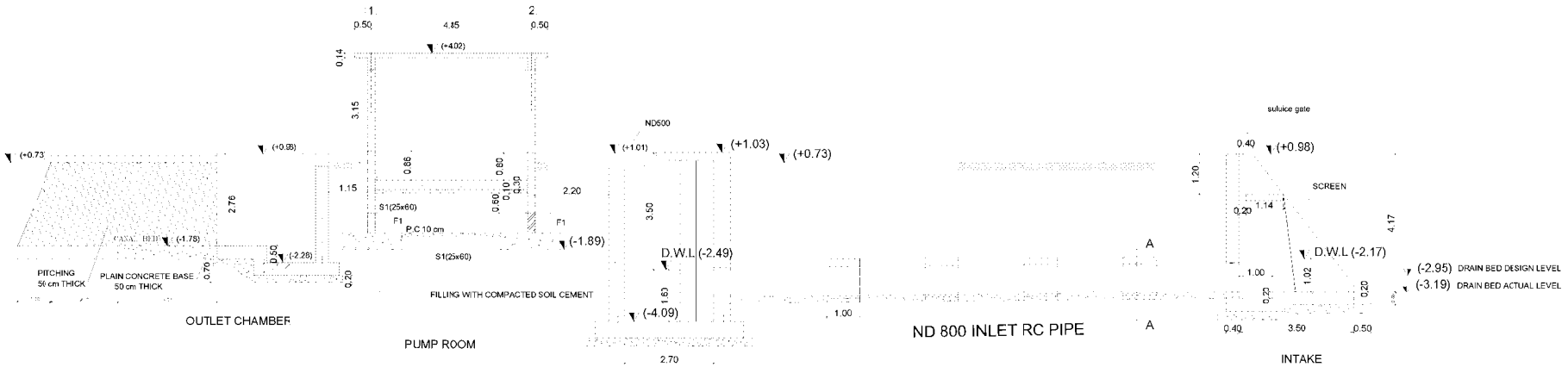
DRAINAGE WATER QUALITY CONTROL
FOR IRRIGATION IN MIDDLE DELTA

PROJECT: ARAB REPUBLIC OF EGYPT
KAFR EL SHEIKH GOVERNORATE

CONTRACTOR :
UNION SEVEN FOR MODERN CONSTRUCTIONS AND SUPPLIES

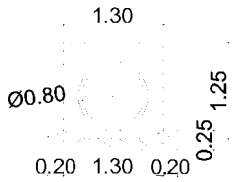
SITE : E4
INTAK\PUMP FACILITIES
INLET CHAMBER TYPE A
TYPICAL PLAN

Checked by:	Scale	Date	DWG. NO.	Rev. NO.
UNION SEVEN	Varies	Sep 20-5	[illegible]	A
Aproved by:		Date	Remarks	

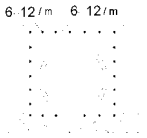


ALL DIMENSION IN METER

SECTION X - X



COUPLER



COUPLER
REINFORCEMENT

SECTION A - A

DRAINAGE WATER QUALITY CONTROL FOR IRRIGATION IN MIDDLE DELTA

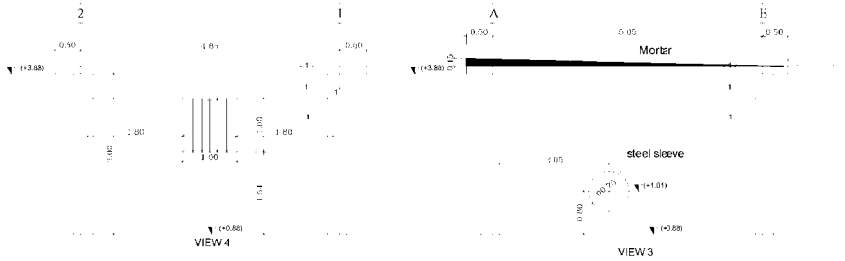
ARAB REPUBLIC OF EGYPT

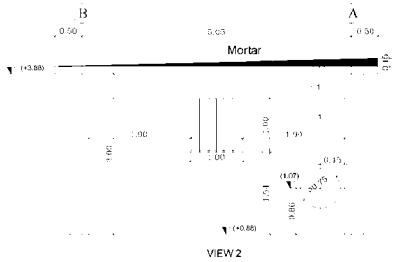
KAFR EL SHEIKH GOVERNORATE

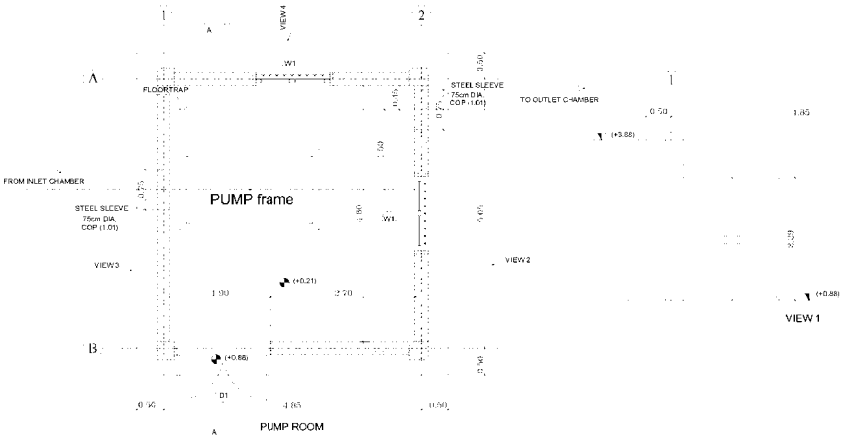
UNION SEVEN FOR MODERN CONSTRUCTIONS AND SUPPLIES

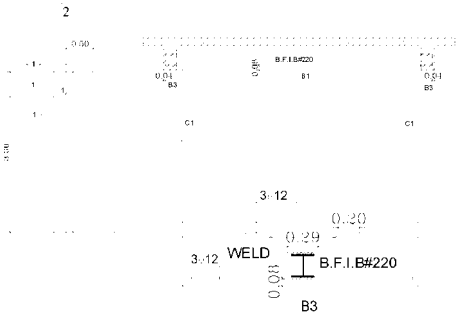
SITE : E4
INTAK\PUMP FACILITIES
INLET CHAMBER TYPE A
SECTION X-X

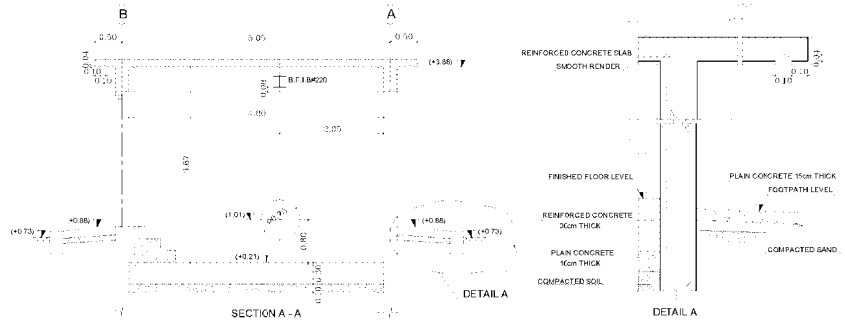
Checked by:	Scale	Date	DWG. NO.	Rev. NO.
UNION SEVEN	Varies	Sep 2015		A
Aproved by:		Date	Remarks	











EXTERIOR FINISH

1	CEMENT PLASTERING AND MIXTER OF SAND+ LIMESTONE POWDER + WHITE CEMENT

INTERIOR FINISHING LIST

FLOORS	PLAIN CONCRETE SCREED
WALLS	CEMENT SAND RENDER AND PLASTIC PAINT
CEILING	CEMENT SAND RENDER AND PLASTIC PAINT

OPENINGS TABLE

TYPE	NO.	DIMENSIONS WIDTH	HEIGHT	SILL	DESCRIPTION
D1	1	1.80	2.29	-	STEEL DOOR - (2) VERTICAL HINGED LEAVES
W1	2	1.00	1.00	1.54	ALUMINUM WINDOW -(2) VERTICAL HINGED LEAVES WITH OUTER STEEL PROTECT ON FRAME OF VERTICAL BARS

5. ALL DIMENSION IN METER

DRAINAGE WATER QUALITY CONTROL FOR IRRIGATION IN MIDDLE DELTA

ARAB REPUBLIC OF EGYPT

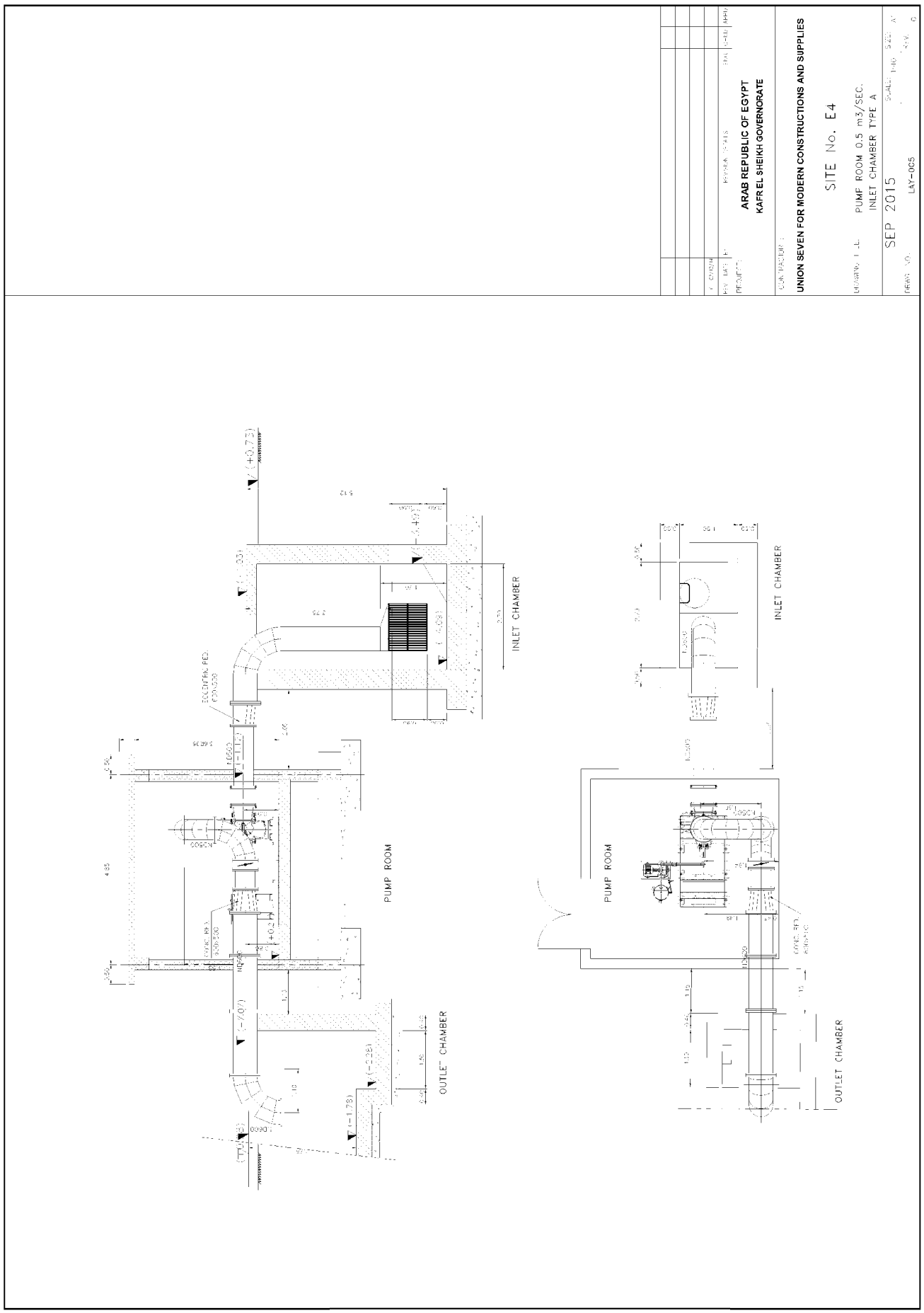
KAFR EL SHEIKH GOVERNORATE

UNION SEVEN FOR MODERN CONSTRUCTIONS AND SUPPLIES

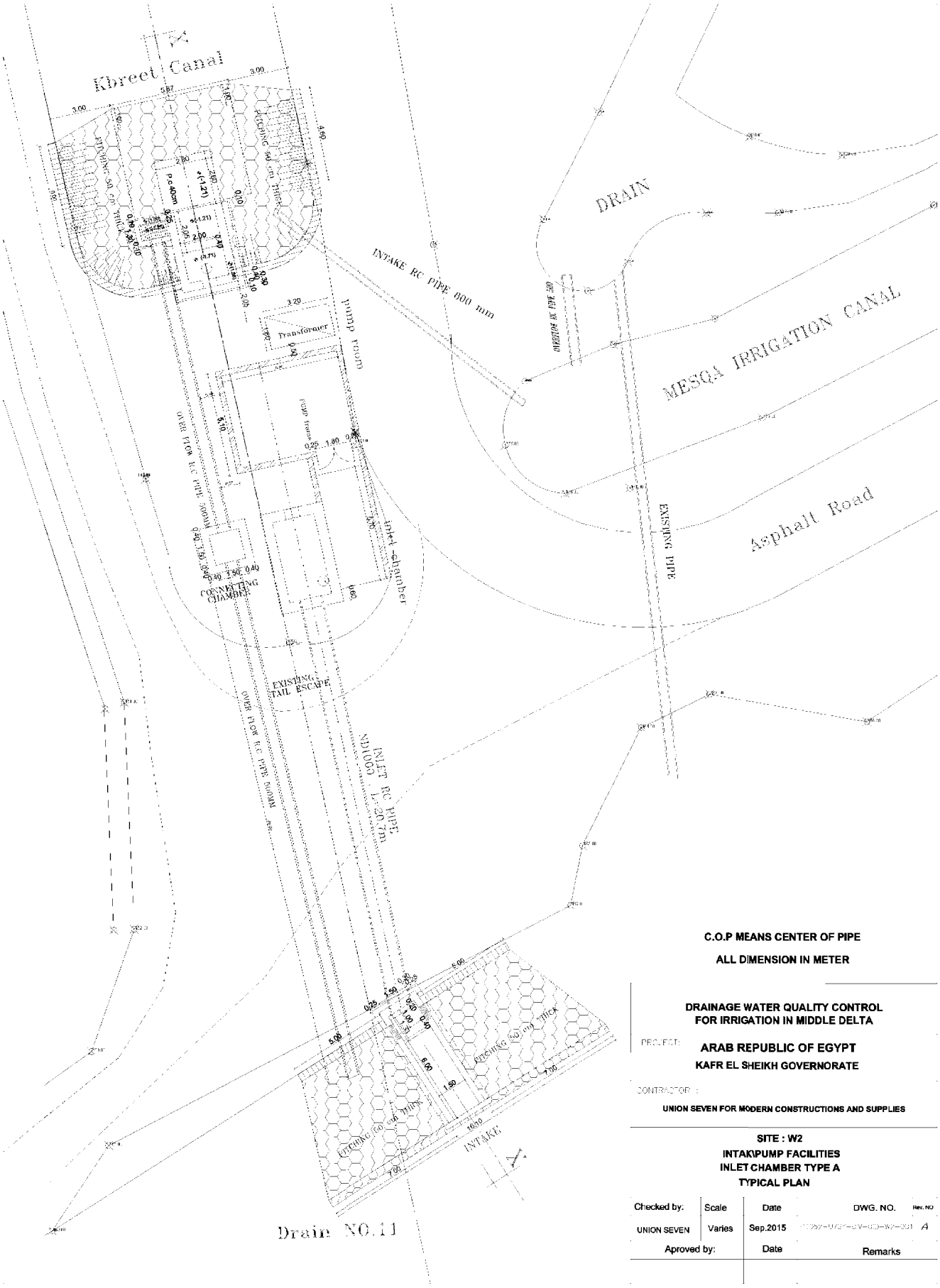
SITE : E4
INTAK\PUMP FACILITIES
PUMP ROOM
SHOPE DRAWING

Checked by:	Scale	Date	DWG. NO.	Rev. NO
UNION SEVEN	VARIES	Sep 2015		//
Aproved by:		Date	Remarks	

8. Reuse Pump Facilities (E4) 4/4



9. Reuse Pump Facilities (W2) 1/4



C.O.P MEANS CENTER OF PIPE

ALL DIMENSION IN METER

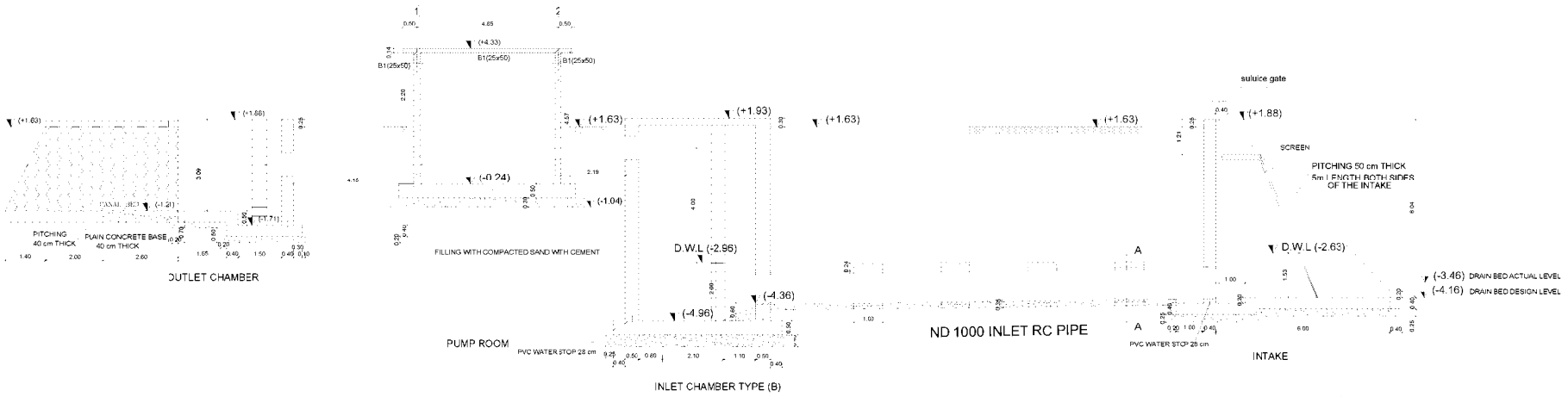
DRAINAGE WATER QUALITY CONTROL
FOR IRRIGATION IN MIDDLE DELTA

PROJECT: ARAB REPUBLIC OF EGYPT
KAFR EL SHEIKH GOVERNORATE

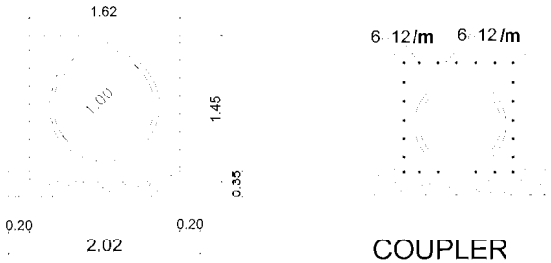
CONTRACTOR :
UNION SEVEN FOR MODERN CONSTRUCTIONS AND SUPPLIES

SITE : W2
INTAK\PUMP FACILITIES
INLET CHAMBER TYPE A
TYPICAL PLAN

Checked by:	Scale	Date	DWG. NO.	Rev. NO
UNION SEVEN	Varies	Sep.2015	[illegible]	A
Aproved by:		Date	Remarks	



SECTION X - X



COUPLER

COUPLER REINFORCEMENT

SECTION A - A

ALL DIMENSION IN METER

DRAINAGE WATER QUALITY CONTROL FOR IRRIGATION IN MIDDLE DELTA

ARAB REPUBLIC OF EGYPT

KAFR EL SHEIKH GOVERNORATE

UNION SEVEN FOR MODERN CONSTRUCTIONS AND SUPPLIES

SITE : W2

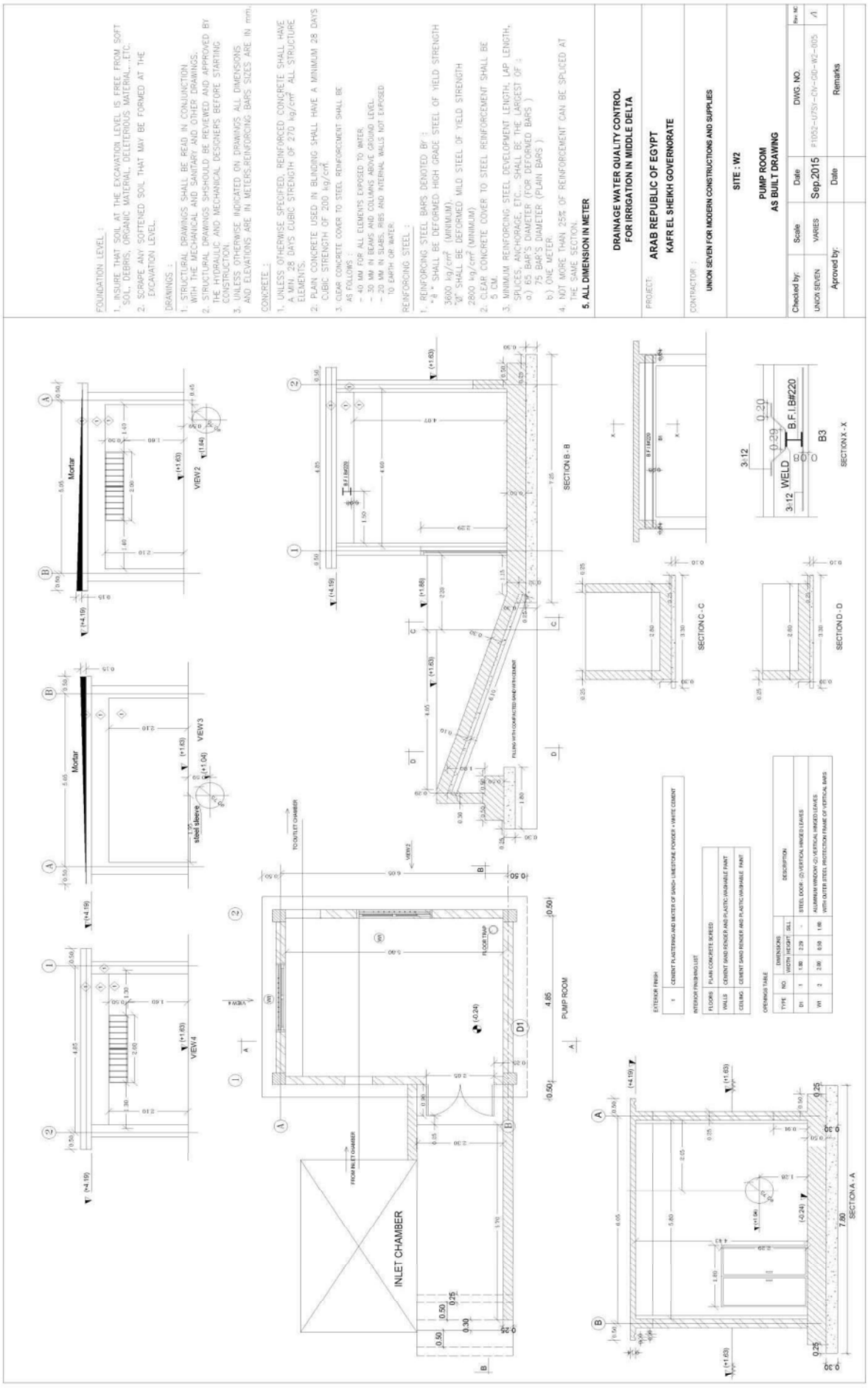
INTAK\PUMP FACILITIES

INLET CHAMBER TYPE A

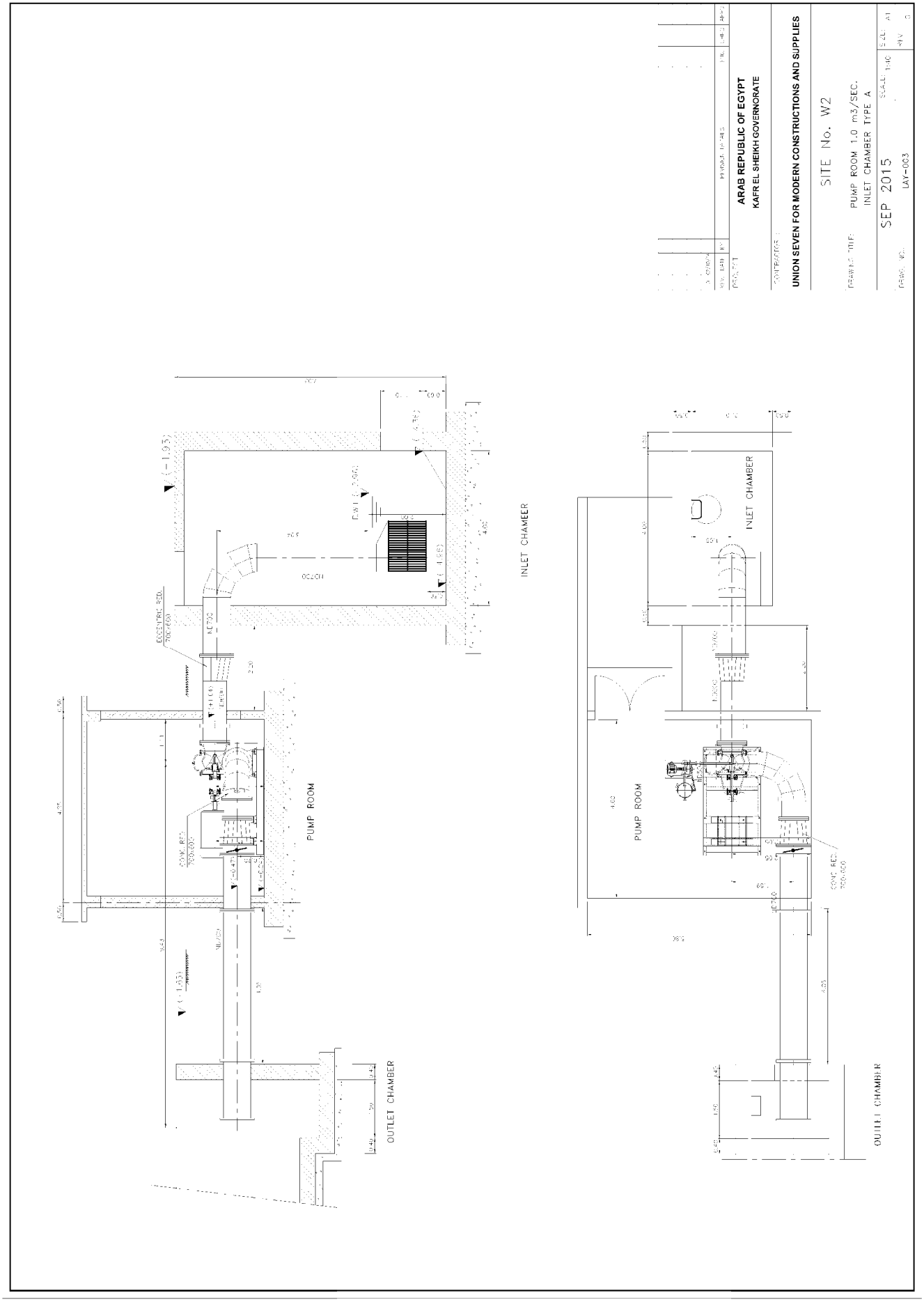
SECTION X-X

Checked by:	Scale	Date	DWG. NO.	Rev. NO.
UNION SEVEN	Varies	Sep.2015		
Aproved by:		Date	Remarks	

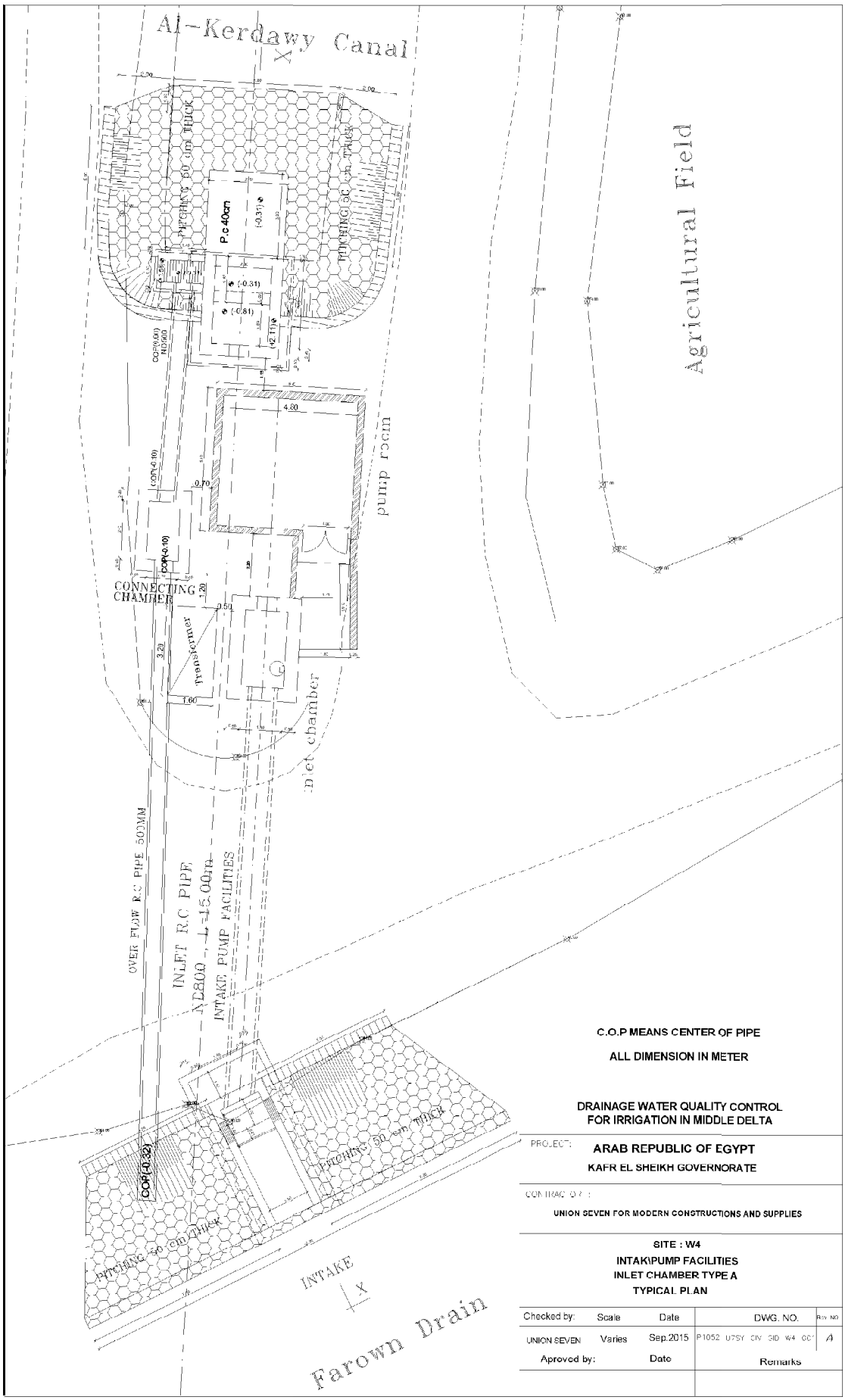
11. Reuse Pump Facilities (W2) 3/4

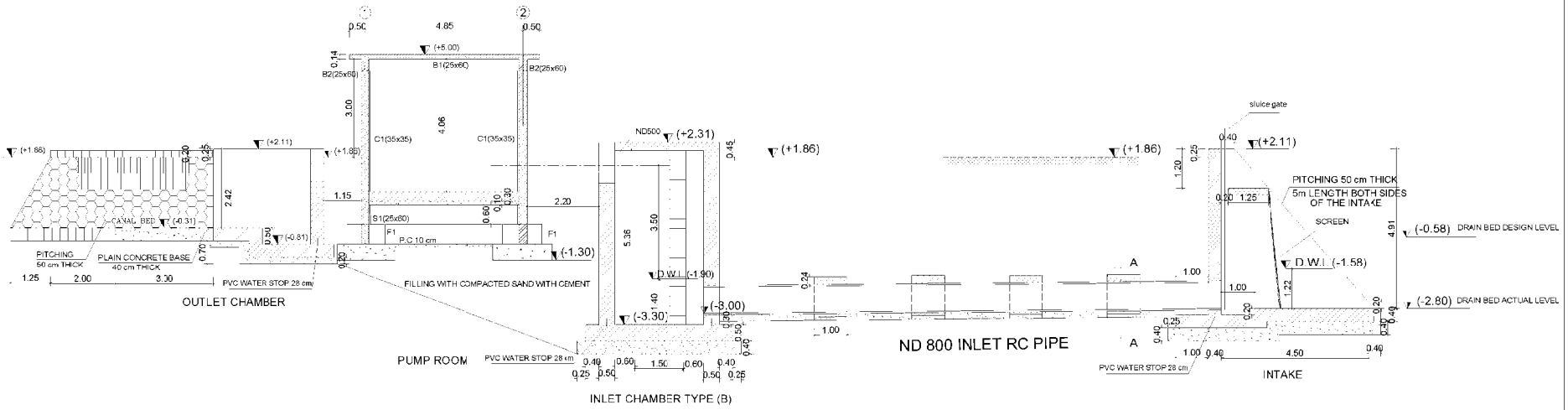


12. Reuse Pump Facilities (W2) 4/4

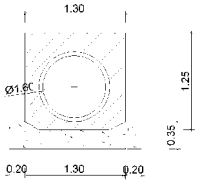


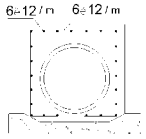
13. Reuse Pump Facilities (W4) 1/4





SECTION X - X





SECTION A - A

ALL DIMENSION IN METER

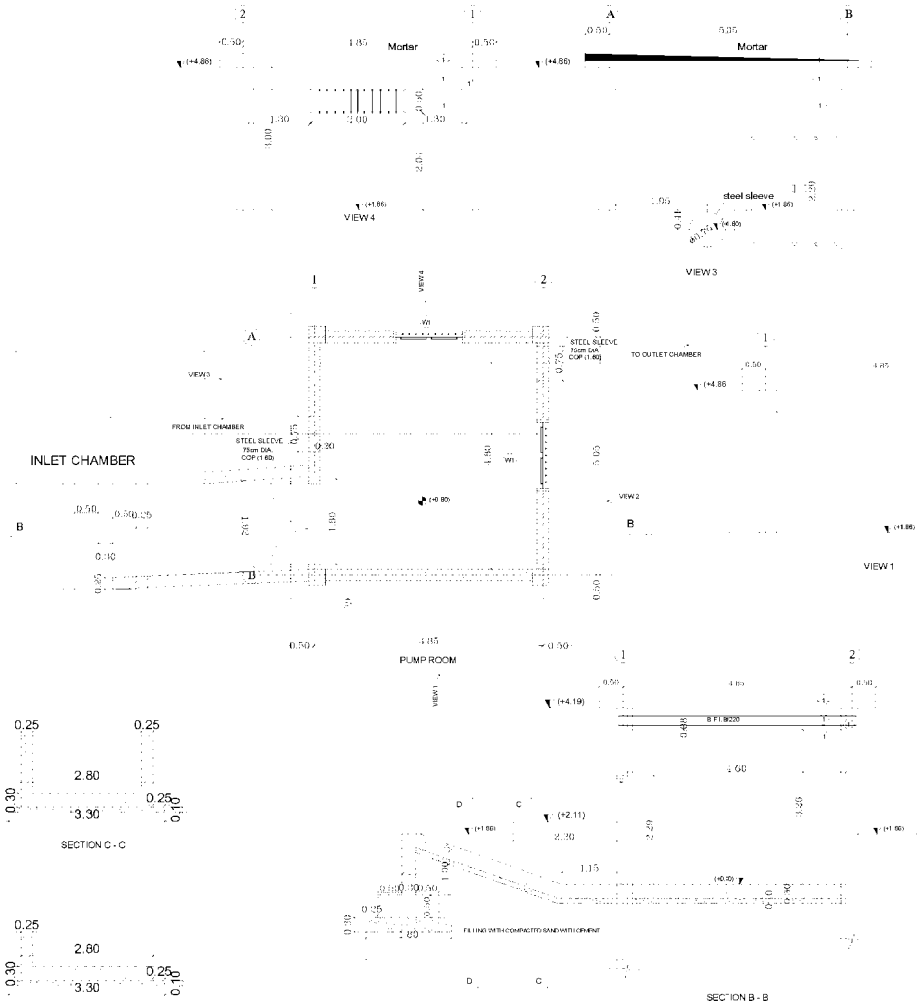
DRAINAGE WATER QUALITY CONTROL FOR IRRIGATION IN MIDDLE DELTA

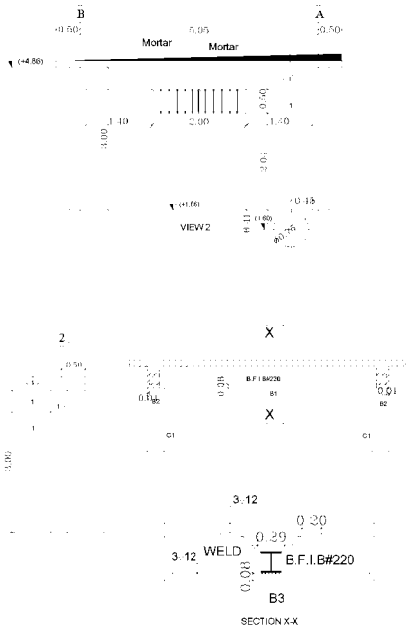
PROJECT: **ARAB REPUBLIC OF EGYPT**
KAFR EL SHEIKH GOVERNORATE

CONTRACTOR:
UNION SEVEN FOR MODERN CONSTRUCTIONS AND SUPPLIES

SITE : W4
INTAK\PUMP FACILITIES
INLET CHAMBER TYPE A
SECTION X-X

Checked by:	Scale	Date	DWG. NO.	Rev. NO.
UNION SEVEN	Varies	Sep.2015	[illegible]	A
Aproved by:		Date	Remarks	





EXTERIOR FINISH

1	CEMENT PLASTERING AND MIXTER OF SAND+ LIMESTONE POWDER + WHITE CEMENT

INTERIOR FINISHING LIST

FLOORS	PLAIN CONCRETE SCREED
WALLS	CEMENT SAND RENDER AND PLASTIC WASHABLE PAINT
CEILING	CEMENT SAND RENDER AND PLASTIC WASHABLE PAINT

OPENINGS TABLE

TYPE	NO	DIMENSIONS WIDTH	HEIGHT	SILL	DESCRIPTION
D1	1	1.80	2.29	-	STEEL DOOR - (2) VERTICAL HINGED LEAVES
W1	2	2.80	0.5	2.04	ALUMINUM WINDOW - (2) VERTICAL HINGED LEAVES WITH 30 TILT STELL PROTUCTION FRAME OF VERTICAL BARS

5. ALL DIMENSION IN METER

DRAINAGE WATER QUALITY CONTROL FOR IRRIGATION IN MIDDLE DELTA

ARAB REPUBLIC OF EGYPT

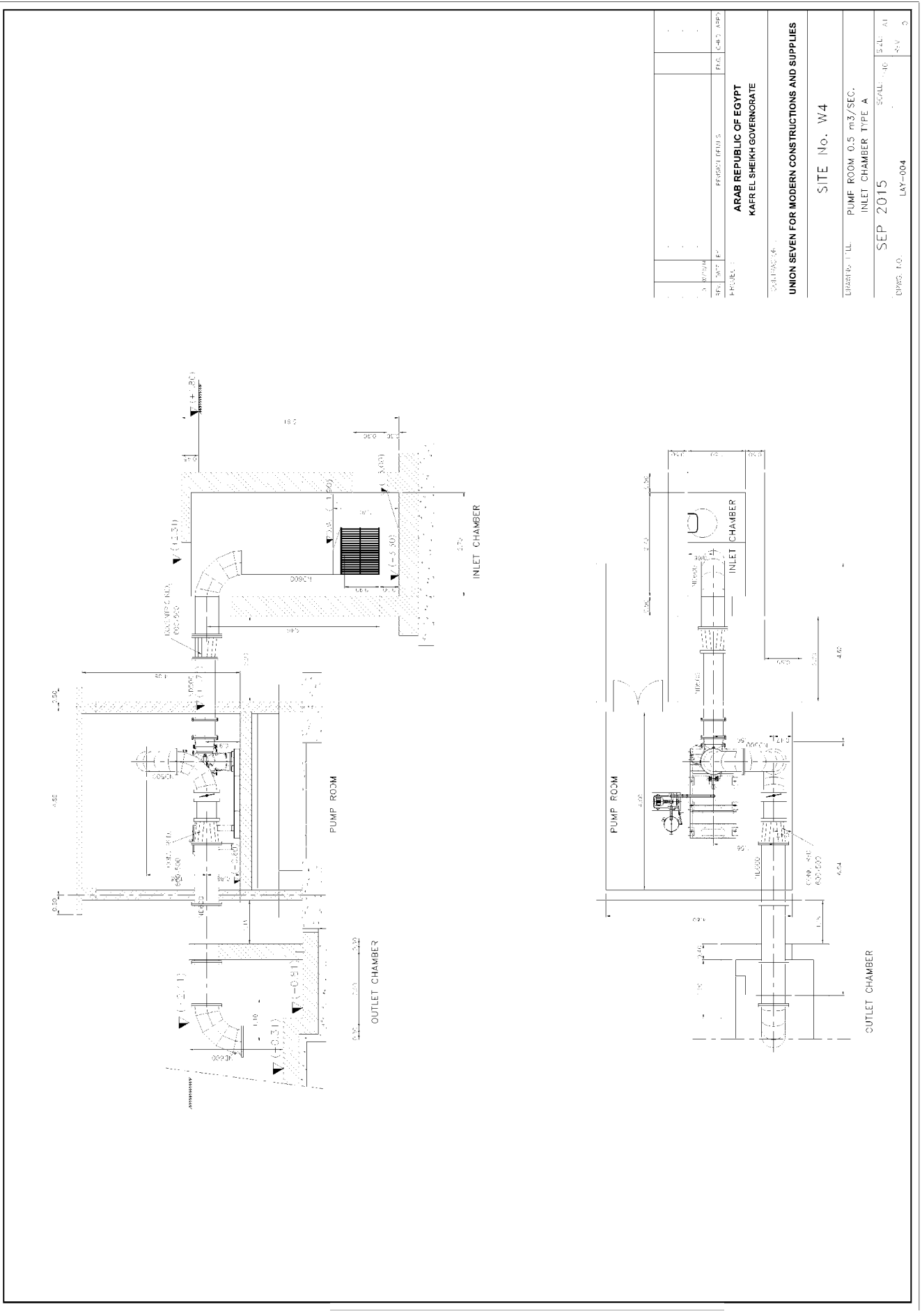
KAFR EL SHEIKH GOVERNCRATE

UNION SEVEN FOR MODERN CONSTRUCTIONS AND SUPPLIES

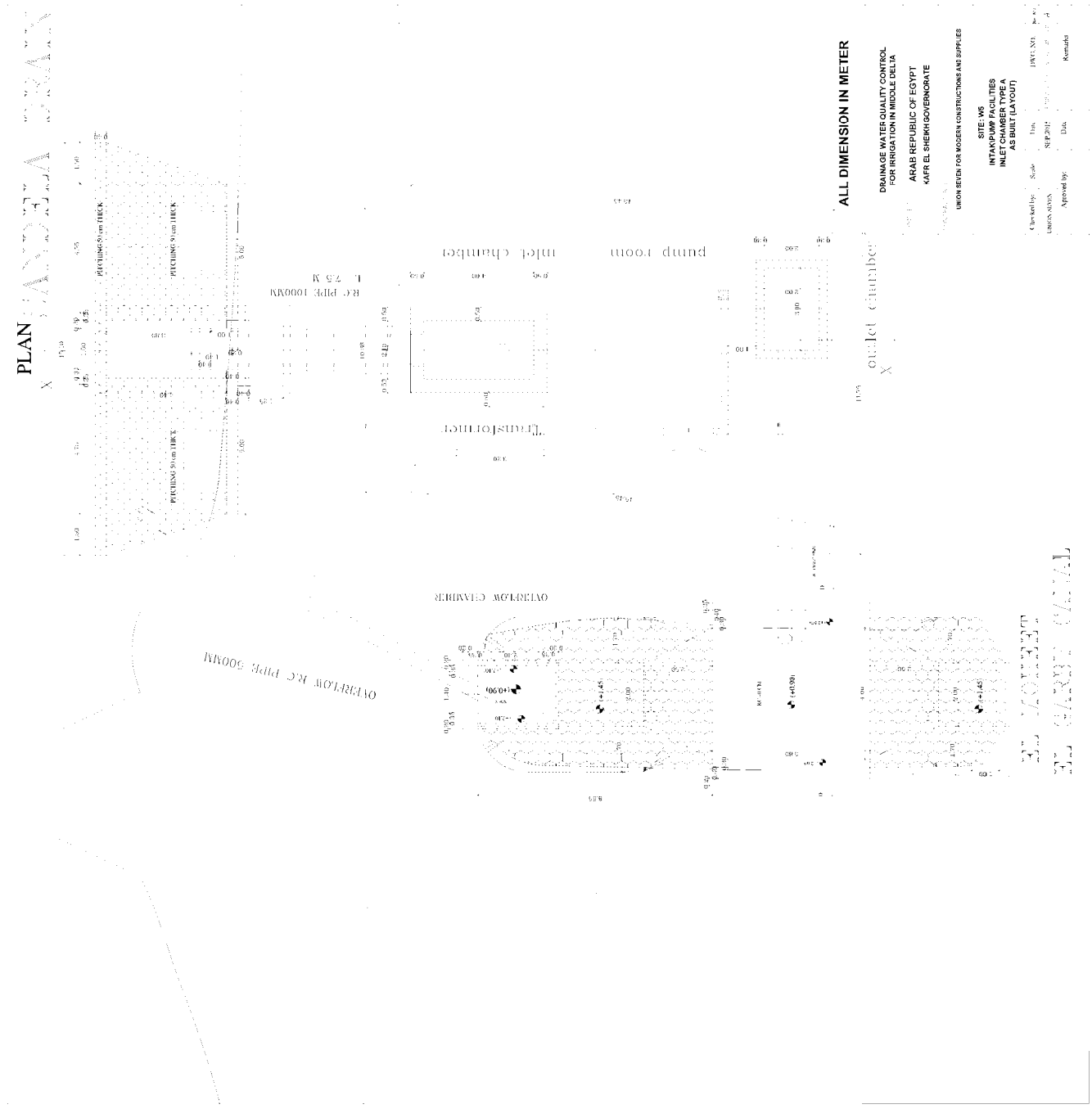
SITE : W4
INTAK\PUMP FACILITIES
PUMP ROOM
AS BUILT DRAWING

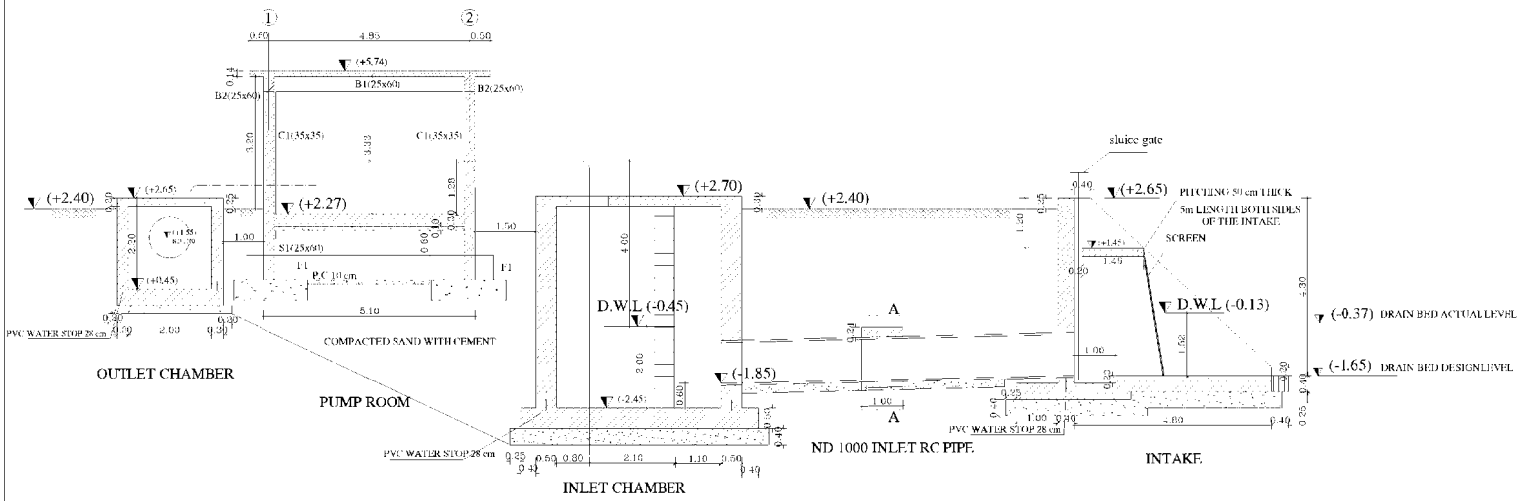
Checked by:	Scale	Date	DWG. NO.	Rev. NO.
UNION SEVEN	VARIES	Sep.2015		0
Aproved by:		Date	Remarks	

