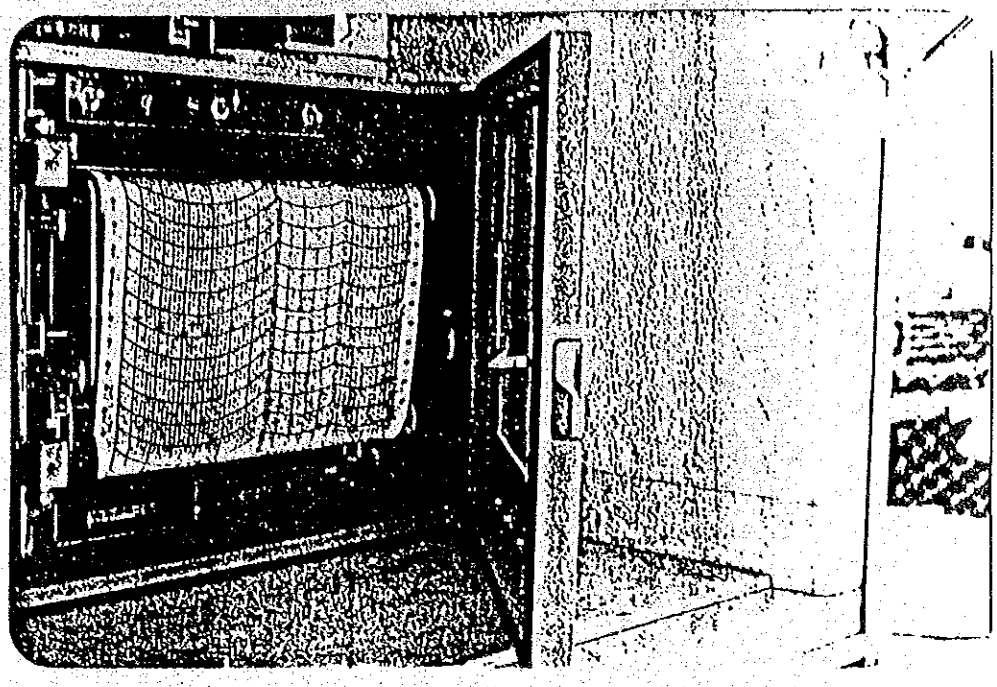
AM–5

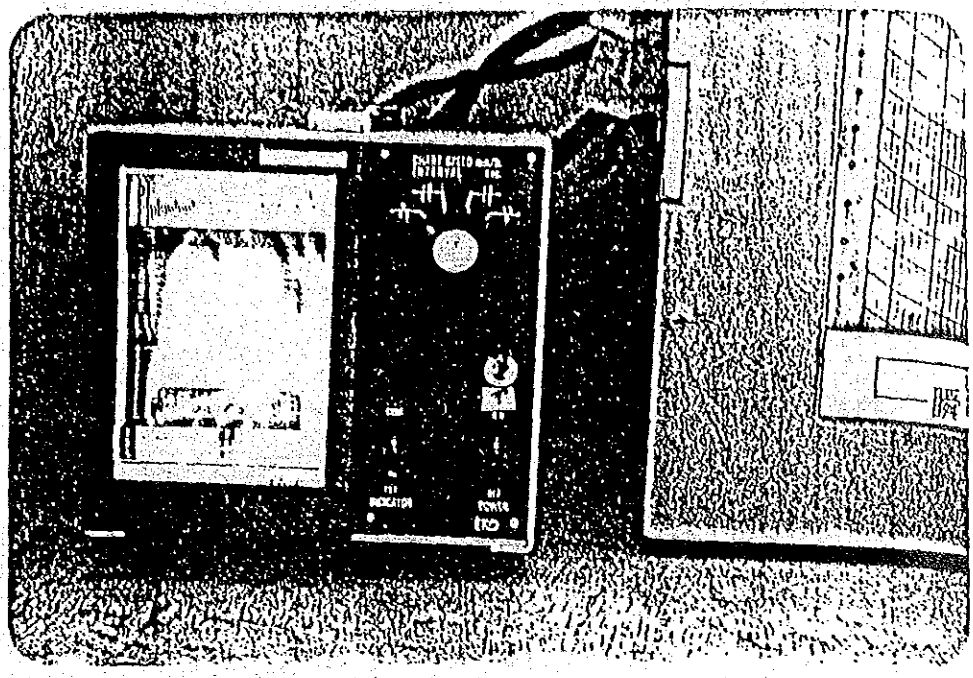


جهاز لقياس قوة شعاع الشمس Solar radiometer

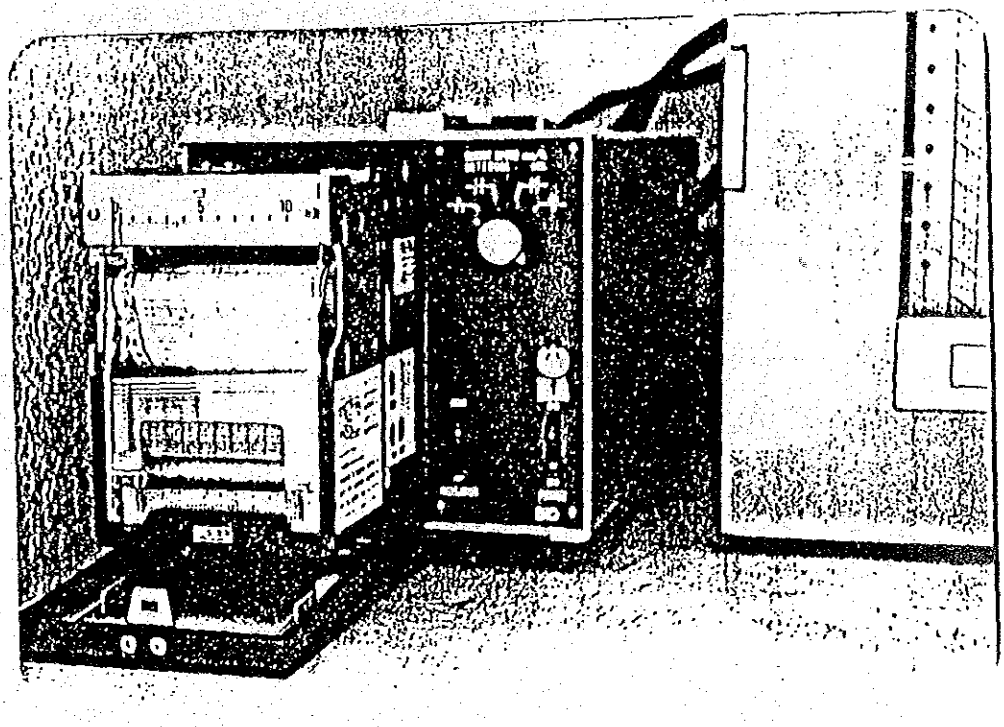
Pyranometer (MS-42)

١. قبل البدء في تشغيل الجهاز يجب التأكد من نظافة زجاج مجس الشعاع الخارجي.
٢. اغلق المفتاح الكهربائي (off)
٣. افتح باب الجهاز بسحبه الى اسفل
٤. اسحب مشبك الاوراق (pull) الى الخارج
٥. سجل على اسم علامة القلم : تاريخ اليوم، الوقت، اسم الفني، اسم المحطة ورقم range
٦. يتم تغيير اوراق التسجيل بعد كل عشرة اسابيع كالاتي :
٧. افتح الباب الزجاجي الصغير واسحب الورق القديم ببطء.
٨. ضع ورق جديد على شكل كتاب داخل المشبك
٩. اسحب من رأس الورق حوالي ٢ - ٤ سم (ربعات) من خلال الاسطوانة وامرر على اتجاه الورق مع على ان تكون نهايات طرف الورق مع مسنات العجلة واعد الباب الزجاجي لكي يثبت الورق من الخلف.
١٠. اضبط عجلة الاتجاه وذلك بفتح مفتاح الاتجاه (on، off) مفتاح (١) على الاتجاه شمال (range) $\frac{20}{12}$ او $\frac{40}{6}$ حتى تدور عجلة الاتجاه على رقم 6 ثم ضع علامة على الورق بقلم المفتاح (١)
١١. اضبط الاتجاه شمال على $\frac{5}{48}$ - سجل : التاريخ، الوقت، اسم الفني، المحطة، رقم range
١٢. عندما تكون كتابة القلم غير واضحة على الورق تغير عجلة الاتجاه كالتالي :
تغلق المفتاح (١ off) ، اسحب عجلة الاتجاه الى الخارج وضع حبرا على عجلة جديدة وتأكد من تبعث وضعها واعدها حتى النهاية. (يجب ان تلاحظ هذه الخطوة منذ البداية)
١٣. نظف وضع الجهاز الى حالته واغلق باب الجهاز.