16. Reuse Pump Facilities (W4) 4/4

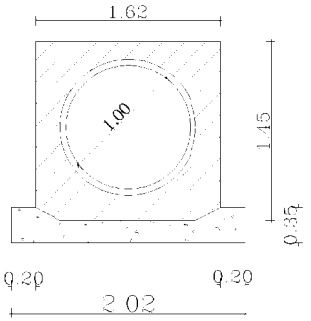


17. Reuse Pump Facilities (W5) 1/4

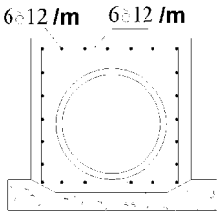




SECTION X - X



COUPLER



COUPLER
REINFORCEMENT

SECTION A - A

ALL DIMENSION IN METER

DRAINAGE WATER QUALITY CONTROL FOR IRRIGATION IN MIDDLE DELTA

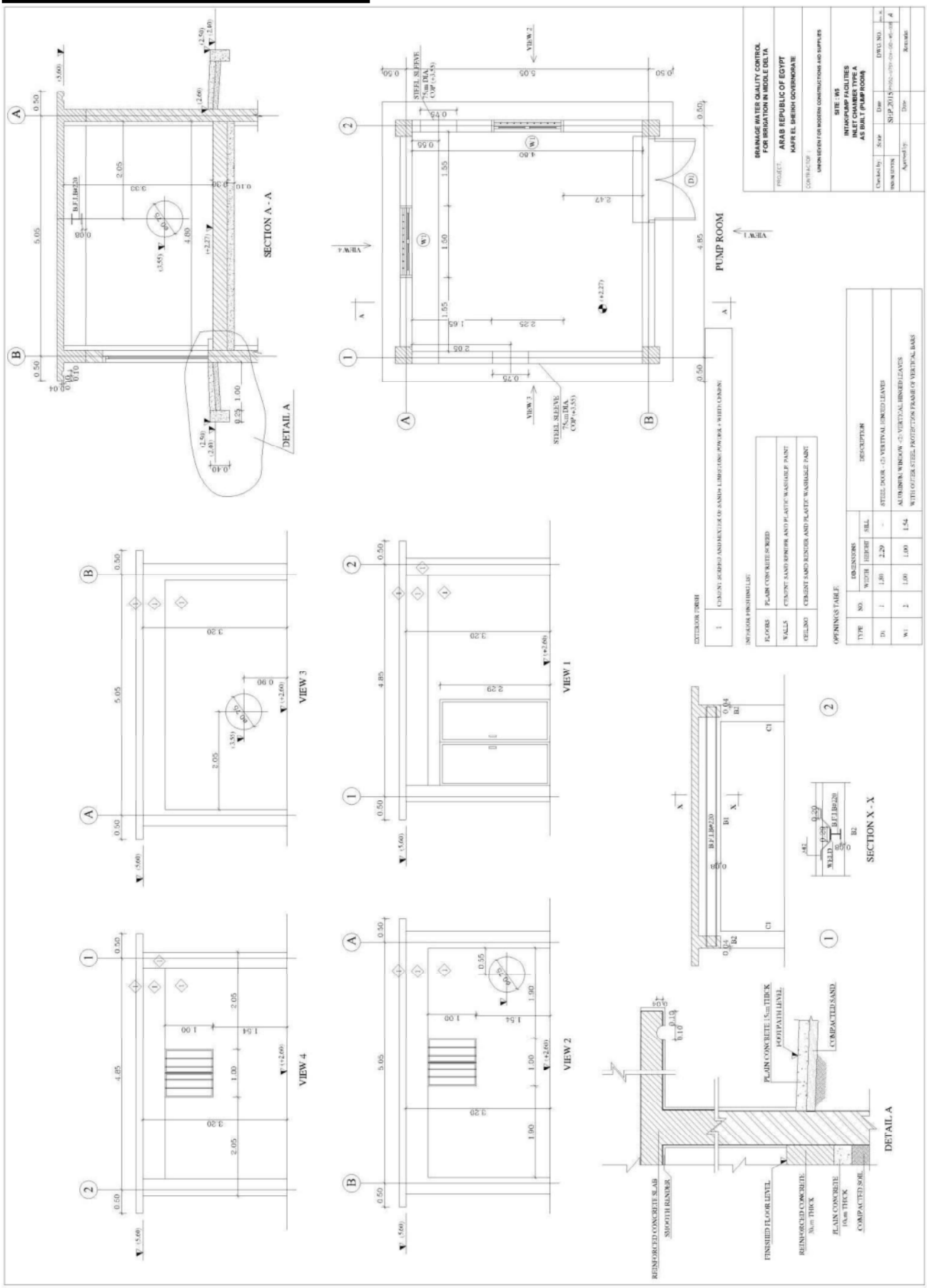
PROJECT: **ARAB REPUBLIC OF EGYPT**
KAFR EL SHEIKH GOVERNORATE

CONTRACTOR :
UNION SEVEN FOR MODERN CONSTRUCTIONS AND SUPPLIES

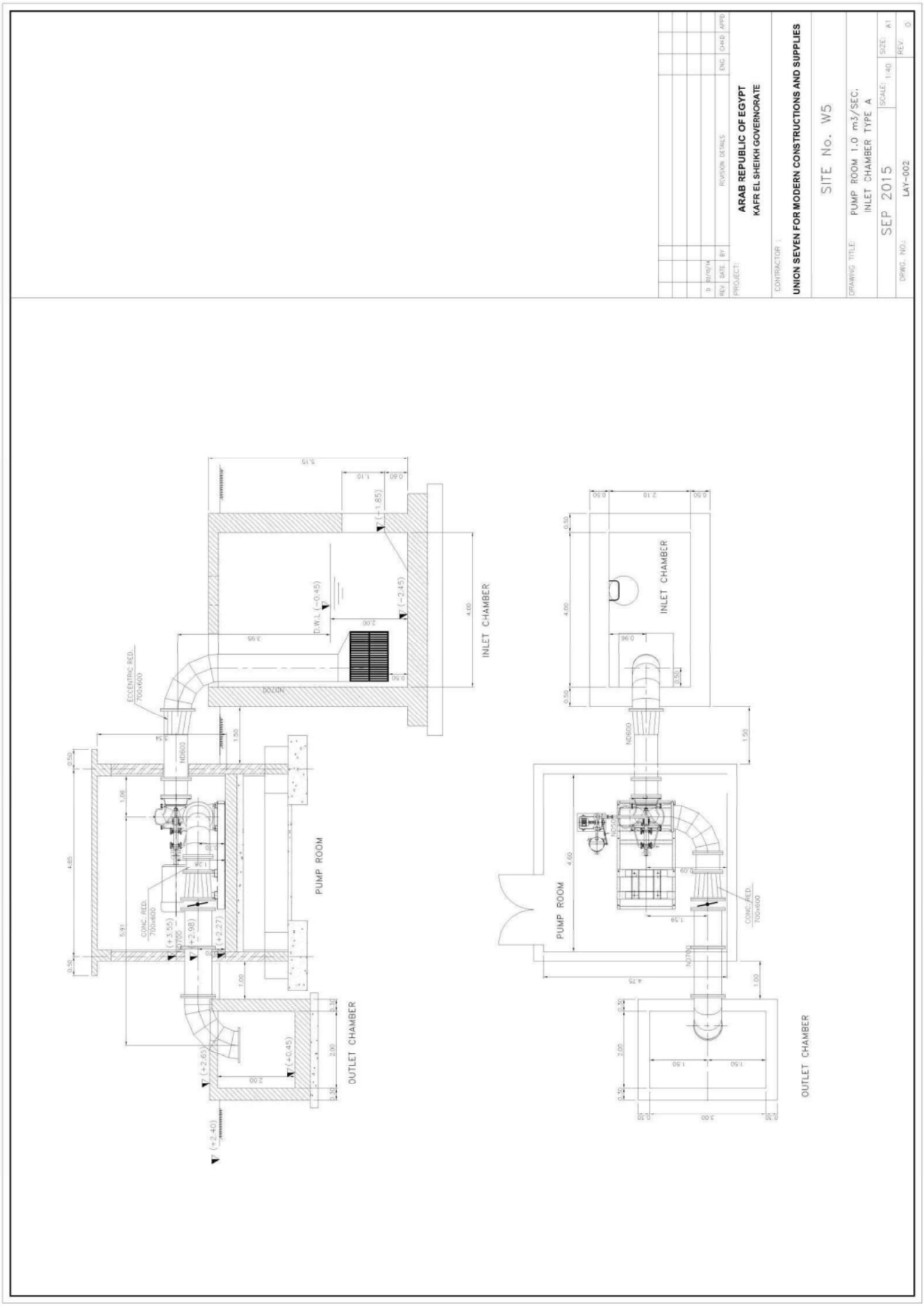
SITE : W5
INTAK\PUMP FACILITIES
INLET CHAMBER TYPE A
AS BUILT SECTION X-X

Checked by:	Scale	Date	DWG. NO.	Rev. NO.
UNION SEVEN	Varies	SEP.2015	P1052-UVS-C-V-GD-W5-002	A
Aproved by:		Date	Remarks	

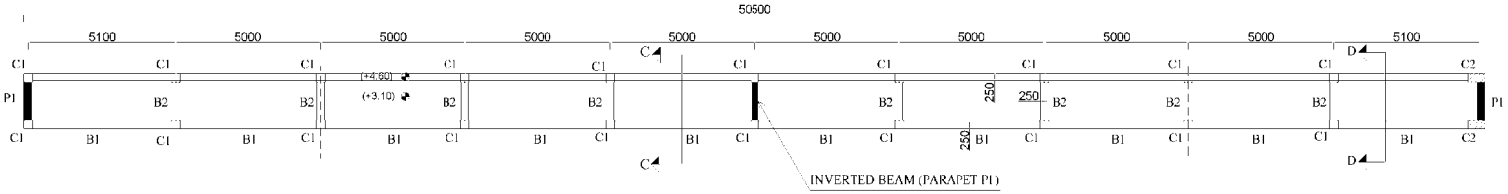
19. Reuse Pump Facilities (W5) 2/4

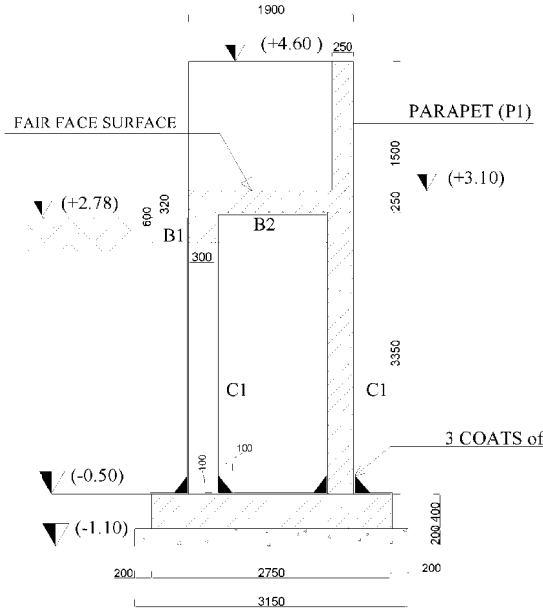


20. Reuse Pump Facilities (W5) 4/4

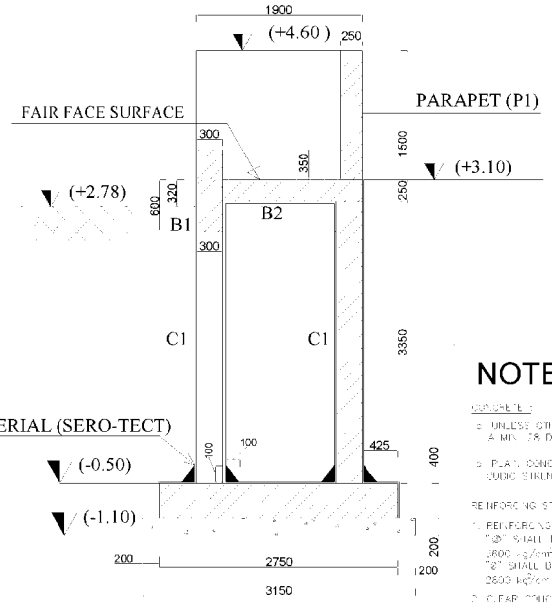


TOP PLAN FOR COMPOST UNIT

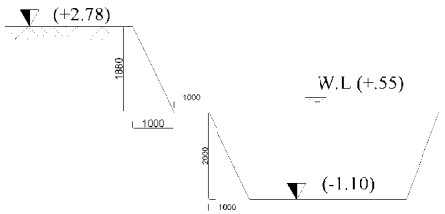




SEC D-D



SEC C-C



PROFILE OF EXACVATION

NOTES :

CONCRETE :

1- UNLESS OTHERWISE SPECIFIED, REINFORCED CONCRETE SHALL HAVE A MIN. 28 DAYS CUBIC STRENGTH OF 225 kg/cm² ALL STRUCTURE

2- PLAIN CONCRETE USED IN BLINDING SHALL HAVE A MINIMUM 28 DAYS CUBIC STRENGTH OF 100 kg/cm²

REINFORCING STEEL :

1- REINFORCING STEEL BARS DENOTED BY :
"R" SHALL BE DEFORMED HIGH GRADE STEEL OF YIELD STRENGTH 4200 kg/cm² (MINIMUM).
"R" SHALL BE DEFORMED MILD STEEL OF YIELD STRENGTH 2800 kg/cm² (MINIMUM).

2- CLEAR CONCRETE COVER TO STEEL REINFORCEMENT SHALL BE 5 CM.

3- MINIMUM REINFORCING STEEL DEVELOPMENT LENGTH, LAP LENGTH, SPLICES, ANCHORAGE, ETC., SHALL BE THE LARGEST OF :
a) 65 BARS DIAMETER (FOR DEFORMED BARS)
75 BARS DIAMETER (PLAIN BARS)
b) ONE METER.

4- NOT MORE THAN 25% OF REINFORCEMENT CAN BE SPLICED AT THE SAME SECTION

5- All Dimensions in Millimeter (mm)

PROJECT :

DRAINAGE WATER QUALITY CONTROL FOR IRRIGATION IN MIDDLE DELTA

ARAB REPUBLIC OF EGYPT

KAFR EL SHEIKH GOVERNORATE

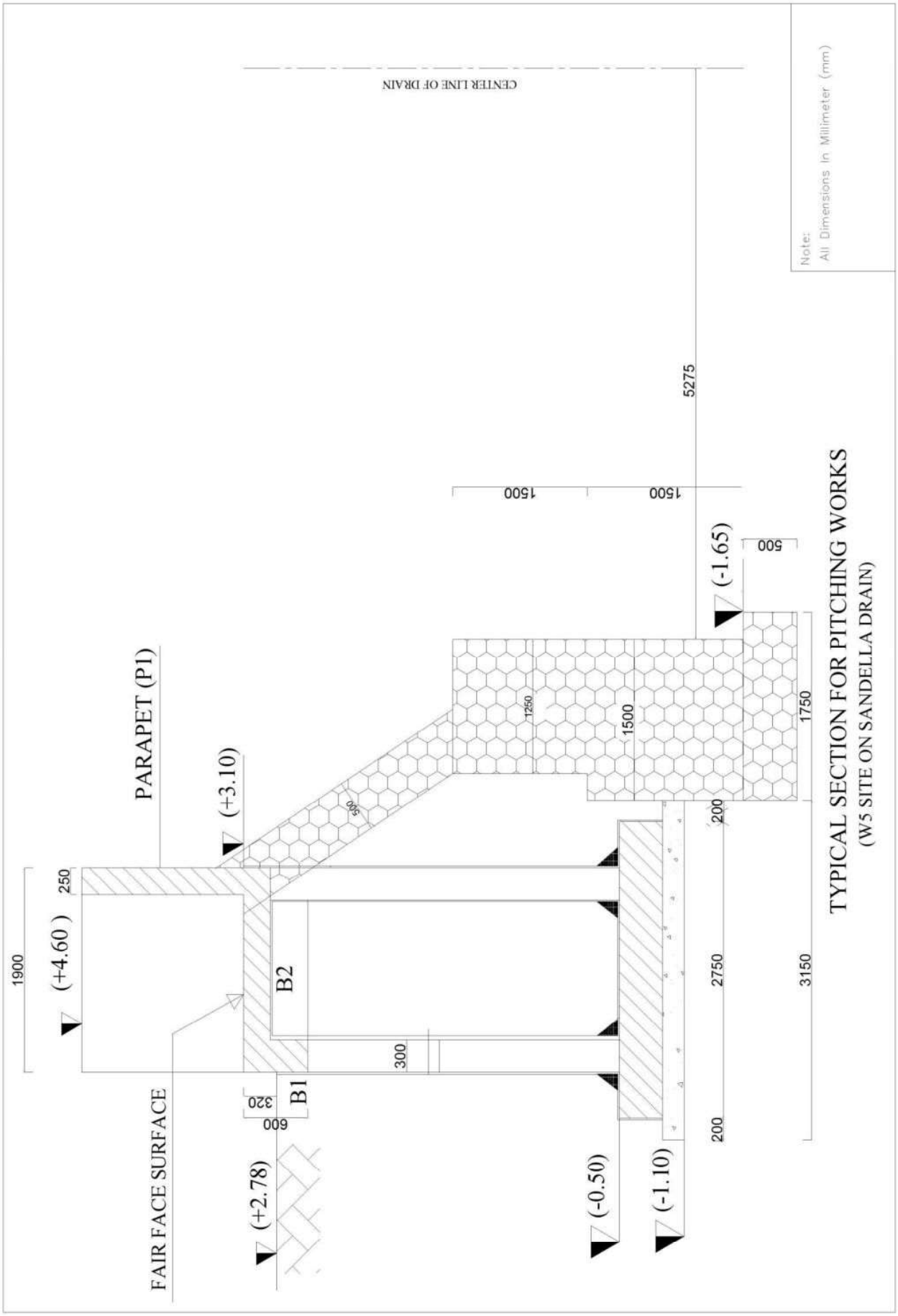
IN-STREAM FACILITIES SITES : W5

AS BUILT COMPOSTING UNIT

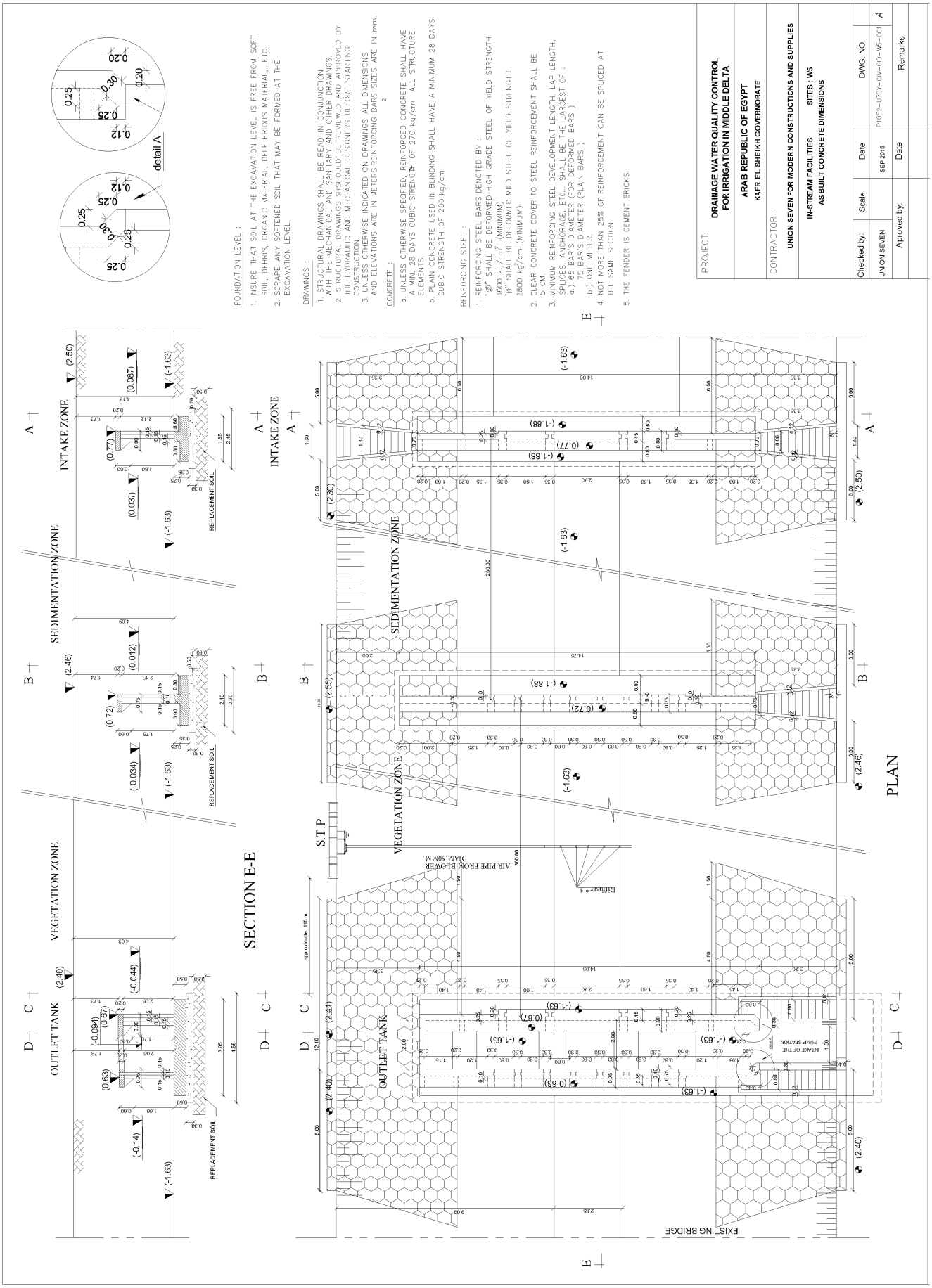
TOP PLAN & CONCRETE SECTIONS

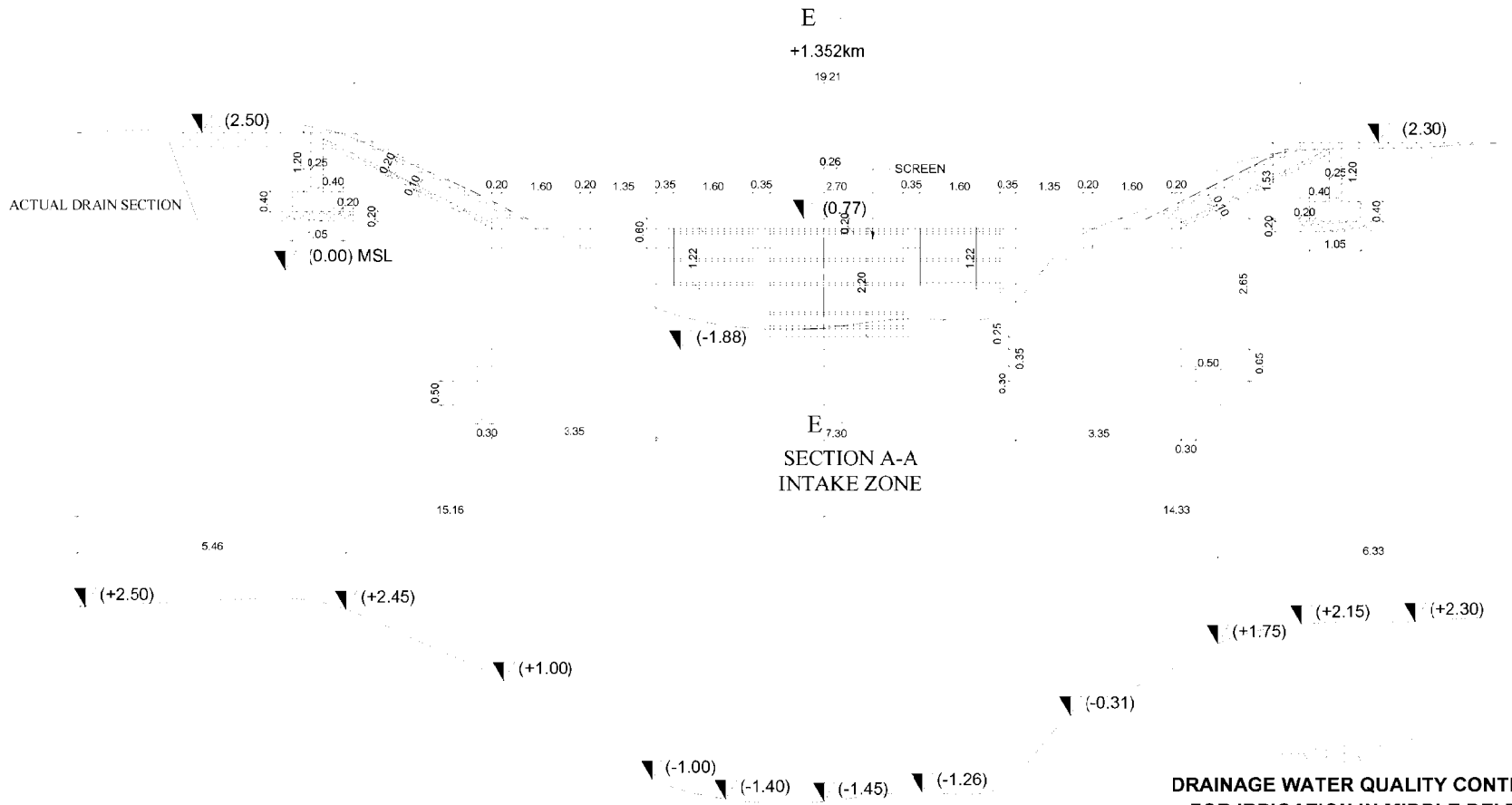
Checked by:	Scale	Date	DWG. NO.	Rev. NO.
UNION 7 TEAM	Varies	SEP.2015	P1052-UT5Y-CX-RP-AS-CU-001	A
Aproved by:		Date	Remarks	

22. Compost Facilities (W5) 2/2



23. In-stream Treatment Facilities (W5) 1/5





DRAINAGE WATER QUALITY CONTROL FOR IRRIGATION IN MIDDLE DELTA

ARAB REPUBLIC OF EGYPT

KAFR EL SHEIKH GOVERNORATE

IN-STREAM FACILITIES **SITES : W5**

DESIGN AND ACTUAL
SECTION PROFILE AT SUNDELLA DRAIN
ASBUILT INTAKE ZONE

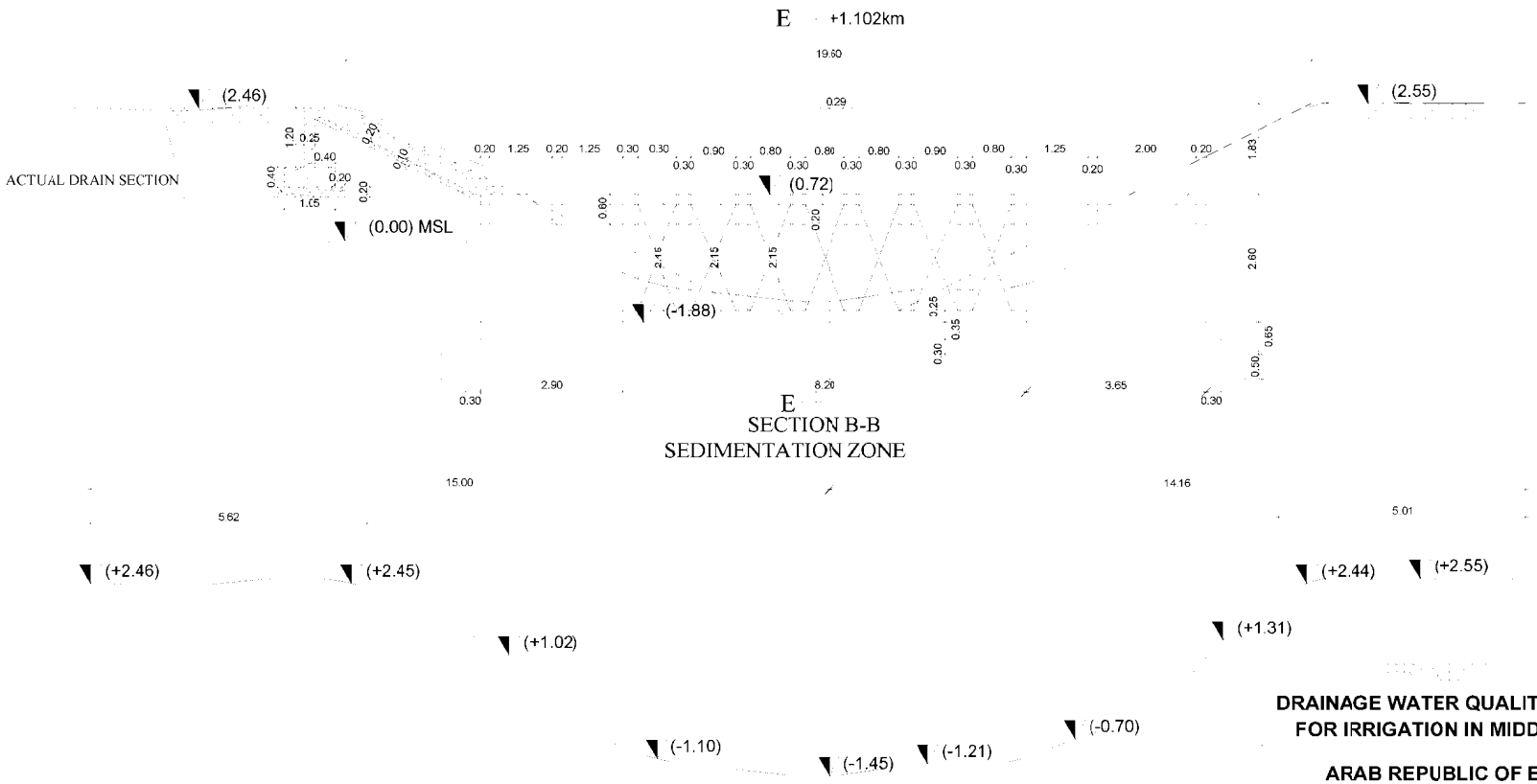
DWG. NO.

Rev. NO.

A

Remarks

SEP 2015



DRAINAGE WATER QUALITY CONTROL FOR IRRIGATION IN MIDDLE DELTA

ARAB REPUBLIC OF EGYPT

KAFR EL SHEIKH GOVERNORATE

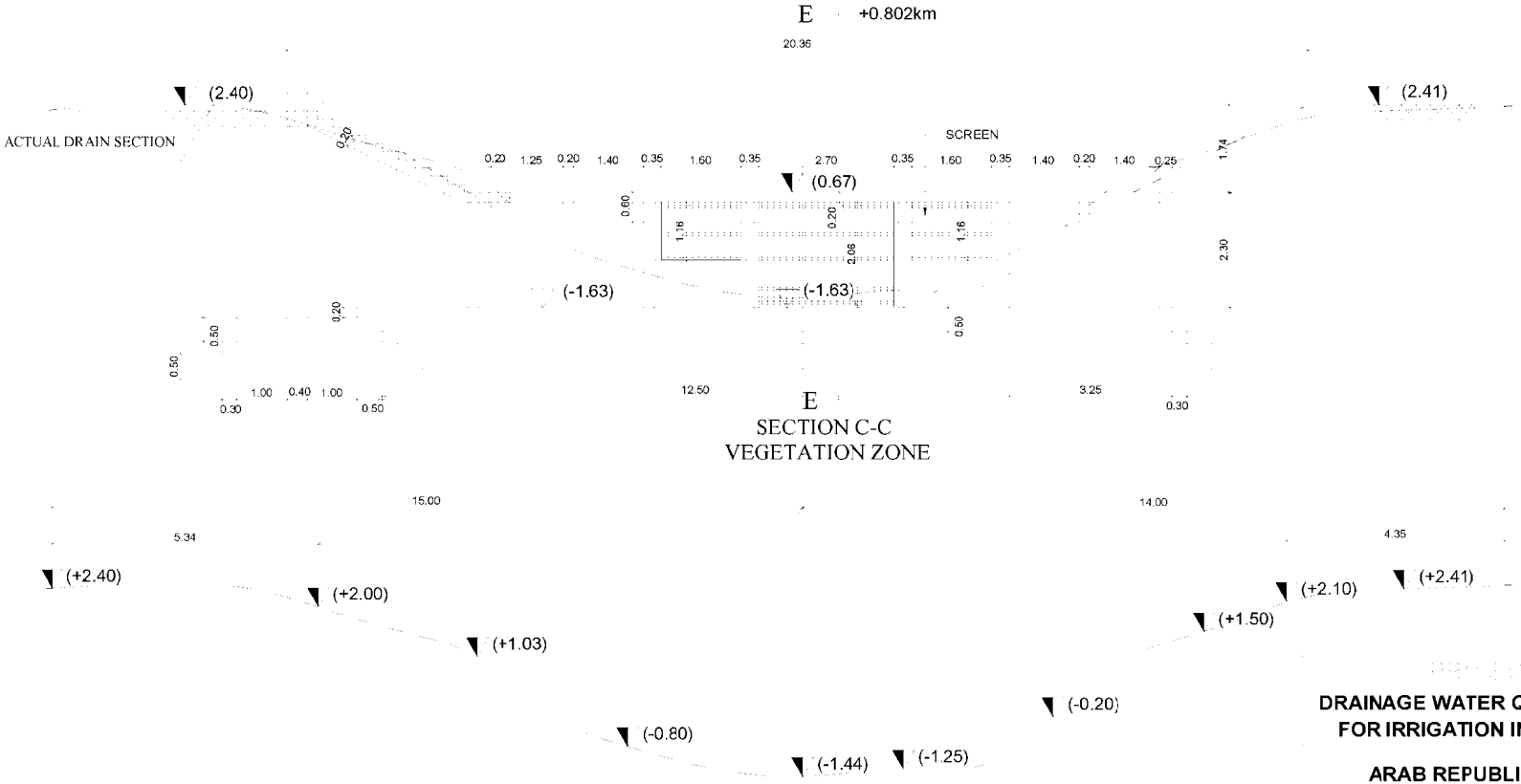
IN-STREAM FACILITIES **SITES : W5**

DESIGN AND ACTUAL
SECTION PROFILE AT SUNDELLA DRAIN
AS BUILT SEDIMENTATION ZONE

DWG. NO. Rev. NO.

Remarks

SEP 2015



DRAINAGE WATER QUALITY CONTROL FOR IRRIGATION IN MIDDLE DELTA

ARAB REPUBLIC OF EGYPT

KAFR EL SHEIKH GOVERNORATE

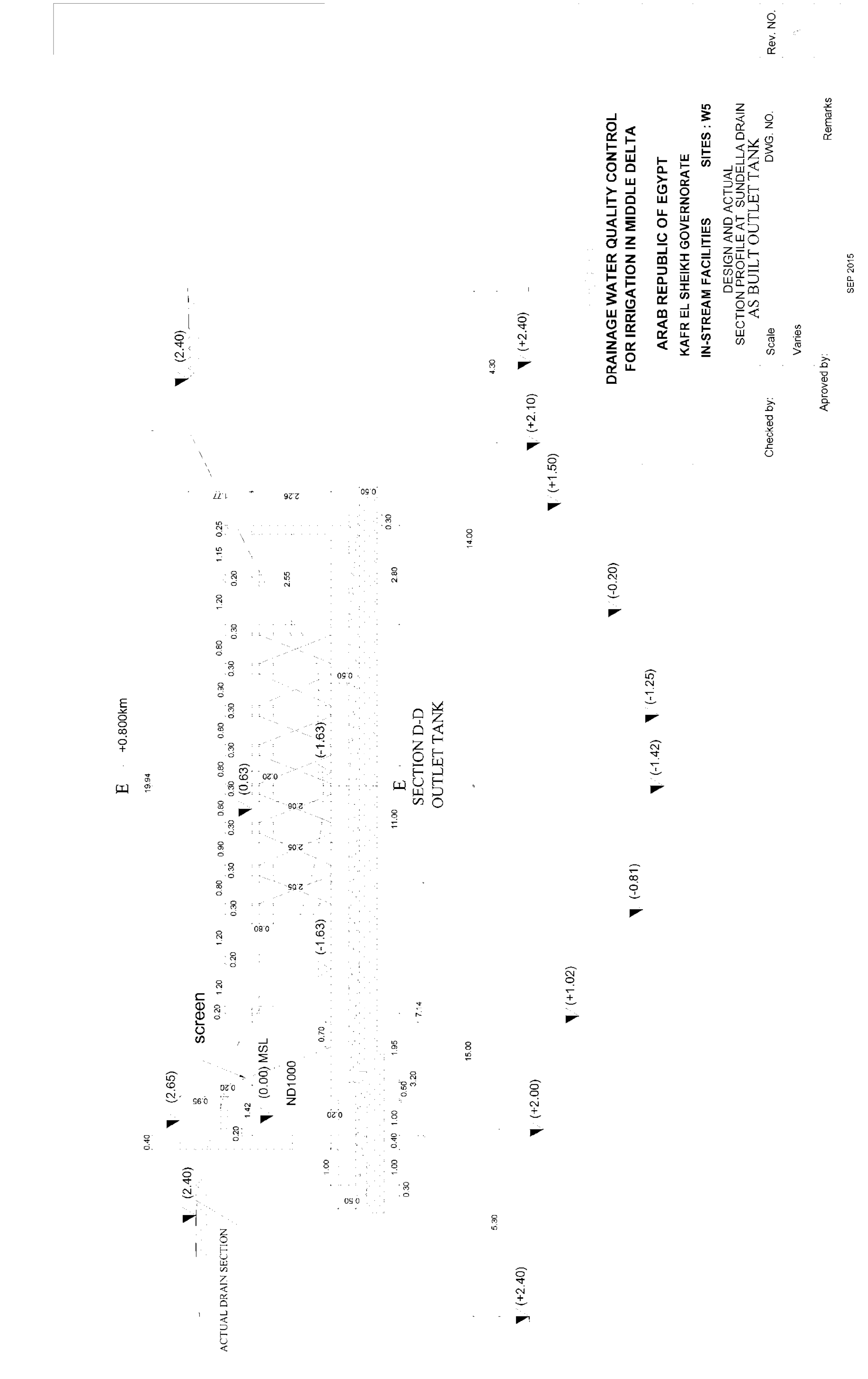
IN-STREAM FACILITIES **SITES : W5**

DESIGN AND ACTUAL
SECTION PROFILE AT SUNDELLA DRAIN
AS BUILT VEGETATION ZONE

DWG. NO. Rev. NO.

Remarks

SEP 2015


DRAINAGE WATER QUALITY CONTROL
FOR IRRIGATION IN MIDDLE DELTA
ARAB REPUBLIC OF EGYPT
KAFR EL SHEIKH GOVERNORATE
IN-STREAM FACILITIES
SITES : W5
DESIGN AND ACTUAL
SECTION PROFILE AT SUNDELLA DRAIN
AS BUILT OUTLET TANK
DWG. NO.
Rev. NO.
Scale
Varies
Checked by:
Aproved by:
Remarks
SEP 2015
SECTION D-D
OUTLET TANK
ACTUAL DRAIN SECTION
screen
(0.00) MSL
ND1000
+0.800km
E
E

28. Rural sewerage Treatment Facilities (W5) 1/3

29. Rural Sewerage Treatment Facilities (W5) 2/3

30. Rural Sewerage Treatment Facilities (W5) 3/3

THE PROJECT FOR DRAINAGE WATER QUALITY CONTROL FOR IRRIGATION IN MIDDLE DELTA IN THE ARAB REPUBLIC OF EGYPT

Design of in-stream treatment facility

Treatment method; sedimentation + vegetation + plastic contact oxidation
Purpose; The compatibility and performance for Egypt of each treatment method have been checked. Moreover, it was considered about the maintenance management organization, and sustainability. Although the water quality of a drainage canal is not good, it is still adapted the water quality standard. So, it does not set up target water quality.

1. Actual water quality and quantity

The water quality test result of a drainage is as follows. (mg/l)

Month	DO	COD	T-N	T-P	SS
June	0.89	26	1.1	0.2	30
July	0.43	27	0.6	0.2	16
August	0.35	23	12.0	0.2	776

Design water quality is examined among the above-mentioned results and chosen the result of August which is worst water quality.
Design flow rate is set to 1.20m3/s by results of water quantity investigation (1.07 m3/s).

2. Sedimentation zone

According to Japanese design criteria, surface loading value in sedimentation zone is less than 50m3/(m2 x day).

Q=103,680m3/day, width of drain is 11.8m, so necessary length is;

103,680÷11.8÷50 = 175m → 250m

Also water depth is 2.2m as same as actual water level.

Decontamination ratio (ratio of pollutant removal, comparing between before and after the treatment) is estimated by Japanese standard as below.

Decontamination ratio：BOD10～30%、SS10～50%

After sedimentation, water quality is treated to bellows.

Item	COD	T-N	T-P	SS
Water quality (mg/l)	16～21	12.0	0.2	388～698

Detention time is 0.94hr by width of drain bottom is 3.00m, width of surface is 11.8m, and depth is 2.2m.

3. Vegetation zone

Vegetation zone is combined with reeds and water hyacinth.

Necessary Detention time is 5 hours,

Necessary capacity＝1.20m3/s×3600×5hr＝21,600m3

Water depth is 0.9m and width is 11.8m, so necessary length is;

length＝21,600m3÷0.2m÷11.8m = 9,152m

Because of the pilot project and considering the maintenance, length is set to 100m.

Referring to the Japanese design criteria, treatment ability is below,

Standard decontamination ratio: T-N 50-75%, T-P 50-90%, BOD 30-50%, SS 70-80%

Actual decontamination ratio is calculated with the rate of required length (100÷9,152=0.01).

Actual decontamination ratio: T-N 0.5-0.75%, T-P0.5-0.9%, BOD0.3-0.5%, SS 0.7-0.8%

After treated by vegetation is follows,

Item	COD	T-N	T-P	SS
quality(mg/l)	15.9-20.9	11.1-11.9	0.2	385-693

Detention time is 0.21hr by width of drain bottom is 8.20m, width of surface is 11.8m, and depth is 0.9m.

4. Detention time and water quality after treated

Detention time and water quality of each zone is as follows,

Zone name	Water quality (mg/l)				Detention time (hr)
	COD	T-N	T-P	SS	
In-flow	23	12.0	0.2	776	—
Sedimentation zone	18.5	12.0	0.2	543	0.94
Vegetation zone	18.4	11.5	0.2	539	0.21
Total	—	—	—	—	1.15

Design of Sewage Treatment Facility

The capacity of the sewage treatment facility is calculated based on the “Septic Tank Structural Standard” in Japan.

1. Design Parameter

1-1 Target year: 2023 (after 20years)

1-2 Project population: 500 people

Actual population is 286 people. Growth rate of population is 2%/year.

286×(1.022)20 = 424 → 500 people

1-2 Unit consumption: 70 liters/capita/day

Unit consumption of sewage changes greatly with the life style of each village, and water supply situations. According to the IDRC data, at the 2007, water supply standard unit consumption will be Cairo 300LPCD, Sharkia143LPCD, and Minya70LPCD.

An unknown amount-of-water average is 34%, real water supply serves as 246LPCD, 106LPCD, and 52LPCD, respectively.

So the target SANDELA of a water supply situation is not good, it expects a margin from 52LPCD of Minya, and is taken as 70LPCD.

1-3 Processing model: Physical treatment by sedimentation + attached growth treatment process with aeration (catalyst carrier use type)

1-4 Average daily flow: 0.07 m3/capita/day ×500 people =35m3/day

1-5 Water quality

Inlet; BOD 360mg/l

(18g/capita/day×50lpcd+42g/capita/day×20lpcd)/70^2×1,000＝355→360

Outlet; BOD 60mg/l

2. Sedimentation Tank

Necessary capacity: V=35(m3/day)×20(hr)/24(hr/day) =29.2m3

Effective depth: 1.8m or more 5.0m → 2.3m

2-1 Primary Sedimentation Tank

Necessary capacity: 2/3 or more of necessary total capacity

V1 = 29.2×2/3 = 19.47m3

Size of tank: width 2.3m, length 3.7m, depth 2.3m

Effective volume: 2.3×3.7×2.3 = 19.57m3 > 19.47m3

Actual relation time = 19.57m3 / 35×24 = 13.4hr

2.2 Secondary Sedimentation Tank

Necessary capacity: 1/3 or more of necessary total capacity

V2 = 29.2×1/3 = 9.74m3

Size of tank: width 2.3m, length 1.9m, depth 2.3m

Effective volume: 2.3×1.9×2.3 = 10.0m3 > 9.74m3

Actual relation time = 10.0m3 / 35×24 = 6.8hr

3. Aeration Tank

Necessary capacity:

0.36g/l×70lpcd＝25.2g/cd 25.2g/cd×500capita×10^{-3}/0.3kg/m3･day = 42.0m3

3-1 Primary Aeration Tank

Necessary capacity: 3/5 or more of necessary total capacity

V1 = 42.0×3/5 = 25.2m3

Size of tank: width 2.3m, length 5.0m, depth 2.2m

Effective volume: 2.3×5.0×2.2 = 25.3m3 > 25.2m3

Contact media requirement (filling rate 55%): 25.3m3×0.55 = 14.0m3

Actual relation time = 25.3m3 / 35×24 = 17.3hr

3-2 Secondary Aeration Tank

Necessary capacity: 2/5 or more of necessary total capacity

V1 = 42.0×2/5 = 16.8m3

Size of tank: width 2.3m, length 3.4m, depth 2.2m

Effective volume: 2.3×3.4×2.2 = 17.2m3 > 16.8m3

Contact media requirement (filling rate 55%): 17.2m3×0.55 = 9.5m3

Actual relation time = 17.2m3 / 35×24 = 11.7hr

4. Sedimentation Tank

Necessary capacity: V=35m3×4(hr)／24hr = 5.84m3

(1/2 of the height of the hopper is not included in the net depth.)

Effective depth: 1.0m or more

60 degrees or more in angle of hopper

Surface loading: 8m3/m2 or less

Necessary area: 35m3÷20m3/m2 = 1.75m2

Size of tank: width 2.3m, length 2.3m, depth 2.2m (Net depth 1.4m)

Effective volume: $2.3\times2.3\times0.6+1/6\times0.80\times(2.3\times1.35\times2+2\times(1.35^2+2.3^2)=5.89m3$

>5.84m3

Actual detention time = 5.89m3 / 35×24 = 4.0hr

Net Surface loading: 2.3m×2.3m = 5.29m2 > 1.75m2

* It is assumed that the outflow of the scum is allowed and sets up neither the overflow weir nor the scum skimmer.

5. Disinfection Tank

Necessary capacity: V = q×n×1/24×1/4 = 0.07×500×1/24×1/4 = 0.37m3

Size of tank: width 1.2m, length 1.2m, depth 1.0m

Effective volume: V = 1.2×1.2×1.0 = 1.44m3 > 0.37m3

Actual relation time = 1.44m3 / 35×24 = 0.98hr

Tank name		Width(m)	Length(m)	Depth(m)	Volume(m3)	Relation time(hr)
Un-aerobic	1st	2.3	3.7	2.3	19.5	13.4
	2nd	2.3	1.9	2.3	10.0	6.8
Aeration	1st	2.3	5.0	2.2	25.3	17.3
	2nd	2.3	3.4	2.2	17.2	11.7
Sedimentation		2.3	2.3	2.2	5.8	4.0
Disinfection		1.2	1.2	1.0	1.4	0.9
Total		—	—	—	79.2	54.1

6. Blower ability calculation

6-1 Aeration Blower

Amount of necessary aeration: Q = (25.3+17.2)×2.0m3/m3·hour = 85m3/hour = 1.91m3/min

Aeration Blower

1.50m3/min×2,800mmAq

50mm×1.5kw

7. Amount of sludge

Design flow; 35m3/day

Amount of BOD removal; 360 – 60 = 300mg/l =0.30kg/m3

Shift ratio from sludge; 30%

Percentage of water content; 98%

35m3/day×0.30kg/m3×0.3×(100/(100-98)×0.001×365days = 57.5m3/years (4.80m3/month)

8. Amount of chlorine

Daily flow; 35m3/day

Ratio of injection; 1.0mg/l

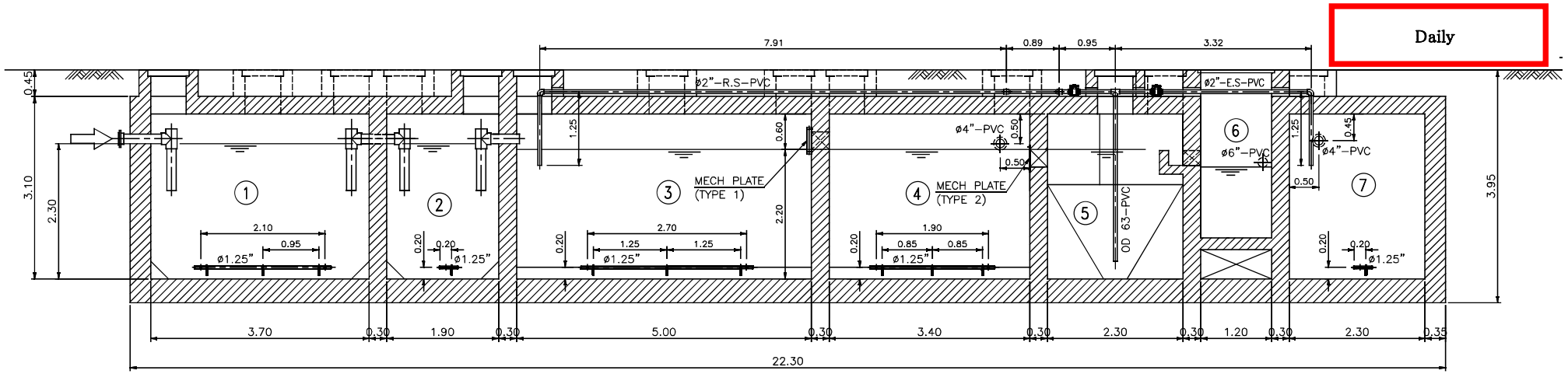
Concentration of chlorine; 5%

Consumption of chlorine = 35,000 l/day×1.0mg/l／(5%×100) = 70 l/day

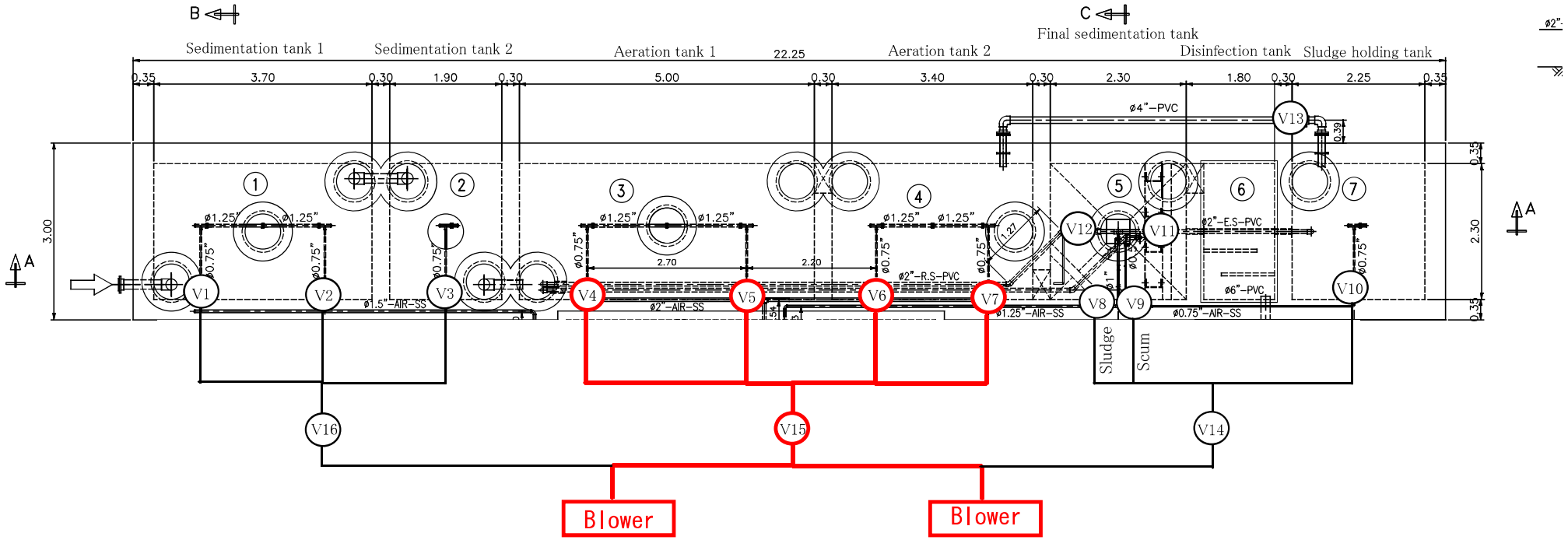
9. Main Equipment List

Facility	Standard	Amount
Aeration Blower	Φ50mm×1.5kw×1.50m3/min	1 set
Standby aeration blower	Φ50mm×1.5kw×1.50m3/min	1 set
Disinfection facility	Pump injection type	1 set
Advection pipe	PVC 200×150	3 set
Ball valve	φ40mm、PVC	11 piece
Aeration equipment	φ40mm、L=1.8m、SUS	4 set
Manhole lid	φ600 DCI	22set
Air pipe	φ40mm、φ50mm SUS	1 set
Contac media catalyst carrier	Primary；14.0m3、Secondary；9.5m3	1 set

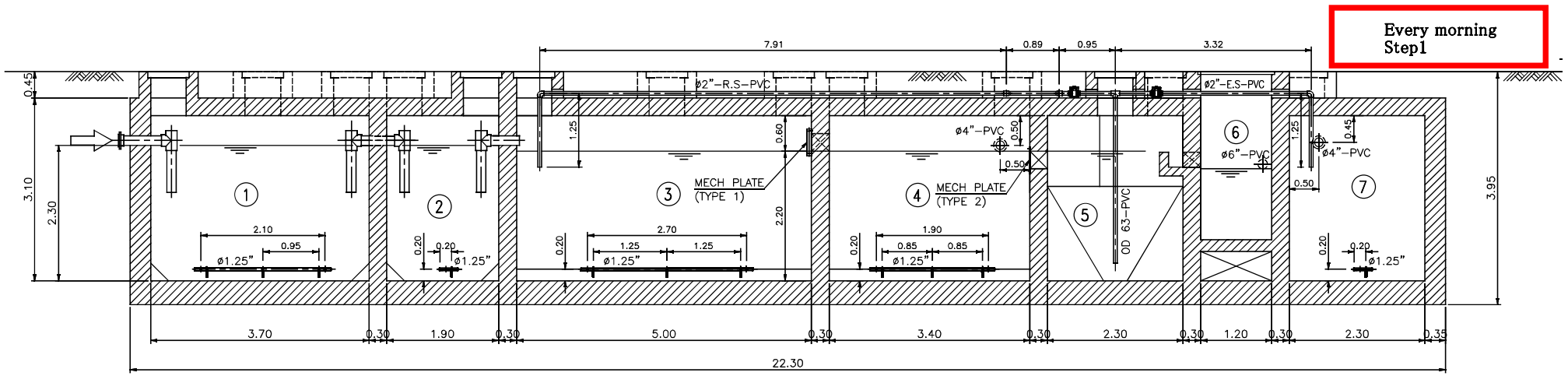
Daily


7.91
0.89
0.95
3.32
ø2"-R.S-PVC
ø2"-E.S-PVC
ø4"-PVC
ø6"-PVC
MECH PLATE (TYPE 1)
MECH PLATE (TYPE 2)
OD 63-PVC
ø1.25"
3.70
0.30
1.90
5.00
3.40
2.30
1.20
0.35
22.30
3.10
2.30
3.95

SEC. (A – A)


B
C
Sedimentation tank 1
Sedimentation tank 2
Aeration tank 1
Aeration tank 2
Final sedimentation tank
Disinfection tank
Sludge holding tank
22.25
ø4"-PVC
ø2"-R.S-PVC
ø2"-E.S-PVC
ø6"-PVC
ø1.5"-AIR-SS
ø2"-AIR-SS
ø1.25"-AIR-SS
ø0.75"-AIR-SS
V1
V2
V3
V4
V5
V6
V7
V8
V9
V10
V11
V12
V13
V14
V15
V16
Sludge
Scum
Blower
Blower

Every morning
Step1



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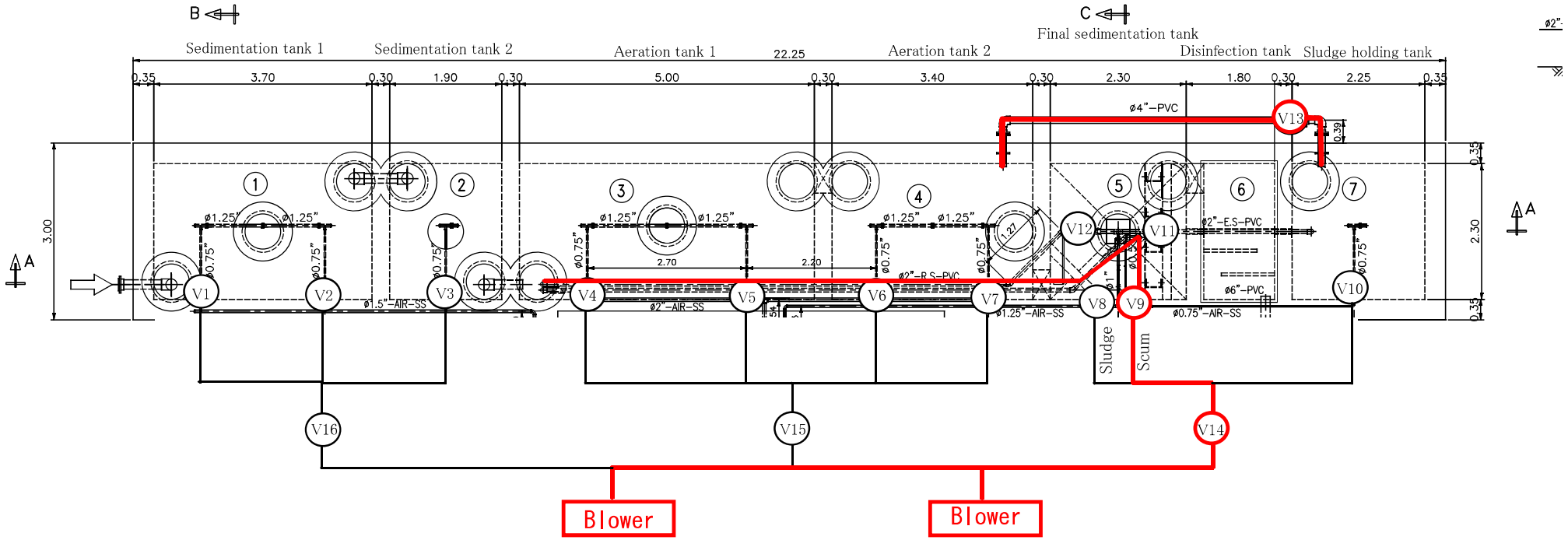
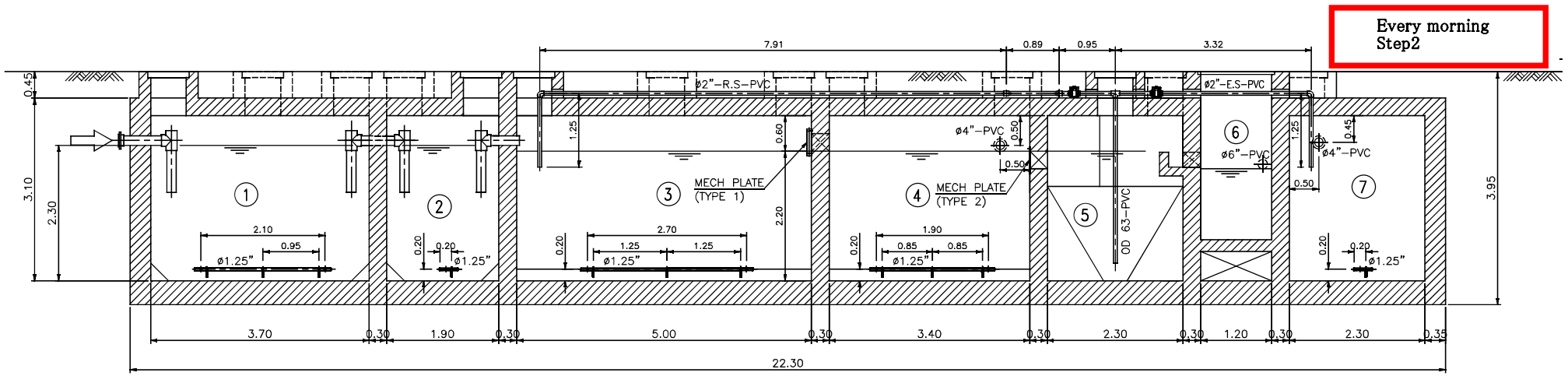


Every morning
Step2



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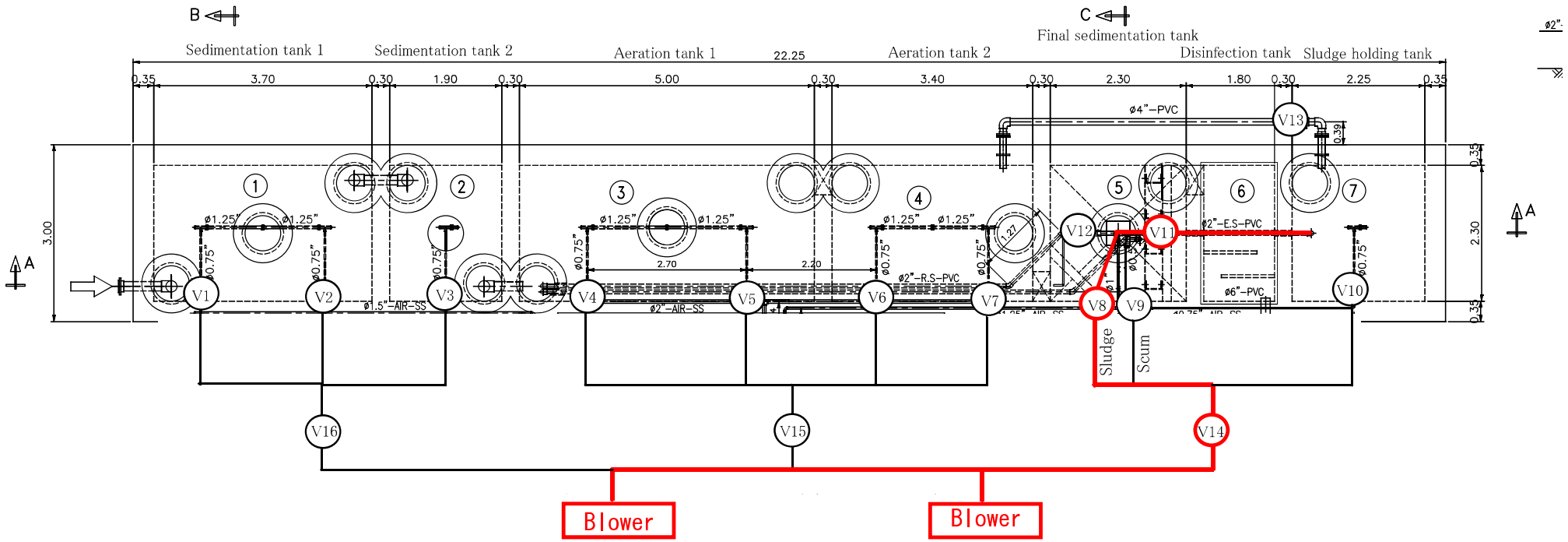
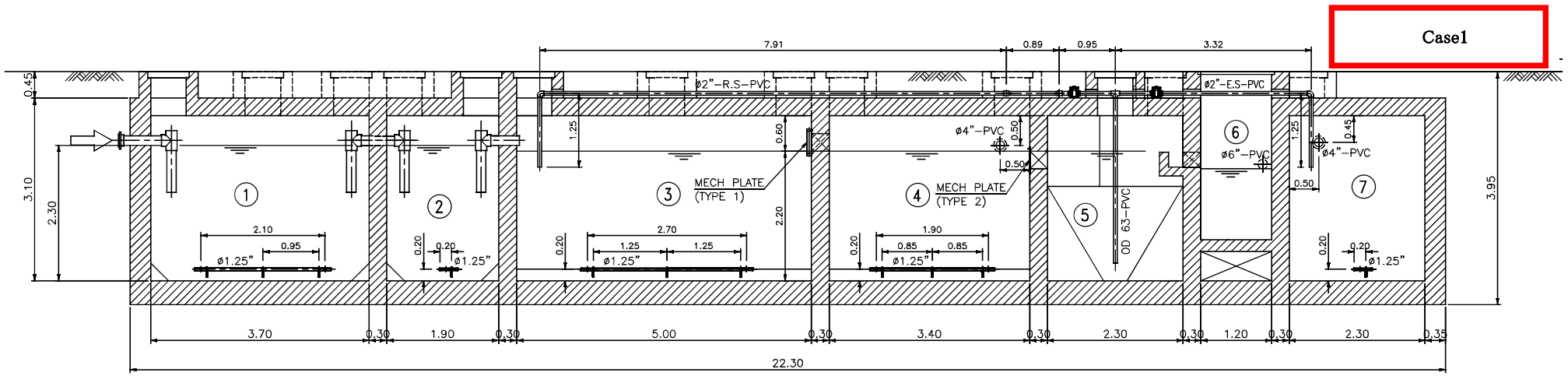
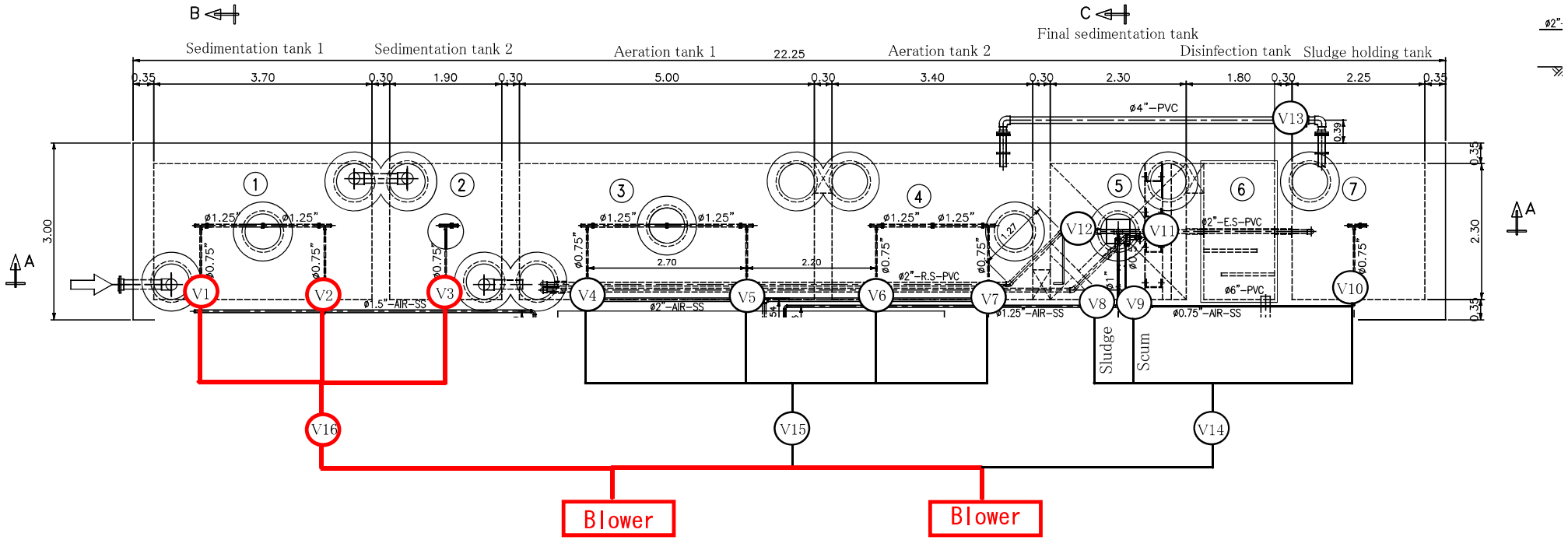


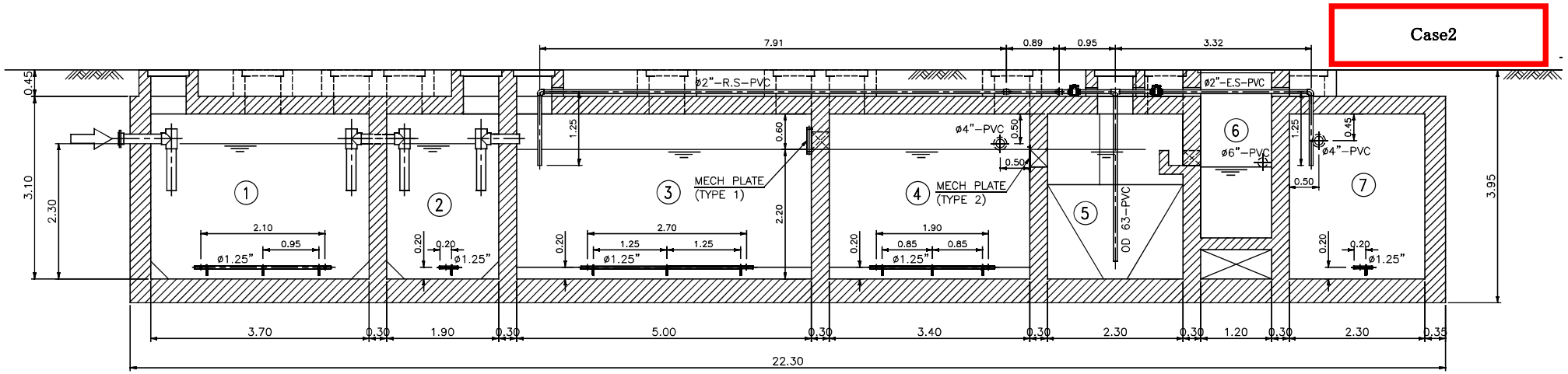
Case1


7.91
0.89
0.95
3.32
ø2"-R.S-PVC
ø2"-E.S-PVC
ø4"-PVC
ø6"-PVC
MECH PLATE (TYPE 1)
MECH PLATE (TYPE 2)
OD 63-PVC
3.10
2.30
3.95
3.70
1.90
5.00
3.40
2.30
1.20
2.30
22.30

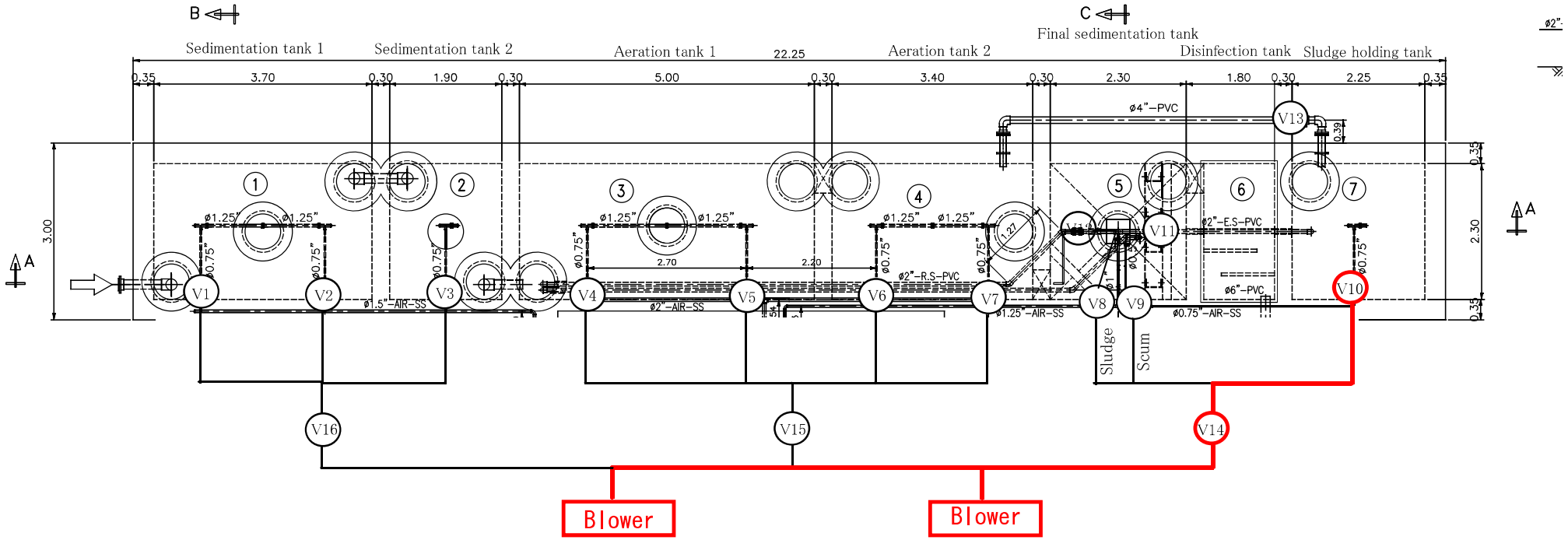
SEC. (A – A)


B
C
Sedimentation tank 1
Sedimentation tank 2
Aeration tank 1
Aeration tank 2
Final sedimentation tank
Disinfection tank
Sludge holding tank
22.25
ø4"-PVC
ø2"-R.S-PVC
ø2"-E.S-PVC
ø6"-PVC
ø1.5"-AIR-SS
ø2"-AIR-SS
ø1.25"-AIR-SS
ø0.75"-AIR-SS
Sludge
Scum
V1
V2
V3
V4
V5
V6
V7
V8
V9
V10
V11
V12
V13
V14
V15
V16
Blower
Blower

Case2


7.91
0.89
0.95
3.32
ø2"-R.S-PVC
ø2"-E.S-PVC
ø4"-PVC
ø6"-PVC
MECH PLATE (TYPE 1)
MECH PLATE (TYPE 2)
OD 63-PVC
ø1.25"
3.70
1.90
5.00
3.40
2.30
1.20
22.30
3.95
3.10
2.30

SEC. (A – A)


B
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Sedimentation tank 1
Sedimentation tank 2
Aeration tank 1
Aeration tank 2
Final sedimentation tank
Disinfection tank
Sludge holding tank
22.25
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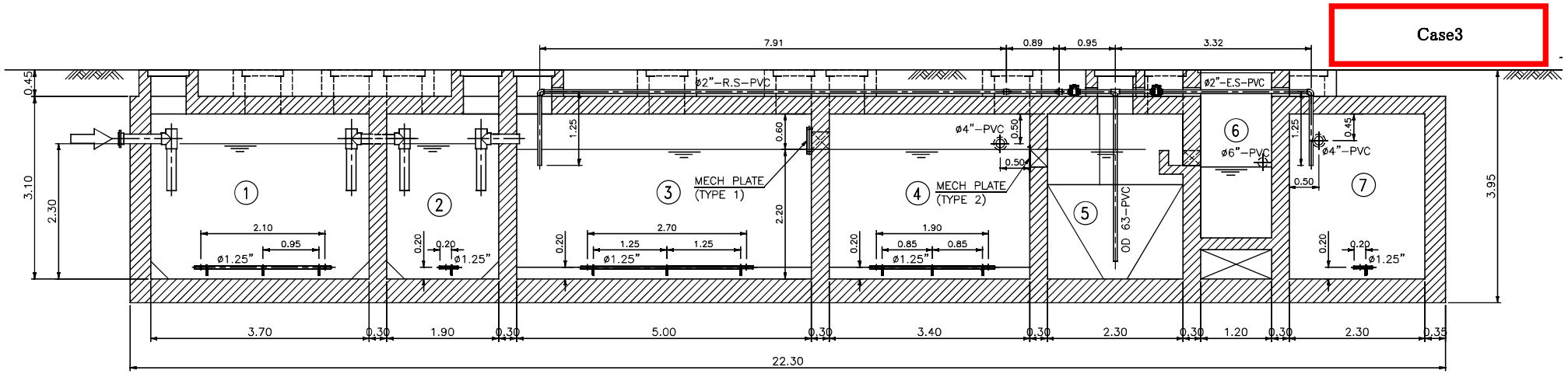
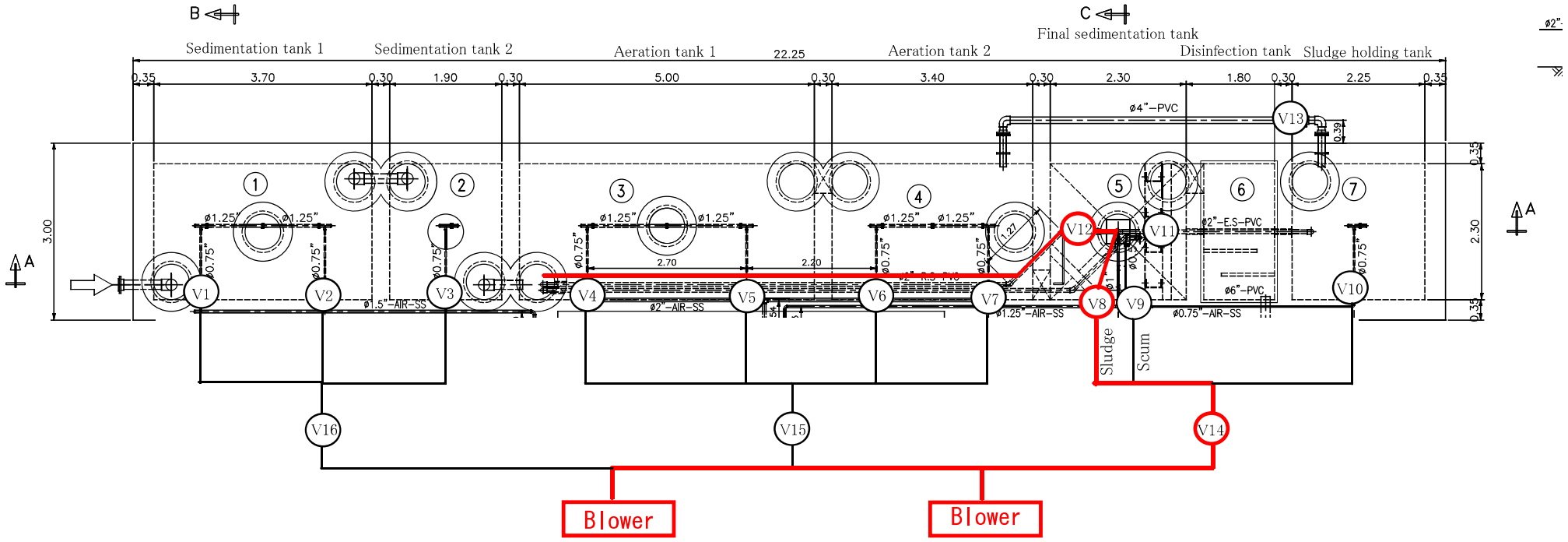
ø2"-R.S-PVC
ø2"-E.S-PVC
ø6"-PVC
ø1.5"-AIR-SS
ø2"-AIR-SS
ø1.25"-AIR-SS
ø0.75"-AIR-SS
Sludge
Scum
V1
V2
V3
V4
V5
V6
V7
V8
V9
V10
V11
V13
V14
V15
V16
Blower
Blower


Case3
7.91
0.89
0.95
3.32
ø2"-R.S-PVC
ø2"-E.S-PVC
ø4"-PVC
ø6"-PVC
MECH PLATE (TYPE 1)
MECH PLATE (TYPE 2)
OD 63-PVC
3.10
2.30
3.95
3.70
1.90
5.00
3.40
2.30
1.20
2.30
22.30

SEC. (A – A)


B
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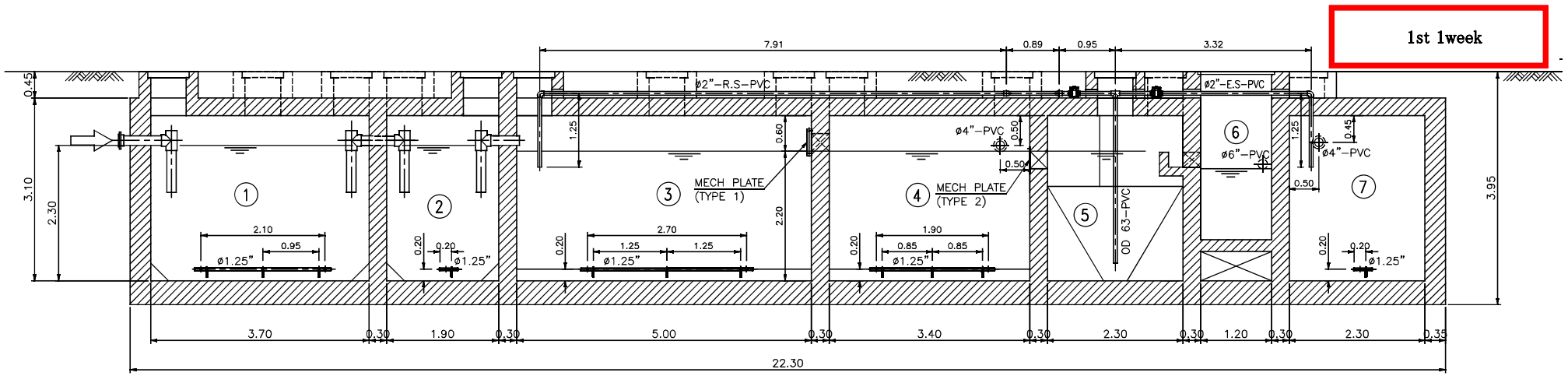
Sedimentation tank 1
Sedimentation tank 2
Aeration tank 1
Aeration tank 2
Final sedimentation tank
Disinfection tank
Sludge holding tank
22.25
ø4"-PVC
ø2"-E.S-PVC
ø6"-PVC
ø1.5"-AIR-SS
ø2"-AIR-SS
ø1.25"-AIR-SS
ø0.75"-AIR-SS
V1
V2
V3
V4
V5
V6
V7
V8
V9
V10
V11
V12
V13
V14
V15
V16
Sludge
Scum
Blower
Blower

1st 1week



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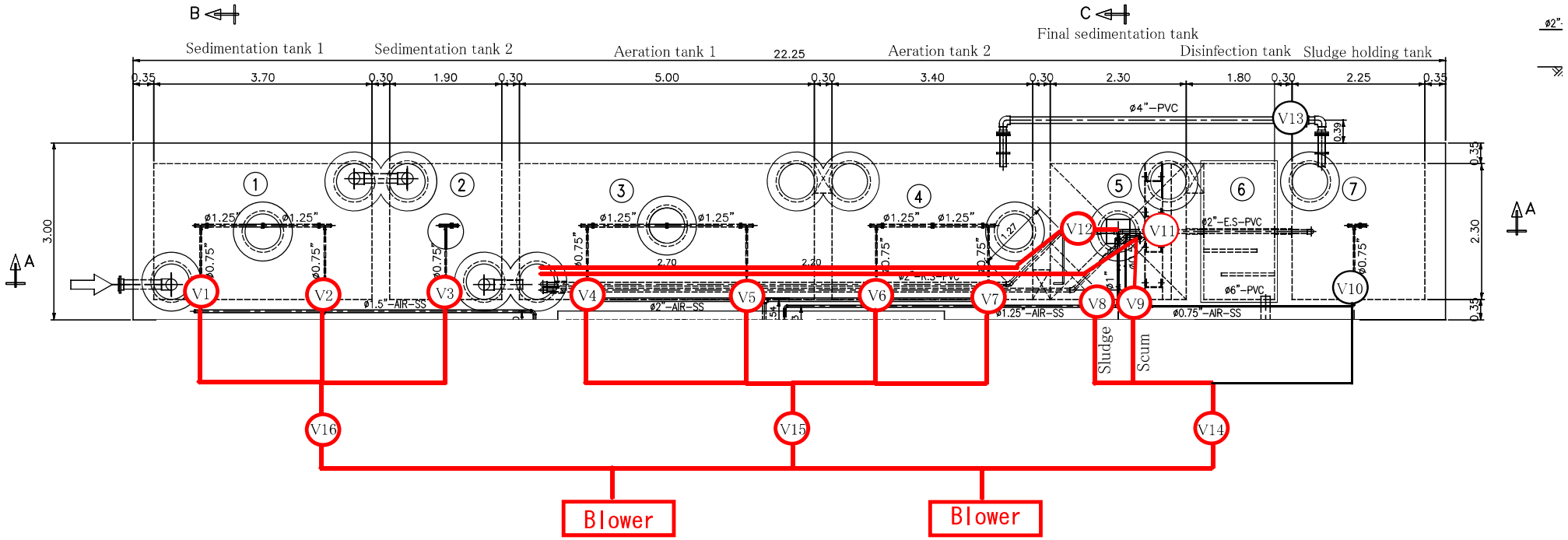
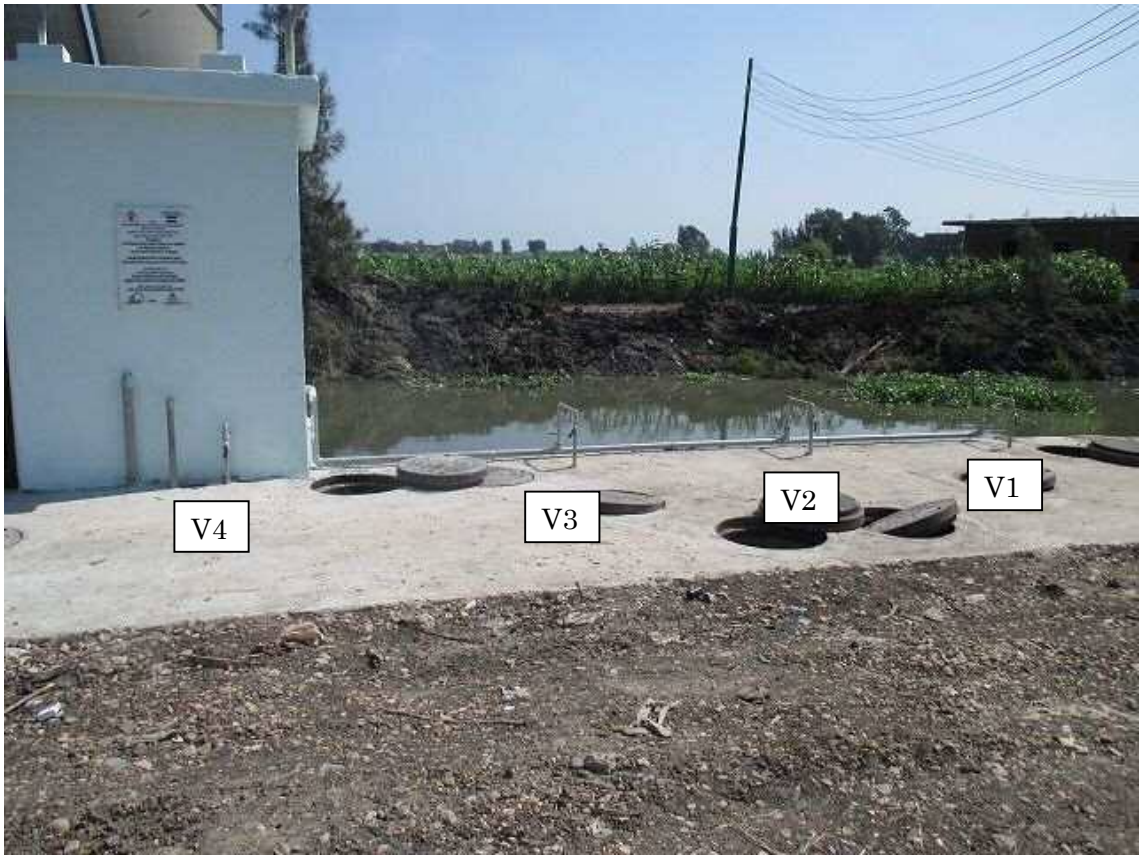
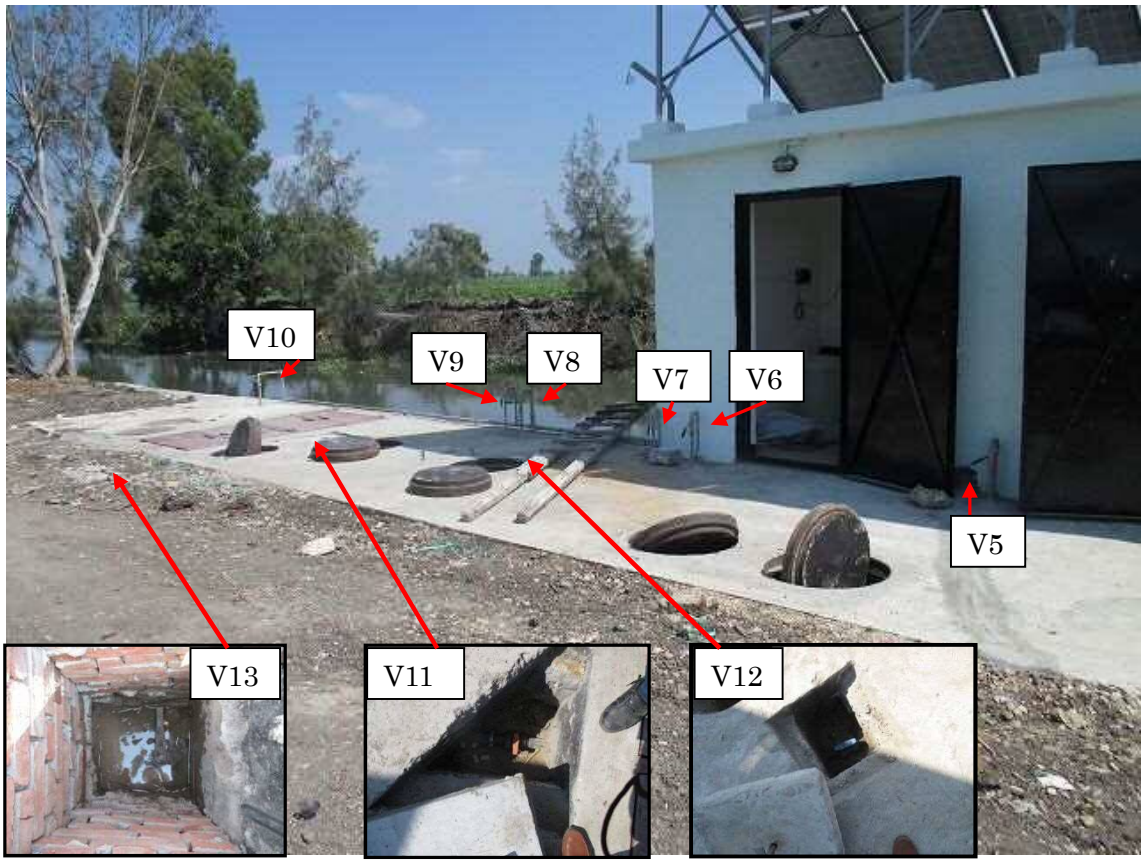
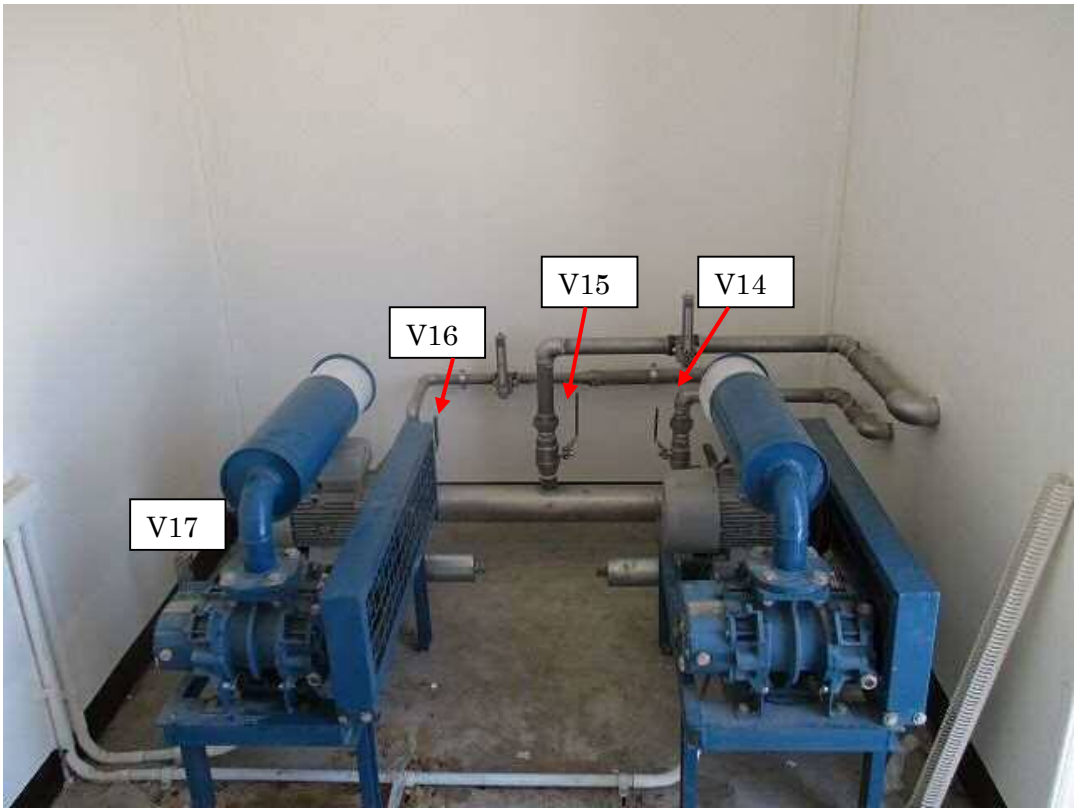



V4
V3
V2
V1


V10
V9
V8
V7
V6
V5
V13
V11
V12



Valve name	Destination	Purpose
V1	Primary sedimentation tank 1	Mixing
V2	Primary sedimentation tank 1	Mixing
V3	Primary sedimentation tank 2	Mixing
V4	Aeration tank 1	Aeration
V5	Aeration tank 1	Aeration
V6	Aeration tank 2	Aeration
V7	Aeration tank 2	Aeration
V8	Final sedimentation tank	Slude transfer to aeration tank or storage tank
V9	Final sedimentation tank	Scum transfer to aeration tank
V10	Sludge storage tank	Mixing
V11	Sludge storage tank	Switch
V12	Aeration tank	Switch
V13	Aeration tank	Switch
V14	V8,V9,V10	Main valve
V15	V4,V5,V6,V7	Main valve
V16	V1,V2,V3	Main valve
V17	In-stream	aeration

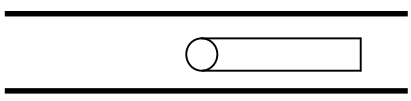
【Daily morning】

・push blower switch ON

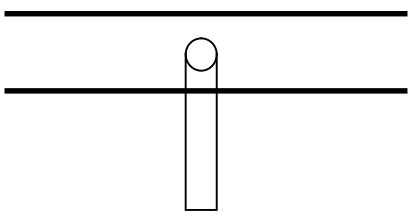
・push clolination switch ON

・switch valve

Valve name	Daily	Every morning		
		Step 1	Step 2	Step 3
		5min	5min	Cont.
		Scum tranfer from sed. tank to aeration tank	Sludge transfer from sed. tank to sludge tank	Change to Normal position
		Sludge water transfer from sludge tank to aeration tank		
V1				OFF
V2				OFF
V3				OFF
V4	ON			ON
V5	ON			ON
V6	ON			ON
V7	ON			ON
V8			ON	
V9		ON		
V10				OFF
V11			ON	
V12			OFF	
V13	OFF	ON	OFF (1st)	OFF
V14	OFF	ON	ON	OFF
V15	ON			ON
V16	OFF			OFF
V17	OFF			OFF



ON



OFF

【1 week starting time】

・push blower switch ON

・push clolination switch OFF

・switch valve

Valve name	1 week start time
V1	ON
V2	ON
V3	ON
V4	ON
V5	ON
V6	ON
V7	ON
V8	ON
V9	ON
V10	OFF
V11	OFF
V12	ON
V13	OFF
V14	ON
V15	ON
V16	ON
V17	OFF

CASE.1 [Mixing operation in 1st Sedimentation tank and 2nd Sedimentation tank]

In case that septic odor is generated hardly or other relevant case happens, mixing operation is necessary according to the necessity

Valve operation pattern is;

V1,V2,V3,V16⇒ON

CASE.2 [Mixing operation in sludge holding tank]

Before removing sludge from the tank or other relevant case happens, mixing operation is needed.

Valve operation pattern (procedure?) is;

V10,V14⇒ON

CASE.3 [Return sludge operation]

In case that activated sludge concentration is low or other relevant case happens, return sludge operation is needed. Return sludge operation means that sludge in 1st or 2nd sedimentation tank is returned to contact oxidation tank.

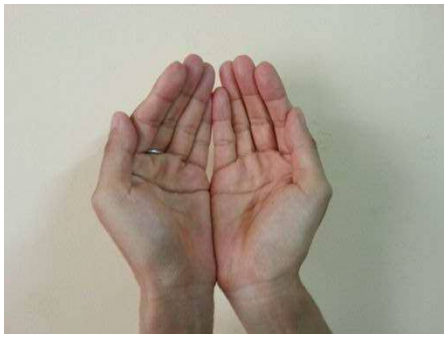
Valve operation pattern is;

V8,V12,V14⇒ON　V11⇒OFF

Appendix-M Training Materials for Environmental Education

AND SAY, WORK; SO ALLAH WILL SEE YOU WORK

Prophet Muhammad said:
“Verily, the Exalted God is the most beautiful and loves beauty,…, and is the Cleanest and loves Cleanliness.”



CLEANLINESS IS FAITH

App-M 1

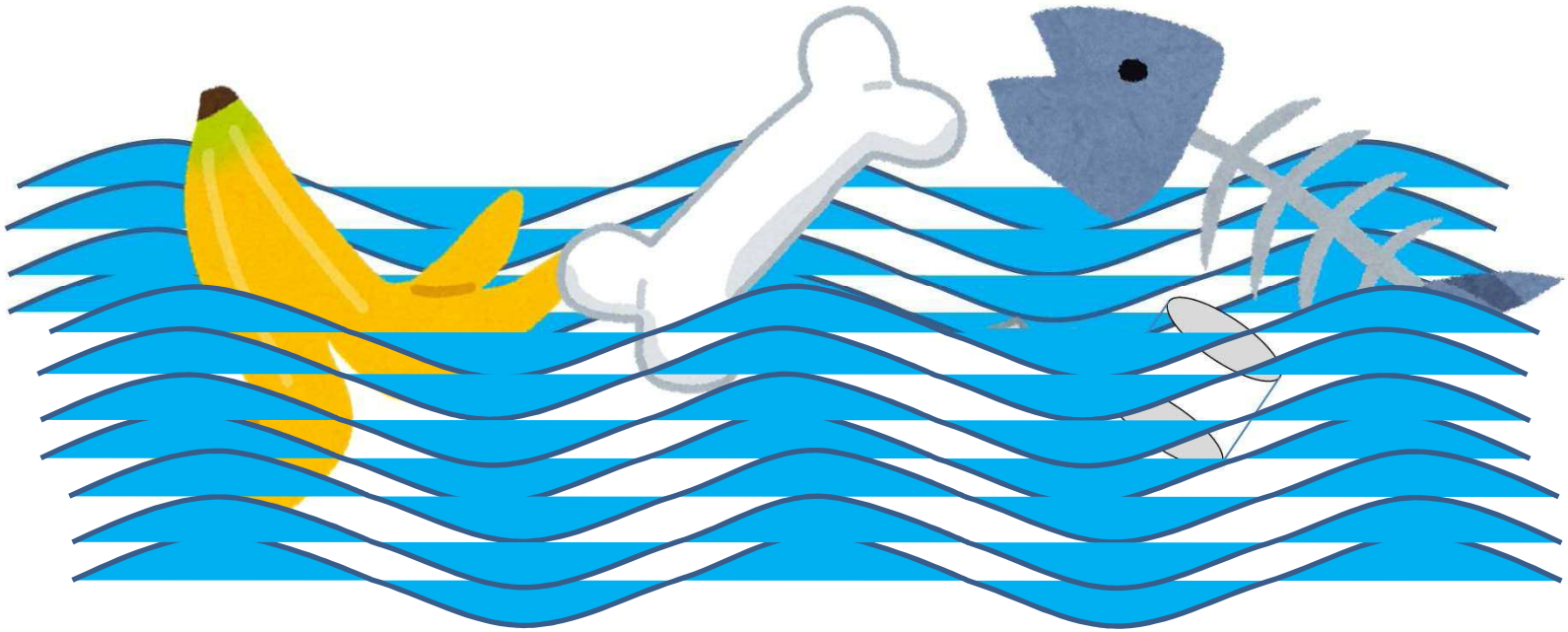
App-M 2

Waste along canal and drainage

Where is your house?

It is beside of a garbage pile on the left of pavement.

If water is polluted by waste

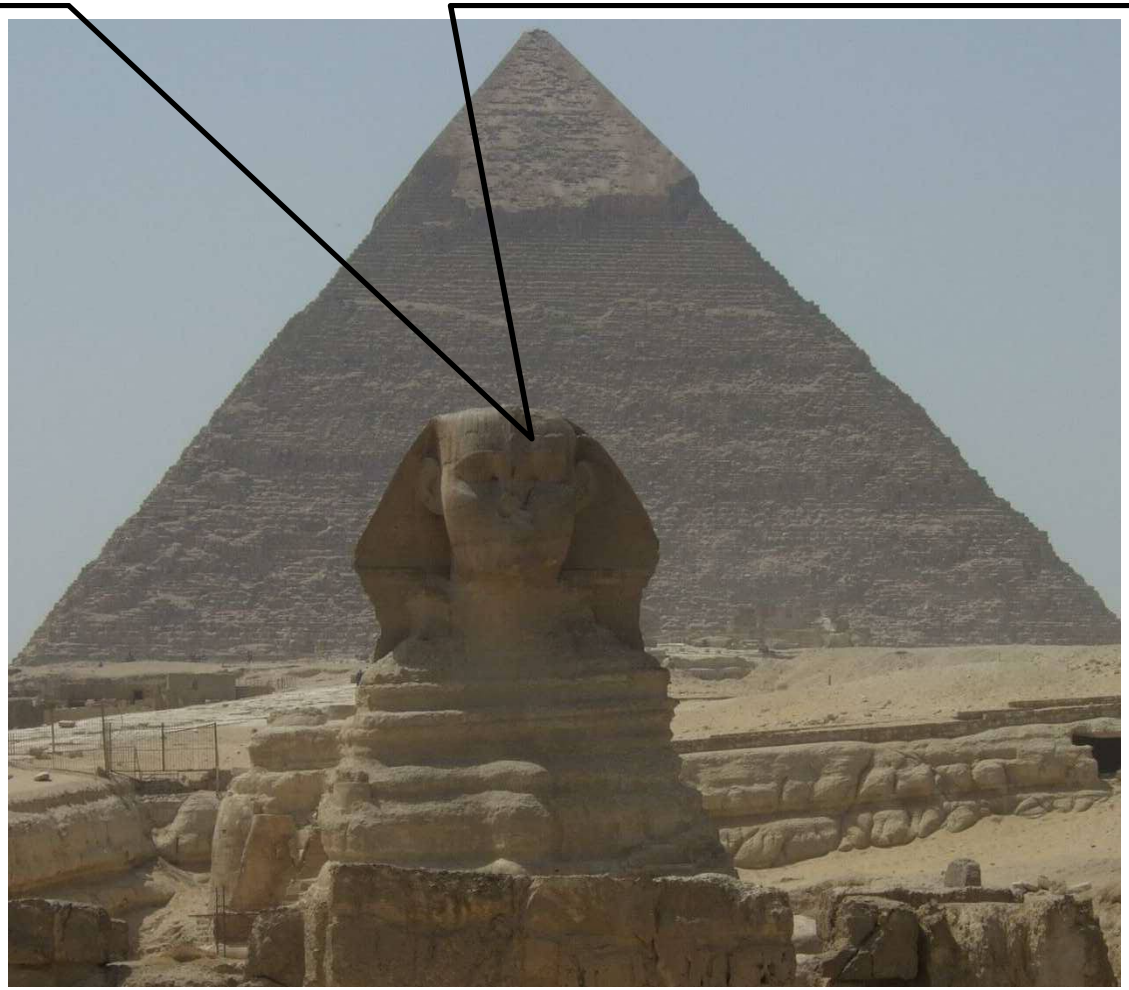


Impacts on Crops

Good harvest in good quality of water

Insufficient harvest in bad quality of water

Please clean water.



App-M 7

Good Case in Kafr El Sheikh

- Problem analysis
- Action plan making
- Activities for environmental conservation
  - Environmental campaign (tree planting, Garbage collection along the canal)
  - Compost making
  - Garbage collection by using a motor bike

Problem Analysis by People

Action Plan Making

App-M 10

Tree Planting along the Drainage

App-M 11

Compost Making by Using Animal Waste

App-M 12

Garbage Collection by Children

App-M 13

Garbage Collection by CDA

App-M 14

Clean Water

App-M 15

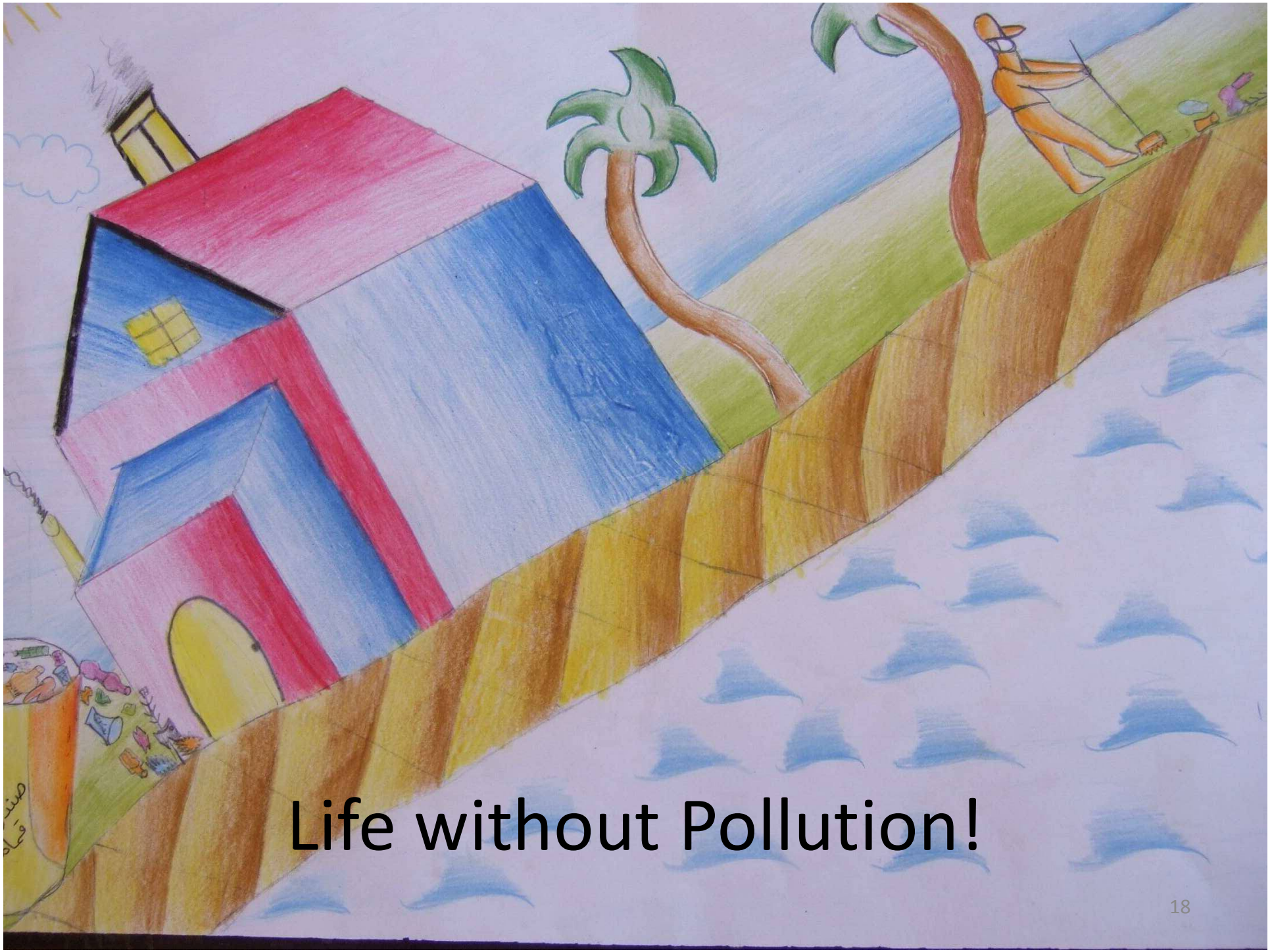
What can we do for cleaning of drainage and canal?

For instance,

- Cleaning of drainage, canal, and roads
- Garbage collection
- Recycle
- Awareness for the people

Let’s discuss!

App-M 17


Life without Pollution!

بسم الله الرحمن الرحيم

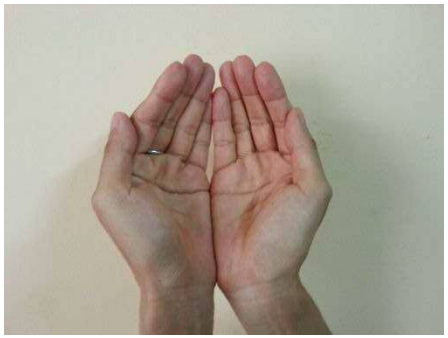
((وقل اعملوا فسيرى الله عملكم ورسوله والمؤمنون))

صدق الله العظيم

قال رسول الله صلى الله عليه وسلم:

((إن الله جميل يحب الجمال، نظيف يحب النظافة))

صدق رسول الله صلى الله عليه وسلم



النظافة من الإيمان

App-M 19

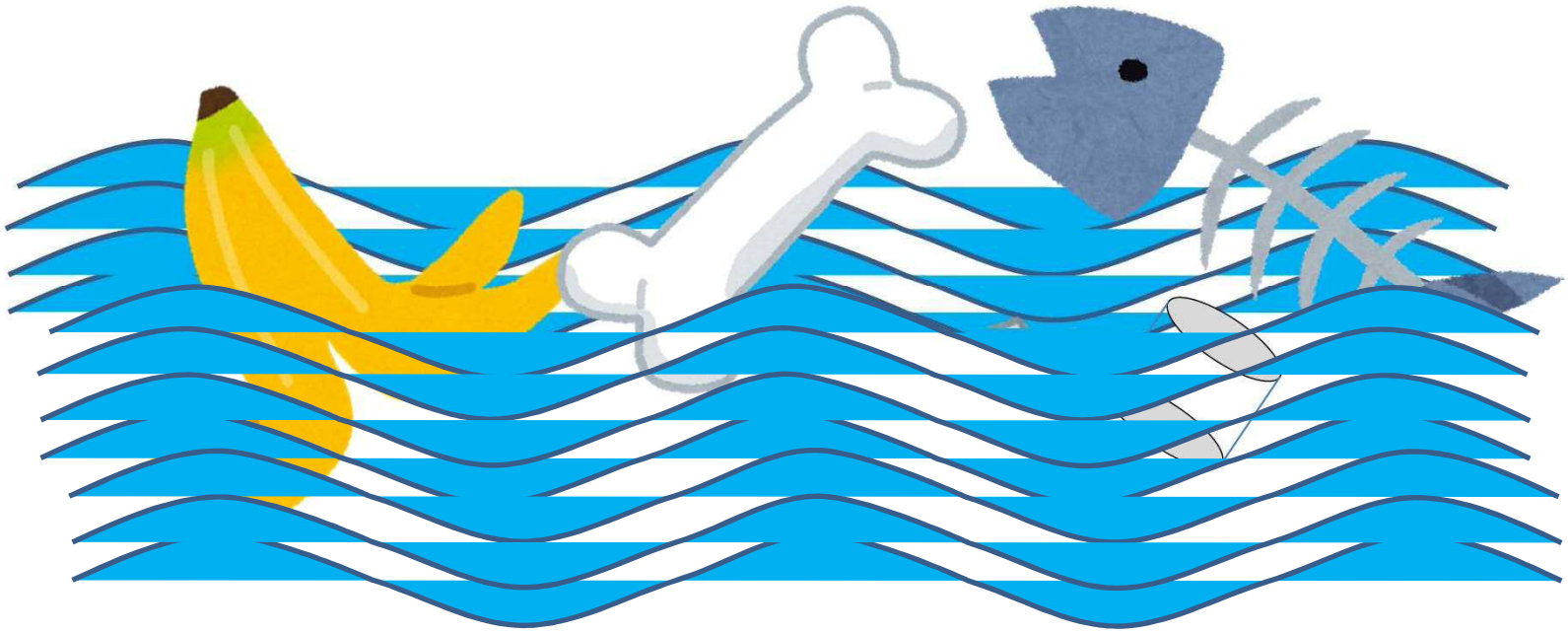

التوعية البيئية

مخلفات ملقاة على جسور الترع والمصارف

App-M 21


أنت بيتلهفيس
بجانب كوم القمامة
على شمال الرصيف

حالة المياه
وما تحتويه من مخلفات وملوثات



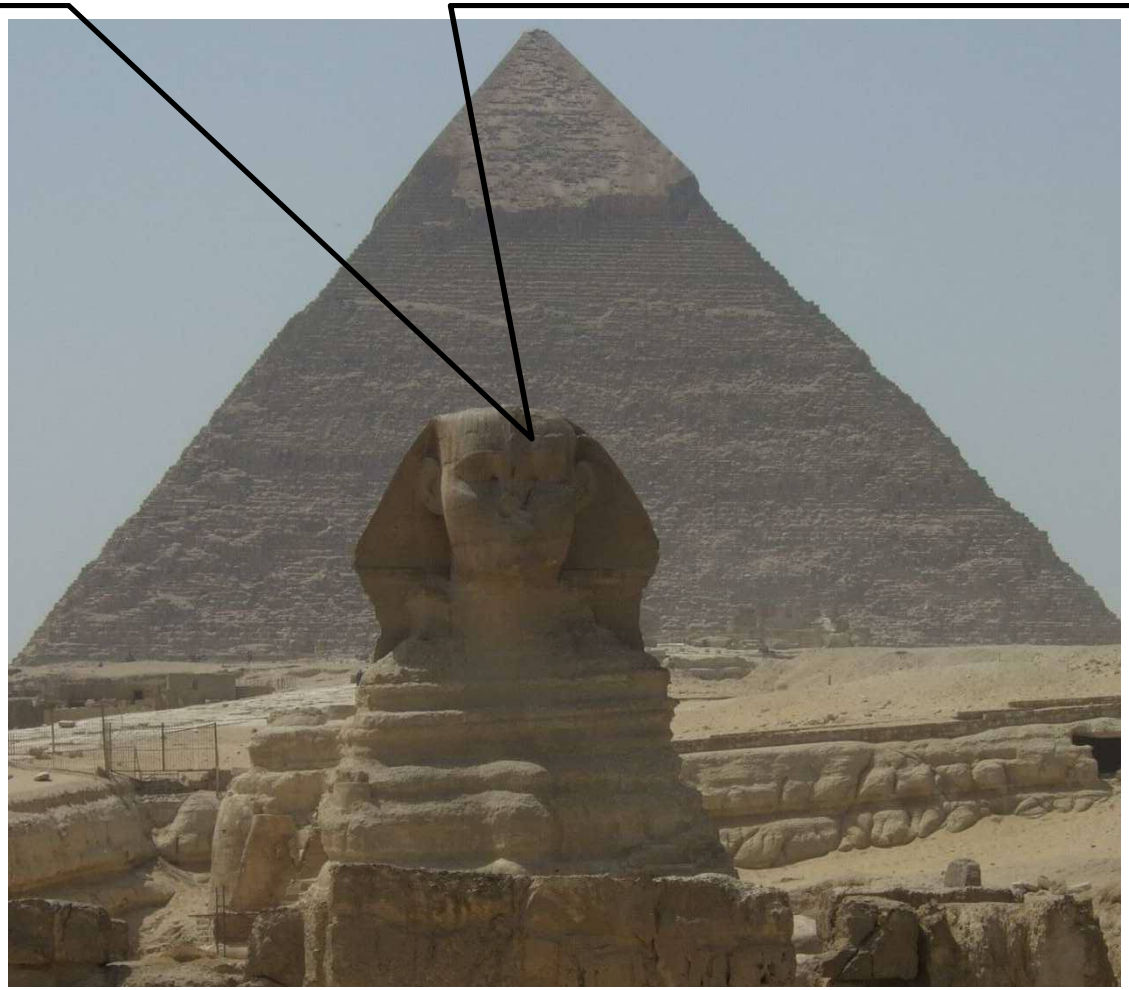
App-M 23

النتائج التي تقع على المحاصيل

محاصيل جيدة عند المحافظة على نظافة المياه

محاصيل رديئة عند إهمال نظافة المياه

حافظوا على نظافة مياهكم



App-M 25

تجربة مفيدة من محافظة كفر الشيخ

- تحليل المشكلة
- وضع خطة عمل
- أنشطة خاصة بالمحافظة على البيئة:

– عمل حملات بيئية (تتضمن زراعة الأشجار وجمع المخلفات من على جسور الترع والمصارف)

– عمل سماد عضوي

– جمع المخلفات باستخدام تروسيكل

تحليل المشكلة

وضع خطة العمل

App-M 28

زراعة الأشجار على جسور القنوات المائية

App-M 29

عمل سماد عضوي من المخلفات الحيوانية

الأطفال أثناء نشاط جمع المخلفات

App-M 31

جمعية تنمية المجتمع أثناء جمع المخلفات

App-M 32

مجرى مائي نظيف

ما الذي يمكن أن نقدمه للحفاظ على نظافة الترع والمصارف؟!

بعض الأمثلة على ذلك:

- تنظيف جسور الترع والمصارف والشوارع والطرقات
- جمع المخلفات
- إعادة تدوير واستخدام المخلفات
- رفع الوعي البيئي عند الناس

!!!مناقشة!!!
يسعدنا سماع آرائكم

App-M 34

App-M 35

مدرسة
شابه الإعدادية
المشتركة
إبداع
تطور
النظافة
لا للإهمال
ازرع شجرة
حضارة
إيمان
مشاركة
وتعاون


حياة بدون تلوث

Appendix-N Pilot Project

Appendix-N Pilot Project

1. Criteria for Site Selection

The candidate site is selected from among the 23 sites proposed by the Kafr El Sheikh Irrigation Department. Table 1.1 shows an overview of each site. Table 1.2 shows site selection criteria, and is shown in Table1.3 score table. As a result of the examination, the sites are shown in Table 1.4 Summary of project sites to be selected.

Table 1.1 Site Outline

Not suitable
Selected site
High value of EC (2≦EC≦4)

↓ In parentheses is the visual estimate.

Priority No.	Drain Canal	Irrigation Canal	EC (ds/m) ≦4	COD (mg/l) ≦80		others (June) Chromium≦0.05 Manganeze≦0.5 Arsenic≦0.05 6≦pH≦9	others (July) Chromium≦0.05 Manganeze≦0.5 Arsenic≦0.05 6≦pH≦9	water quantity by survey (m3/s)	Available Re-use Drain Water (m3/s) trial calculation	Shortage of irrigation water (m3/s)	accessibilty	BCWUA
			June	June	July							
E-1	Farsh Al Ganaen	Marsa Al Gamal	1.62	36	30	-	-	1.8	1.441	2.203		×
E-2	El Bahrawy	El Khaleg	6.49	97	26		-	4.47	-	-		×
E-3	Noser	El Mansor	3.46 (irri)	55 (irri)	-	-	-	28.35	-	-		△
E-4	Mekhazan	Mekhazan	2.52	34	24	-	-	(0.8)	0.213	0.881		△
E-5	Abo Khashaba	El Roken	1.43	37	40	Manganese (0.85)	-	(0.5)	0.199	1.542		△
E-6	Erin	Ariamon	1.05	28	18	-	-	(0.64)	0.301	0.44		○
E-7	Farsh Al Ganaen	Sant	1.77	42	24	-	-	2.25	-	-	Renovation of the pump is scheduled.	○
E-8	Abo Rayaa	El Khaleg	4.72	56	22		-	3.66	-	-		×
W-1	El Hedood (8 El Ala)	Reweinh	1.13	46	32		-		-	-		△
W-2	No.11	Kbreet	1.23	36	21	-	-	(0.8)	1.729	2.423	△	×
W-3	El Minshah	El Minshah & its branches	2.25	25	27	arsenic (0.087)	-		-	-	1.5km pipeline	○
W-4	Faraon	El Karadwah	1.32	41	17	-	-	(0.4)	-	-	△	○
W-5	Sandela	El Moheet El Gharby	1.17	26	27	-	-	1.07	-	0.991		×
W-6	No.10	Abo Hamar	2.7	40	53	-	-	(0.75)	0.366	1.102		×
W-7	Nashart Al Asfal	Meet Yazeed	1.75	39	45		-		-	-	△	×
W-8	No.10	Manial Ismaeel	2.72	42	40	-	Manganese (0.66) Phosphate (4.19)	(0.4)	1.165	1.102		×
W-9	No. 9 El Asfal	El Sherkah El Mostagadah	1.69	27	28	arsenic (0.082)	-		-	0.551		△
W-10	Tharwat	El Tarawy	2.05	49	25	pH (10.67)	-	(0.15)	-	-	△	×
W-11	Nashart El Asfal	El Ghamriah	1.48	36	38	-	-	1.12	-	-	×	×
W-12	Zaghloul El Raesy	El Rashediah	2.75	20	24	arsenic (irri 0.095)	-	8.22	-	-	×	×
W-13	Moheet El Zeiny	El Nahaal	1.64	26	38	arsenic (0.082)	-	2.56	-	-	×	?
W-14	Howd El Hagar	El Koniesah	1.39	49	28	-	-	(0.6)	-	-		×

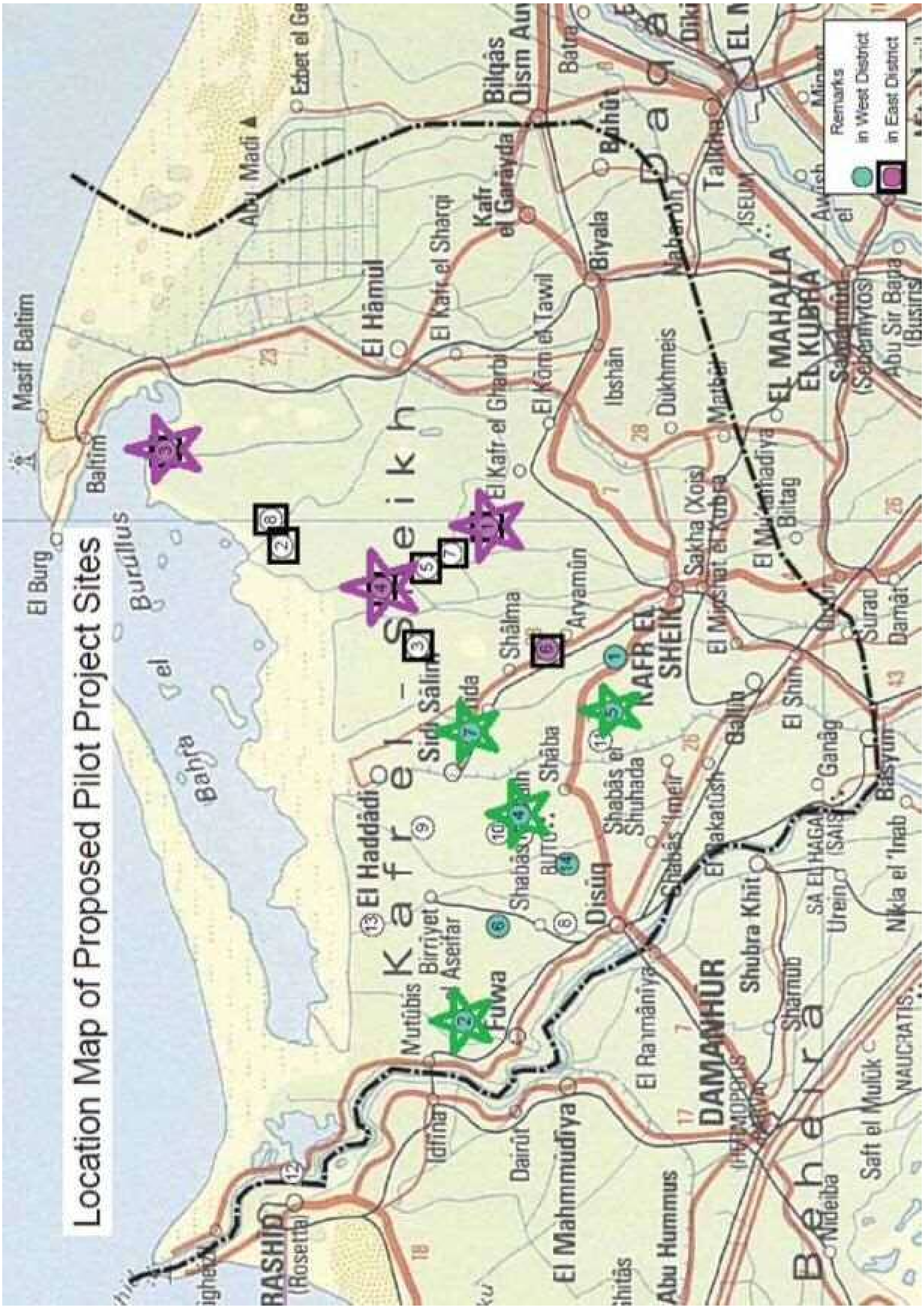

Location Map of Proposed Pilot Project Sites
Remarks
in West District
in East District
Kafr el Sheikh
Beheira
Baltim
El Burg
Masif Baltim
Buhaira el Burullus
El Hâmul
Sidi Sâlim
Fuwa
Disûq
KAFR EL SHEIKH
DAMANHUR
RASHID (Rosetta)
Biyala
Sakha (Xois)
EL MAHALLA EL KUBRA
Basyun
Shubra Khit
Idfina
Mutûbis
El Haddâdi
Qallin
Shâba
Shâlma
Aryamûn
Dukhmeis
Ibshân
Abu Hummus
El Mahmmûdiya

Table 1.2 Criteria of Site Selection

Priority	Criteria item		evaluation	score	Evaluation	score	Evaluation	score	Remarks
1	The shortage of irrigation water in the summer occurs frequently.		non	0	Sometimes	5	Always	10	
2	The water quality of drainage can be used.	salinity	EC≧4	0	4＞EC≧2	5	EC＜2.0	10	dS/m
		other elements to be improved	impossible	0	Improvable	3	Unnecessary	5	
3	Water quantity of drainage reuse is enough in irrigation period.		non	0	Between	5	Enough	10	
4	There is no problem about right of way for proposed facilities.		no	0	Between	5	Yes	10	
5	The local inhabitants has will of drain water reuse.		no	1	Between	3	Hardly	5	
6	There are WUA which are working well.		unorganized	1	Organized	3	Good	5	
7	There is no duplication in other donors		existing	0	Plan	3	No	5	
8	It is the site which can be accessed easily. / The effect of exhibition is expectable.		difficult	1	Between	3	Easy	5	
9	Quality and sort of pollutant source are comparatively clear and the data are exact.		complication	1	Clear	3	clear & exact	5	
10	The fixed effect are acquired in the short term		impossible	0	Between	3	Short	5	
11	River system is simple.		−	−	Complication	1	Simple	2	
12	It tends to guess the general situation of Nile Delta.		−	−	Impossible	1	Possible	2	
13	Water quality conservation mesdure are applicable. (Involve reuse pump)		−	−	Impossible	1	Possible	2	
14	It is easy to carry out evaluation of water control activities.		−	−	Difficult	1	Easy	2	
15	The plan of the various activities in EGYPT is privileged.		−	−	no plan	1	Plan	2	
16	The detailed topographical maps of the target site are available.		−	−	No	1	Yes	2	
17	The data of the water quantity of irrigation and drainage are available.		−	−	No	1	Yes	2	
							Sum	89	

Table 1.3 Evaluation Table Selection

Priority	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total	determination
E1	10	15	5	10	5	1	5	5	1	3	2	2	2	2	1	2	2	73	○
E2	−	0	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	
E3	10	10	5	10	5	3	5	5	1	3	2	2	2	2	1	2	2	70	○
E4	10	10	5	10	5	3	5	5	1	3	2	2	2	2	1	2	2	70	○
E5	−	0	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	
E6	5	15	5	10	3	3	5	5	1	3	2	2	2	2	1	2	2	68	
E7	−	−	−	−	−	−	0	−	−	−	−	−	−	−	−	−	−	−	
E8	−	0	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	
W1	5	15	5	10	3	3	5	5	1	3	2	2	2	2	1	2	2	68	
W2	10	15	5	10	5	1	5	5	1	3	2	2	2	2	1	2	2	73	○
W3	−	0	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	
W4	10	15	5	10	5	5	5	5	1	3	2	2	2	2	1	2	2	77	○
W5	10	15	5	10	5	1	5	5	1	3	2	2	2	2	1	2	2	73	○
W6	10	10	5	10	5	1	5	5	1	3	2	2	2	2	1	2	2	68	
W7	10	15	5	10	3	1	5	5	1	3	2	2	2	2	1	2	2	71	○
W8	−	0	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	
W9	−	0	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	
W10	−	0	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	
W11	5	15	5	10	3	1	5	1	1	3	2	2	2	2	1	2	2	62	
W12	−	0	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	
W13	−	0	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	
W14	5	15	5	10	3	1	5	1	1	3	2	2	2	2	1	2	2	62	
W15	5	15	5	10	3	5	5	1	1	3	2	2	2	2	1	2	2	66	

Table 1.4 Project Summary

site	Reuse pump	In-stream	Rural sewage	Compost
E1	1.0 m^3/s	-	-	-
E3	-	(to be reconsidered)	-	-
E4	0.5 m^3/s	-	-	-
W2	1.0 m^3/s	-	-	-
W4	0.5 m^3/s	-	-	-
W5	1.0 m^3/s	○	○	○
W7	1.0 m^3/s (substitute site)	-	-	-

2 Current Situations of Pilot Project Sites

2.1 Agriculture

(1) Cropping pattern

Figure 2.1 shows the cropping patterns in the pilot project sites, namely, E1, E4, W2, W4, and W5. The information regarding cropping pattern in the figure was obtained in 2012, through the interview to agricultural cooperatives whose jurisdictions cover the pilot project sites.

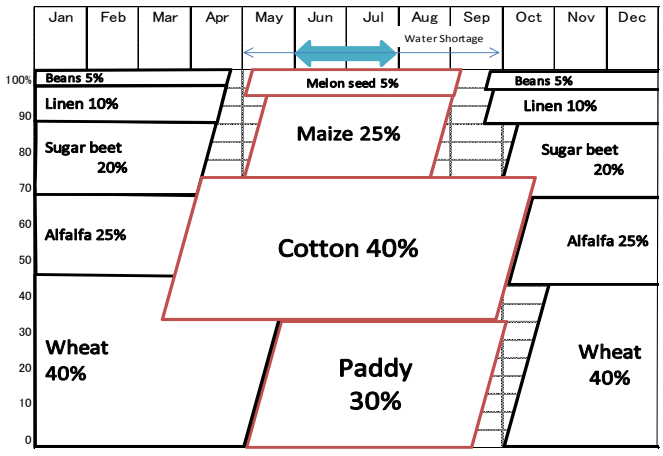
The major crops in summer and winter seasons are the same as those at the governorate level, namely rice (paddy), cotton and maize as summer crops and wheat, sugar beet and alfalfa as winter crops. In addition to the traditional crops (major crops are conventionally called “traditional crops”), melon seed (Cantaloupe) is comparatively often cultivated in the sites. The diversity of crops cultivated by one farmer is very limited, especially small-scale farmers.

The majority of farmers in the pilot project sites are generally practicing crop rotation for soil fertility conservation and soil management. It is effective for suppressing weed and soil diseases to alternate crop type / land use (flooded/upland) year by year. In addition, cotton cultivation exhaust soil fertility quicker compared to other crops. Therefore, it would be essential and reasonable for the farmers to practice crop rotation.

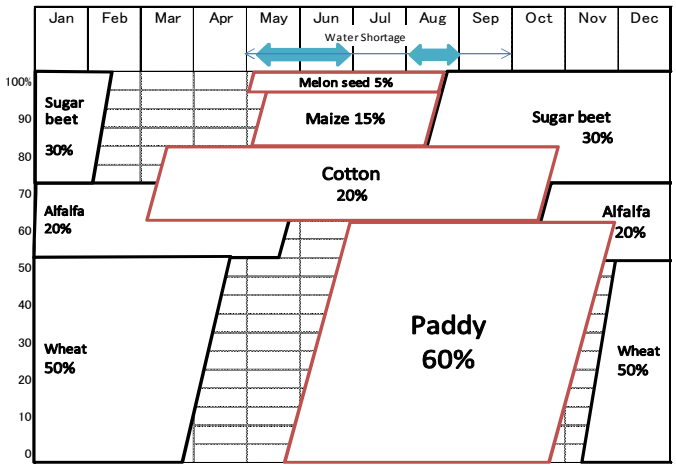
With regard to water availability, the farmers especially in the downstream area of the sites often experience water shortage in the summer season as shown in Figure.2.1. In the downstream area, the farmers sometimes have no choice but to use drainage water for irrigating their field when water from irrigation canals is not sufficient. The farmers in the downstream area are worrying about the low quality of drainage water and think it can affect their crop production, although the impact of the quality of drainage water to crop production is not clear. As a matter of course, the farmers normally consider and expect availability of irrigation water and decide on the crops to be cultivated. However, even though the farmers know required water amount for cultivating rice is considerably larger than other crops, they are keen to cultivate rice because of its high profitability.

In addition, although the farmland area permitted to be used for rice cultivation is officially regulated by MWRI and MALR for equal irrigation water distribution over the service area, the farmers seem like they are not taking care of the regulation. It is partially because MALR gave farmers permission to plant any crops they like 20 years ago and the farmers still seem not aware of the recent regulation. Therefore, the cropped area of each crop has been fluctuating year by year. As a result, water management is more complicated.

E1: Marsa Al Gamal



E4:Mekhazan



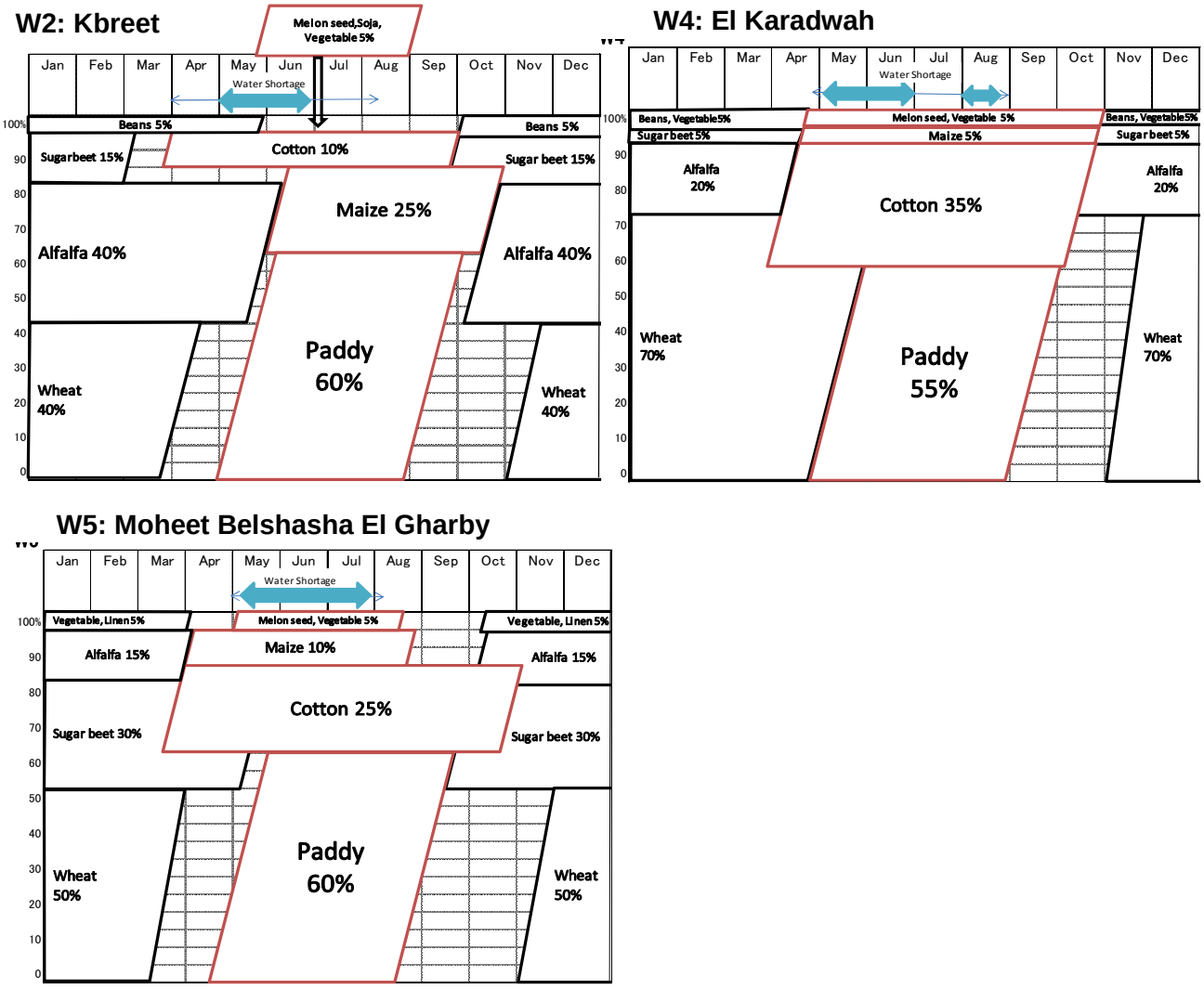


Figure 2.1 Cropping pattern in the pilot project sites

Source: JICA Study team (2012)

Note: The data shown in the figure was obtained from interview to the agricultural cooperative officers, those who exercise jurisdiction over the pilot project sites. It was described orally by the officers based on the record of cropping area kept in the agricultural cooperative.

(2) Rice cultivation

Rice is cultivated in summer season, from April to October. Cultivation period is sometimes delayed because of the unavailability of irrigation water in April, especially in downstream areas. Over recent years, since the price of cotton has been low and rice is becoming one of the popular crops for farmers, the farmers tend to expand the area of rice field.


Transplanted rice seedlings

There are three (3) ways of Planting; 1) Broadcasting manually, 2) Transplanting seedlings manually and 3) Transplanting seedlings by machine. The amounts of sawed seeds by broadcasting and transplanting range from 60 to 75 kg / feddan and from 40 to 45 kg/ feddan, respectively. (JICA Study Team, 2012) The farmers transplant seedling 30-45 days after seed sowing, and plant 6-10 seedlings/hill, and planting density is very high.

Commonly used fertilizers are urea, superphosphate and nitrate and ammonium sulfate. The total applied amount of fertilizer range from 200 to 300kg per feddan. The estimated total applied nitrogen ranges from 160 to 280 kg/ha *1, and it was greatly larger than Japanese standard of nitrogen application rate. During the interview to the farmers in 2012, it was found that cash outlay for purchasing fertilizer account for the large part of total farming cost.

Harvesting operation is practiced manually or by the harvester. The farmers are eager to utilize the harvester to reduce cost for hiring labor; however, utilization of the harvester is sometimes difficult because rice plant often fall down in the harvesting period. (see picture) It may be because of excess amount of nitrogen application over the cultivated rice varieties' adaptability for heavy manuring.


Rice plants fallen down in harvesting period

The usual yield estimated by the farmers is approximately 2-4 tons per feddan (equal to 4.7-9.5 t/ha) according to the interview to the farmers. (JICA study team, 2012 and 2014)

(3) Other Crops

Summer Crop

Cotton: Cotton is often planted at the harvest time of onions (onions are exported to European countries and the Arab countries, mainly). Cotton is sown next to the furrow where onions are planted, and it aims at the effective land use in March / April. During the period from the early to mid- October to November, the farmers harvest cotton manually. The price of cotton was 1,700 LE/156kg in 2013. Recently farmers tend to cultivate rice instead of cotton because of its lower market price and high labor cost. Labor cost for harvesting cotton by hand is especially high compared to other crops. The farmers interviewed in 2012 usually spend 2,000 -4,000 LE per feddan on cotton harvesting labor, meanwhile the harvester rental cost for rice was only around 300 LE per feddan. This means that cotton is not a beneficial crop for farmers in terms of cost effectiveness anymore nowadays.


Harvest of Cotton

Maize: Maize is cultivated as green fodder and for people's consumption. The planting density is different depending on the purpose of use. The farmers plant maize densely when it is for fodder, while they plant it with wide intervals when it is for grain as food. Intercropping of maize and watermelon is practiced for the purpose of effective land use. According to the interview in 2014, nitrogen fertilizers, namely Nitrate and Urea are mainly applied. Total nitrogen applied amount per feddan was 100-230 kg/feddan. Fertilizer application is practiced at the time of the irrigating field. Due to the lack of irrigation water resulting in insufficient effect of fertilizer, maize is often damaged and the stalks become very thin. However, according to the interview conducted in 2013 to the farmers along Karadwah canal, some farmers in the downstream area experienced damage of maize roots caused by high ground water level. Hence, the farmers in the area are willing to cultivate paddy instead of maize.

Winter Crop

Wheat: Wheat is cultivated from November to April in the winter season. Wheat covers 40-70 % of

the total cultivated area in the winter season. The planting density of wheat is high, and some diseases caused by seed infection, for instance stinking smut, were observed in the project site. It is necessary that agricultural extension officers promote using certified seeds with good quality and appropriate varieties in cooperation with an agricultural research institute.

Wheat spike in the field affected by stiking

Sugar beet: It is generally produced under a contract between the farmers and a private sugar company. After the harvest, the farmers transport their produce to a collecting point appointed by the sugar company. Since the shipment schedule is settled to make it suited the convenience of the sugar company, farmers have cannot ship out their produce just after harvesting and have no choice but to wait for certain period. Moreover, the farmers do not have warehouse for storage of harvested sugar beets. Therefore, the farmers usually leave harvested sugar beet on street or farmland, and which cause deterioration of product quality. Sometimes next cultivation is delayed because harvested sugar beets occupy farmland for long time.

Alfalfa: Alfalfa is cultivated from October to April, seven month, generally and it can be harvested four to five times during the period. The available amount of fodders (alfalfa and maize) is sometimes not enough, so some farmers give aquatic plants such as reeds growing along canals to domestic animals as fodder.

2.2 Irrigation and Drainage

It is important to grasp the situation of water management at the pilot project sites by water discharge measurement. At the W4 site, there is Karadwah Branch Canal is equipped with improved Mesqas at upstream, midstream and downstream, and it is easy to measure water discharge. In terms of irrigation and drainage, the service area of the Karadwah Canal covering the W4 pilot site can be regarded as a sample site on the branch canal level, since it is the most typical site among the pilot project sites. Therefore, a water management survey was implemented at W4.

1) Operation and Management of Intake Gate

On the 1st day of the 4 day irrigation period under the rotational irrigation system, the Bahary (= gate operator) opens the intake gate (a steel gate with 2 m width x 1 gate) of the Karadwah Branch Canal. He then adjusts the check gate (two steel gates with 2.45 m width x 2 gates) on the Shaba Canal to keep the certain water level at downstream of the gate facility. On the investigation day, 31st of October, 2013, its water level was 1.5 m. On this summer season, the check gate operation was done at the upstream water level of the facility twice to three times during the summer cropping period as an unusual case. It is supposed that such water management has been done by considering the overall water balance of the Shaba Canal irrigation area. These works were done by the Bahary under the instruction of the inspector of the Irrigation Department of Kafr El Sheikh Governorate (refer to the photo right).

Check Gate on Shaba Canal (KM2.5)

Upstream of the intake facility, there is floating garbage (plastic containers, foam polystyrene containers, etc.) from the daily life of the inhabitants. The Irrigation Department should remove it and keep clean the facility. It seems that the removing works are not carried out. It is necessary to remove the garbage and clean the facility. In addition, awareness is needed so that people do not dispose their garbage in the canal.

2) Operation of Intake Gate of Karadwah Canal

The 24 hour continuous flow is carried out for the winter season from September to next April and the simple rotational irrigation system, which consists of 4 days-ON and 6 days-OFF in principal, is applied for the period of the summer cropping season, namely, from May to August. The data of water level at upstream and downstream of the facility are kept by the Irrigation Department. However, exact gate opening and closing times are not recorded.

Intake Gate of Karadwah Canal

During the winter season, the flow discharge is decreased by adjusting the gate operation. Even during this period, sufficient water has reached until the maximum water level of the spillway at end point (EP) of the Karadwah canal.

On the intake facility of the Karadwah canal, the Neyrpick gate (an automatic discharge control gate with float) was installed for automatic inflow control. But, the gate equipment was adjusted by surrounding farmers by adding stones on the float to increase gate opening degree, which is illegal. As a result, the gate is not functional as planned (refer to the photo right). At this intake facility, much garbage is accumulated at the upstream of the facility, similar to the check gate facility on the Shaba canal.

3) Intake Discharge to Karadwah Canal

The intake discharge was measured using a current-meter at the intake facility. Based on the observation, during the winter season from September to next April, the intake discharges varied from about 0.6 to 1.0 m^3/sec. However, during summer season, the discharge was increased to around 2.5 m^3/sec for cultivation of rice and cotton (refer to the photo right).

Discharge Measurement at Karadwah Canal

In the year 2013, the improvement works of canal side slopes were intermittently carried out from May to July. Usually, the water flow during the OFF period of 6 days, in principal, is perfectly stopped at the improvement Mesqa pump station No. 6 (refer to Figure 2.2). Given that No.6 station is located upstream of the improvement works mentioned above, it is supposed that the service area of pump station No. 6 could enjoy more water in 2013 than in other years.

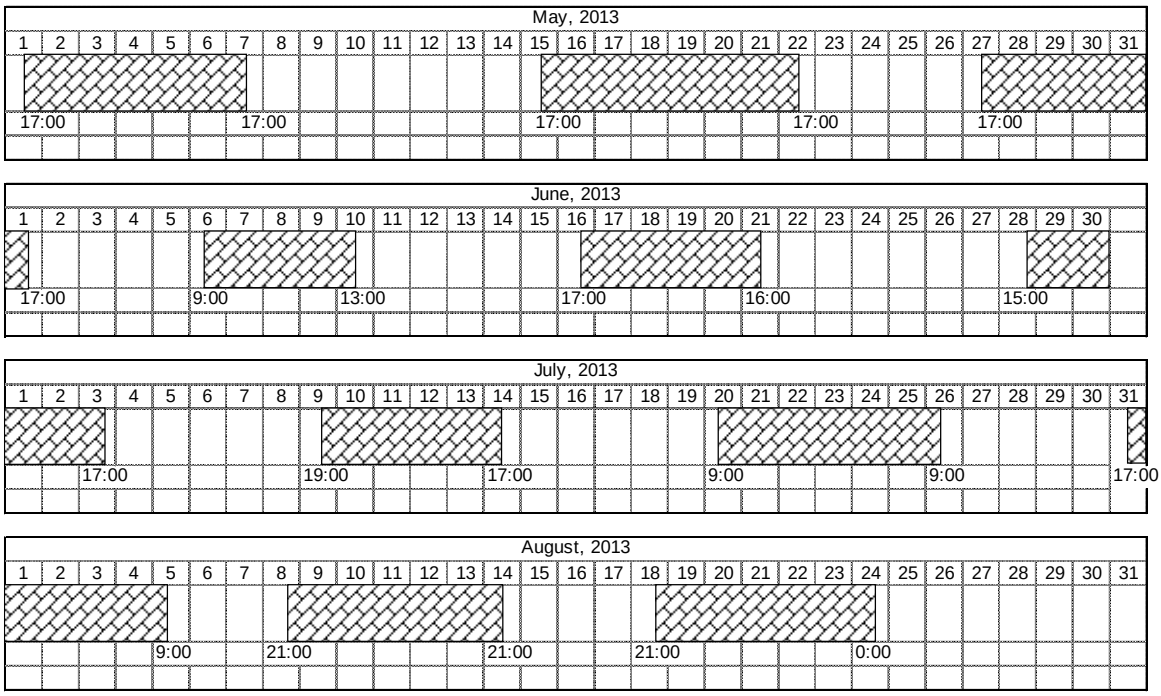


Figure 2.2 Irrigation Water Supply Record Karadwah Canal in summer, 2013

4) Water Management within Karadwah Canal

The check gate was installed at the point KM 3 (3 kilometers from the start) on the Karadwah canal. It is assumed that the gate is not operated at present due to the rotational irrigation system in the summer season.

According to the water intake schedule of the Karadwah Canal ruled by the Irrigation Department, on the1st and 2nd day of the ON period, the farmers in the upstream area can take water from the canal, and on the 3rd, 4th, or another day, the farmers in the downstream area can. However, during the bigger water demand periods, the farmers get water from the canal using pumps, when water flows into it. Any offenders do not pay any penalty to over-intake volume. The number of persons who collects the penalty, however, is insufficient. (These sentences are opposite in meaning).

Farmers at the midstream do not complain about water shortage problems to the Irrigation Department, while the farmers at the downstream area do. It is because that more water passes the mid-stream area and they can access it.

5) Water Management on ON-Farm Level

The irrigation water is taken by the improvement Mesqa pump to a delivery tank. A pipeline Mesqa(s) having many valves as a division device is placed at the head of the Marwas (refer to the photo right).


Improved Mesqa with Delivery Tank

In the improved Mesqa areas, farmers have to provide fuel by themselves for pump operation. The pump operator must manage the equipment in accordance with the farmers' request(s). The pump was operated for three (3) days continuously to meet the demand at the maximum water demand time.

The farmer opens the valve in a division device to supply water to his farmland for his set hour. Most of Marwa is

a non-paved small canal and its length is around 1 km or less at most.

6) Water Distribution

In order to grasp the water distribution situation of the irrigation area of the Karadwah Canal, every three (3) pump stations with improved Mesqa were selected at the upstream, midstream and downstream areas. The cropping situation of this summer season and pump operation records from April to August were collected by the leader of WUA and/or the pump operator. Since the data of Pump Station No. 1 and No. 39 have a lack of reliability, the reaming data were used for analysis (refer to Figure 2.3).

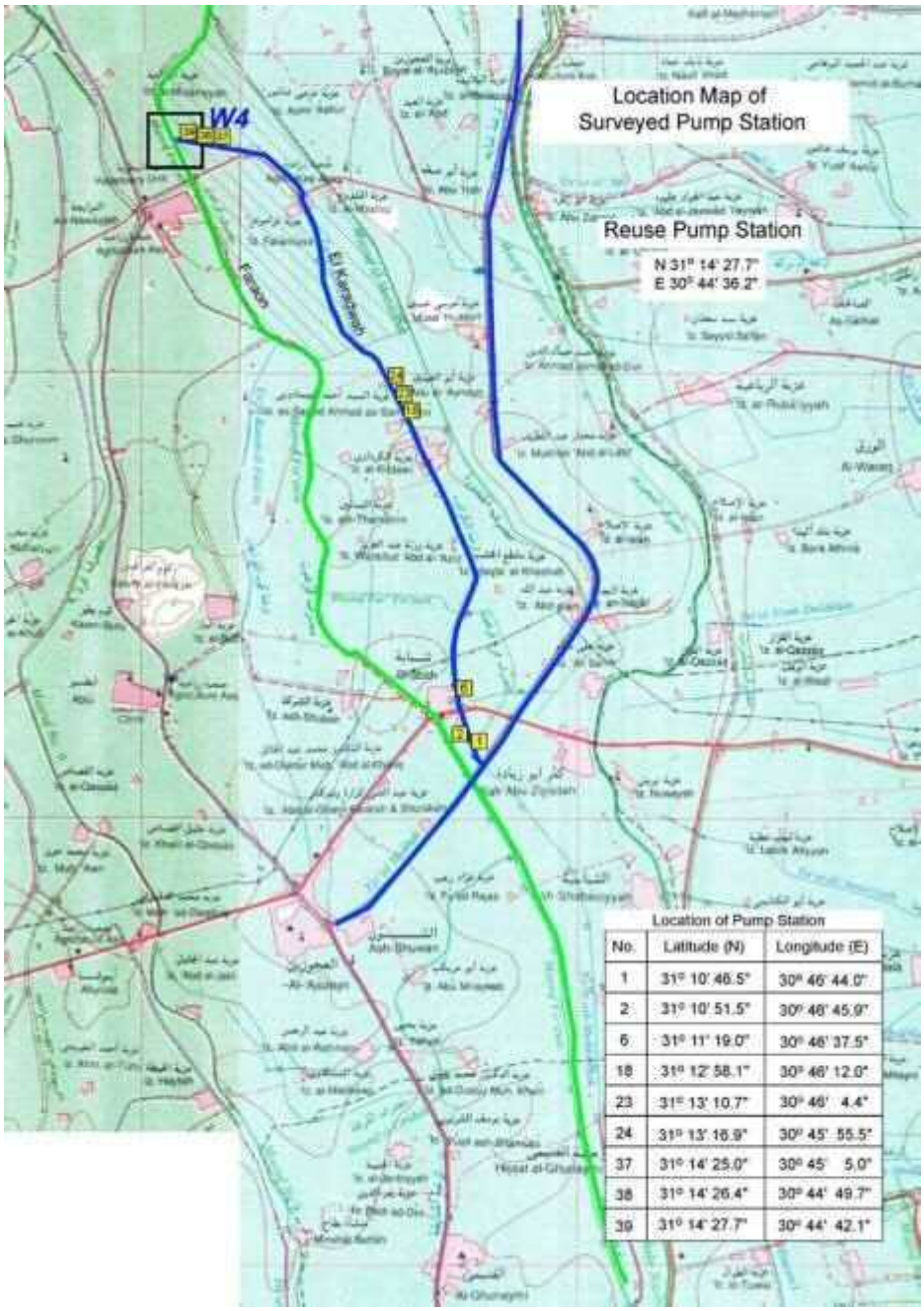


Figure 2.3 Location Map of Surveyed Pump Station

In the upstream area, No. 1, 2 and 6 pump stations (PSs) were selected as samples, which are located near the intake facility of the Karadwah Canal. In the area served of No.1 PS, a steel pipe aqueduct crossing the Faraon drainage canal conveys water to farmlands that have about 10 feddan.

In the midstream area, No. 18, 23 and 24 PSs were selected as samples near Al-Kirdawi village. At the east edge of these areas covered by the El Manduran drainage canal are flowing parallel to the Karadwah Canal. The drain water cannot be used for agriculture due to poor water quality (according to farmers' experience) and adverse ground slope. However, during the severe water shortage period, some farmers who have farms along the canal can use the drained water for irrigation.

In the downstream area, No. 37, 38 and 39 PSs were selected as samples. On the boundary between No. 37 and No. 38 PSs, an existing unpaved Mesqa is located. This Mesqa did not join the IIMP or IIIMP until now. They get water from the Karadwah canal by using small-scale mobile engine driven pumps individually.

7) Present Situation of Water Shortage

The following information was collected through hearing to leaders of WUA and pump operators in the service area of the Karadwah Canal.

In July and August, when water demand is the highest, the water shortage situation becomes severer. During the planned water distribution period of 4 days, irrigation water will reach at the downstream area for 3 to 6 hours on the 4th day only. The water amount is insufficient to operate the pump(s) under the improved Mesqa. Even though farmers request more water from the Irrigation Department, irrigation water could not reach the area sufficiently on the remaining days. Therefore, the farmers are forced to use drain water by using their small-scale mobile engine pump(s), which are placed along the Faraon drainage canal. They draw the drained water at the EP of the Karadwah Canal. The taken water runs reversely to the upstream of the canal and the water should reach around 1.2 km from the EP since the water shortage area is expanded 1.2 km from the EP.

On the midstream area of the canal, the Faraon branch drainage canal runs in parallel with the Karadwah canal. Since water quality of the drain is not suitable for farming (according to farmers' experience), they have to use the drain water in case of water shortage. Moreover, the drain water is limited to use only for the farm lots along the drainage canal. On the upstream area, there is no water shortage problem.

8) Status of Use of Existing Drain Water Reuse Pumps

Along the Faraon drainage canal, there are 16 small-scale movable pumps for lifting drain water to the irrigation canal. Farmers can use the drained water by other pump(s) of the improved Mesqa for their farmlands through a Marwa (farm ditch).

The lifting capacity of a pump of the improved Mesqa facility is almost equal to a lifting capacity of 2 sets of the small-scale movable pumps. The operating number of small-scale movable pumps, therefore, depends on the operation number of the pump(s) of the improved Mesqa pump stations. Until No. 37 of the improved Mesqa pump station, this rule can be applied. However, for the Improved Mesqa pump stations at more upstream, 6 small-scale movable pumps should be operated to secure a suitable water level to suck the water by a pump of the improved Mesqa pump station.

9) Operating Situation of Reuse Pump of Drain Water

Some farmers can use the small-scale movable pumps for reuse of the drain water under the permission of the pump owner, and they have to bring fuel for the pump operation. If there are many pump users, the top priority is given to the farmer who is suffering from water shortage most through

the discussion among the users. If upstream users operate the pump, the downstream users cannot take water from the branch canal due to water shortage.

10) O&M of Pumps of Drain Water Reuse

Small-scale movable pumps are privately owned and the necessary O&M works are usually done by the owner. During pump operation hours, the necessary O&M cost is commonly shouldered by the user(s). However, the owner, sometimes, shoulders the repairing cost instead of the pump user(s) because they are relatives in the area. On farming works, the cooperative works are done by them. In this light, farmers who operate PS No. 32 to No. 39 are somehow relatives. Therefore, the pump equipment is easily rented.

11) Water Balance Analysis

a) At Mesqa Level1

The irrigation and cropped areas' data were collected from an interview with the leader of WUA and/or pump operators. The unit water requirement from the MWRI, 2012, was applied to estimate water demand, and irrigation efficiency of assumed 0.9 was also applied for on-farm level analysis.

The actual daily pump operation with start times and end times were recorded by the pump operator.

The lifting capacity of the pump(s) was collected from the plate on the pump equipment. The nominal lifting capacity is 60.3 lit/sec and the lifting efficiency of 0.9 was assumed.

The water balance analysis in the summer cropping season period of 4 months (from May to August) was carried out on a 10-day basis.

According to the result of these analyses on the upstream area, water shortage is shown in June and July. But in other months, over lifting was observed. The ratio of the total water demand and total lifted volume for these 4 months is 1.0:1.3 (=148,936: 198,595) (refer to Table 2.1).

Table 2.1 Water Balance Study of PS No.2 for Summer Season, 2013

Crop Name	Cropped Area and Ratio	
	Planted Area (feddan)	Ratio (%)
Cotton	5	16
Rice	27	84
Summer Maize	0	0
Summer Others	0	0
Total	32	100

Irrigation Efficiency = 0.9 Pump Lifting Efficiency = 0.9

Month	Decade	Cotton	Rice	Summer Maize	Summer Others	NWR (MCM/decade)	GWR (MCM/decade)	Lifted Water Volume (M3/decade)	Balance (MCM)
May	1	166.6	415.9	64.9	106.0	12,062	13,402	11,088	-2,314
	2	166.6	415.9	64.9	106.0	12,062	13,402	16,038	2,636
	3	183.4	457.4	71.4	116.5	13,267	14,741	33,660	18,919
Jun	1	215.6	485.8	186.2	134.4	14,195	15,772	18,018	2,246
	2	215.6	485.8	186.2	134.4	14,195	15,772	22,770	6,998
	3	215.6	485.8	186.2	134.4	4,195	15,772	16,038	266
Jul	1	239.8	459.3	272.1	95.4	13,600	15,111	14,058	-1,053
	2	239.8	459.3	272.1	95.4	13,600	15,111	13,662	-1,449
	3	263.8	505.1	299.2	105.1	14,957	16,619	18,612	1,993
Aug	1	124.6	119.2	223.7	56.9	3,841	4,268	19,306	15,038
	2	124.6	119.2	223.7	56.9	3,841	4,268	7,128	2,860
	3	137.2	131.2	246.0	62.6	4,228	4,698	8,217	3,519
Total		2,293.2	4,539.9	2296.6	1204.0	134,043	148,936	198,595	49,659

As for the ratios of the midstream, almost the same trend of the upstream area was shown, and the ratio of total water demand to the total lifted volume was 1.0: 1.7 (=169,421: 281,942). This means more water was taken (used?) than demanded (refer to Table 2.2).

Table 2.2 Water Balance Study of PS No.23 for Summer Season, 2013

Crop Name	Cropped Area and Ratio	
	Planted Area (feddan)	Ratio (%)
Cotton	10	24
Rice	26	61
Summer Maize	6	14
Summer Others	0	0
Total	42	100

Irrigation Efficiency = 0.9 Pump Lifting Efficiency = 0.9

Month	Decade	Cotton	Rice	Summer Maize	Summer Others	NWR (MCM/decade)	GWR (MCM/decade)	Lifted Water Volume (M3/decade)	Balance (MCM)
May	1	166.6	415.9	64.9	106.0	12,661	14,068	24,750	10,682
	2	166.6	415.9	64.9	106.0	12,661	14,068	19,008	4,940
	3	183.4	457.4	71.4	116.5	13,926	15,473	22,958	7,485
Jun	1	215.6	485.8	186.2	134.4	15,661	17,401	26,532	9,131
	2	215.6	485.8	186.2	134.4	15,661	17,401	25,146	7,745
	3	215.6	485.8	186.2	134.4	15,661	17,401	18,414	1,013
Jul	1	239.8	459.3	272.1	95.4	15,743	17,492	33,264	15,772
	2	239.8	459.3	272.1	95.4	15,743	17,492	18,216	724
	3	263.8	505.1	299.2	105.1	17,313	19,237	27,918	8,681
Aug	1	124.6	119.2	223.7	56.9	5,628	6,253	26,730	20,477
	2	124.6	119.2	223.7	56.9	5,628	6,253	22,572	16,319
	3	137.2	131.2	246.0	62.6	6,194	6,882	16,434	9,552
Total		2,293.2	4,539.9	2296.6	1204.0	152,480	169,421	281,942	112,521

At the downstream area, within 4 months (120 days), the period of 70 days shows water shortage. Furthermore, most of the lifted water is supplied from the Faraon drainage canal according to the farmers' information. Under this analysis, this area is chronically suffering from water shortage in the summer season. The ratio of lifted volume to water demand is 0.7: 1.0 (=129,888: 180,461). This fact shows the severe condition of water shortage (refer to Table 2.3).

Table 2.3 Water Balance Study of PS No.38 for Summer Season, 2013

Crop Name	Cropped Area and Ratio	
	Planted Area (feddan)	Ratio (%)
Cotton	2.5	7
Rice	33.5	88
Summer Maize	2.0	5
Summer Others	0.0	0
Total	38.0	100

Irrigation Efficiency = 0.9 Pump Lifting Efficiency = 0.9

Month	Decade	Cotton	Rice	Summer Maize	Summer Others	NWR (MCM/decade)	GWR (MCM/decade)	Lifted Water Volume (M3/decade)	Balance (MCM)
May	1	166.6	415.9	64.9	106.0	14,479	16,088	9,900	-6,188
	2	166.6	415.9	64.9	106.0	14,479	16,088	20,790	4,702
	3	183.4	457.4	71.4	116.5	15,924	17,693	4,356	-13,337
Jun	1	215.6	485.8	186.2	134.4	17,186	19,096	5,544	-13,552
	2	215.6	485.8	186.2	134.4	17,186	19,096	13,266	-5,830
	3	215.6	485.8	186.2	134.4	17,186	19,096	4,158	-14,938
Jul	1	239.8	459.3	272.1	95.4	16,530	18,367	11,484	-6,883
	2	239.8	459.3	272.1	95.4	16,530	18,367	10,692	-7,675
	3	263.8	505.1	299.2	105.1	18,179	20,199	5,940	-14,259
Aug	1	124.6	119.2	223.7	56.9	4,752	5,280	12,474	7,194
	2	124.6	119.2	223.7	56.9	4,752	5,280	12,870	7,590
	3	137.2	131.2	246.0	62.6	5,230	5,811	18,414	12,603
Total		2,293.2	4,539.9	2296.6	1204.0	162,413	180,461	129,888	-50,573

b) At Branch Canal Level

At the intake point, the discharge measurement was done as mentioned before, and the total intake volume was calculated based on these data. The Irrigation Department has no records of the actual discharge of the canal, and has daily water level records only at upstream and downstream of the intake facility. The discharge measurement was carried out by using a current meter in accordance with the Irrigation Department's method. The measuring points are set at the 20 % and 80% of the water depth based on the standard in Egypt.

Since under the rotational irrigation system, on the 1st day after the gate opening, it seemed that the inflow discharge was not stable, the 2nd day was selected as the measuring day under the stable flow condition. It was assumed the discharge was almost stable during the 4 gate opening days. The gate opening and closing times were also collected from the Irrigation Department. The intake discharge was calculated by using both data of the actual discharge volume and the gate opening duration. Irrigation efficiency, namely 0.85, was applied for the branch canal level.

The unit water requirement of the MWRI in 2012 was applied. On the other hand, total growth area data from the agricultural cooperatives was different from that from Irrigation Department. Therefore, considering the total area data from the Irrigation Department and the data of proportion of each crop from the agricultural cooperatives, each crop growth area was calculated.

According to the result of the water balance study, the ratio between the total intake volumes to the water requirement for 4 months in summer season was 0.9: 1.0. The improvement works of the canal side slopes around downstream of PS No.6 may have affected the intake discharge during this summer season from May to July as mentioned before. According to the water balance study, for the last 10 days of June to the mid 10 days of July, 61% (=760,148/1,230,813) to 71 % (=881,105/1,228,712) of the water demand was supplied. This fact shows that a more efficient water distribution plan is necessary (refer to Table 2.4).

Table 2.4 Water Balance Study of Karadwah Canal for Summer Season, 2013

Crop Name	Cropped Area and Ratio	
	Planted Area (feddan)	Ratio (%)
Cotton	870	29
Rice	1,581	53
Summer Maize	324	11
Summer Others	225	8
Total	3,000	100

Irrigation Efficiency = 0.85

Month	Decade	Cotton	Rice	Summer Maize	Summer Others	NWR (MCM/decade)	GWR (MCM/decade)	Lifted Water Volume (M3/decade)	Balance (MCM)
May	1	166.6	415.9	64.9	106.0	847,358	996,892	1,555,649	558,757
	2	166.6	415.9	64.9	106.0	847,358	996,892	1,078,077	81,185
	3	183.4	457.4	71.4	116.5	932,054	1,096,534	1,065,012	-31,522
Jun	1	215.6	485.8	186.2	134.4	1,046,191	1,230,813	1,226,000	-4,813
	2	215.6	485.8	186.2	134.4	1,046,191	1,230,813	945,540	-285,273
	3	215.6	485.8	186.2	134.4	1,046,191	1,230,813	760,148	-470,665
Jul	1	239.8	459.3	272.1	95.4	1,044,405	1,228,712	881,105	-347,607
	2	239.8	459.3	272.1	95.4	1,044,405	1,228,712	829,409	-399,303
	3	263.8	505.1	299.2	105.1	1,148,657	1,351,361	865,621	-485,740
Aug	1	124.6	119.2	223.7	56.9	382,139	449,575	867,380	417,805
	2	124.6	119.2	223.7	56.9	382,139	449,575	531,178	81,603
	3	137.2	131.2	246.0	62.6	420,580	494,800	572,141	77,341
Total		2,293.2	4,539.9	2296.6	1204.0	10,187,668	11,985,492	11,177,260	-808,232

12) Effective Water Resources Utilization on On-Farm Level

As mentioned above, water shortage partially appears in the project area. However, increasing population needs more water for their agriculture, industries, and their daily life, and more effective water resources utilization will be required in Egypt in the near future. Regarding this matter, the following countermeasures might be recommended on On-Farm Level.

a) Establishment of Branch Canal Water Users Association (BCWUA)

In the area served of the Karadwah Canal, the BCWUA were already organized and the key members were selected. However, the relative Irrigation Law (new3) including the BCWUA relative clause has not been approved by the People's Assembly (=Parliament) yet. Thus the BCWUA cannot officially perform their responsibilities yet. At present, they can do a part of garbage management only.

The negotiation between upstream and downstream farmers has not been carried out yet regarding water distribution and management. They follow the intake rule established by the Irrigation Department, which states that the upstream farmers can get irrigation water on the 1st and 2nd days within the 4 day irrigation period, and the downstream farmers can get water on the 3rd and 4th day. When the irrigation period extends, the downstream farmers have the priority to get the water. The boundary is set at 6 km from starting point of the canal. However, this rule has no penalty clause, and so the upstream farmers commonly get the irrigation water.

As mentioned above, without communication/negotiation between upstream and downstream farmers, unequal water distribution occurs consequently leading to severe water shortage at the downstream area annually. It is desirable that the Irrigation Law (new) should be approved by the People's Assembly as swiftly as possible and that close communication should be held among the beneficiaries.

b) Farmers' Willingness to Proposed Drain Water Reuse Pump Station

As mentioned above, the farmers who are suffering water shortage are forced to use drain water for farming. Since high fuel cost can result in a decrease of their farm income, farmers are waiting for the proposed drainage water reuse pump station. One of the reasons is that the Irrigation Department shares O&M costs of the drain water reuse pump station. However, the Irrigation Department has an O&M rule that the total operation hours is limited till 1,000 hours per year and the operation period is restricted to within summer cropping season, namely, from May to August. Depending on the condition of the water shortage, the farmers request operation of the drain water reuse pump from the Irrigation Department.

c) Introducing Water Saving Irrigation Method

At present, JICA has conducted the Science and Technology Research Partnership for Sustainable Development (SATREPS) 4 for rice cultivation, etc. in the Nile Delta areas including Kafr El Sheikh Governorate, under the Technical Cooperation Project. When the outputs of the project are applied to not only the project area but also all Nile Delta areas, especially for rice cultivation, the effective utilization of irrigation water could be achieved.

d) Installation of Water Level Control Gates on Tile Drain System

The tile drain facilities had been placed under a farmland in the Nile Delta area. Many tile drain facilities are brought out to draw the groundwater table down for prevention of salt accumulation on a farmland surface. However, when the simple check gate facility is added on the existing tile drain system, the groundwater table could be easily controlled and could save irrigation water on

a farmland. For instance, if the groundwater table is raised up by closure of the check gate during a flowering stage and a growing stage of ears of rice, which need peak water demand, irrigation water could be saved. Since this period is short, from one week to 10 days, damages to other crop roots and salt accumulation may be negligible.

e) Modification of Paddy Cropping Period

Sifting of paddy cropping period can be recommended as one the alternatives. The present nursery period in April can be shifted to March, and the transplanting work could be carried out in April. In this case, harvest of paddy could be in June and/or July. During harvesting of the 1st paddy, the nursery of 2nd paddy should be prepared, making the harvesting of 2nd paddy in October. The improvement of paddy breed (from long-matured variety to short-matured variety) should be examined in collaboration with the Rice Research Center in Kafr El Sheikh. If the new variety is realized, a farmer can enjoy three (3) crops within one year. The winter crop will be limited. In cool March, the small green house can be used to protect the nursery. Consequently, the peak water demand could be decreased due to shifting the paddy cultivation period.

f) Consumption Trend of Rice

It can be said that the young generation likes rice for lunch. The rice demand will be increased accordingly with population increase in the near future. The water saving cropping method of paddy should be established.

g) Expansion of Improved Farming Method

The drain water contains much nitrogen and phosphorus, and it is needed to decrease the amount of applied fertilizers. It is, therefore, important to educate farmers not to dispose garbage in the canals and to reduce the fertilizer application. Under the reduction of fertilizer application, the farming cost would be decreased and farmers' living standard could be improved.

2.3 Water Quality of Drains in Pilot Project Site

(1) Conducting water quality monitoring of drains

Water quality monitoring survey at the drain of pilot project sites has been conducted for two years from May 2013 to March 2015 in order to monitor water quality through the year. Water samples were taken once a month in the irrigation period and once every two months in the non-irrigation period. Water quality analysis was conducted both in field analysis and in laboratory analysis. Water samples for laboratory analysis were brought to the Central Laboratory for Environmental Quality Monitoring (CLEQM) and analyzed as shown in following table.

Table 2.5 Outline of Water Quality Monitoring Survey in Pilot Project Sites

Location	5 sites of pilot project sites in Kafr El Sheich governorate
Target drains name	*East sites:* Farsh Al Ganaen (E-1), Mekhazan (E-4) *West sites:* No. 11 (W-2), Faraon (W-4), Sandela (W-5)
Frequency of monitoring	*Irrigation period:* once a month *Non-irrigation period:* once every months
Water quality parameters for monitoring	1)Temperature, 2)Electrical Conductivity (EC), 3)pH, 4)Dissolved Oxygen (DO), 5)Biological Oxygen Demand (BOD), 6)Chemical Oxygen Demand (dichromate) [COD (Cr)], 7)Total Suspended Solid (TSS), 8)Total Nitrogen (T-N), 9)Total phosphate (T-P), 10)Total

(2) Water quality monitoring result of drains

- General overview

Water quality result of drains in terms of main water quality parameters is summarized in

Table 2.6. The values shown in the table are annual mean ones of water quality in 2013 and 2014. Average value of EC varies between 0.922 dS/m and 3.229 dS/m by sites with acceptable level for irrigation reuse, while an average value of E-4 is high level reaching 3 dS/m. It is recommendable to keep monitor on these values in the future.

Average value of COD (dichromate) varies between 15 mg/l to 35 mg/l and an average value of BOD varies between 10 mg/l and 20 mg/l by sites, which are also acceptable levels for irrigation reuse. The average value of COD (dichromate) and BOD in 2014 was higher than 2013 in all sites, which indicates that water quality pollution by organic matter is going on. It is also found that T-N level and T-P level are high in all sites.

Table 2.6 Summary of Water Quality of Drains in Pilot Project Sites (average)

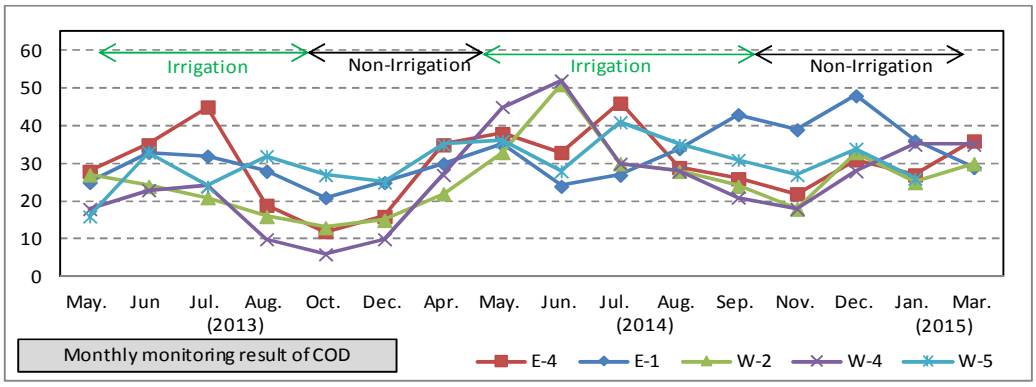
Prameters	Unit	E-1		E-4		W-2		W-4		W-5		Water reuse standard
		2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	
EC	dS/m	1.724	1.494	3.229	2.983	0.922	1.063	1.103	1.243	1.032	1.161	< 4 ds/m
DO	mg/l	3.42	3.26	1.60	3.27	3.10	2.09	2.77	3.35	2.39	2.63	–
COD (Cr)	mg/l	27	35	26	32	19	29	15	32	26	32	< 80 mg/l
BOD	mg/l	16	19	12	17	12	16	10	17	13	20	< 30 mg/l
T-N	mg/l	7.09	10.75	14.20	11.03	12.84	10.66	10.82	12.17	9.16	9.42	–
T-P	mg/l	0.582	0.501	0.328	0.330	0.395	0.304	0.328	0.261	0.378	0.293	–

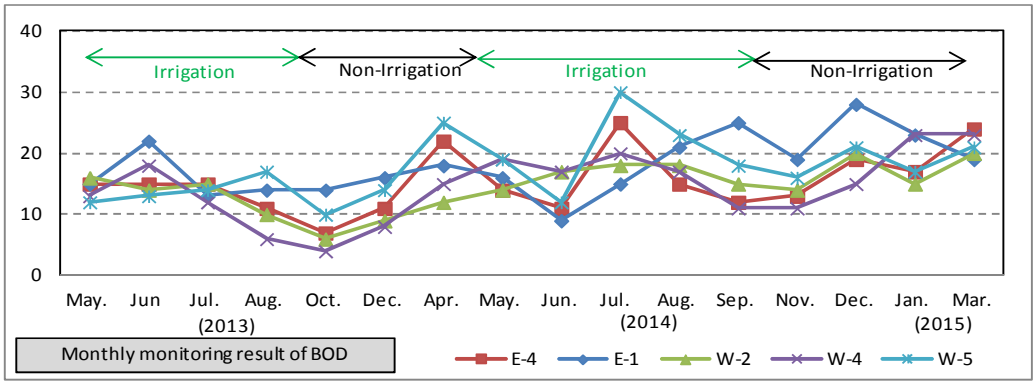
Source: JICA Survey Team

Note: The data of 2013 shows the average number from May to December in 2013 and the data of 2014 shows the average number from April 2014 to March 2015.

- Organic matter and Oxygen

The main sources of organic matter reaching the drains are domestic wastewater from villages along drains and urban untreated wastewater from upstream. A maximum value of COD (dichromate) was recorded as 52 mg/l at W2 in June 2014 and a maximum value of BOD as 30 mg/l at W4 in July 2014 (refer to Figure 2.4). Furthermore, DO value has been recorded as less than 5mg/l in all sites throughout the period. Water quality improvement in terms of organic matter and oxygen is necessary in a long term perspective. Meanwhile, significant water quality difference between irrigation period and non-irrigation period did not appear.





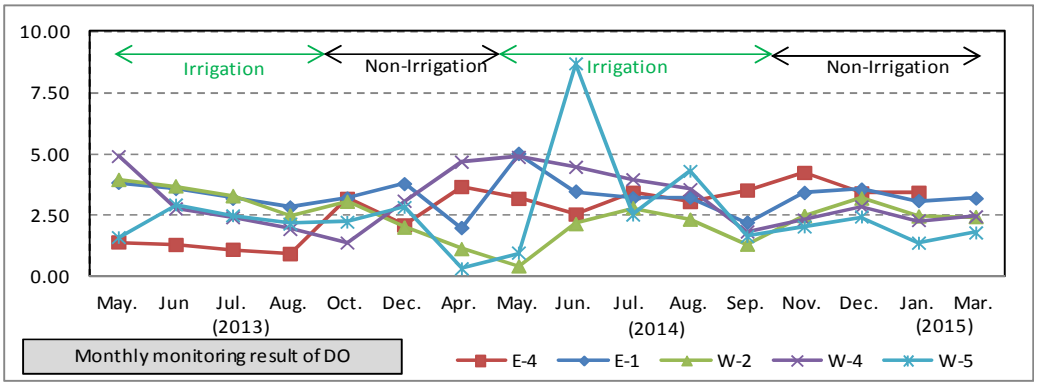
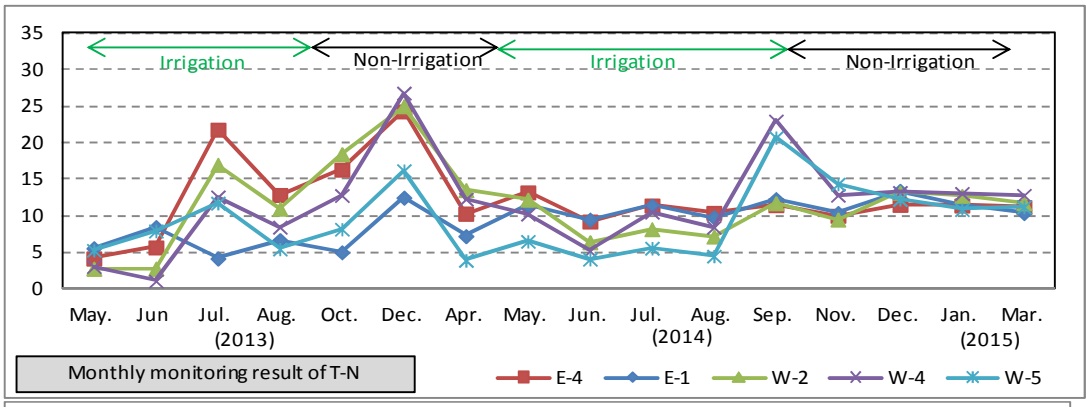


Figure 2.4 Monthly Water Quality Result Of Drains in Pilot Project Sites (Organic Matter and Oxygen)

- Nutrients

The main sources of nutrients reaching the drains are the application of fertilizers, mixing of livestock waste, as well as domestic wastewater. A maximum value of T-N as 26 mg/l was recorded at W4 in December 2013 and a maximum value of T-P as 0.8 mg/l at E1 was recorded in April 2014 (See Figure 2.5). Both parameters have been recorded at high level throughout the period. Water quality improvement is also necessary, taking nutrients pollution into consideration. Meanwhile, significant water quality difference between irrigation period and non-irrigation period did not appear, as seen with the organic matter and oxygen.



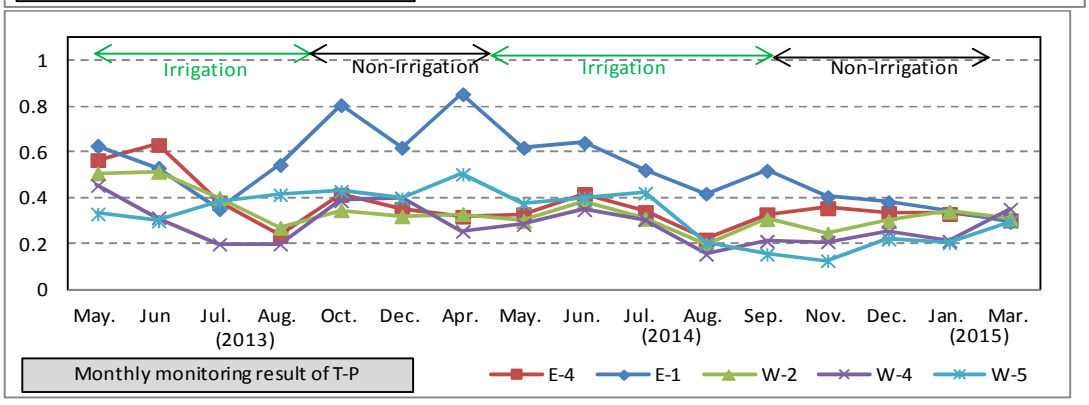


Figure 2.5 Monthly Water Quality Result Of Drains in Pilot Project Sites (Nutrients)

- Others

Full data of the water quality monitoring results of drains in pilot project sites, including other parameters, are attached in Appendix-C.

3. Implementation of Pilot Project

3.1 Implementation Schedule and Procurement

Implementation schedule of pilot project is shown on Figure 3.1. Facilities were constructed by an Egyptian contractor. Equipment of pump stations and rural sewage treatment facilities were procured in Egypt.

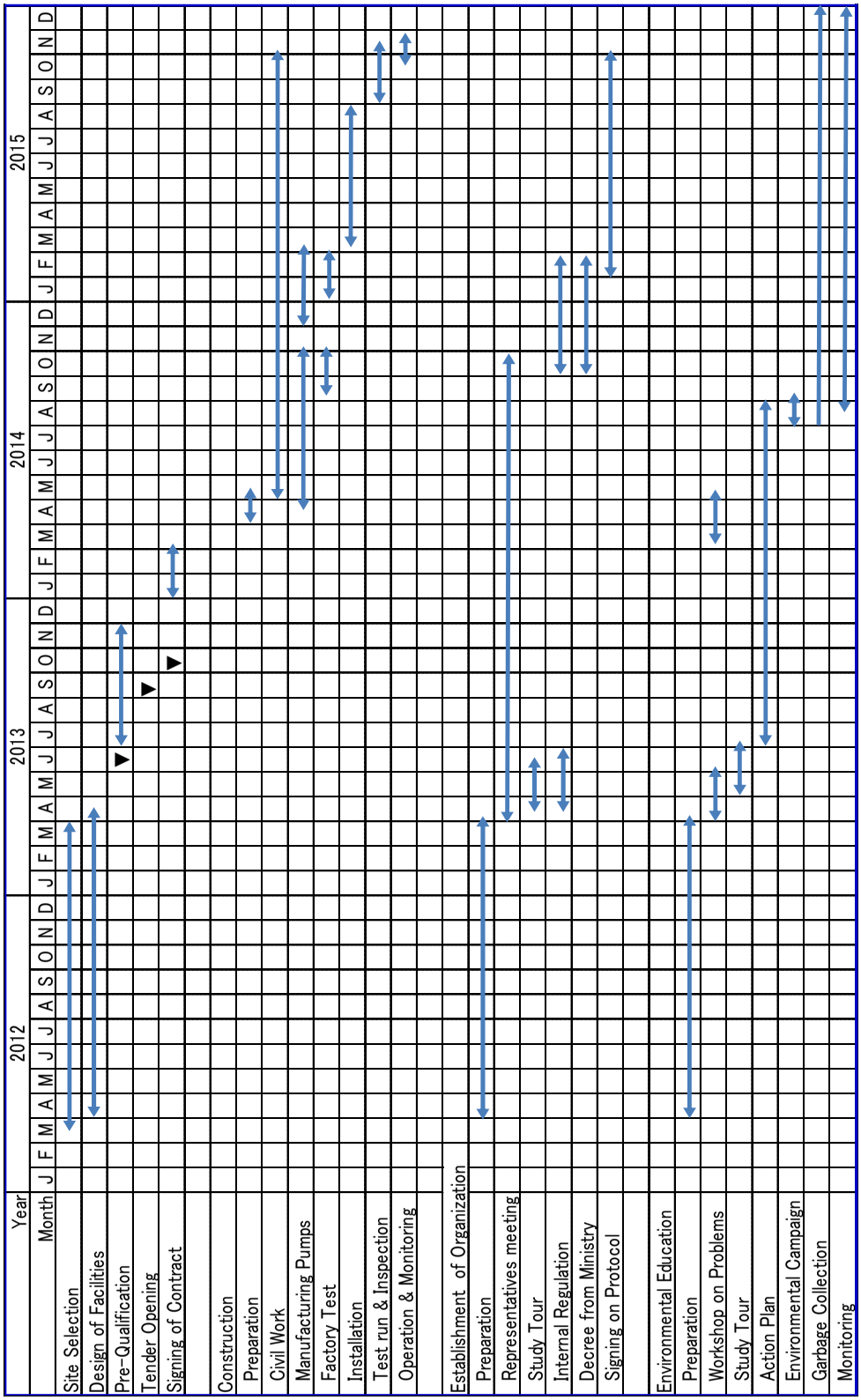


Figure 3.1 Schedule of Pilot Project

3.2 Facility Design

(1) Composting Facilities

Livestock waste that falls into the drainage that has been clogged beside drain, has been one of the causes pollution. Therefore, the pilot projects construct a composting facility, and prevent contamination of the drainage.

Roughly, a composting facility is a formula and a mechanical deposition. Mechanical is a method for using the power to ensure uniform quality by deliberate agitation. Composting purpose of these facilities in this project is the integration than composting. Composting facility planed type of deposition that is easy type of maintenance and cheap prices. And planed type L, and be installed in a side drainage. (These sentences don't make sense. I am not sure what is being said here).

Composting facilities have been installed in the drainage side of W5, and is made of reinforced concrete. As shown in Figure 3.2, L-type wall's height is of 1.5m, and its length is 50m.

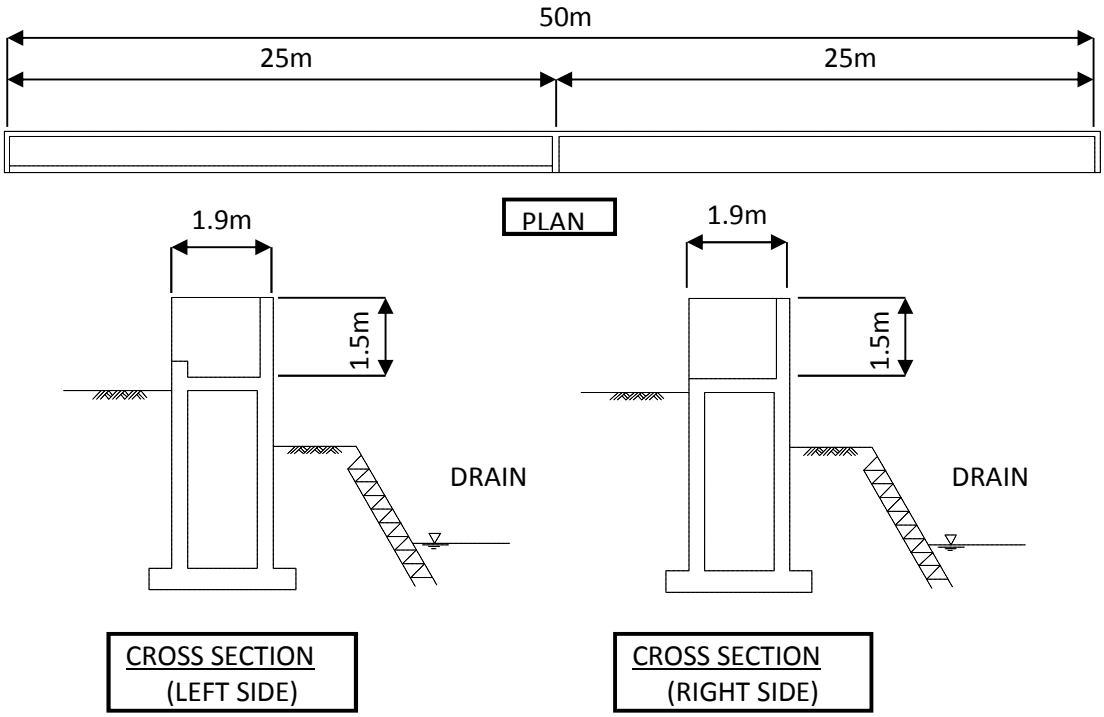


Figure 3.2 Composting Facilities

(2) In-stream Water Treatment

Installation of the in stream water treatment's purpose is to improve the water quality of irrigation water where appropriate. There are sites that as water quality in the region, such as areas of high salinity and heavy metals have been detected in trace amounts (something is missing from this sentence). However, their removal is required through a chemical treatment or a membrane process, so the maintenance cost is very high and is not suitable for use as irrigation. Water quality items of treatment are COD and SS (this makes no sense) are expected to be accompanied by the removal of nitrogen and phosphorus.

Removal of the salt is applicable through the membrane process generally. The manufacturing cost of the desalination of drinking water in general is high. Now as the economic development progresses, there is a need for maintenance costs of about 8 LE/m^3. It is also expensive in construction costs, and so the pilot project is not suitable. Therefore, the site of high salinity is excluded from the target.

The economic efficiency of irrigation water salinity examined was removed by the membrane process. If 7.8 LE/m^3 is the cost of water purification, and 10,000 m^3 of water is needed for irrigation per feddan, irrigation water fees per feddan is 78,000 LE/year. Net income by rice is generally 2,000 LE, and so irrigation using water with salt removal is impossible.

Treatment facilities for the purpose of improving water quality in canals can be constructed in river channels or major bed areas that are under the control of MWRI. Based on the comparative chart of general treatment facilities found in the Guideline for In-stream Treatment issued by the Japan Institute of Construction Engineering on March 31, 1997, an applicable treatment method for this project is shown in Table 3.1.

According to the comparative chart in Table 3.1, the possible treatment methods that can be constructed in river channels or major bed areas that are easy in maintenance of sludge disposal per year, are the following:

- Aeration
- Contact process by gravels
- Contact oxidation through interspaces plastics
- Contact aeration process by gravels
- Contact aeration with plastics
- Use of aquatic plants

In the solutions above, the use of contact media is difficult to replace. Thus if the maintenance is not the function of the drainage channel, it cannot be ensured. In stream water treatment is to proceed in the following order:

Inlet → suspended solids removal → sedimentation zone → weir → aquatic plants zone → weir→outlet

Table 3.1 Treatment Methods for River Water

Basis of Purification		Treatment Method	Applicable place		Efficiency		Necessary Sludge Disposal
			River-area	River-side	BOD (%)	SS (%)	
Physical	Filtration	Vertical Well	×	○	80～95	90～95	3-4 / year
	Aeration	Aeration	○	△	10≧	10≧	No need
Physical+ Biological	Sedimentation +Bacteria	Contact process by Gravels	○	○	60～80	75～90	1 / 5years
		Contact Oxidation through interspaces of Plastics	○	○	50～70	65～85	1-4 / year
		Granular Crushed Stone method	△	○	50～70	70～85	2 / year
Biological	Bacteria	Contact Aeration Process by Gravels	×	○	80～90	85～95	1 / 5years
		Contact Aeration with Plastics	×	○	75～85	75～85	1-4 / year
		Aeration Pond	×	○	40～50	40～60	12 / year
		Aeration + Granular Crushed Stone method	×	○	75～85	75～85	2 / year
		Laminar Flow Treatment	○	×	10～30	10～30	Flush by flood
	Use of Aquatic Plants	Reed bed	×	○	30～50	70～80	1 / year
		Water Hyacinth	○	○	30～50	30～40	1 / year
Physical+ Chemical+ Biological	Adsorptive Filtration +Bacteria	High-speed Soil Treatment	×	○	80～95	90～95	3-4 / year

Note) ○: Applicable △: Applicable depending on the conditions ×: Inapplicable

The in stream water treatment installed in W5 is shown in Figure 3.3. Its structure is a combination of sedimentation and purification plants.

Using this treatment facility, a removal performance of COD 20% and SS 30% can be ensured. Detail design is attached at the Appendix of this report.

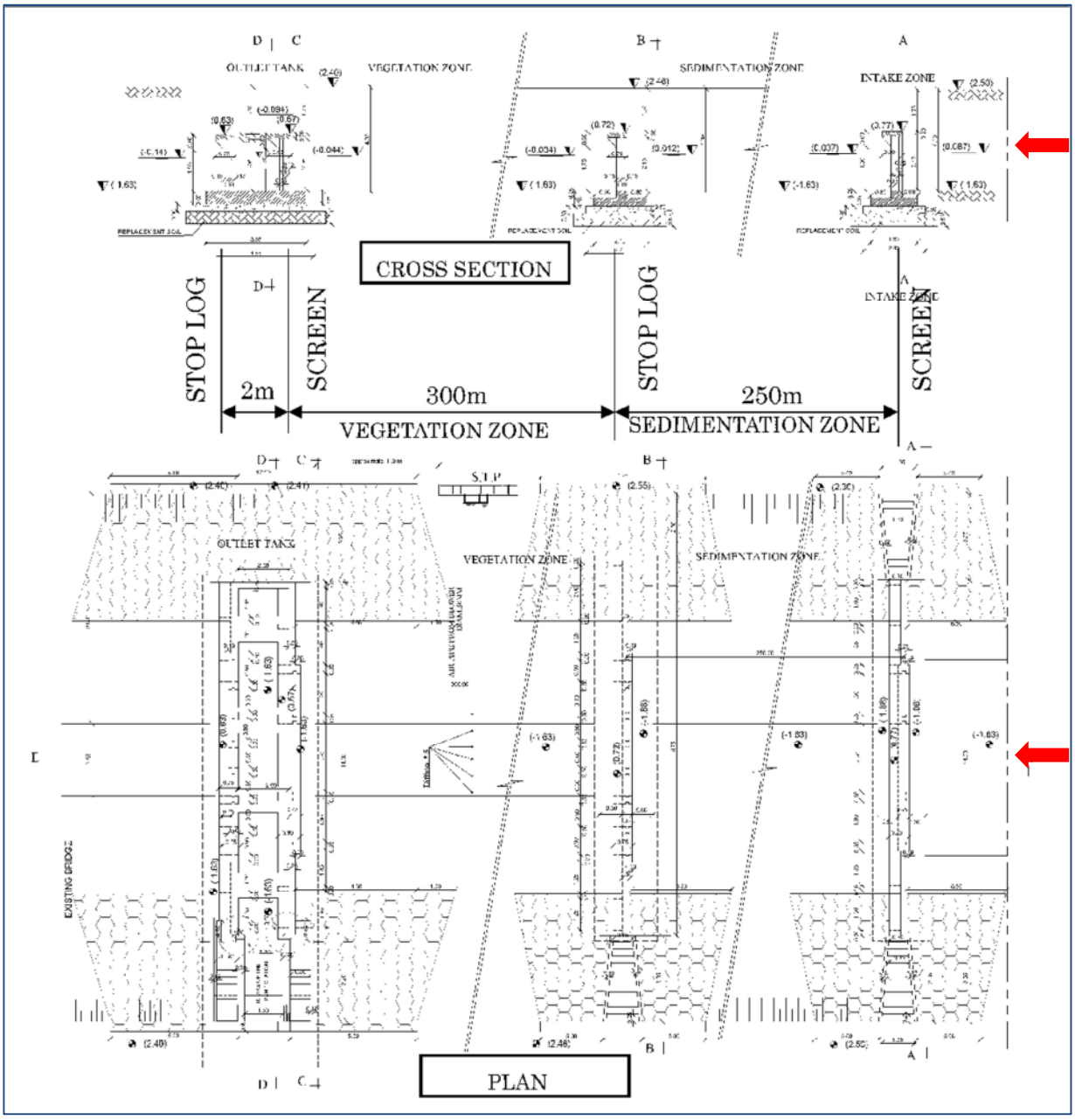


Figure 3.3 In-stream Water Treatment Facilities

(1) Rural Sewerage Treatment

1) Treatment Methods

The main treatment methods and their features in the sewage treatment facilities in rural communities in Japan will be explained below. A simple flow chart is illustrated in Figure 3.4 and a comparison table is shown in Table 3.2.

a) Septic Tank Method

- Sewage flows into a putrefactive tank, where solids are settled and separated from liquids. It is a treatment method which involves some anaerobic decomposition. Treated water will flow out of the tank to an underground soil treatment system or it will further be disinfected and drained.
- Since the system only allows the settling and anaerobic decomposition of SS-dominated BOD, the treatment capacity is low.
- Although it is no longer used in Japan because of its low treatment capacity, the method is widely used in the small-scale wastewater treatment facilities in Egypt.
- Sludge in a putrefactive tank will be removed by a truck equipped with a vacuum hose.
- Removal of sludge is the only maintenance required.

b) Sedimentation＋Contact Oxidation Method

- Sewage flows into a sedimentation tank, where solids are settled and separated from liquids.
- It is then sent to aerobic treatment in a contact oxidation tank followed by a sedimentation tank in the rear section where second sedimentation takes place. Treated water is then sent to a disinfection tank before it is discharged out of the system.
- Sludge will be transported from the second sedimentation tank to the first sedimentation tank. It will then be removed by a truck equipped with a vacuum hose.
- BOD removal rate of approximately 90% can be expected.
- Maintenance involves removal of sludge and backwashing of a contact oxidation tank.

c) Anaerobic Filtration Bed ＋Contact Oxidation Method

- Sewage flows into an anaerobic filtration bed, where solids are settled and separated from liquids and anaerobic decomposition takes place. It is then sent to aerobic treatment in a contact oxidation tank followed by a sedimentation process in the sedimentation tank. Treated water is then sent to a disinfection tank before it is discharged out of the system.
- Sludge will be transported from a sedimentation tank and an anaerobic filtration tank to a sludge thickening tank. It will be removed by a truck equipped with a vacuum hose.
- BOD removal rate of approximately 90% can be expected.
- Maintenance involves removal of sludge and backwashing of a contact oxidation tank and an anaerobic filtration bed.

d) Batch Activated Sludge Method

- After passing through a flow equalization tank, sewage will intermittently flow into a batch tank according to the time schedule. It will be treated in a batch tank by the processes of inflow, oxidation, stirring, and discharge. It will then be treated in a disinfection tank and discharged.
- After completing the sedimentation process in a batch tank, sludge will be transported to a sludge thickening tank. It will then be removed by a truck equipped with a vacuum hose.
- BOD removal rate of approximately 90% can be expected, but depending on operation performances, better treatment can also be expected.

- Maintenance involves sequential controls. Time schedule control of batch tanks will be necessary. Sludge density in a batch tank, which varies depending on the concentration of inflowing wastewater, needs to be controlled by the MLSS analyzer, so that sludge removal volume can be regulated. Also, aeration volume needs to be controlled using a DO analyzer installed in a batch tank to regulate DO concentration. When sequential control does not function properly, treatment capacity will dramatically decline.

e) Continuous Inflow - Intermittent Aeration Method

- After passing through an aeration tank, sewage will continuously flow into a sedimentation tank. After the separation of solids and liquids is completed, treated water will go through a disinfection tank and be discharged.
- Sludge will be transported from a sedimentation tank to a sludge thickening tank. It will then be removed by a truck equipped with a vacuum hose.
- BOD removal rate of approximately 90% can be expected, but depending on operation performances, better treatment can also be expected.
- For maintenance, sludge density in a batch tank, which varies depending on the concentration of inflowing wastewater, needs to be controlled by the MLSS analyzer, so that return sludge volume from a sedimentation tank can be regulated. Also, aeration volume needs to be controlled using the DO analyzer installed in a batch tank to regulate DO concentration. When sequential control does not function properly, treatment capacity will dramatically decline.

f) Membrane Separation Activated Sludge Method

- After passing through a de-nitrification tank, sewage will be pumped to a nitrification tank. Active sludge in a nitrification tank will be returned to a de-nitrification tank by the gravity flow. MF membrane will be placed in a nitrification tank. Treated water will be pumped by a suction pump to a disinfection tank and discharged.
- Sludge in a de-nitrification tank will be transported to a sludge thickening tank. It will then be removed by a truck equipped with a vacuum hose.
- BOD removal rate is 98%. Removal effect of nitrogen and phosphorus is also high.
- For maintenance, the removal volume of sludge from a de-nitrification tank needs to be controlled. Quality of membranes also needs to be maintained. Treatment ability is lost when membranes are damaged or when clogging occurs.

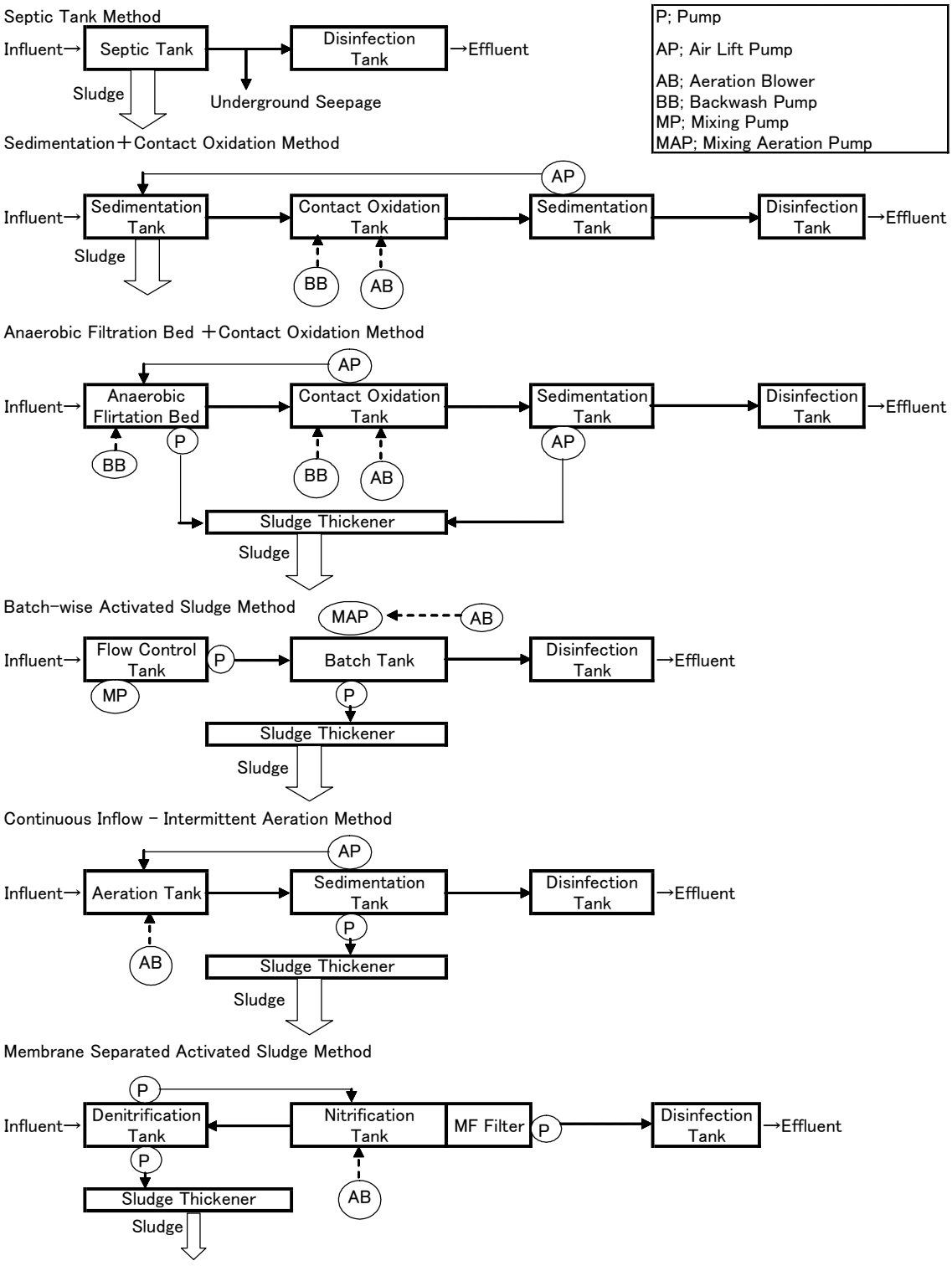


Figure 3.4 Treatment Flow

Table 3.2 Rural Sewage System

Treatment Type	Sedimentation Method	Biofilm Method		Suspended Bacteria Method		
	Septic Tank	Sedimentation + Contact Oxidation	Anaerobic Filtration Bed + Contact Oxidation	Batch-wise Activated Sludge	Continuous Inflow - Intermittent Aeration Method	Membrane Separation Activated Sludge
Feature of the structure	· Treatment process is sedimentation only. · Treated water seeps underground or effluents to the stream.	· Sedimentation Tank · Contact Oxidation Tank · Sedimentation Tank	· Flow Control Tank · Anaerobic Filtration Bed · Contact Oxidation Tank · Sedimentation Tank	· Oxidation and sedimentation processes are carried out in the same tank. · Separate tanks are required for batch treatment	- Oxidation tank + Sedimentation tank - Timer for Intermittent Aeration is incorporated.	- De-nitrification tank + Nitrification Tank - Sludge separation by MF filter - Simple structure
Sludge Return	Not required	Not required	Not required	Not required	Not required	Not required
Purification Performance	Not Good	Depend on the capacity of the structure	Depend on the capacity of the structure	Depend on the operational condition	Depend on the operational condition	· Depend on the operational condition - High performance
Sludge Volume	25 ~ 35% of removed BOD	25 ~ 35% of removed BOD	20 ~ 25% of removed BOD	40 ~ 60% of removed BOD	40 ~ 60% of removed BOD	50% of removed BOD
Required Land Area	Small	Middle	Middle	Small	Small	Small
Experience of using	No experience in Japan	Many (small scale)	Many (small scale)	Many	Many	Few
Construction Cost	◎	◎ (small scale)	○ (small scale)	○	○	△
Maintenance	Once a month	Once a month	Once every 2 weeks	Once a week	Once a week	Once a week
Easiness of O&M	◎	◎	◎	○	○	○
Total	○ Water quality does not improve very much because of low purification performance.	◎ Treated water quality is stable. There is no special equipment.	◎ Treated water quality is stable. There is no special equipment.	○ High level O&M is required such as blower control, selection of the treatment process and MLSS control.	○ High level O&M is required such as blower control, selection of the treatment process and MLSS control.	△ While Treated water quality is excellent, exchange cost of the membrane filter is quite expensive. High level O&M is required.

2) Selection Rural Sewage Treatment

As shown in Table 3.2, the suspended bacteria method has more proven track records of adoption compared to that of the bio-film method. A small site area required for the suspended bacteria method can also be appreciated as a useful advantage. However, because the method requires intensive maintenance with high maintenance cost of the equipment to ensure water quality, it would not be suitable for the project area. Similarly, although septic tanks are widely used in small communities in Egypt as a wastewater treatment system, they have low treatment capacity, and effective improvement of water quality cannot be expected. When taking into account the future water quality of the entire water resources, adoption of septic tanks would not be desirable. Consequently, the bio-film method will be adopted for the community wastewater treatment facilities.

The bio-film method can be classified into the following types:

- Sedimentation + Contact oxidation
- Anaerobic filtration bed + Contact oxidation

Both processes require backwashing of contact media to prevent the growth of bio-film. Lack of backwashing will enlarge bio-film, and it will damage contact media or cause clogging to occur, decreasing the treatment capacity of the processes.

The project will adopt the “Sedimentation + Contact oxidation” method. With this method, some of the maintenance process can be reduced. The carrier that has been widely used recently in Japan will be adopted as a filter material in contact oxidation tanks. This enables the omission of the backwashing process, and because the retention effect of bio-film on carriers will be higher than that in average aeration tanks, stability of the treated water will be relatively high. Annual removal of sludge and inspection of two blowers are the only maintenance needed.

The maintenance and operation framework will be decided with the Egyptian water and sewage corporation (holding company) and concern organization.

The structure shown in Figure 3.5, is of the rural sewage treatment installed in W5. Detail design and maintenance manual are attached in the Appendix of this report.

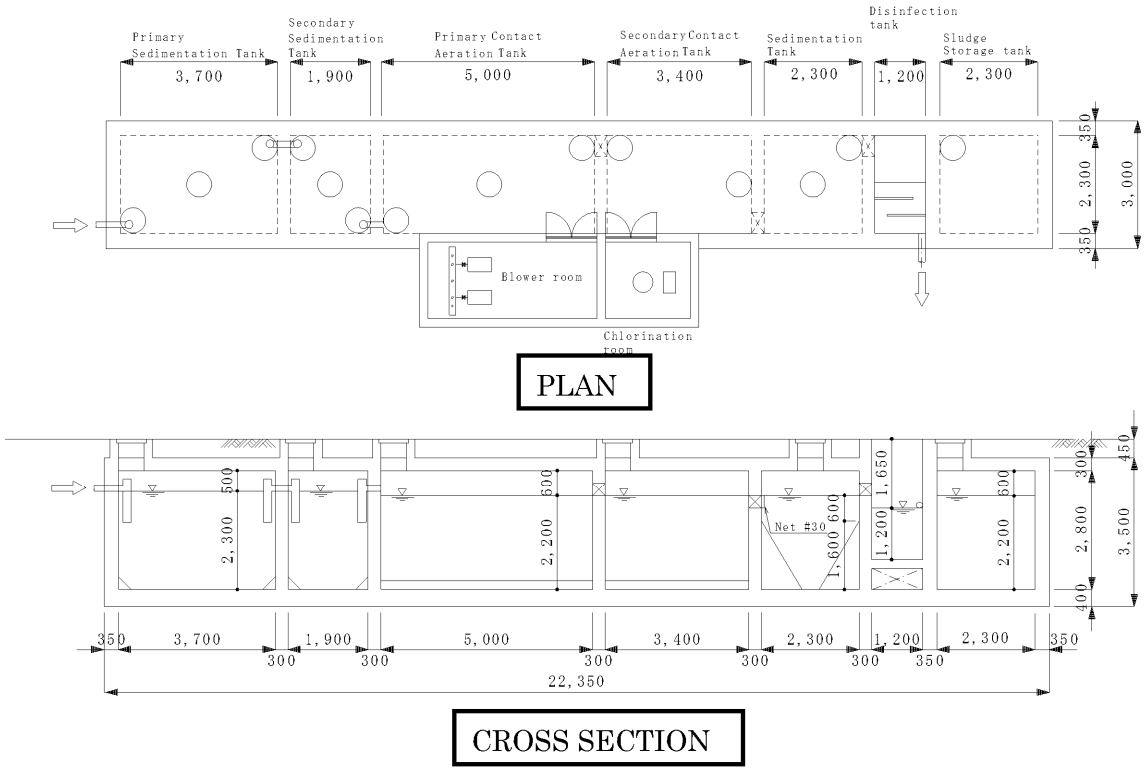


Figure 3.5 Rural Sewerage Treatment

(1) Drainage Water Reuse Pump

Drainage water reuse sizes are 0.5m^3/s and 1.0 m^3/s, which is the standard in Egypt. Their installation location is at the end of irrigation canals. It is placed at the backfill part of the existing irrigation canals (These two sentences can be combines into one: Their installation location is at the end of the irrigation canals, precisely at their backfill parts). Pump sites update facilities, reusable water tank, and outlet pipe, using the existing facilities for repair.

Drainage water reuse pump capacity is 0.5 m^3/s or 1.0 m^3/s. Shown in Figure 3.6 standard 1.0 m^3/s.

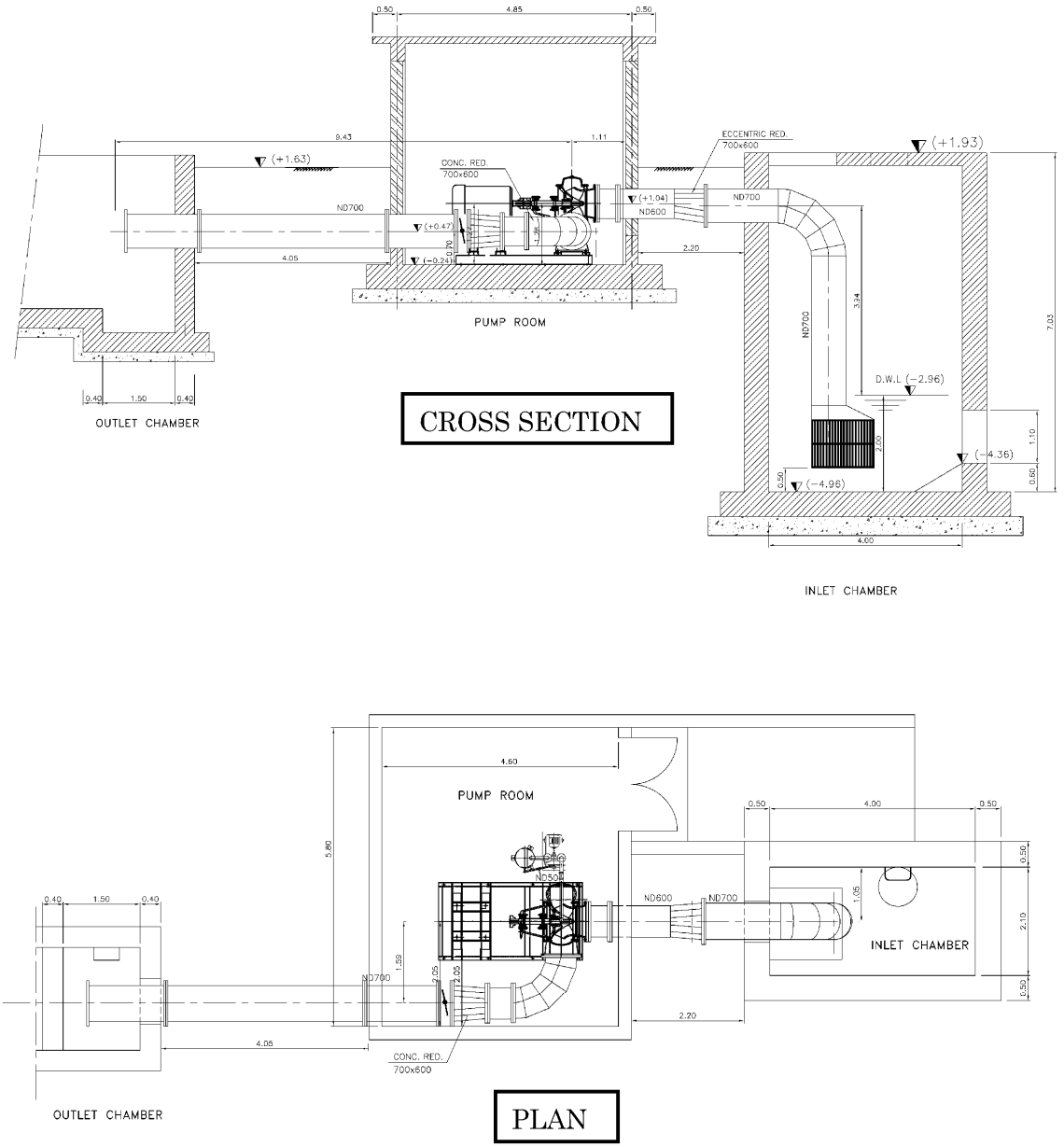


Figure 3.6 Drainage Water Reuse Pump

3.3 Establishment of the Drainage Pump Committees and the CDA

1) Introduction

The Government of Egypt has been promoting Irrigation Transfer Management to establish an effective water management system. Particularly, the Ministry of Water Resources and Irrigation (MWRI) has addressed the importance of the strengthening of the Water Users Associations (WUAs) in the "National Water Resources Plan 2017 (NWRP)." Also, the World Bank, and other international donors, have implemented IIP (Irrigation Improvement Project) and IIIP (Integrated Irrigation Improvement and Management Project) to establish and strengthen WUAs and BCWUAs (Brach Canal Water Users Associations). The basic concept of capacity development of users' associations is in accordance with this policy direction.

WUAs and BCWUAs are essential to promote an effective irrigation transfer system. In fact, the MWRI has been promoting the establishment of WUAs and BCWUAs; yet, the number of these

organizations is rather limited. Not only did the political turmoil disturb the progress of establishment of the users' associations, but there are also several other reasons behind this situation. Particularly, the lack of fund for establishing the associations and the lack of the legal status of BCWUAs could hinder the promotion of an irrigation transfer system.

According to the CDAIS (Central Department of Irrigation Adversary Service), which is the governmental authority of WUAs, there are not enough budgets to establish new WUAs and BCWUAs. For this reason, the CDAIS focus on following up with activities for WUAs, rather than establish new WUAs and BCWUAs. Furthermore, the legal status of BCWUAs has not been clarified yet in Egypt. BCWUAs have not fully activated, and their activities are still limited. Therefore, the decentralization process of irrigation management is still under process and it is necessary to further efforts in order to complete it.

2) Approach

There are two types of users' associations organized under the pilot project; 1) DPCs: Drainage-reuse Pump Committees and 2) CDA: Community Development Association. The DPCs consist of main beneficiaries of the drainage reuse pump stations, while the CDA consists of the irrigation complex facilities. Since the drainage reuse pump stations were introduced at all the 5 pilot project sites, the DPCs were also organized at all the 5 sites. The CDA was organized at the community where the irrigation complex facilities have been introduced.

The reason for establishing the DPCs as a users' organization of the drainage reuse pump stations is beneficiaries of the pump stations (this sentence makes no sense. It can be removed entirely). Main beneficiaries of the drainage reuse pump stations are farmers who have farmland at downstream areas of the canals. Farmers in upstream areas are not direct beneficiaries of the pump stations. They are also not involved in the operation of the pump stations. BCWUAs appear to be too big to manage the drainage reuse pump stations properly. Therefore, the DPC have been newly organized for the drainage reuse pump stations under the pilot project.

The CDA has also been newly organized with local villagers at the irrigation complex site (W5 Kahmseen village). The main objective of the CDA is to conduct basic operation and maintenance of the sewage treatment facility, which is one of the components of the irrigation complex facilities. The CDA is registered to the Ministry of Social Solidarity as a NGO. A CDA is one of the most common organizations in rural areas. Most of them provide community services and charity activities in rural villages. Therefore, the CDA could take ownership of the sewage treatment facility and conduct operations and maintenance as one of their community services.

Table 3.3 Types of Organizations

Site	Facility	Type of Organization	Main members
Farsh Al Ganaen (E-1)	Pump Station	DPC	Farmers
Mekhazan (E-4)	Pump Station	DPC	Farmers
No.11 (W-2)	Pump Station	DPC	Farmers
Faraon (W-4)	Pump Station	DPC	Farmers
Sandela (W-5)	Pump Station	DPC	Farmers
	Sewage Treatment Facility	CDA	Villager

Source: JICA Study Team

3) Status of the Organizations

The DPCs are voluntary organizations that use the drainage reuse pump stations properly. There is no specific legal framework for the DPCs; however, it is important for the DPCs' members to get official approval from the Government. The members of the DPCs have selected representatives and formulated internal regulations at each site. It is also important for the Irrigation Sector to recognize

these DPCs as representatives of beneficiaries of the drainage reuse pump stations to operate the pump stations effectively. Therefore, the Irrigation Sector issued a ministerial decree about the DPCs and they are officially approved as representatives of the pump stations.

The CDA was established based on the Law on Nongovernmental Organizations (Law No.84 of 2002) and registered to the Ministry of Social Solidarity. The Egyptian NGO Law articulates requirements and conditions regarding CDAs and civil associations including organization structure, financial management system, and possible activities. Unlike the DPCs, the CDA has solid legal status so that they can provide community services such as garbage collection and operation of the sewage treatment plant.

4) Preparation for Establishment of Users' Organizations

There are 3 major preparation activities for establishment of the DPCs and the CDA; 1) Introductory Workshop, 2) Selection of Representatives, and 3) Setting up Internal Regulation. These preparation activities are almost common for the establishment process of the DPCs and the CDA. The following describe details of each activity:

Introductory Workshop

The purpose of the Introductory Workshop is to introduce the concept and objectives of the project to the project beneficiaries. This step is important to get a consensus from the beneficiaries of the Pilot Project. Particularly, community members are directly involved in operation and maintenance of the irrigation complex facilities. The Pilot Project could not continue if the community members would not accept the Pilot Project facilities and activities. The Introductory Workshop is the first step to establish trusting relationship among all the stakeholders including local beneficiaries as well as irrigation and drainage authorities.

The Introductory Workshop was held in February 2014 at all the 5 pilot project sites. Around 60 to 80 people participated in each workshop. The participants included; farmers, community members, and the Kafr El Sheikh Irrigation Sector, Drainage Sector, and the Local Unit. The JICA Study Team briefly introduced the outline of the Project. Also, governmental staff from the Irrigation Sector and the Drainage Sector addressed the importance of water quality improvement and drainage reuse for irrigation.

Table 3.4 Summary of the Introductory Workshops

Name of Drain	Facility	W/S Date	No. of Participants
Farsh Al Ganaen (E-1)	Pump Station	27 Feb, 2013	58
Mekhazan (E-4)	Pump Station	28 Feb, 2013	65
No.11 (W-2)	Pump Station	25 Feb, 2013	74
Faraon (W-4)	Pump Station	26 Feb, 2013	141
Sandela (W-5)	Irrigation Complex	24 Feb, 2013	60

Source: JICA Study Team

Most of the participants responded to the Project positively. Promoting drainage reuse is key to minimizing water shortage for irrigation. In fact, most of the farmers in downstream areas face water shortage problem, especially in the summer season. They do not have any choices, but use drainage for irrigation. The JICA Study Team also asked the participants to cooperate with the project activities because the project is not only a construction of the pump stations, but also includes environmental activities as part of its components.

Some of the farmers, however, showed their concerns about drainage water quality. In fact, some participants asked whether the drainage water quality is good enough for irrigation. They worried that contaminated drainage water might have harmful effects on their crops. The JICA Study Team and

their counterparts explained that the Project monitored drainage water quality and it would not be a problem if they used drainage water for irrigation.

The JICA Study Team introduced the concept of the Irrigation Complex to the community members.

The JICA Study Team explained the pump stations to the local farmers.

Selection of Representatives

After a series of these Introductory Workshops, local beneficiaries started to select representatives of the DPCs and the CDA at each project site. Farmers and community members had a meeting and discussed the selection of representatives and their roles and responsibilities. 5 to 7 representatives were selected at each DPC. Although females also participated in the meeting for representative selection, there were no female representatives at all the DPCs and the CDA. The table below shows a summary of the representative selection meeting.

Table 3.5 Summary of Representative Selection

Site	Name of Drain	Mtg Date	No. of Parts.	No. Rep.
E-1	Farsh Al Ganaen	6 Mar, 2013	51 (M:41, F:10)	7
E-4	Mekhazan	7 Mar, 2013	50 (M:40, F10)	6
W-2	No.11	2 Mar, 2013	67 (M:54, F:13)	7
W-4	Faraon	4 Mar, 2013	60 (M:40, F:20)	5
W-5	Sandela	3 Mar, 2013	80 (M:77, F:3)	5

Source: JICA Study Team

Most of the representatives of the DPCs and CDA were selected through having a discussion with local community members rather than holding an election. This is because the number of representative at each site is still small. Their roles and responsibilities are also limited under this pilot project. In addition, all the community members agreed to select representatives through discussions. As such, the representatives of the DPCs and the CDA were decided through the discussions among community members.

Senior community members were selected as representatives in most cases. Elderly members in communities are often influential to other community members. In fact, senior community members play a role of arbitration if there is a problem in communities. Also, active farmers became representatives of the DPCs. For example, 5 members out of the 7 representatives at Mekhazan (E-4) site have 6 feddans of farmland, and they do not rent out their farmland, but they manage it themselves. These farmers are leading farmers in the area.

Setting up Drafted Internal Regulation

Internal regulations of the DPCs are one of the key aspects to establish DPCs. This is because members of active committees are aware of their own internal regulations. Internal regulations stipulate basic rules of the DPCs. Members of active DPCs are supposed to understand and be

aware of their internal regulations. For example, there is an active BCWUA in Garbeya Governorate, and most members are aware of their own internal regulations. Some of the board members even took a training session on internal regulations. Therefore, it is important to get the DPC members involved in the process of setting up internal regulations.

Internal regulations were drafted based on Law No.12/1984 and Law No.213/1994. These laws define management of irrigation and drainage networks, including branch canals, Mesqas, and drains. Also, internal regulations of WUAs were also referred to as a model. Drafted internal regulations consist of 37 articles. It covers a wide range of topics such as frequency of meetings, communication protocols, organization structures, memberships, and administrative rules.

The drafted internal regulations were finalized after all the capacity development activities were done. It was not easy for the DPCs' members to finalize their internal regulations before they implement any activities. For this reason, internal regulations were just drafted at the time of establishment, and they were finalized when all the facilities were ready to operate.

5) Finalization of Internal Regulation

The DPC members have reviewed the draft of the internal regulations through implementation of their action plans. In December 2014, The DPC members finalized the internal regulations and they got consensus from DPC members. The DPCs were empowered through the pilot activities, and finalization of the internal regulations is a part of this empowerment process. They could review basic principles of their own organizations.

The DPC members have submitted the final internal regulations to the Undersecretary of the MWRI and irrigation sector in Kafr El Sheik to get approval on it. Although the DPCs do not have any legal status, the DPCs are related to a wide range of stakeholders including irrigation, drainage sectors, and local units. Therefore, it is important for the DPCs to formulate the internal regulations and get approval from the Undersecretary of Irrigation Sector in Kafr El Sheik.

Table 3.6 Main Items of the Internal Regulations

Items	Contents
1. Regulation of the Internal Actions	· Term of Appointment · Communication, Records and Books · Committee Meetings · Membership
2. Responsibilities	· Responsibilities of the Board members · Terms of reference of the Committee/ Functions of Committee Members · Relationship between Branch Canal Water Users Association and the Committee
3. Penalties and Irregularities	· Sanctions of violating Committee members - Replacing violators and offenders · Types of irregularities impose sanctions for violations · Dispute Settlement

Source: JICA Study Team

6) Ministerial Decree

In addition to the internal regulations, the Undersecretary of Irrigation in Kafr El Sheik circulated a ministerial decree regarding the DPCs' establishment. In other words, the DPCs were officially approved by the Ministry. The DPCs became official representatives of the beneficiaries of the drainage reuse pump stations. The Ministerial decree mentions purposes and main members of the DPCs.

Contents of the Ministerial Decree
Article I: Pump Committee members
Article II: Roles of Engineers
Article III: Pump Committee's obligations
Article IV: Dissolution of Pump Committee
Article V: Implementation of resolution

After the DPC members submitted their internal regulation to the Undersecretary, the ministerial decree was issued and circulated in January 2015.

7) Roles and Responsibilities (Protocol)

The facilities of the pilot project are related to various stakeholders. Particularly, a wide range of stakeholders are involved in irrigation complex facilities consisting of drainage reuse pump stations, in-stream facility, sewage treatment facility, and compost making facility. Not only irrigation and drainage sectors, but also other organizations such as the CDA, HCWW in Kafr El Sheik, and local units play important roles of facility management. Therefore, clarification of roles and responsibilities of all the stakeholders is essential to start up the drainage reuse system.

A protocol was developed through a number of discussions with the stakeholders. The main purpose of the protocol is to clarify roles and responsibilities of each stakeholder. The Protocol was drafted up by each facility in April 2015. The draft protocol was shared with relevant authorities at the 5th Joint Steering Committee. The drainage sector in Kafr El Sheik suggested that the protocol for irrigation complex facilities should be combined as one protocol. Thus, there are two types of protocols developed; 1) a protocol for irrigation complex facilities and 2) a protocol for each pump station (4 pump stations in total).

The Protocol for Irrigation Complex Facilities

Regarding the protocol for irrigation complex facilities, the stakeholder meeting was held at the governor's office in Kafr El Sheikh in August 2015. There were 10 organizations attending the meeting. The Governor showed his appreciation to the project, and the JICA Project Team emphasized the importance of the protocol in order for the project to succeed. All the participants agreed to engage in irrigation complex facilities based on the protocol. The following organizations attended the meeting, and they all signed the protocol;

1. The Governor of Kafr El Sheikh,
2. Undersecretary of Drainage in Middle Delta,
3. Undersecretary of Irrigation in Kafr El Sheikh,
4. The Holding Company for Water and Wastewater in Kafr El Sheikh,
5. General Directorate of Irrigation in West of Kafr El Sheikh,
6. General Directorate of Drainage in West of Kafr El Sheikh,
7. Head of the Kafr El Sheikh City Council,
8. Head of Sandel Local Unit,
9. Head of the CDA,
10. Head of the Drainage re-use Pump Committee.

The Governor in Kafr El Sheik expressed his appreciation for the Project.

Protocol meeting at the Governor's office in Kafr El Sheik

Outline of the Protocol for Irrigation Complex Facilities

The protocol for the irrigation complex facilities consists of five parts; 1) Operation and Maintenance of the Pump Station, 2) Operation, Maintenance, and Follow-up with the In-Stream Treatment Facility, 3) Operation, Maintenance, and Follow-up with the Network Pipeline and the Sewage Treatment Plant, 4) Operation, Maintenance, and Follow-up with the Compost Facility using Agricultural Waste, and 5) Operation, Maintenance, and Follow-up with the Garbage Collection System. The table below shows a summary of the operation and maintenance systems of each facility.

Table 3.7 Summary of Operation and Maintenance

Facility	Operation and Maintenance
Drainage re-use Pump Station	・ Irrigation Sector has all the responsibilities for O&M. ・ DPC plays a role of coordinator between irrigation engineers and farmers. Also, they promote environmental activities. ・ Drainage Sector has the responsibility for maintenance in drain.
Sewage Treatment Facility	・ The CDA has all the responsibilities for daily operation and maintenance such as collection of service fee, preparation of operators, and coordination with HCWW and local units. ・ HCWW provides technical support to the CDA. ・ Local Units support the CDA in terms of administrative works including service fee collection from villagers.
In-Stream Facility	・ Drainage Sector has responsibility for In-Stream Facility since it is installed in the drain. Particularly, Drainage Sector takes care of drainage water level, garage stack piled up at the screen, and dreading.
Compost Making Bed	・ The CDA operates the compost making bed. They coordinate users and produce compost. Also, the CDA coordinate relevant organizations such as Agricultural office if necessary.
Garbage Collection System	・ The CDA continues garbage collection system. They collect garbage from villagers and bring it to the dumpsite of the local unit. They also collect garbage collection fee from villagers.

Source: JICA Study Team

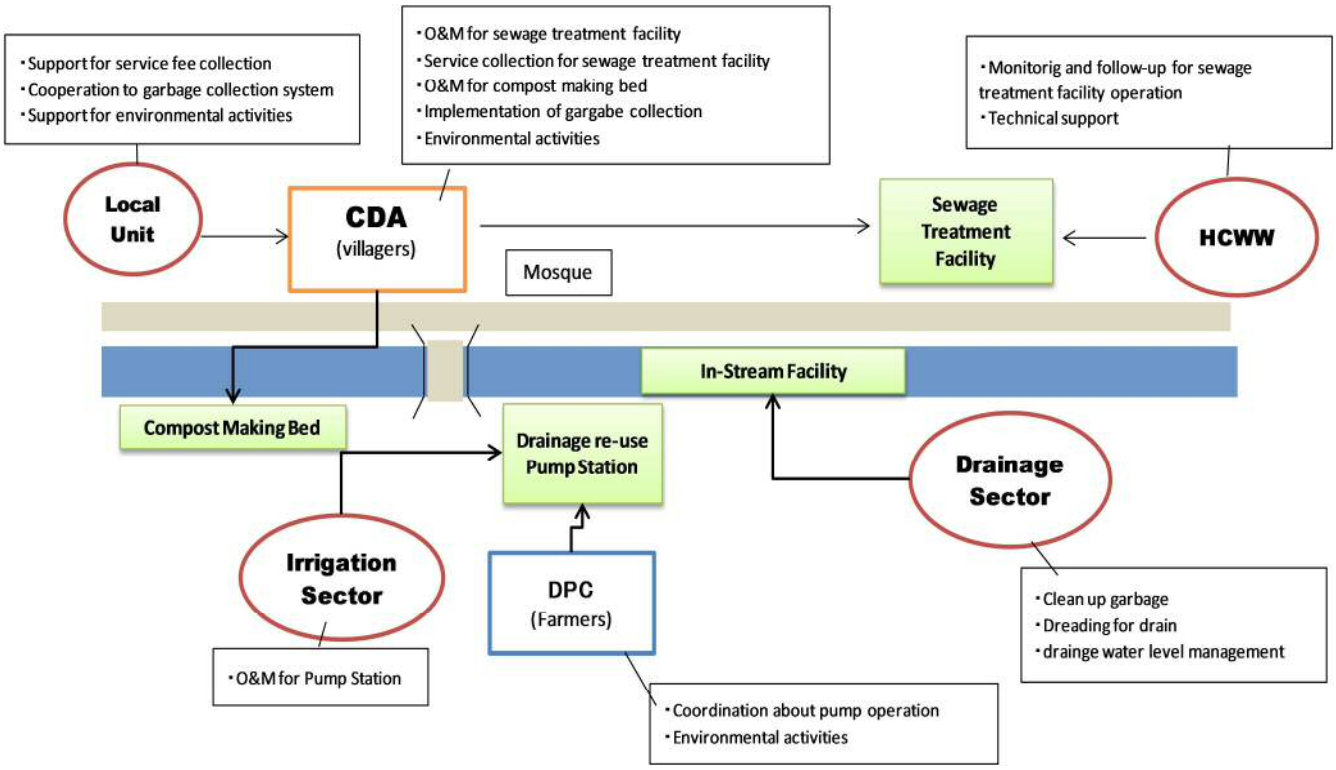


Figure 3.7 Operational Structure of the Irrigation Complex Facilities

Challenges in Consensus Process

The irrigation complex facilities are a new approach to increase drainage reuse for irrigation. It consists of many different facilities. Some of the facilities have already been installed in other areas in the delta region. For example, drainage reuse pump stations have already been installed in many areas. The irrigation sector is used for the operation and maintenance of the drainage reuse pump stations. On the other hand, some of the facilities are new to the irrigation and drainage sectors, and to other stakeholders such as in-stream facility and sewage treatment facility. It took time to get consensus about the operating system of these new facilities.

The in-stream facility is one of the reasons for prolonged protocol procedure. This is because the in-stream facility is a new facility to the drainage sector. It took time for them to understand what the in-stream facility is and how they are involved in maintenance and operation of the facility. The drainage sector has no experience in taking care of this kind of a facility, and was not willing to take responsibility for the in-stream facility. In fact, the drainage sector requested that the DPCs should take full responsibility for this facility after the first protocol was drafted.

It was necessary to have a series of meetings with the drainage sector. They finally agreed to take full responsibility regarding operation and maintenance of the in-stream facility. There are three main activities; 1) clean up garbage in the drain, 2) dreading, and 3) drain water level control. The drainage sector understood that these activities are not different from normal activities. Besides, these activities are mandatory. Therefore, the protocol for the irrigation complex facilities was not concluded as soon as the Project Team expected it to be.

The sewage treatment facility was also one of the reasons for the prolonged process of the protocol. There were a number of discussions with the HCWW before a consensus was reached on the Protocol. Although the CDA takes responsibility for the sewage treatment facility, the HCWW plays an important role in the sewage treatment facility operation. The HCWW provides technical support to the CDA and help them with the dreading and facility maintenance. It took time to decide the scope of the HCWW's technical support. HCWW's budget is also limited, and so could only provide technical support.

The Protocol for the Drainage reuse Pump Stations

The protocol for the drainage reuse pump stations is rather simple. This is because the irrigation sector is used to dealing with pump stations. There is nothing new to them in terms of pump operation systems. As such, the consensus process of the protocol is straightforward. The protocols were concluded in each pump station site (4 sites in total) among the irrigation sector, drainage sector, and the DPCs. The basic principle of the protocol is the same as that of other pump stations.

The protocol stipulates roles and responsibilities of each stakeholder; irrigation sector, drainage sector, and the DPCs. Irrigation sector have full responsibility for the pump stations. They provide pump operators and cover operation costs. The drainage sector plays the role of supporter for the DPCs to promote environmental activities, as well as for the management of drainage. The DPCs are to coordinate with the irrigation sector in terms of pump operation such as operation schedule and operation periods. Also, the DPCs promote environmental activities to raise farmers' and community members' awareness. The following table summarizes the contents of the protocol for the pump stations.

Table 3.8 Summary of the Protocol about the Pump Stations

Item	Summary
1) Pump Operator	Irrigation sector provides an operator. In case Irrigation Sector fails to provide an operator, the DPC provides an operator under the supervision of the Irrigation Sector.
2) Pump Guard	Irrigation sector provides a guard. In case Irrigation Sector fails to provide a guard, the DPC provides an operator under the supervision of the Irrigation Sector.
3) Materials for Pump Operation	Irrigation sector provides necessary materials for pump operation.
4) Operation Schedule	Irrigation sector and the DPCs coordinate operation schedule.
5) Operation Hours	The DPCs inform the demand of operation hours to Irrigation sector.
6) Roles of the DPCs	Irrigation Sector empowers the DPCs to perform their roles and responsibilities.
7) Environmental Activities	The DPCs promote environmental activities to raise community awareness of the environment.
8) Monitoring	The DPCs monitor pump operation and maintenance.
9) Electricity of the Pump Stations	Irrigation sector have responsibility for electricity of the pump stations.
10) Cleaning Irrigation canal	Irrigation sector take care of irrigation canal, and the DPCs cooperate with Irrigation sector to keep canal clean.
11) Cleaning Drainage	Drainage sector take care of drainage, and the DPCs cooperate with Drainage sector to keep the drain clean.
12) Drainage Water Quality	Drainage sector implements drainage water quality check. Drainage sector cooperate with the DPCs to implement environmental activities.
13) Others	In case the DPCs undertake any other things, which are agreed above, they discuss and coordinate with relevant authorities.

Source: JICA Study Team

Signing on the Protocol at E-1

Signing on the Protocol at W-2

3.4 Environmental Awareness Activities

3.4.1 Training of Environmental Awareness

After the establishment of the DPC and the CDA in the sites, for the purpose of enhancement of environmental protection awareness, a series of lecture style training sessions were organized. The training targeted the reuse pump users (beneficiaries), extension staff of agricultural cooperatives covering the area, and official personnel of local units concerned. The training targeting the beneficiaries by reuse pumps was implemented for two days, and the main themes of the 1st and 2nd day were waste management and canal water conservation, respectively.

(1) Training topic (1): 1st day

- How to reduce the amount of the garbage

- 3R (reduce, reuse and recycle)
- Methods and tools for garbage collection
- Garbage storage methods
- How to sort the waste?
- Who will collect the garbage?
- How to recycle waste (plastic, paper, glass and so on)
- How to recycle agriculture waste (rice straw, cotton dry stems) to produce fertilizer and animal fodder or fuel
- Compost making by using animal waste

(2) Training topic (2): 2nd day

- Irrigation water quality
- Pollution of irrigation canals and drainage canals
- Human diseases due to water pollution
- Proper pest control
- Proper application of chemical fertilizers
- Utilization of organic fertilizers
- Wastewater treatment and reuse for irrigation
- Treatment and recycle of human's solid waste
- How to keep canals clean

Concerning the W5 site, there is one main village and three hamlets, which are scattered within the Sandala village. Therefore, the training sessions were organized at all these places to enhance their participation as much as possible. On the other hand, since the hamlets in other sites are not scattered, it was possible to cover each site through a single series of training. The following table shows the training schedule in the 5 sites and the number of the participants.

Table 3.9 Training Schedule for the Beneficiaries

Site	Village/Hamlet	Date	Participants number	Contents
W5	El Motanaby hamlet	23 March 2013	40	Training topic (1)
W5	Sandala village	27 March 2013	19	Training topic (1)
W5	Abo El Kanayis hamlet	31 March 2013	24	Training topic (1)
W5	Abo El Kamsen hamlet	1 April 2013	21	Training topic (1)
W5	Abo El Kanayis	5 April 2013	33	Training topic (2)
W5	Abo El Kanayis	17 April 2013	20	Training topic (2)
W5	El Motanaby hamlet	24 April 2013	18	Training topic (2)
W5	El Motanaby hamlet	27 April 2013	26	Training topic (2)
W4	El-nawayga	26 March 2013	20	Training topic (1)
W4	El-nawayga	26 May 2013	20	Training topic (2)
W2	Abo draz	25 March 2013	20	Training topic (1)
W2	Abo draz	18 May 2013	20	Training topic (2)
E1	Abo sewalem	24 March 2013	14	Training topic (1)

Site	Village/Hamlet	Date	Participants number	Contents
E1	Abo sewalem	28 May 2013	17	Training topic (2)
E4	Mekhazen	13 April 2013	24	Training topic (1)
E4	Mekhazen	19 May 2013	12	Training topic (2)

Animal waste and agricultural waste, such as rice straw and cow dung, account for a large percentage of garbage in the area, which means that disposal of those waste is a big issue for the participants. Therefore, they were interested in the reuse of rice straws as forage, and compost making by using cow dung, which could contribute to both waste disposal and farming activities. Regarding garbage from their houses, management of plastic bags is a main issue. Both men and women showed interest to establish a garbage collection system in their villages. Moreover, they recognized the importance of canal cleaning and agreed to do the work by themselves. On the other hand, the people did not show much interest in waste recycling, such as handicraft by using plastic bags.


Participants of W5 trying to recycle plastic bottles


Explanation of Waste Management at W5

It is expected that children will play an important role for the pilot project to be implemented in the final phase. Therefore, environmental awareness training sessions targeting primary school children in the area were organized at two schools. The training focused mainly on topic (1), namely, waste management. The students were interested in the training session, especially, recycle of waste, and they expressed the want to learn about those topics further. Some of the recycled goods were given to the children as gifts. The training dates and number of participants were as shown below:

Table 3.10 Training Schedule for Schools

Site	Date	Participants number
W2	28 March 2013	60
E4	2 April 2013	52


Training for school children

For the purpose of capacity development and sustainable waste management, sessions of the training topic (1) were organized for official personnel of the local units concerned. They have not had enough opportunities to participate in this kind of training so far, and they were interested in the training topics. It is essential to involve them in the process of pilot project implementation, which will lead to sustainable canal cleaning even after the project completion. Furthermore, considering that the agricultural waste management and the proper chemical application are heated issues, it is important to collaborate with agricultural cooperatives in the area. Therefore, the same training sessions were organized for the extension workers and cooperative members, as well as for the local unit staff. The schedule and number of participants of those training sessions are as follows:

Table 3.11 Training Schedule for the Local Units

Site	Name of local unit	Date	Participants number*
W5	El-hamra	14 April 2013	18
W2	Abodraz	22 April 2013	21
E4	El-rasef	23 April 2013	19
W4	Abomandor	28 April 2013	24
E1	Omsen	2 May 2013	23
W4	Shaba	7 May 2013	40
W2	Qebret	9 May 2013	33

Villagers' participant number is also included.

Table 3.12 Training Schedule for Agricultural Cooperatives

Site	Name of cooperatives	Date	Participants number*
E4	Mekhazen	11 April 2013	12
W2	Abo tartor	15 April 2013	12
W5	Sandala	16 April 2013	15
W4	El-nawayga	18 April 2013	16
E1	Omsen	5 May 2013	10
W4	El-karadwa	8 May 2013	12

Villagers' participant number is also included.

3.4.2 Study Visit to the Advanced Sites

After the lecture style training mentioned above, the representatives of DPC, CDA members, local unit staff, and extension workers of agricultural cooperatives participated in the study visit to observe actual conditions in the demonstration field. They observed the recycle of waste as compost and forage, glass recycle and so on, which are managed by the environmental training lecturer, and they visited an advanced BCWUA, namely, Marbat BCWUA[5] in Sidi Ghazi district, to exchange opinions and views for proper organization management. Moreover, W5 CDA members visited two CDAs that manage sewage treatment systems, namely, Qulaea CDA and Al-mufti CDA[6].

In terms of organization, The Committee members and local unit staff in the pilot project sites visited Marbat BCWUA. This BCWUA is one of the most active BCWUAs in Kafr El Sheikh Governorate. The BCWUA has been established in 2006 under the World Bank funded project, IIIMP. There are 1,269 beneficiaries in total, and 63 members are assigned as board members. The main activities of this BCWUA are: 1) problem/conflict solution, 2) maintenance of the canals, 3) lobbying for the Ministry, and 4) environmental awareness creation. In addition, one of the roles of this BCWUA is to clean the irrigation canals and drainage in cooperation with the Directorate of Water Resources and Irrigation and Community Development Association.

The following table shows the outline of the Study visit:

Table 3.13 Summary of Study visit

Pilot Project Sites	Visiting Sites	Purpose	Training Day
E-1, E-4, W-2 W-4, W-5	Marbat BCWUA	· Learning the role of environmental activities of BCWUA, · Information sharing about BCWUA activities, · Learning key lessons of active BCWUA.	One day training. Conducted from 20 May 2013 to 3 June 2014
W-5 (CDA)	El Mufty CDA Koleaah CDA	· Learning how to manage sewage treatment facilities, · Learning key lessons of sewage treatment facility operation.	Training on 13 May and 25 May 2013.

The schedule, destinations and number of participants are as shown below:

Table 3.14 Study visit Schedule

Site	Village	Participants	Date	Destination/contents	Participants number
W2	El-khayreh	Local unit staff, representatives of beneficiaries	20 May 2013	Marbat BCWUA • Roles and responsibilities of BCWUA members • Financial and administrative system of BCWUA • Operation of re-use pump system • Garbage collection system by the local unit covering the irrigation area • Collaboration with the local unit Demonstration field • Reuse of animal waste as forage • Reuse of agricultural residue as compost • Reduction of chemical fertilizer • Recycle of glass, plastic and so on	14
W5	Sandala, El-motanby, Abo el-kanayes El-kamsen	Local unit staff, extension worker, representatives of beneficiaries	22 May 2013	Marbat BCWUA Al-muft CDA • Establish of rules for subscribing in the sewage network • Management method of sewage treatment system	13
W5	El-kamsen	CDA and local unit staff	25 May 2013	Marbat WUA Al-mufti CDA	13
E4	El-nashawy	Local unit staff, extension worker, representatives of beneficiaries	27 May 2013	Marbat BCWUA Demonstration field	14
W4	El-nawayga	Local unit staff, extension worker, representatives of beneficiaries	29 May 2013	Marbat BCWUA Demonstration field	12
W5	El-kamsen	CDA and local unit staff	30 May 2013	Qulaea CDA • Establish of rules for subscribing in the sewage network • Management method of sewage treatment system Demonstration field	14
E1	Abo sewalem	Extension worker, representatives of beneficiaries	3 June 2013	Marbat BCWUA Demonstration field	12

The study visit started with a meeting with the Board of Directors of the Marbat BCWUA. The

Board of Directors explained the main roles of the association and the follow up activities of the reuse pump station, which supplies water to the Marbat canal. One of the remarkable findings in this active BCWUA is that board members and other farmers of Marbat BCWUA are highly concerned about the environment and are willing to improve their environmental condition. In addition, the relationship between the stakeholders has been well coordinated. For example, they work together with the CDA and irrigation department to raise farmers' environmental awareness. The participants of the study visit seemed eager to learn how to manage BCWUAs and to promote these activities effectively.

This experience motivates the committee members under the pilot project sites to think about how they can make an action to change their community. In fact, one of the participants of this study visit mentioned that this was a good chance to think about what we can do for our own community. Besides, it is important to know the situation in other areas to promote irrigation management transfer. This is because irrigation management transfer will not be accomplished without mutual understanding between people in different conditions. The activities of users' associations at the destination are fresh for most of the participants. It is so particularly for the participants from W-5, where the rural sewerage treatment facility will be installed. The study visit is more swayed for the project beneficiaries to know the importance of group activities and their management. This first-hand experience will be helpful to organize more active users' associations.

Beneficiaries visited field in Marbat BCWUA to learn how to make compost.

Board members of Marbat BCWUA explained their activities to the visitors.

The CDA member in W-5 visited CDAs in El Mufty and Koleaah villages. There are sewage treatment facilities in these villages and the CDAs operate and maintain the facilities. These facilities have been installed under "Decentralized Wastewater Management Project in Kafr El Sheikh Governorate," which was funded by GIZ. The purpose of this project was to establish simple and community-based sewage disposal systems in rural communities in order to improve hygienic conditions in rural areas.

The basic approach of "Decentralized Wastewater Management Project in Kafr El Sheikh Governorate" was a community-based approach. A formally registered CDA in the village served has all the responsibility for the management and operation and maintenance of the system. The assets are owned by the community. Although this type of sewage treatment plant is different from the JICA pilot project, there are many things to learn, particularly, about the CDA approach.

There are three main components in the project mentioned above; 1) Land preparation, 2) Legal issue of the facility, and 3) Operation and Maintenance. According to the Project Coordinator, land acquisition was one of the main difficulties to promote the project. It is important to get contribution and cooperation from communities regarding land acquisition for sewage treatment

plants. Also, a CDA should be registered officially to have the ownership of the facility, otherwise, they do not have the right to have assets. Finally, O&M is also a main concern for the project sustainability. This German funded project even recommended that O&M should be simple enough to operate by community members or they should contract out the O&M to other parties.

Pump facility for the sewage treatment plant in Koleaah village

Sedimentation basin in El Mufty village

The sewage treatment facility was installed in El Mufty village in 2005 and in Koleaah village in 2009. Community members in this village bought the land for the sewage treatment plant, and then they donated the land to the CDA. The CDA assigns a guard and an administrator to manage the facility. The sewage treatment plant covers approximately 600 households in the village, and they collect 4 LE per month per household. According to the board members of the CDA, around 25% of the beneficiaries do no pay the fee on time. If they do not pay the fee, the CDA reports their names to the local unit.

The board members of the CDA in El Mufty village showed administrative and financial books of the CDA to the participants of the study visit. The participants could know the actual management of the association and how to deal with problems. The participants from W-5 were particularly interested in the relationship between the local unit and the CDA. The CDA members of El Mufty explained how to communicate with the local unit and how they could solve a problem with the local unit.

In addition, the CDA member of El Mufty emphasized the importance of the sewage treatment system in the village and how they changed after having the sewage treatment facility. The CDA members of El Mufty also introduced the employee of the facility operator's daily activities in the association, as well as the organization structure of the CDA.

In Koleaah village, the CDA collected money to buy the land for the sewage treatment plant and the project constructed the plant. The sewage treatment plant covers about 265 households and the CDA collects 10 LE per month per household. According to the community members, they used a septic tank before the sewage treatment plant was installed in the village, and it cost 60 LE monthly per household. Therefore, they emphasized the benefit of the sewage treatment plant.

Some of the members of the CDA in Koleaah village pointed out that it becomes more difficult to collect the fee for O&M of the facility, especially after the revolution. This is because people seem to have become more demanding after the revolution, and they complain more frequently to authorities. These stories gave valuable lessons to the participants of the study visit. Also, the vice-president of the CDA in Koleaah village pointed out that holding seminars and workshops is important to educate the community members to maintain the sewage treatment facility properly.

The participants were impressed by the good financial and administration systems of Marbat BCWUA, Qulaera CDA and Al-mufty CDA and enjoyed discussions with the members. They got a certain level of knowledge about the operating system of the sewage treatment facility through the visit. Moreover, they were interested in the reuse of agricultural waste as compost and forage, and the recycle of glass at the demonstration field. The participants expressed that they will implement compost making by using agricultural waste. As a whole, the study visit was effective to promote their motivation for the pilot project implementation and foster their understanding of organization management.

Workshop on reuse-pump management at Marbat BCWUA

Demonstration of compost making at the field

3.4.3 Problem Analysis

As mentioned before, the CDA and DPCs members of the Pilot Project sites participated in the basic environmental training and the study visit to the advanced areas. Therefore, it can be said that the people in the Pilot Project site have an interest in environmental conservation to some extent and they can identify their environmental issues that need to be solved. Based on this idea, a series of problem analysis W/S at the Pilot Project sites was organized in April 2014. The purpose of the W/S was to facilitate the people to identify the environmental issues and to examine how they can manage them.

At the W/S, “drainage water is not clean” was set as the core problem by the Project Team. The participants discussed the causes of the core problem and developed problem trees. Some common problems among the sites were identified, e.g., “sewage water is discharged into the drainage without treatment,” “household waste is thrown to drainage” (there is no garbage collection system), “lack of awareness for garbage disposal,” and “animals’ dead bodies are thrown to the drainage” at most of the sites. This indicates that the participants regard the dumping of solid waste into water bodies as a big issue. Moreover, “water pollution from the factories which are located upstream” and “agricultural waste” were also raised as causes of the core problem, however, they seem not to be common issues. The developed problem trees at each site are attached in Appendix J.

Participants write causes of the core problem

Development of problem tree

3.4.4 Action Plan Making (April 2014)

Action Plan Making Workshops were held in April 2014 following the problem analysis. The purpose of these workshops was to make a monthly plan for activities to solve problems identified during the problem analysis. The DPC and the CDA members gathered and discussed what they could do to improve the drainage situation. As a result of intensive discussions, the action plans were formulated at each site. Establishment of garbage collection systems and implementation of environmental awareness were included in all the action plans.

The results of the problem analysis show that throwing garbage is one of the main causes of drainage water quality degradation. Most of the people think that it is important to establish a garbage collection system. People will not stop throwing garbage in drains if there is no such collection system. It is not easy for the DPCs to establish garbage collection systems, since it is generally managed by local units. Therefore, they shall coordinate between local units and a local NGO or CDA in the communities.

The DPCs think that people throw their garbage and dead animals because of lack of awareness. There are mosques in every community and Imams, who are worship leaders in mosques, who will be able to deliver the importance of environmental conservation. Thus, all the DPCs and the CDA plan to conduct environmental awareness campaigns through Imams. The following table is a summary of the action plans.

Table 3.15 Summary of Activities in Action Plans as of April 2014

Site	Major Activities
E-1 (Pump Committee)	· Establishing Garbage Collection System, · Raising awareness of garbage and dead animal disposal through Imams, · Discussing dead animal disposal with the local unit, · Monitoring the progress of the sewage treatment member facilities.
E-4 (Pump Committee)	· Establishing Garbage Collection System, · Raising awareness of garbage and dead animal disposal through Imams and schools, · Requesting Drainage Dept. and the local unit to check the drainage water quality.
W-2 (Pump Committee)	· Establishing Garbage Collection System, · Raising awareness of garbage and dead animal disposal through Imams and schools
W-4 (Pump Committee)	· Integrating Garbage Collection System in a nearby village, · Raising awareness of garbage and dead animal disposal through Imams, · Conducting environmental awareness creation activities through the Pump Committee members, · Disusing the problem of industrial waste with the local unit.

Site	Major Activities
W-5 (Pump Committee)	· Establishing Garbage Collection System in Sandela village, · Raising awareness of garbage and dead animal disposal through Imams, · Requesting drainage sector to remove water hyacinth.
W-5 (CDA)	· Establishing Garbage Collection System, · Raising awareness of garbage and dead animal disposal through Imams and schools, · Conducting environmental awareness creation activities through the Pump Committee members, · Planning manure making training for farmers.

Action Plan Making W/S at W-2

Action Plan Making W/S at W-5 (CDA)

The DPCs and the CDA delivered their own action plans to all the stakeholders. The stakeholders include drainage and irrigation directorate in Kafr El Sheikh as well as the local units at each site. It is important for the DPCs and the CDA to build a good relationship with all these stakeholders to implement their activities, since these newly established organizations do not have enough resources.

Thus, the DPCs and the CDA need to involve various stakeholders, especially local units and irrigation and drainage directorate, in their action plan from the beginning.

3.4.5 Environmental Campaign at Schools

(1) Involvement of the Ministry of Education

At the Problem Analysis W/S, it was pointed out that lack of awareness is one of the issues causing drainage water deterioration. As mentioned before, speech by Imams to promote environmental awareness has begun at the sites. In addition to that, environmental awareness in schools was proposed in the action plans at some sites. Therefore, the Project Team proposed the organization of an environmental campaign and requested the Ministry of Education, Kafr El Sheikh Directorate, for collaboration in June 2014. The idea was very welcomed by the ministry, and it was agreed that the ministry arranged the campaign at each pilot site.

(2) Involvement of Drainage/ Irrigation Sector at Kafr El Sheikh Directorate

There is no direct governmental organization which is in charge of environmental awareness regarding open drainage. In general, Drainage Advisory Service (DAS) under the EPADP has a task to manage the underground drains while Irrigation Advisory Service (IAS) is in charge of WUA organizations, training of WUA members and so on. EPADP understands that it is needed to make the roles and responsibilities of organizations for environmental awareness promotion clear under the MWRI. Therefore, the Project Team and EPADP agreed to organize a workshop at Kafr El Sheikh Directorate to discuss the matter involving various sectors.

The workshop was held on the 20th of August 2014 at the Tanta Training Center. EPADP in Cairo, Irrigation/Drainage sectors in Kafr El Sheik, as well as IAS and DAS attended the workshop and discussed how they could cooperate for the project implementation and environmental awareness within the project period and after the project completion. The result of discussion at the W/S is described in the following table. Based on the discussion, it was agreed that both DAS and IAS staff would participate in the Environmental Campaign in schools and continue awareness activities after the Project.

Table 3.16 Summary of the Discussion

Sector	Within the Project Period	After the Project
Drainage Directorate	• Implementation with the JICA Team, • Assistance for obtaining permits and approvals from other sectors.	• Drainage water quality control, • Crop production control.
Irrigation Directorate	• Implementation with the JICA Team, • Assistance for obtaining permits and approvals from other sectors.	• Irrigation water quality control, • Application of Law No.48, • Support the Pump Committees, • Operation of the Pump Stations.
DAS Department	• Implementation of Environmental activities with the JICA Team, • Support the Pump Committees.	• Ongoing awareness creation, • Support the Pump Committees, • Coordinate the stakeholders.
IAS Department	• Support creation of awareness activities and activities of the Pump committees.	• Ongoing awareness creation, • Support the Pump Committees, • Coordinate the stakeholders.

Source: JICA Study Team

Discussions by the participants

Undersecretary of Planning, Follow-up & Evaluation Department, EPADP made opening remarks (right)

(3) Organization of Environmental Campaign at Schools

There are two phases of the environmental campaign conducted in August and September 2014: 1) Environmental awareness lecture at schools and 2) Garbage collection by the school children along the drainages. The environmental campaigns were conducted at schools nearby the pilot project site. There were 7 schools in total. Mainly, primary and preparatory schools were targeted. The school students, teachers, DPC members, CDA members (at W5 site only), local Units, Ministry of Education of Kafr El Sheikh, DAS and IAS participated in the series of campaigns. The schedule of the series of campaigns is as shown below:

Table 3.17 Schedule of the Environmental Campaigns

Stage	Date	Site	School
1st	21/08/2014	E4	Al-Neshawy Primary School
1st	24/08/2014	W2	Muhammad Khattab School

Stage	Date	Site	School
1st	25/08/2014	W2	Shawky Al-Qady Prep School
1st	26/08/2014	W4	Shaba Prep. School
1st	27/08/2014	E1	Al-Khuba Prep School
1st	28/08/2014	W4	Al-Nawiaja Prep. School
1st	31/08/2014	W5	Sandela Prep. School
2nd	02/09/2014	E4	Al-Neshawy Primary School
2nd	03/09/2014	W4	Al-Nawiaja Prep. School
2nd	04/09/2014	W2	Muhammad Khattab School
2nd	07/09/2014	W4	Shaba Prep. School
2nd	08/09/2014	W5	Sandela Prep. School
2nd	09/09/2014	W2	Shawky Al-Qady Prep. School
2nd	010/09/2014	E1	Al-Khuba Prep. School

At the 1st phase, general concepts concerning environmental awareness, e.g., garbage collection at certain sites, prevention of waste dumping to the canals/drainage, 3R (reuse, reduce and recycle) and so on was explained by using a picture-card show. Good practices such as cleaning activities by school children in other sites were also introduced. After the explanation, the participants were asked what they could do by themselves for environment improvement. The students said that they can collect garbage or they can paint posters for environmental awareness. The Staff of Local Unit said they can provide tractors for garbage collection at the 2nd phase. Based on the opinions from the participants, activities at the 2nd phase environmental campaign were planned. In general, the proposed main activities in the presentation were the making of environmental awareness posters, and garbage collection.


Students who present opinions (W2 site)


Explanation by using a picture-card show (E4 site)

At the 2nd phase, as planned, some students prepared and presented their drawings which appeal to the importance of environmental conservation. Local units also provided loaders for garbage collection. At E1 site, the planting of seedlings was also implemented by the school students. Based on the discussion at the W/S at the Tanta Training Center, some staff of IAS and DAS participated in the campaign by making speeches regarding water quality conservation for the students. All the stakeholders including The Ministry of Education were in support of this activity.


Drawing of Environmental Campaigns at W-4


A student showing her drawing (W-4)


Primary school student who presents her poster (E4 site)


Environmental Awareness by a DAS staff (E4 site)

The Project Team has provided T-shirts to the students, with the slogan "life without pollution" printed on them, so that the children could appeal to the importance of environmental conservation through garbage collection in their communities. The children enjoyed the garbage collection activity very much. Such scenes were very impressive for other participants and the people along the drainages/canals. Many governmental staff who participated in the activity pointed out that it is important to continue this activity in the future.


Planting of a seedling (E1


Garbage Collection at W-4


Garbage Collection at W-2

awareness. The CDA in W-5 has been conducting the garbage collection in El Kamseen village since August 2014. However, it has not been established yet in the other 4 pilot project sites. The DPCs in E-4, W-4, and W-5 have been still discussing how to establish garbage collection systems with local units. The DPCs in E-1 and W-2 seem to find it difficult to start garbage collection since their local units are not supportive due to financial issues.

Environmental awareness creation through Imams was done in all the project sites between May and August 2014. Imams have conducted awareness campaigns at mosques. There were positive impacts on W-2 and W-4. For example, one of the DPC members in W-2 is actually an Iman, and villagers in W-2 were well motivated for environmental conservation through the Imam. Also, the DPC in W-4 mentioned that awareness creation trough Imams was effective, and the number of people who throw garbage in drains has been decreased.

On the other hand, Imams in W-4 only gave a few words to villagers about the environment so that there was not a big impact on their behaviors. According to the DPC members in W-4, most of the Imams had to speak on many other topics. Therefore, their impact on environmental conservation seemed to be limited. It is important to make a strategy to implement environmental awareness campaigns based on the situation in each site.

Table 3.18 Summary of the Progress

Site	Garbage Collection	Environmental awareness campaigns/ other activities
E-1	· Garbage collection was not established because the local unit was not cooperative.	· The Committee members asked Imams to conduct awareness speeches; yet, they have not confirmed the activity.
E-4	· Preparation for garbage collection is still under process. · A local NGO will start the activity.	· Imams have been speeches for 3 months.
W-2	· Garbage collection was not established because the local unit was not cooperative.	· Imams have been conducting awareness speeches every Friday for 3 months. · However, villagers do not have any other choice but to throw garbage.
W-4	· One of the villages nearby the site has started garbage collection · The village downstream has not started the activity, yet they are discussing garbage collection systems with the local unit.	· Imams have been conducting awareness speeches for 3 months. · Villagers requested to start garbage collection systems soon.
W-5 (Pump Committee)	· Garbage collection has not been established because the local unit was not cooperative. · They will continue to discuss this matter with the local unit.	· Imams have been conducting awareness speeches only a few times. · The committee members will encourage Imams to conduct speeches more frequently.
W-5 (CDA)	· Garbage collection has been started in August 2014.	· Imams conducted awareness speeches during the Ramadan period. · The CDA members have also conducted awareness campaigns for community members once a month.

After implementing the action plans, review workshops were held in September 2014 at each site. The purpose of the workshops was to review what the DPCs and the CDA members have done, and to think about how to improve their future action plans. The DPCs themselves evaluated their own activities and discussed whether they should continue each activity or not. The following section describes the results of the workshops' review.

Workshops' Review at E-4

Workshops' Review at E-1

E-1 (Drainage Pump Committee)

Garbage Collection: The DPC members had discussions with the local unit, however, staff of the local units were not cooperative and they did not have any resources to support the DPC. Consequently, the garbage collection system had not been established in E-1. After the DPC members reviewed their action plan, they decided to conduct environmental awareness activities in villages upstream of the canal. The DPC members realized that most of the garbage comes from upstream villages. For this reason, they will change their course of action to decrease garbage from upstream rather than establishing garbage collection systems in their community.

Environmental Awareness Creation: Although the DPC members asked Imams to conduct awareness speeches at mosques, it had not been done yet. According to the DPC members, it is necessary to ask the Imams to do awareness speeches through higher authorities such as the local unit. The DPC members do not have a strong relationship with the Imams. To make things worse, the local unit is not cooperative. Therefore, the DPC members will try to get irrigation and drainage sectors involved in their activities to conduct environmental awareness campaigns.

Results of the Review Workshop: The DPC members evaluated both garbage collection and environmental awareness campaigns as "bad." This is because both of the activities had not been done. One of the reasons for this situation is that they could not get any support from the local unit. To change this situation, they are planning to get the irrigation and drainage sector more involved in their activities for the coming period. The table below shows the result of the workshop review.

Table 3.19 Results of the Workshop Review in E-1

Questions	Garbage Collection	Awareness Creation
Q1: What have you done? Progress/ Achievement	· Garbage collection has not been established. Rather, we should focus on reducing garbage disposal in upper villages.	· Not done yet
Q2: Evaluation (Very Good/ Good/ Not Good)	· Bad	· Bad
Q3: Reasons for Evaluation above	· There is no progress. · The local unit was not cooperative. · The situation has not been changed at all.	· Activities have not been done.
Q4: What is the most significant change?	· There is no change.	· There is no change.
Q5: Should we continue this activity?	· Most of garbage in the canal comes from upper villages. We should ask villagers upstream to stop throwing garbage.	· We should focus on raising environmental awareness of people in upstream villages.

Source: JICA Study Team

E-4 (Drainage Pump Committee)

Garbage Collection: The DPC members have been working on establishing garbage collection systems, yet it has not been ready to implement. The local unit has already agreed to start garbage collection, and the DPC has been asked to find a partner with a legal entity to operate garbage collection systems such as NGOs. The DPC has decided to work with an Islamic Charity Organization, which is registered as an official NGO in the village. Currently, the DPC has been coordinating between the local unit and the Islamic Charity Organization.

Environmental Awareness Creation: The DPC members have asked Imams in their community to conduct environmental awareness speeches. The Imams gave a speech about the importance of the environment every Friday between May and August 2014. Some of the Imams were changed in August, and there are new Imams in the village. For this reason, the environmental awareness speeches were not continued at some mosques. The awareness speeches will be resumed after the DPC members contact the new Imams.

Results of the Review Workshop: Although garbage collection has not been started yet, the DPC members evaluated it as "good." This is because preparation works have been done, and they expect that garbage collection will start soon. The DPC members also evaluated their environmental awareness campaign as "good." The Imams have actually raised villagers' awareness of the environment. One of the significant changes of this awareness campaign is that some people started to burn their garbage instead of throwing it into the drain. On the other hand, some people claim that they need garbage collection system in the village; otherwise, they do not have a choice but to throw garbage into the drain. Therefore, all the DPC members agreed that establishment of garbage collection systems is their most prioritized activity in the coming period.

Table 3.20 Results of the Workshop Review in E-4

Questions	Garbage Collection	Awareness Creation
Q1: What have you done? Progress/ Achievement	· Garbage collection has not started, yet the local unit and an Islamic Charity Society have agreed to start garbage collection.	· 9 Imams conducted awareness creation between May and August. · The DPC members had a discussion with school staff to raise their awareness.
Q2: Evaluation (Very Good/ Good/ Not Good)	· Good	· Good
Q3: Reasons for Evaluation above	· All the stakeholders did great efforts. · Preparation for garbage collection is in great progress.	· People responded to awareness creation activities, and they started to burn garbage instead of throwing it.
Q4: What is the most significant change?	· The local unit has started to fine people who throw garbage, and people started to throw garbage at night.	· People started to burn garbage or bury it instead of throwing.
Q5: Should we continue this activity?	· Should continue to coordinate among the stakeholders to start garbage collection.	· Should continue awareness campaigns.

Source: JICA Study Team

W-2 (Drainage Pump Committee)

Garbage Collection: The DPC members had a discussion with the local unit to establish garbage collection systems, however, the local unit does not have enough resources to support the DPC. It is difficult for the DPC to start garbage collection without any support from the local unit. It seems to take time to start garbage collection. Consequently, the DPC members have decided to focus on other activities such as creating environmental awareness.

Creating Environmental Awareness: The DPC had a meeting with Imams to start environmental awareness speeches at mosques. Imams have delivered words of environmental conservation. They asked villagers to stop throwing garbage and dead animals in canals. In addition, some active Imams conducted environmental awareness speeches during their religious class on weekdays. One of the DPC members is an Imam and he encouraged other Imams to participate in creating awareness.


An Imam talked to children at W-2

Results of the Workshop Review: One of the main problems in this DPC is that it is difficult to establish garbage collection since the local unit is not supportive and does not have enough resources. For this reason, the DPC members did not evaluate garbage collection activity. By contrast, creating environmental awareness has been done actively. Some people understand the importance of cleanliness and started to be concerned about the environment. However, the DPC members pointed out that many people are still throwing their garbage in the canals because there are no garbage collection systems.

Table 3.21 Results of the Workshop Review in W-2

Questions	Garbage Collection	Awareness Creation
Q1: What have you done? Progress/ Achievement	· There is no progress in activities · The Local Unit does not have enough resources to help the Committee start garbage collection.	· Conducted awareness speeches through Imams · Imams have also conducted awareness speeches during religious class.
Q2: Evaluation (Very Good/ Good/ Not Good)	---	· Good
Q3: Reasons for Evaluation above	---	· Some people actually stopped throwing and started to burn garbage instead. · However, people do not have any other choice but to throw since there is no garbage collection system.
Q4: What is the most significant change?	---	· Some people start to burn garbage or bury it instead of throwing.
Q5: Should we continue this activity?	---	· Should be continued, but it is also necessary to think about alternative ways to manage solid waste.

Source: JICA Study Team

W-4 (Drainage Pump Committee)

Garbage Collection: There are two local units operating in the W-4 area; 1) Shaba village located upstream of El karadwah irrigation canal and 2) Nawaja village located downstream of the drainage reuse pump site. Garbage collection has started in Shaba village since July 2014, whereas it has not started yet in Nawaja village. According to the DPC members, people in Shaba village are concerned about garbage, and it is an urgent matter for them. The local unit and a CDA in Shaba village are also willing to establish a garbage collection system. In contrast, the DPC members are still trying to convince the local unit to start garbage collection in Nawaja village.

Environmental Awareness Creation: Environmental awareness creation has been done in both Shaba and Nawaja villages. The local unit in Shaba village is active enough to encourage Imams to conduct awareness speeches. The Imams have conducted awareness speeches at mosques every Friday for three months. Creating awareness in Nawaja village was rather limited. The DPC members mentioned that Imams in Najawa village delivered speeches about the environment only a few times.

In addition, the DPC members have also delivered a message of importance of the environment to children at schools. The DPC members feel that creating awareness at school is more effective than through Imams. This is because children became messengers of environmental awareness to their parents. In fact, one of DPC members' children asked his mother to stop throwing garbage after he came back from school. The DPC will plan to continue spreading environmental awareness at schools in the coming period.

Results of the Workshop Review: The result shows that the DPC members are concerned about the local unit in Nawaja village. One of the main reasons the evaluation in Nawaja village was "not good" is that the DPC could not get enough support from the local unit. Hence, the DPC members evaluated both activities of garbage collection and creating environmental awareness as "not good." It is important for the DPC to build a good relationship with the local unit in Nawaja village in the future.

On the other hand, both garbage collection and awareness activities in Shaba village are going well. Garbage collection has actually started and all the stakeholders are cooperative. According to the DPC, there is a garbage collection system now, which will help the awareness campaign have a stronger impact on villagers' behavior, since people do have an alternative way to deal with their garbage, rather than just throwing it.

Table 3.22 Results of the Workshop Review in W-4

Questions	Garbage Collection	Awareness Creation
Q1: What have you done? Progress/ Achievement	· 1) Established a garbage collection system in Shaba village, · 2) Preparations were done in Nawaja village, but it has not started yet.	· 1) Shaba village: conducted awareness campaigns through Imams for 3months, · 2) Nawaja village: conducted awareness campaigns through Imams for one month. · 3) The Committee members conducted awareness campaigns at schools in Shaba village.
Q2: Evaluation (Very Good/ Good/ Not Good)	· 1) Very Good · 2) Not Good	· 1) Very Good · 2) Not Good · 3) Good
Q3: Reasons for Evaluation above	· 1) Garbage collection has actually started in Shaba village. · 2) Garbage collection has not been introduced yet, and the local unit is not supportive.	· 1) It was conducted for 3 months, and people do care about garbage throwing now. · 2) It was conducted for only one month, and its impact is very limited. · 3) Children delivered message to their parents so it was effective.
Q4: What is the most significant change?	· 1) The amount of garbage is getting less. · 2) Not yet	· 1) People stopped throwing garbage and cooperated with garbage collection service. · 2) Some people are aware of the environment · 3) Children talked to their parents about the environment.
Q5: Should we continue this activity?	· Garbage collection should be continued in both villages.	· All the awareness activities should continue.

Source: JICA Study Team

W-5 (Drainage Pump Committee)

Garbage Collection: Main members of the DPC in W-5 come from Sandela village, which is located in upstream area of Sandela drain. The DPC had a plan to establish garbage collection working through Youth Society, a local NGO, in the village. However, the local unit was not supportive for this Youth Society. Therefore, the DPC was not able to start garbage collection. According to the DPC members, administrative jurisdiction of the current local unit will be changed. The DPC will discuss establishment of garbage collection system in Sandela village with a new local unit.

Environmental Awareness Creation: Following a meeting between the DPC and Imams, environmental awareness creation was conducted. Yet, the impact of the activity was rather limited since Imams gave only a few words on the environmental awareness. Most of the Imams also have to deliver many other topics after praying on every Friday. It seems that there is not strong incentive for Imams to conduct awareness creation actively. The DPC members are discussing how to promote environmental awareness creation in the future. They will also try to get the local unit involved in their awareness creation activities.

Results of the Review Workshops: Although garbage collection has not been established yet, the DPC members expect that a new local unit will be supportive and they will be able to start garbage collection. For this reason, the DPC members evaluated the activity of garbage collection as "Good". Also, not all the Imams were active to conduct environmental awareness creation. However, some villagers responded to environmental awareness creation, and they started to burn their garbage instead of just throwing. The DPC also evaluated the activity of removing water hyacinth in the drain as "Very good". This is because water hyacinth in the drain was removed by drainage sector soon after they had a discussion with drainage engineers.

Table 3.23 Results of the Review Workshop in W-5 (Drainage Pump Committee)

Questions	Garbage Collection	Awareness Creation	Remove Water Hyacinth
Q1: What have you done? Progress/ Achievement	· Discussion with the Local Unit, and they refused to cooperate with a local NGO.	· Conducted awareness creation through Imams at 4 mosques. ·	· Discussion with drainage sector, and make a request for them to remove
Q2: Evaluation (Very Good/ Good/ Not Good)	· Good	· Good	· Very Good
Q3: Reasons for Evaluation above	· Although the current local unit is not supportive, there will be a new local unit in October. · The establishment process is still ongoing.	· Imams actually delivered the importance of the environment. · Imams delivered only few words and few times so impact was not big.	· The problem was solved with proper manner and good timing.
Q4: What is the most significant change?	· Not yet	· Some people stop throwing garbage and started to burn it instead.	· The drain was cleaned.
Q5: Should we continue to this activity?	· Should continue to discuss the new local unit.	· Will continue, but It is better push Imams to do this activity through the Local Unit.	· Should continue in the same manner.

Source: JICA Study Team

W-5 (CDA: El Kamseen village)

Garbage Collection: Garbage collection has started since August 2014 in W-5, Kamseen village. The CDA members had a series of discussions with the local unit, and they finally agreed that the CDA use a public dumpsite managed by the city council. The CDA collects garbage from each household in the village and carries it to the dumpsite. The JICA Study Team provided a motorbike to the CDA to enable them to start a garbage collection system. The CDA collects 3LE/month from each

residential unit to operate the garbage collection system. According to the CDA members, people stopped throwing their garbage and the amount of dumped garbage has actually decreased. Furthermore, since they started garbage collection, most of the villagers pay the service fee for the CDA, and they appreciate this activity.


Garbage Collection at W-5


The Motorbike was provided by the JICA Study Team

On the other hand, there are also some concerns about the operation of garbage collection systems. Although, the CDA collects 3LE/month from the villagers, collected money will not cover all the operational costs. There are around 65 residential units so the CDA collects approximately 195LE/month in total. However, the fuel cost for the motorbike is around 75LE/month. Oil exchange also costs about 60LE/month. There is no labor cost at the moment since a driver of the motorbike is a volunteer from the CDA members. They will plan to pay for a driver in the future. From this point of view, it seems to be difficult for them to continue garbage collection in the future.

Environmental Awareness Creation: Awareness creation was conducted through the Imam in El Kamseen village during the Ramadan period (July). The Imam made speech on importance of environmental conservation and asked villagers to stop throwing garbage and dead animals into the drain. Following the Ramadan period, the CDA members conducted awareness creation activities themselves once a month. At the awareness, the CDA members invite the villagers and asked them to make groups. The CDA members join each group and instruct the participants not to throw garbage

and dead animal. According to the CDA members, awareness creation through the CDA is more influential on the villagers than that of the Imam. In fact, many people stop throwing garbage into the drain. Therefore, they decided to continue their own awareness creation activities once a month.

Other activities (bread and gas distribution): The CDA has also been providing bread and gas distribution services. There are around 80 subscribers including people nearby villages. They collect 22.5 LE per month from each household for bread distribution. The role of the CDA is to go to town to buy bread and deliver to the subscribers. The CDA can make a profit 2.5 LE per household. The CDA also distributes gas once a week. They do not confirm how much money they earned because price of gas varies time to time; yet, they can still make a profit from gas distribution as well.

According to the CDA members, villagers appreciate these CDA's activities. Community members suffered from shortage of bread and gas before, and now they do not suffer from shortage of bread and gas any more. In addition, the CDA can make certain profit from these activities. This makes the CDA strengthen financially, and it will contribute to institutional sustainability in the future.

Results of the Review Workshop: Garbage collection has started at El Kamseen village since August 2014. Community members actually stop throwing garbage into the drain and appreciated the garbage collection service. At the same time, there are also concerns about operation of garbage collection service. The CDA still has to improve operation of garbage collection so that they evaluated garbage collection as "Good". For awareness creation, the Imam conducted environmental awareness creation at the Mosque, and the CDA members also conducted awareness creation themselves. People's behavior has changed and the amount of garbage in the village and the drain are getting decrease. Therefore, the CDA members think that environmental awareness creation was effective and they should continue the activities.

Table 3.24 Results of the Review Workshop in W-5 (CDA)

Questions	Garbage Collection	Awareness Creation
Q1: What have you done? Progress/ Achievement	· Established garbage collection, · Started the operation since August, · 62 residential units are registered to the service, · Collected around 360LE as service fee,	· Conducted awareness creation through Imams in July, · Conducted awareness creation through the CDA members once a month.
Q2: Evaluation (Very Good/ Good/ Not Good)	· Good	· Very Good
Q3: Reasons for Evaluation above	· Almost all the villagers paid the service fee, and they appreciate garbage collection, · 3LE per month is not enough for operation in the future. · It takes time to go to the dumpsite and it costs a lot.	· The activity is very effective. People actually stop throwing garbage and dead animal disposal into the drain.
Q4: What is the most significant change?	· People became aware of the environment. · There is less fighting between villagers regarding garbage throwing.	· Most people stop throwing garbage into the drain.
Q5: Should we continue to this activity?	· Should continue this activity because people appreciate it. · It is necessary to expand service area or increase service fee to continue the service.	· Awareness creation should continue through the CDA because it seems more influential.

Source: JICA Study Team

3.4.7 Involvement of Other Ministries for Environmental AwarenessPromotion

On the 27th of October 2014, a joint meeting consisting of MWIR, The Ministry of Youth and Sports, The Ministry of Awqaf (Religious Endowments), local units concerned, city council and The Department of Environment under Kafr El Sheikh Governorate, was organized for environmental awareness promotion in Kafr El Sheikh. On the 19th of November, a meeting between Ministry of Awqaf in Kafr El Sheikh and the DPC was held to request Imams to participate in spreading

environmental awareness. A series of awareness meetings (seven in total) targeting Imams for prevention of garbage dumping into canal/drains was organized in December. Moreover, the Project Team members also visited to the Ministry of Youth and Sports on the 24th of November to request collaboration for environmental awareness. In addition, a series of cross-sectorial meetings among The Ministry of Youth and Sport, local units concerned, Imams, and the people in the Pilot Sites was held at each site.

Awareness targeting Imams for Environmental Awareness

Meeting among stakeholders (Local Unit, Imams, Ministry of Youth and Sport, and villagers) for environmental awareness at W4 site

After the awareness sessions targeting Imams, they have started giving speeches at mosques every Friday. At the W5 site in Sandela village, the Youth Society under the Ministry of Youth and Sports organized an environmental cleaning activity on February 2015. They charted a tractor to clean the embankment of the canal, and the children in Sandela painted trees white along the canal. The cleaning activity mentioned above triggered the start of regular garbage collection at Sandela village by using the existing CDA under the support of the Sandela local unit.

Painting trees by children at W5

Cleaning of canal embankment using a tractor by the Youth Society at W5

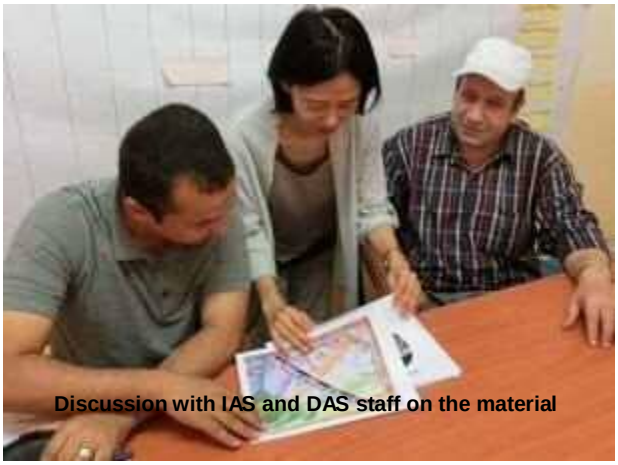
3.4.8 Finalization of the Environmental Awareness Training Material

After the project completion, it is necessary to continue and expand environmental awareness in Kafr El Sheikh Governorate by governmental staff.

The draft picture style environmental awareness activity was proposed by the project team. The activity is mainly composed of photos taken through the pilot project and posters drawn by school children. These materials show the process of the pilot project implementation, namely, problem analysis, action plan making and environmental campaign implementation. Therefore, it is not only awareness that is promoted, but also necessary procedures for the people to consider in how they can

tackle the environmental problems by awareness promotion.

The draft activity was modified through discussions with DAS and IAS staff in charge of environmental awareness related to drainage and canal at the village level. They suggested adding a message from the Koran, "cleanness is faith," and adding one page showing a clean canal as a future image. They pointed out that it is important to include photos showing all of the men, women, children and adults participating in environmental cleaning activities. The finalized material was distributed to the Irrigation and Drainage Department in Kafr El Sheikh for promotion of environmental awareness training by Egyptian side (This doesn't make much sense. What are you trying to say?). The final environmental awareness training material is attached as Appendix M.



Discussion with IAS and DAS staff on the material

3.4.9 Final Evaluation of Action Plans

Based on the Action Plans, the final review of the W/S targeting CDA and pump committee members at each site was organized in August 2015. In addition to the internal review of the W/S, five questions were asked to the participants and they answered the questions and provided their reasons. The overall result is as follows:

Garbage Collection and Drainage Cleaning

At W2, E1 and E4, they could not establish garbage collection systems due to shortage of financial support by the local units concerned. Still, E4 people had a plan to start a garbage collection system by establishing a new CDA. They have already submitted the application form for CDA establishment to The Ministry of Solidarity, and it is under process for approval. Moreover, they have discussed drainage cleaning with The Drainage Department several times. Consequently, the drainages were cleaned on schedule. Therefore, the evaluation is "very good" in general. On the other hand, at W5 (both CDA and Pump Committee) and W4, garbage collection had started and their evaluation is high. However, the CDA faces financial difficulty for garbage collection.

Environmental Awareness

Mostly, environmental awareness activities have been implemented successfully, by involving Imams and the local units concerned. All of the sites have already done some kinds of activity, such as speeches by Imams, which helps promote environmental awareness among the villagers. Committee members at some sites said that such environmental awareness was effective in changing villagers' behavior, which subsequently results in less pollution of the water.

It is noted that DAS staff also participated in the W/S and they played the roles of facilitators, which makes it possible for the staff to continue environmental awareness activities after the project completion.

Review W/S by the DAS Staff at E1 site

Review W/S by East DAS Staff at W5 site

The results of W/S are as follows:

E-1

Regarding drainage cleaning, no progress has been identified. Therefore, the committee members will continue to contact and pressure the local unit until they carry out the required action(s). On the other hand, environmental conservation among the villagers has been promoted due to some efforts. The members will continuously contact with Awqaf and Imams for more awareness promotion. Also, they requested the Drainage Authority and local unit to carry penalties against people who dispose of their waste in the waterways. As for garbage collection, the situation has not been changed after the W/S review which was conducted in September 2014. That is why they didn't discuss the garbage collection issue any further.

Table 3.25 Summary of the Final Review of the W/S

Questions	Garbage Collection/Drainage cleaning	Awareness Creation
Q1: What have you done? Progress/ Achievement	· A meeting was held at the local unit office with 1 Drainage Engineer	1) Meetings were held with the head of the local unit five times 2) A meeting was held with The Awqaf Department in Al Riyad District.
Q2: Evaluation (Very Good/ Good/ Not Good)	· Very good	· Weak for 1) · Good for 2)
Q3: Reasons for Evaluation above	· Drains drained in time were requested.	· The Local Unit failed to perform the required duties · Awareness is still ongoing by Imams.
Q4: What is the most significant change?	· This has resulted in cleaning the water and unblocking the flow	· Some villagers have become quite responsive; they collect their garbage in plastic bags and keep them until they are burned. However, other villagers (particularly upstream) still dispose their waste in the waterways
Q5: Should we continue this activity?	· Yes	· Yes

Source: JICA Study Team

E-4

The people negotiated with the drainage department staff for the cleaning of the drainage, which makes it possible for them to use drainage water more easily for irrigation. Concerning awareness activities, due to the collaboration with the local unit and Imams, they succeeded in spreading the awareness to the people and minimizing water pollution. As for garbage collection, an application to establish the CDA has been submitted to the Ministry of Solidarity in April 2015 and it is still under the process for approval (it is not mentioned below, though). Once they get their registration,

they will cooperate with Al-Raseef local unit near E4 to apply the garbage collection system.

Table 3.26 Summary of the Final Review of the W/S

Questions	Garbage Collection/Drainage cleaning	Awareness Creation
Q1: What have you done? Progress/ Achievement	· Two meetings were held with the Drainage department staff	· Awareness activities were conducted in collaboration with the local unit · Awareness speeches were conducted by Imams
Q2: Evaluation (Very Good/ Good/ Not Good)	· Very good	· Very good
Q3: Reasons for Evaluation above	· Drainage was cleaned as scheduled	· Water Pollution is minimized to some extent · Raising awareness of the villagers was done
Q4: What is the most significant change?	· Water is available in the drainage in the peak period. Drain has become free of from water hyacinth	· Water has become cleaner in the water courses
Q5: Should we continue this activity?	· Yes	· Yes

Source: JICA Study Team

W-2

Cleaning activities and awareness activities have been implemented as scheduled for drainage water quality improvement. The committee members were satisfied with the outcomes and their performances. As for garbage collection, the situation has not been changed after the review of the W/S, which was conducted in September 2014. That is why they didn't discuss the garbage collection issue any further.

Table 3.27 Summary of the Final Review of the W/S

Questions	Garbage Collection/Drainage cleaning	Awareness Creation
Q1: What have you done? Progress/ Achievement	· Drainage cleaning schedule has been maintained. · Meetings for amendment of cleaning schedule were held with the Drainage department staff two times.	· Meetings with Imams have already been held three times
Q2: Evaluation (Very Good/ Good/ Not Good)	· Very good	· Very good
Q3: Reasons for Evaluation above	· Cleaning schedule is well organized, and the cleaning work is quite good.	· Low levels of pollution in the watercourses and watercourses embankments are preserved.
Q4: What is the most significant change?	· Performing cleaning in the duly set times has improved water quality	· Cleaner water and higher productivity is expected
Q5: Should we continue this activity?	· Yes	· Yes

Source: JICA Study Team

W-4

Meetings with the governmental staff concerned for drainage cleaning and awareness activities have been organized several times, which brought about good impacts, for e.g. raising awareness. It is noted that a garbage collection system has started since December 2014. The W-4 site consists of two villages, namely, Abu Mandour and Shaba. Shaba village has started garbage collection through an existing CDA under the support of the local unit.

Table 3.28 Summary of the Final Review of the W/S

Questions	Garbage Collection/Drainage cleaning	Awareness Creation
Q1: What have you done? Progress/ Achievement	· Meetings were held with the Drainage Department twice	· Meetings were held with the relevant local unit three times · Meetings were held with the relevant Awqaf Directorate twice
Q2: Evaluation (Very Good/ Good/ Not Good)	· Very good	· Good
Q3: Reasons for Evaluation above	· Cleaning schedule is well organized in the due time	· Lower pollution levels in drainage water and raising awareness of the villagers
Q4: What is the most significant change?	· Water should become available for the PS during operation	· Cleaner water productivity
Q5: Should we continue this activity?	· Yes	· Yes

Source: JICA Study Team

W-5 (pump committee)

In general, planned activities, except pump operation, have been implemented as scheduled. At the Sandela village (mother village of Khamseen hamlet) the garbage collection system has started through the existing CDA since June 2015. According to the villagers, environmental cleaning activity held in February 2015 by the Youth Society triggered the start of the garbage collection. According to the committee members, more contact should be made with both the Irrigation Department and Drainage Department for cleaning and dredging operation.

Table 3.29 Summary of the Final Review of the W/S (W5, DPC)

Questions	Garbage Collection/Drainage cleaning	Awareness Creation
Q1: What have you done? Progress/ Achievement	1) Meetings with the Drainage Directorate to arrange for drainage cleaning schedule were organized 2) Drainage was cleaned and dredged 3) Preservation of the In-stream Treatment facility from water hyacinth and weed has not been implemented 4) Implementation of a garbage collection system.	Environmental awareness activities were conducted through some authorities (Imams and the local unit)
Q2: Evaluation (Very Good/ Good/ Not Good)	· Good for 1) and 2) above · Weak for 3) above Very good for 4) above	Good
Q3: Reasons for Evaluation above	· Drain was cleaned and dredged, but not as expected/whished for 1) and 2) above · In-stream Treatment Facility has not been completed or operated yet for 3) above · Relevant authorities (local unit and Imams) have been cooperative for 4) above	It is still required to conduct environmental awareness activities with all authorities and villagers.
Q4: What is the most significant change?	None	This will lead to enhancing and raising awareness of the people and will also contribute to improving the water quality
Q5: Should we continue this activity?	Yes	Yes

Source: JICA Study Team

W-5 (CDA)

The planned activities, except for pump operation, have been implemented on schedule. STP is operated by the head of the CDA members after the operation training. Regarding garbage

collection, it is a little difficult for them to manage the cost of the motorbike fuel, so, they discussed the possibility of transferring the collected garbage by the CDA to the neighboring main village, which can transport the garbage to the waste center specified by the Local Unit

Awareness activities presented good progress, which changed the villagers' behavior.

Table 3.30 Summary of the Final Review of the W/S (W5, CDA)

Questions	Sewage Treatment System Operation	Garbage Collection/Drainage cleaning	Awareness Creation
Q1: What have you done? Progress/ Achievement	STP is in service now	Garbage collection Is on-going regularly.	A meeting was held with The Awqaf Department
Q2: Evaluation (Very Good/ Good/ Not Good)	Very Good	Good	Very good
Q3: Reasons for Evaluation above	STP is in service now	Limited financial resources and an overload on the Motorbike (prefer to have a small truck), limited number of residents	Strong Impact of Imams within the community
Q4: What is the most significant change?	Drainage water Has become cleaner	Environmental awareness activities, especially for children, and minimization of waste all over the hamlet has been promoted.	Behaviors of villagers have been improved
Q5: Should we continue this activity?	Yes, it is expected that water shortage will be minimized	Yes	Yes

4. Economical Analysis of the Proposed Pilot Project

(1) Basis of Economic Analysis

The Study Team carries out an economic analysis of the Pilot Project. Since the scale of the project is small, Financial Internal Ratio of Return (FIRR) using financial price is applied. The major benefit of the project is an increase of unit yield of crops during the water shortage period, namely summer crop season. The constraints are the water shortage at the tail of the irrigation (branch) canal, and the bad quality of drainage water to be reused for irrigation to mitigate the water shortage at the tail. The project establishes the water reuse pump to mitigate the water shortage at the tail of the canal, and in 2 sites treatment facilities to improve water quality of the drainage water will be established. The tangible benefits of these components are estimated by the increase of crop production.

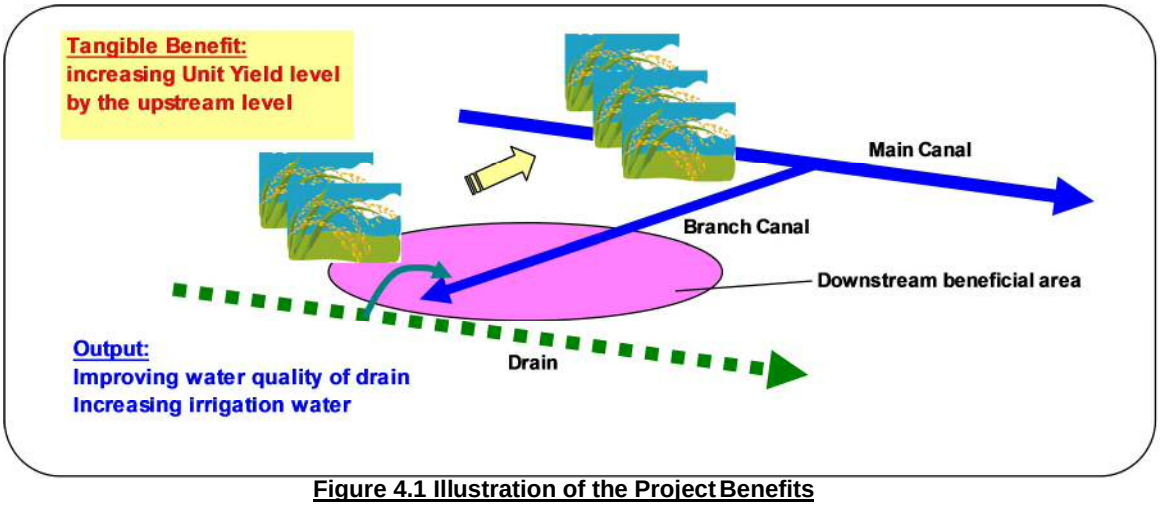


Figure 4.1 Illustration of the Project Benefits

The project also establishes a rural sewerage system in one site. The facility contributes not only to the irrigation with reuse of drainage water, but also to the improvement of the hygienic environment in

the village, which would reduce the occurrence of water-borne diseases. This kind of benefit is difficult to calculate, but here a trial estimate by reducing the medical expenses of the residents is carried out.

(2) Project Cost

Table 4.1 Summary of Project Costs

Site	Component	Construction Cost (LE)	O&M Cost (LE/yr)
E-1	Re-use Pump (1.0m^3/s)	707,383	51,833
E-3	In-stream treatment	939,312	28,179
E-4	Re-use Pump (0.5m^3/s)	630,073	30,695
W-2	Re-use Pump (1.0m^3/s)	707,383	60,811
W-4	Re-use Pump (0.5m^3/s)	630,073	36,428
W-5	Re-use Pump (1.0m^3/s)	780,827	53,136
	Rural sewerage system	773,096	23,193
	In-stream Facility	927,716	27,831
	Compost making Facility	153,619	0
	W-5 Total	2,636,258	104,160
W-7	Re-use Pump (1.0m^3/s)	707,383	62,232

Table 4.1 summarizes the project costs in each site. The costs consist of construction cost and operation and maintenance cost. Construction cost includes educational cost because environmental campaigns and awareness raising activities of water quality conservation are planned in each site. Renewal of reuse pumps is counted every 10 years and every 20 years for sewerage systems and in-stream facilities. There are two types of pump capacity: 1.0m^3/s and 0.5m^3/s. Although one of the pump capacities is half of the other, there is only approximately a 10% difference between the two pumps.

Operation and maintenance cost includes pump operation costs and other maintenance such as repairing costs. Pump operation costs is mainly electricity costs, which is estimated based on the pump capacity and water requirement in each site. Other maintenance costs are estimated at 3% of construction costs, except for the compost making facility in W-5. This is because the compost making facility is simple and maintenance free. These maintenance and operation costs are estimated every year equally.

(3) Project Benefits

1. Beneficiated Areas

The following table shows the irrigated area and water shortage area of each site, the cropping pattern in summer with and without project situations, the operation hours of reuse pumps at peak periods, and the beneficiated areas of the Pilot Project. Based on the possible capacity of the reuse pumps, in-stream treatment facilities, cropping patterns and pump operation hours, the beneficiated areas of the Pilot Project in each site were identified.

Table 4.2 Estimation of Beneficiated Areas in Each Pilot Site

Site	Irrigated Area (fed)	Water Shortage Area (fed)	Design Pump Capacity (m^3/s)	Summer Cropping Pattern			Pump Operation at the Peak Period (hrs/day)	Beneficial Area (fed) (%) to irrigated Area)
				Crop	Without project (%)	With Project (%)		
E-1	5,600	1,000	1.0	Paddy Maize Cotton Other	30 25 40 5	50 25 20 5	16	1,000 (18%)
E-3	7,100	2,100	-	Rice Maize Cotton Other	10 15 60 15	50 15 20 15	-	400 (6%)
E-4	1,100	400	0.5	Paddy Maize Cotton Other	60 15 20 5	60 15 20 5	13	400 (36%)
W-2	5,500	1,100	1.0	Rice Maize Cotton Other	75 8 12 5	75 8 12 5	20	1,100 (20%)
W-4	3,000	1,000	0.5	Paddy Maize Cotton Other	60 25 10 5	60 25 10 5	20	600 (20%)
W-5	1,800	900	1.0	Rice Maize Cotton Other	60 10 25 5	60 10 25 5	15	900 (50%)
W-7	37,400	2,000	1.0	Rice Maize Cotton Other	55 10 30 5	55 10 30 5	20	1,280 (3%)

Note:

- Water shortage area and present cropping pattern are based on the field survey.
- Cotton production has been rapidly decreasing in recent years. Therefore, if the water shortage is alleviated by re-use, paddy cultivated area may increase. However, the paddy crop is regulated up to 50% per irrigation canal command area by the government's policy. If the farmers violate this regulation, they are fined. Considering the future trend and the government policy, it is assumed that in the site with the paddy crop area of less than 50%, the cotton crop area would be converted into a paddy crop area up to 50% of the total cultivated area (E-1 and E-3). As for the sites in which paddy crop are already more than 50% of the total area, it is assumed that the present cropping pattern will remain the same for the "With Project" situation.
- The capacity of reuse pumps is determined by the available discharge of the drainage water in the target drain.
- Because the standard specification of a pump set is either 1.0 m^3/s or 0.5 m^3/s, one pump with the capacity of either sizes is basically planned for installation.
- Pump operation time at peak periods is calculated as follows: 1) calculating the total water requirement in each period by unit water requirement by crop x cropping pattern with project situation x water shortage area, 2) then the required operation time is obtained from dividing the total water requirement by pump capacity. Maximum operation time is designed at 20 hours/day.
- In E-1 site, the pump operation time at peak period is designed at 16 hours/day. But if we reduce the pump capacity from 1.0m^3/s to 0.5m^3/s, water requirement at peak period cannot be supplied by the re-use pump. Therefore, the capacity of the pump is designed as 1.0m^3/s.
- In the sites of W-4 and W-7, the max operation time (20 hours/day) would not be able to cover all the water shortage area. Therefore in these 2 sites, the beneficiated areas are

identified as the maximum areas that the designed pump can serve.

- In the site of E-3, the beneficiated area is estimated from the length of the in-stream treatment facility, which is approximately 2.5 km.

2. Benefit: Crop yield increase by alleviating water shortage

The crop yield increase due to the project is basically estimated by considering the difference between the yield level of the head of the irrigation canal and that of the tail. Increase ratio of the crop production due to the project is estimated based on the questionnaire survey carried out in the selected areas where water shortage issues had been strongly addressed by the irrigation officers of Kafr El Sheikh Governorate. The difference of average unit yields of paddy and cotton at the head and tail from the sample farm households in 10 canals were around 8% and 20% respectively. In this analysis, it was assumed that the yield level at the very tail of the canal could be increased up to the middle part of the canal, hence, the unit yield increase ratio was assumed at 4% for paddy and other crops, and 10% for cotton.

3. Benefit: Crop yield increase by improving water quality

Improvement of water quality in the drain could contribute to increasing the crop yield. There is no standard on the correlation between water quality and crop yield in Egypt. In this estimation of the benefit, we refer to an example of a water quality improvement project in Japan (National Land Improvement Project, Shinnoubi site). The figure shows the correlation between the degree of COD and the unit yield of paddy. Considering the similarity of the field condition of that of the drainage in Egypt, the data along the open channel used for both irrigation and drainage are applied from the Shinnoubi project. Based on the figure, the increase ratio of crops by water quality improvement was estimated. Assuming that COD level can be improved from 40mg/l to 30mg/l, the unit yield increase is estimated at 3.6%. For W-5, a compost making facility is installed and it will reduce the amount of agricultural reside dropping into the canal. Putting this effect into consideration, the unit yield increase by water quality improvement in W-5 is assumed at 4%.

4. Benefit: Reduction of medical expenses

As a benefit accrued from the rural sewerage system, reduction of medical expenses is applied as a proxy to estimating the benefit of the facility. Although it is very difficult to calculate the benefit, it is attempted here as preliminary analysis, based on the questionnaire survey in the target village. According to the sample households, the medical expenses of a household are estimated at 100 LE/month on average. With the project, it is assumed that half of the medical expenses would be reduced.

5. Preliminary Calculation of FIRR

Based on the costs and benefits explained above, although it is a preliminary estimate, the FIRR of the project in each site was calculated. The following table shows the results:

Table 4.3 Preliminary Calculation of FIRR (Financial Internal Rate of Return)

Site	E-1	E-3	E-4	W-2	W-4	W-5	W-7
FIRR (%)	32.7	12.3	5.8	30.5	11.8	12.0 (15.5)	50.6

Note FIRR in W-5 is the value excluding the rural sewerage system.

In E-1 and E-3, the change of cropping pattern, namely from cotton to paddy is incorporated in the cost-benefit analysis. It was assumed that the transfer from cotton to paddy would gradually increase, so that the full benefit would be realized in 5 years. As for W-5, the benefit of reducing medical expenses is included in the calculation. Also, the treated water from the sewerage

system is used at the downstream ranges of the drain. This beneficiated area was added to the analysis. Due to the little amount of treated water by the sewerage system, additional beneficial areas were estimated at 96 feddans.

Sewerage system is rather for providing civil minimum for the residents (this sentence makes no sense). Therefore, the tangible economic benefit of the sewerage system is considered low. With the large capacity of reuse pumps in E-1, W-2 and W-7, the beneficiated area could be widely extended, which would make the economic efficiency high. As for E-4 and W-4, the pump capacity is small and so the beneficiated area is relatively smaller. That made for the lower FIRR. The economic analysis will be reviewed and elaborated after implementing the Pilot Project.

5. Farm Budget Analysis

Increase of farm income of a typical farm household due to the project will be examined. The table below sows the farm income with and without the project for a typical farming area and cropping pattern of a farm household in W-5 as a model case. With the cultivated land of 2.4 feddans, incremental farm income is estimated at 2,250LE or 938LE/feddan.

Table 4.4 Farm Budget Analysis

Crop	Without Project					With Project					Difference (LE)
	Cropped Area (fed)	Yield (t/fed)	Price (LE/t)	Income ratio	Net Income (LE)	Cropped Area (fed)	Yield (t/fed)	Price (LE/t)	Income ratio	Net Income (LE)	
Summer Crop											
Paddy	1.44	2.48	2,000	58%	2,877	1.44	2.68	2,000	61%	3,270	
Maize	0.24	2.5	1,500	45%	1,688	0.24	2.7	1,500	49%	1,985	
Cotton	0.60	0.99	6,300	30%	1,871	0.60	1.13	6,300	38%	2,705	
Other (melon)	0.12	13.22	697	70%	6,450	0.12	14.3	697	72%	7,176	
Winter Crop						0.00					
Wheat	1.20	1.59	1,700	43%	1,162	1.20	1.59	1,700	43%	1,162	
Berseem	0.48	39.02	55	87%	1,867	0.48	39.02	55	87%	1,867	
Sugar beet	0.72	17.62	270	66%	3,140	0.72	17.62	270	66%	3,140	
Total	4.80				**19,055**	4.80				**21,305**	**2,250**
				(LE/fed)	7,940				(LE/fed)	8,877	938

5 Outputs and Lessons of Pilot Project

5.1 Lessons Learnt from the DPCs and the CDA

The idea of the irrigation complex facilities is new to most of the stakeholders. One of the purposes of the pilot project was to explore how the DPCs and the CDA work effectively. There are a number of key findings made, and lessons learned, through the capacity development activities of the DPCs and the CDA. In this section, these findings and lessons are summarized.

- The protocol of the irrigation complex facilities should be prepared well in advance of the operation starting day. The irrigation complex facilities consist of many different facilities. Some of the facilities are new to the stakeholders, and so it takes time to get consensus on these new facilities. For example, the in-stream facility is new to the drainage sector and they were reluctant to take the responsibilities of the facility. After a series of discussions, they finally agreed to take full responsibilities of the in-stream facility. Therefore, it is important to take time to discuss and get consensus from the stakeholders on the protocol.

- Capacity development activities of the DPCs and the CDA should be synchronized with the progress of the construction of the facilities. The DPCs and the CDA were established in 2013 and they actually started operation of the facilities in 2015. There was a gap between the period of the capacity development activities and the period of the facility operation. For example, the “Study Visit” was conducted in May 2013. This “Study Visit” experience seems to have become an old memory for the DPCs and the CDA’s members when they started operation. It is important to motivate the DPCs and the CDA by implementing a series of the capacity development activities at the right time, in consideration with the progress of the facility construction.

- Building a relationship with local units and local NGOs is important to activate the DPCs and the CDA. It is difficult for the newly established organizations to implement some activities without collaboration with other organizations. The DPCs and the CDA do not have enough resources to solve problems such as drainage pollution. Building a relationship with other stakeholders could be one of the strategies to get extra resources. In fact, the DPC at E-4 has been preparing for garbage collection through working with The Islamic Charity Society, a local NGO in the community. Also, the CDA at W-5 was supported by the local unit to start garbage collection. Thus, establishing a good relationship with local units and local NGOs is an important aspect to activate users' organizations.

- Spreading environmental awareness should be done parallel to garbage collection or other garbage disposal activities. Awareness activities have had certain impacts on villagers, however, these impacts seem to be rather limited if there are no garbage collection systems. This is because villagers do not have any choice but to throw garbage in canals. For example, the CDA at W-5 had started garbage collection and conducted environmental awareness campaigns simultaneously. As a result, many people have actually stopped throwing garbage. Whereas, people in W-2 have understood the importance of the environment through the Imams' awareness speeches, yet there were no garbage collection systems in the community. Some people have started to burn their garbage instead of throwing it, however, this is still harmful to the environment.

- According to the law, local units have a duty to collect garbage at main villages, however, small settlements, namely hamlets, are not targeted by the law. Most of the pilot sites are located on small villages and they are not covered by the local units for garbage collection. It is, thus, difficult to establish such a system. Even if local units concerned are cooperative, financial issues still need to be solved. Therefore, it is very important to collaborate with existing NGOs in the areas.

- It is recommended to implement environmental awareness through multiple channels. One of the most common ways to spread awareness is through Imams at Mosques. However, it seems not to be enough to raise environmental awareness of the community members. Some of the DPC members commented that Imams have many topics to tackle after praying and they sometimes delivered only a few words on the environment. In some cases, women do not go to mosques and they have a limited chance to listen to Imam's speeches. For this reason, awareness creation should be done in various ways. According to the DPC members in W-2, children talked to their parents about the importance of the environment after they attended the awareness sessions at school.

- Some problems of the DPCs are behind their capacity and geographical areas. Most of the DPCs are organized at the tail end of the canals. However, sometimes their problems are connected with upstream areas. For instance, Mars El Gama canal of E-1 is one of the longest canals in the pilot project sites. There are several local units working upstream of the canal. Most garbage at E-1 comes from upstream villages, and so the DPC members in E-1 should cooperate with several other local units upstream. It is difficult for the DPC members to facilitate garbage collection in other villages and change the situation. Their garbage problems seem to be solved through higher organizations such as BCWUAs.

- Strengthening financial management capacity of the CDA is important to activate their activities. CDAs will be able to officially be involved in a wide range of activities, such as bread distribution and other community services. Some community services might be profitable, while some other activities might not. In fact, the CDA at W-5 have made a profit from bread and gas distribution and are planning to utilize these profits to operate garbage collection. Financial management capacity is a key aspect to success in their activities.

- Women's involvement in spreading environmental awareness is also important. In rural areas, one of the main roles of women is to sort out domestic garbage and dump it. Environmental awareness

campaigns have been conducted through Imams and schools in most sites. However, it is difficult to deliver the message directly to women in the channels. Only the Imam in W-2 site conducted awareness sessions exclusively for women on weekdays. This Imam is one of the DPC members and holds a religious class for women on weekdays, and hence could give lessons on the environment for women. Creating awareness by the committee members, while considering different genders, is also necessary in the future.

5.2 Effect of Environmental Education Activities

(1) Involvement of Other Sectors for Environmental Conservation

The involvement of various sectors is effective for environmental conservation. During the Pilot Project, not only the MWRI, but also other agencies, namely, The Ministry of Education, The Ministry of Youth and Sports, The Ministry of Awqaf, and local units were involved in the environmental awareness sessions, and as a result various changes were observed. Imams started giving speeches about environmental awareness every Friday, which is effective in improving villagers' behaviors. Moreover, environmental cleaning activities by the Youth Society at A5 site (Sandela Village) have triggered the local unit to start the garbage collection. Water quality conservation is not only a matter for MWRI, since water quality deterioration is related to insufficient morals and low education, in addition to technical matters. For expansion of environmental conservation awareness, these agencies have to be stakeholders, along with the MWRI.

(2) Women's Participation in Environmental Conservation

Generally, it is very difficult for women to become members of DPC or CDA in rural areas, and as a result environmental awareness for women was not sufficient. On the other hand, there are many female teachers at each school, and when environmental campaign for the school children was carried out, they complained about no garbage collection systems and strongly requested the staff of the local units to do the activity regularly. It is clear that female teachers have a high level of concern about waste management. In the Delta area, seemingly, women who have a high education level such as teachers or journalists can express their opinions in public. Therefore, in the future, through further collaboration with school teachers, there is a possibility for women to take initiatives in environmental awareness from women to other women.

(3) Utilization of Existing CDA for Garbage Collection

In rural areas, local units cannot cover all the small villages (hamlets) for garbage collection due to insufficient financial sources. In such cases, it is possible to make use of existing CDAs. At W4 site (Shaba Village) and A5 site (Sandela Village), the people have started garbage collection by means of existing CDAs. In general, CDAs has financial sources and equipment to some extent, and so it is possible to establish a garbage collection system by using these CDAs. Even if some villages do not have a CDA, the villagers can negotiate with neighboring villages that have existing CDAs for garbage collection. It is recommended to collaborate with existing CDA as much as possible.

(4) Continuous Environmental Awareness Creation

Due to environmental awareness by the local units and Imams, people's behaviors regarding waste disposal have been improved, which leads to less pollution of water according to the final reviews of the W/S. However, it is very important to continue such awareness activities, since it takes time for the concept of environmental conservation to take root at the village level. For sustainable water conservation, not only temporary events such as environmental campaigns, regular environmental awareness creation activities are necessary. According to the current system, DAS have a duty

for water conservation of drainages, and they should visit the field around twice per year. It is requested that DAS and IAS staff visit the villages to communicate with the people more frequently.

(5) Effective Utilization of Materials for Environmental Conservation

As mentioned before, some school students prepared attractive posters for environmental awareness at the campaign, which are very impressive, even for the governmental staff. These paintings can be utilized as awareness material, and such materials can become attention grabbing for villagers to promote awareness, which can be more effective than relying only on oral explanations. The CDA at the W5 site requested the project to provide the picture-card-show style material, which was prepared by the project, for continuous awareness by the CDA members targeting the villagers. It is recommended to prepare/use such kinds of material, which is sustainable and not costly.

(6) Mediation between Villages upstream and Villages downstream

According to the villagers, even though they stopped dumping waste in the irrigation canals and drainage, it is not very useful since villagers upstream throw garbage into the watercourses. Given that it is not a big issue for the villagers upstream, it is necessary to involve those villages in operating irrigation complexes effectively. Therefore, local units, The Drainage Department and The Irrigation Department are requested to mediate villages upstream and villages downstream, and to promote collaboration between both parties.

5.3 Impact on Crop Production

Yield survey was conducted in order to grasp the impact on the crop production caused by the intervention of the pilot project in the sites. The survey was conducted before and after the completion of the pilot project, where 2013 and 2014 can be referred to as "before the pilot project" and 2015 as "after the pilot project." The yield survey was conducted targeting paddy and maize, which are major summer crops in the project sites and require relatively large amount of water for growth.

(1) Methodology

Table 5.1 shows the places and crops whose data were collected through the yield survey from 2013 to 2015. The yield survey in 2013 was conducted by JICA study team, and the surveys in 2014 and 2015 were conducted in cooperation with The Rice Research Center (RRC).

Table 5.1 Obtained Yield Data from 2013 to 2015

Site/crop	W5		W4		W2		E1		E4	
Year	Rice	Maize	Rice	Maize	Rice	Maize	Rice	Maize	Rice	Maize
2013*1					○					
2014*2	○	○	○		○	○	○	○	○	○
2015	○	○	○	○	○	○	○	○	○	○

Note1: In 2013, the survey could be conducted only in W2 due to suspension of the project activities from July to October, 2013. Note2:Maize yield data at W4 in 2014 is not available because it was too late to harvest maize and there were no maize fields remaining on the site.

The yield surveys were conducted in upstream and downstream areas in each pilot project site. The figure on the right shows the locations the survey was conducted, for example in the W2 site in 2013. One (1) plot was surveyed for data collection in each down/upstream point with three (3) replications. The items observed in the surveys of rice and maize are shown in Table 5.2 below.

Table 5.2 Obtained Data Items in the Yield Survey

Rice	Maize
Yield (ton/ha and ton/fed)*1	Yield (ton/ha and ton/fed)*2
Yield components*3	Air-dried shoot weight (kg/m^2)
No. of panicles /m^2	No. of cobs /m^2
No. of spikelets / panicle	Harvest Index*4

Ripening ratio	-
1,000 grains weight	-

Note1: Rice yield is air-dried grain weight with hull. Note2: Maize yield is air-dried grain weight without cob.
Note3: The way of measuring rice yield components in 2014 and 2015 is different from that in 2013.
Note4: Harvest Index is the weight of a harvested product as a percentage of the total shoot weight.

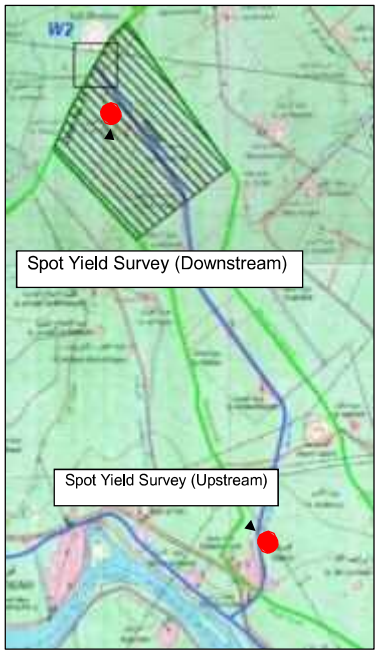


Figure 5.1 Location of Yield Survey (2013,W2)

(2) Results

Table 5.3 shows rice yield (ton/ha and ton/fed) with yield components in 2014 and 2015, and the Table 5.4 shows that of W2 site in 2013. On the other hand, Table 5.5 shows maize yield with other measured items in 2014 and 2015. Average rice yields in upstream and downstream in 2015 were 8.4 ton/ha and 6.8 ton/ha respectively, while those in 2014 were 8.3 ton /ha and 7.1 ton /ha respectively. Average maize yields in upstream and downstream in 2015 were 12.6 ton /ha and 8.2 ton /ha respectively, while those in 2014 were 11.5 ton /ha and 8.7 ton /ha respectively.

Table 5.3 Rice yield with yield components in 2014 and 2015

Location*1	Variety		Estimated Yield (t/ha)*2		Estimated Yield (t/fed)*2		Yield components*3							
							Panicles/m^2		Spikelets /panicle		Ripening ratio		1,000 grains weight (g)	
Year*4	14	15	14	15	14	15	14	15	14	15	14	15	14	15
W5-U	Giza 178	Giza 178	5.9	8.3	2.4	3.5	554	568	98	127	80.0%	90.7%	23	22
W5-D	Giza 178	Giza 177	5.1	6.5	2.2	2.7	521	487	85	110	76.0%	82.7%	22	27
W4-U	Sakha 101	Sakha 101	9.9	9.6	4.2	4.0	558	605	110	115	86.0%	82.7%	27	27
W4-D	Sakha 104	Skha 104	5.4	5.4	2.3	2.3	420	435	95	113	84.0%	78.4%	26	26
W2-U	Giza 177	Sakha 104	9.0	7.8	3.8	3.3	491	532	108	128	91.0%	86.4%	28	28
W2-D	Giza 178	Giza 178	7.7	8.1	3.2	3.4	479	467	120	130	87.0%	83.7%	23	22
E1-U	Giza 177	Sakha 104	8.0	8.2	3.4	3.4	387	581	100	114	83.0%	91.2%	27	27
E1-D	Giza 178	Giza 178	9.2	7.7	3.9	3.2	714	459	105	128	80.0%	82.2%	22	21
E4-U	Sakha 101	Giza 178	8.9	8.0	3.8	3.4	593	632	92	134	89.0%	85.2%	27	21
E4-D	Giza 178	Sakha 104	8.3	6.3	3.5	2.6	789	684	80	103	85.0%	76.1%	22	27
Ave.-U	-	-	8.3	8.4	3.5	3.5	517	584	102	123	85.8%	87.3%	26	25
Ave.-D	-	-	7.1	6.8	3.0	2.9	585	507	97	117	82.4%	80.6%	23	24

ource: Dr. Abdallah, RRC, 2014 and 2015
Note1: "U" and "D" stand for "Upstream" and "Downstream", respectively. Note2: Rice yield is air-dried grain weight with hull.
Note3: Yield components were measured by the method commonly applied

in RRC. Note4: "14" and "15" in the table are 2014 and 2015, respectively.

Table 5.4 Rice yield with yield components in W2 site, 2013

Location	Yield (t/ha)	Yield (t/fed)	Panicles /m^2	Spikelets/ Panicle	Ripening ratio	1,000 grains weight (g)
W2-U	9.3	3.9	595	84.2	85 %	21.7
W2-D	8.1	3.4	629	82.5	72 %	22.0

Source: JICA Study Team, 2013

Table 5.5 Maize yield, no. of cobs /m^2, air-dried shoot weight and Harvest Index in 2014 and 2015

Location*1	Variety		Air-dried shoot weight (kg/m2)		No. of Cobs/m2		Estimated yield(t/fed)*2		Estimated yield (t/ha) *2		Harvest Index	
Year*3	14	15	14	15	14	15	14	15	14	15	14	15
W5-U	K-8	30K8	4.2	3.4	7	8	4.6	6.1	10.8	14.4	0.26	0.42
W5-D	K-8	30K8	3.0	1.7	6	6	2.8	3.4	6.6	8.2	0.22	0.47
W4-U	-	30-62	-	4.2	-	10	-	5.1	-	12.2	-	0.29
W4-D	Triple cross	30-62	3.0	1.9	7	6	1.8	3.5	4.3	8.3	0.14	0.43
W2-U	N-11	30-62	3.9	3.4	8	9	3.8	5.6	9.0	13.3	0.23	0.39
W2-D	Single cross-10	30-62	3.9	2.2	7	7	3.1	3.8	7.4	8.9	0.19	0.41
E1-U	Single cross-3062	30K8	5.3	3.9	11	10	4.4	4.8	10.0	11.4	0.19	0.29
E1-D	Triple cross	30K8	4.8	2.4	9	7	4.1	3.3	9.7	7.7	0.20	0.32
E4-U	Single cross-10	30K8	4.6	3.2	9	8	6.9	4.8	16.3	11.5	0.35	0.36
E4-D	Single cross-10	30K8	6.3	2.3	8	7	6.5	3.4	15.4	8.0	0.25	0.35
Ave.-U	-	-	4.5	3.6	8.8	8.8	4.9	5.3	11.5	12.6	0.26	0.35
Ave.-D	-	-	4.2	2.1	7.4	6.5	3.6	3.5	8.7	8.2	0.20	0.40

Source: Dr. Abdallah, RRC, 2014 and 2015
Note1: "U" and "D" stand for "Upstream" and "Downstream", respectively. Note2: Maize yield is air-dried grain weight without cob.
Note3: "14" and "15" in the table are 2014 and 2015, respectively.

It was expected that yield in downstream would be improved because of better water availability due to the re-use of drainage water pumped up at the station established by the pilot projects. However, yield gaps of rice and maize between upstream and downstream in some project sites have not decreased so well (see Fig 5.2 and Table 5.7). Rice and maize yields in 2015 tended to be higher in upstream areas than those in downstream areas, similar to those in 2014. Moreover the yields did not have a clear relationship with the applied nitrogen fertilizer amount (fertilizer application management was questioned in the survey given to the farmers in 2015).

With regard to rice, the yield gap between upstream and downstream increased from 2014, except in W2 and W4. Among the yield components (although yield components vary depending on the diversities) the ripening ratios in 2014 and 2015 have significant correlation with the yield in the two (2) years at 5 % significance level (see Fig 5.3). This means that a decrease in ripening ratio was the main constraint on the rice yield in the pilot project sites over the two (2) years.

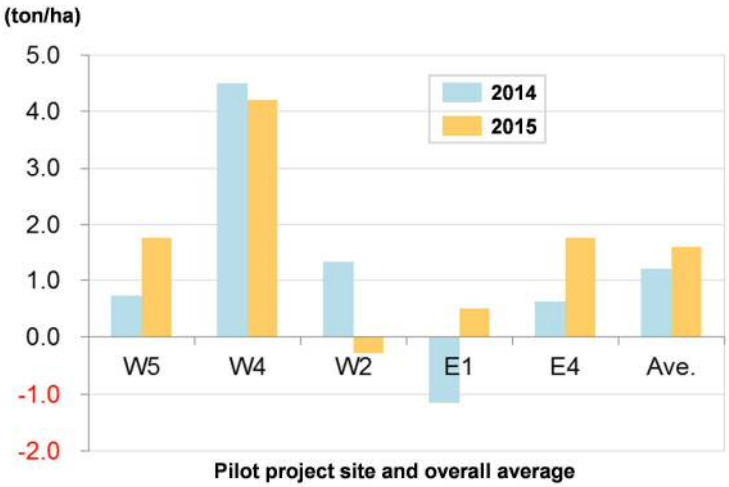


Figure 5.2 Yield Gaps between Upstream and Downstream (2014 and 2015)

Source: Dr. Abdallah, RRC, 2014 and 2015

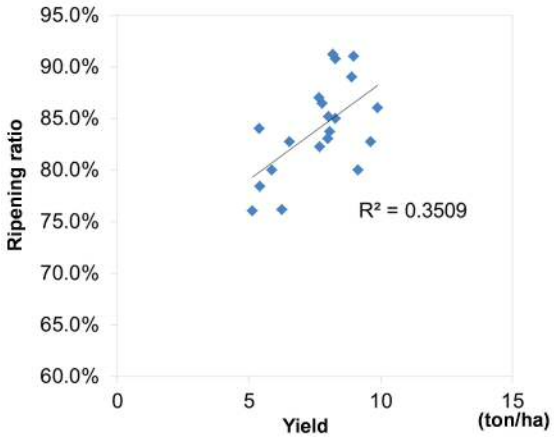


Figure 5.3 Relationship between Yield and ripening Ratio (2014 and 2015)

Source: Dr. Abdallah, RRC, 2014 and 2015

Table 5.6 shows the difference in yield and yield components between 2014 and 2015. The number of spikelets/ panicle increased at every location in 2015. On the other hand, the ripening ration upstreamv in 2015 had increased on average, while that downstream had decreased. These imply that the vegetative to flowering growth stage in 2015 was better than that in 2014 regardless of location, however, environmental stress like drought affected the plant growth and translocation after the heading period in the downstream area.

Table 5.6 Difference of Rice Yield and Yield Components between 2014 and 2015

Location*1	Yield(t/ha)	Yield(t/fed)	Yield components			
			Panicles /m2	Spikelets /panicle	% of ripened grains	1,000 grain weight (g)
W5-U	2.4	1.0	14	29	10.7%	-1.2
W5-D	1.4	0.6	-34	25	6.7%	4.8
W4-U	-0.3	-0.2	47	5	-3.3%	0.2
W4-D	0.0	0.0	15	18	-5.6%	0.1
W2-U	-1.2	-0.5	41	20	-4.6%	0.2
W2-D	0.4	0.2	-12	10	-3.3%	-1.2
E1-U	0.2	0.1	194	14	8.2%	-0.2
E1-D	-1.5	-0.6	-255	23	2.2%	-1.4
E4-U	-0.9	-0.4	39	42	-3.8%	-5.9
E4-D	-2.1	-0.9	-105	23	-8.9%	4.7
Ave.-U	0.0	0.0	67	22	1.5%	-1.4
Ave.-D	-0.3	-0.1	-78	20	-1.8%	1.4

Source: Dr. Abdallah, RRC, 2014 and 2015

Note: Gap value was calculated following the formula; value of 2015-value of 2014.

As for maize, gaps of yield, air-dried shoot weight, and number of cobs between upstream and downstream became larger in 2015 than that in 2014 (see Table 5.7). When it is compared between 2014 and 2015, yields in 2015 were higher than those in 2014 as a whole, except in E1-downstream and E4-downstream/upstream. This tendency might be partially because the varieties cultivated in 2015 were totally changed from those in 2014. It is also implied by the big difference of HI values between 2014 and 2015 (see Table 5.8). However, it could be said that there's some constraint on yield improvement in E1 and E4 in 2015.

Even though the variety cultivated in up/downstream areas in E1, E4 and W5 was the same in 2015, yields and HI values in E1 and E4 were lower than that in W5 (see Table 5.5). In E1 and E4, it was found that the farmers downstream had difficulty in getting irrigation water from May to June in 2015 according to the interview conducted in the same year, simultaneously with the yield survey. Even though the farmers faced such a difficulty, water pump for drainage water reuse was not operated so frequently in E1 and E4. It would be necessary to improve the communication between the farmers

and the pump operation committee.

Table 5.7 Maize Yield Gaps between Upstream and Downstream in Each Pilot Project Site

Site	Air-dried shoot weight(kg/m^2)		No. of Cobs/m^2		Estimated yield(t/fed)		Estimated yield(t/ha)		Harvest Index	
Year	14	15	14	15	14	15	14	15	14	15
W5	1.2	1.7	1.0	1.4	1.8	2.6	4.2	6.2	0.0	-0.1
W4	N/A	2.3	N/A	4.0	N/A	1.6	N/A	3.9	N/A	-0.1
W2	-0.0	1.2	1.0	2.0	0.6	1.9	1.5	4.4	0.0	-0.0
E1	0.5	1.5	2.0	3.0	0.4	1.5	0.3	3.7	-0.0	-0.0
E4	-1.7	0.9	1.0	1.3	0.4	1.5	0.9	3.5	0.1	0.0
Ave.	0.3	1.5	1.4	2.3	1.3	1.8	2.8	4.3	0.1	-0.0

Source: Dr. Abdallah, RRC, 2014 and 2015

Note: Gap value was calculated following the formula; value of upstream-value of downstream.

Table 5.8 Difference of Maize Yield and Other Components between 2014 and 2015

Location[*1]	Air-dried show weight (kg/m^2)	No. of Cobs/m^2	Estimated yield (t/fed)	Estimated yield (t/ha)	Harvest Index
W5-U	-0.7	0.7	1.50	3.57	0.16
W5-D	-1.2	0.3	0.65	1.54	0.25
W4-U	N/A	N/A	N/A	N/A	N/A
W4-D	-1.1	-1.3	1.70	4.03	0.29
W2-U	-0.5	0.7	1.83	4.36	0.16
W2-D	-1.8	-0.3	0.63	1.48	0.22
E1-U	-1.4	-1.0	0.36	1.40	0.10
E1-D	-2.4	-2.0	-0.83	-1.98	0.12
E4-U	-1.5	-1.0	-2.04	-4.85	0.01
E4-D	-4.0	-1.3	-3.11	-7.41	0.10
Ave.-U	-0.9	0.1	0.37	1.02	0.09
Ave.-D	-2.1	-0.9	-0.19	-0.47	0.20

Source: Dr. Abdallah, RRC, 2014 and 2015

Note: Gap value was calculated following the formula; value of 2015-value of 2014.

One of things that should be mentioned is that the allocation of irrigation water in the summer season in 2015 was better and distributed more properly than that in 2014, especially in West Delta. It was partially because the rice-cropping period was more widely varied, and this misalignment prevented the peak period of water requirement from being lapped over. It was found in the interview with the farmers conducted in 2015, simultaneously with the yield survey, farmers downstream, especially in West Delta, thought irrigation water availability in 2015 was better than 2014. It is one of the reasons why water pump for drainage water reuse was not operated so frequently in 2015.

Although farmers in West Delta thought irrigation water availability was "not bad," yield in the downstream area resulted in lower than that in the upstream area. This indicates that irrigation water application downstream was not appropriate even though the farmers recognized it as enough. In other words, the farmers downstream are oblivious of actually existing inadequacy in their irrigating ways because they have been used to facing water unavailability and are accustomed to managing their farmland under limited available water. It would be necessary to raise the farmers' awareness downstream regarding appropriate irrigating methods. In fact, through the yield survey, it was suggested that inadequate water management still leads to low yield in the downstream areas, at least partially. Hence, drainage water reuse would complement water availability downstream after the farmers in the downstream area are able to implement irrigation in a proper way.

In addition, the above situation of irrigation water distribution this year indicates that coordination of cropping patterns can improve the allocation of irrigation water within the delta area in a way. Rice cultivation (area and physical farmland location) is officially regulated by MWRI and MALR based on the irrigation plan made every year by MWRI, because rice cultivation consumes much water for its growth. However, this regulation is not actually followed by farmers on the

ground, and some farmers do not have the right understanding and awareness of this regulation. It would also need to be adjusted for more efficient use of irrigation water in future. Then, together with promoting efficient use of irrigation water, re-use of drain water would play a supplementary role for minimizing the inequality of water allocation.

5.4 Impacts of Compost Making Facility

As of October 2015, the use of the compost making facility had started. By exhibition of the facility as one of the irrigation complex's, it is possible to demonstrate water conservation of drainage by compost making. In general, the farmers keep agricultural waste, such as rice straw and cow dung, at their compounds for compost production in traditional ways, and they face difficulty in disposing surplus of the waste. However, the amount of rice straw production in 2015 was not very large, and consequently, the volume of the surplus was limited. CDA at W-5 has a plan to collect rice straws and cow dung from the surrounding farmers for compost production and sale.

Rice straw and cow dung at the compost making

5.5 Effectiveness of In-stream Treatment Facility

In-stream treatment facility is constructed as a part of the irrigation complex facility to improve water quality by direct treatment on the drain. Effectiveness of in-stream treatment is expected to reduce organic matter and nutrients load, as well as increasing dissolved oxygen, in the drain.

Water improvement results of the drain by in-stream treatment facilities were confirmed through water quality monitoring as shown in Table 5.9. Dissolved Oxygen (DO) was increased 0.50 mg/l on average, Chemical Oxygen Demand (COD) removal ratio was confirmed as 37% on average, Total Nitrogen (T-N) removal ratio was confirmed as 11% on average, and Total Phosphorous (T-P) removal ratio was confirmed as 45%.

Table 5.9 Water Quality Result of In-Stream Treatment Facility

Parameter	Month	Raw water (mg/l)	Treated water (mg/l)	Removal ratio (Increasing value for DO only)	Remarks
DO	Aug. 2015	0.94	1.21	0.27	
	Sep. 2015	1.01	1.26	0.25	
	Sep. 2015	1.10	1.41	0.31	
	Oct. 2015	0.50	1.66	1.16	
	Average			**0.50 (mg/l)**	
COD	Aug. 2015	16.9	11.4	33	per manganite
	Sep. 2015	80	46	43	dichromate
	Sep. 2015	28	12	57	dichromate
	Oct. 2015	37	31	16	dichromate
	Average			**37 (%)**	
T-N	Aug. 2015	3.61	3.38	6	
	Sep. 2015	2.31	2.07	10	
	Sep. 2015	2.23	1.72	23	
	Oct. 2015	4.73	4.51	5	
	Average			**11 (%)**	

Parameter	Month	Raw water (mg/l)	Treated water (mg/l)	Removal ratio (Increasing value for DO only)	Remarks
T-P	Aug. 2015	5.52	1.28	77	
	Sep. 2015	2.68	1.15	57	
	Sep. 2015	0.89	0.542	39	
	Oct. 2015	1.12	1.06	5	
	Average			**45 (%)**	

Source: JICA study team

5.6 Effectiveness of Rural Sewerage Treatment Facility

Rural sewerage treatment facility is constructed as a part of the irrigation complex facility for the treatment of domestic wastewater from the village beside drain. This approach is a countermeasure for water pollution of the drain, and to prevent the deterioration of drain water quality. Accordingly, proper sewerage treatment by the facility contributes to drain water quality improvement.

Water quality analysis results of the rural sewerage treatment facility are shown in Table 5.10. COD removal ratio was confirmed as 85 % and BOD removal ratio was confirmed as 99 % in comparison to raw water and treated water quality. Besides, COD and BOD values of treated water quality were low (COD: 60 mg/l, BOD: 5 mg/l respectively), which indicates treatment was well done.

In terms of the nitrogen and phosphorus compounds, removal ratio of total nitrogen (T-N) was confirmed as 14 % and removal ratio of total phosphorus (T-P) was confirmed as 43 %. The number of total coliforms and fecal coliforms were reduced to less than 100 MPN/ml. In a comparison between the treated water quality and the effluent limit, only the DO value was slightly not satisfied in the effluent limit, but the other parameters (COD, BOD, total coliforms, fecal coliforms) satisfied the effluent limit. In conclusion, it was confirmed that proper treatment was done through the water quality analysis.

Although the scale of rural sewerage treatment facility constructed by the pilot project was as small as $30m^3$/day, future dissemination to other villages along the drain, and increasing the number of rural sewerage treatment facilities, will be effective for water quality improvement of the entire drain.

Table.5.10 Water Quality Result of Rural Sewerage Treatment Facility

Parameter	Unit	Raw water	Treated water	Removal ratio (Increasing value for DO only)	Effluent limit (Law48)
Turbidity	NTU	623	119	81 (%)	-
DO	mg/l	0.93	2.52	1.59 (mg/l)	more than 4
COD (dichromate)	mg/l	408	60	85 (%)	less than 80
BOD	mg/l	380	5	99 (%)	less than 60
T-N	mg/l	7.60	6.51	14 (%)	-
T-P	mg/l	5.57	3.20	43 (%)	-
Total coliforms	MPN/100ml	18.9×10^6	less than 100	-	less than 5,000
Fecal coliforms	MPN/100ml	17.5×10^4	less than100	-	less than 5,000

Source: JICA study team
Note: Based on water quality analysis result conducted in October 2015.