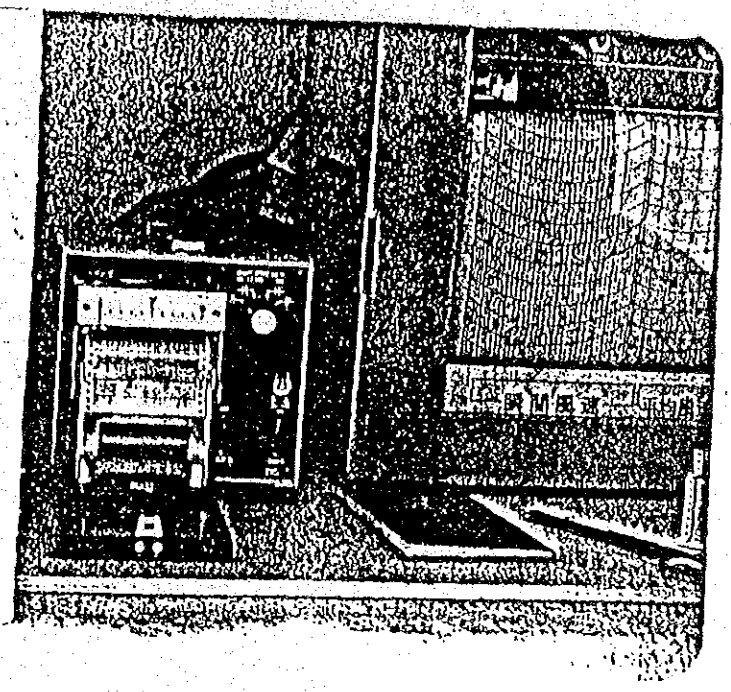
PM－1



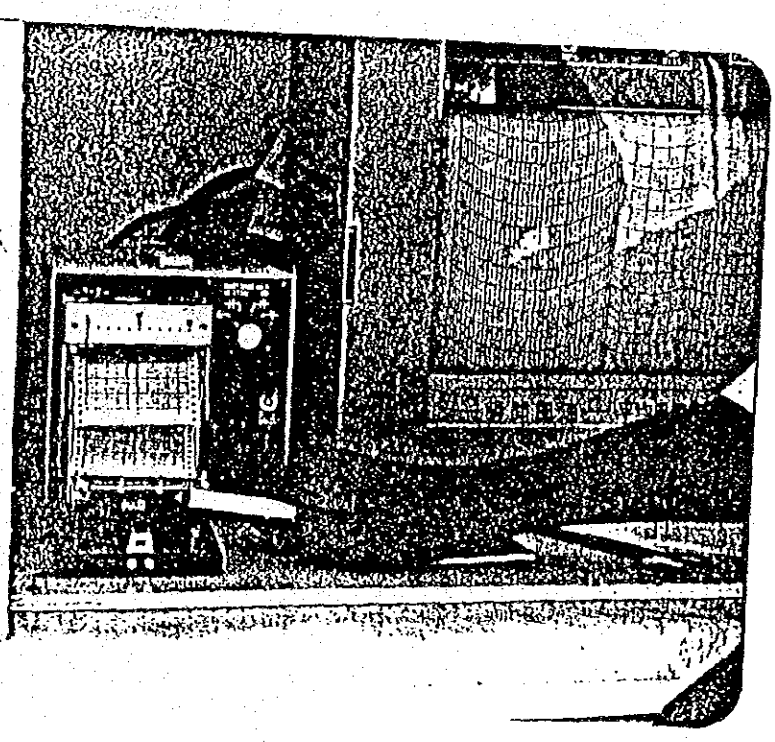
PM－2



PM－3



PM－4

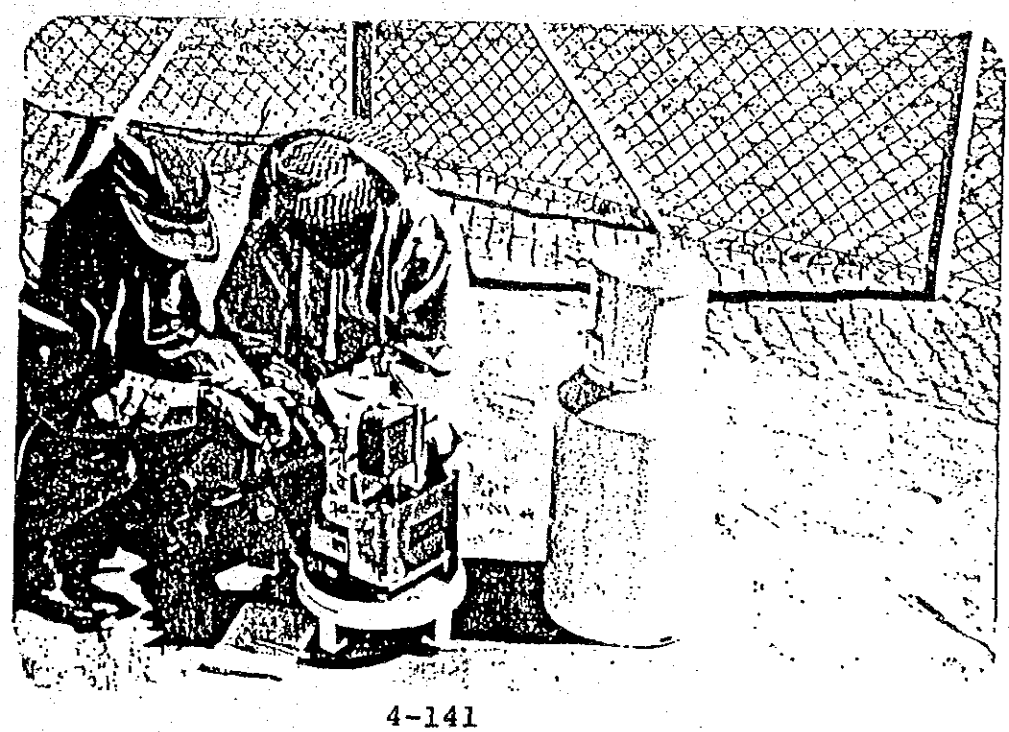


جهاز قياس المطر RAIN Gauge (SKI - 5)

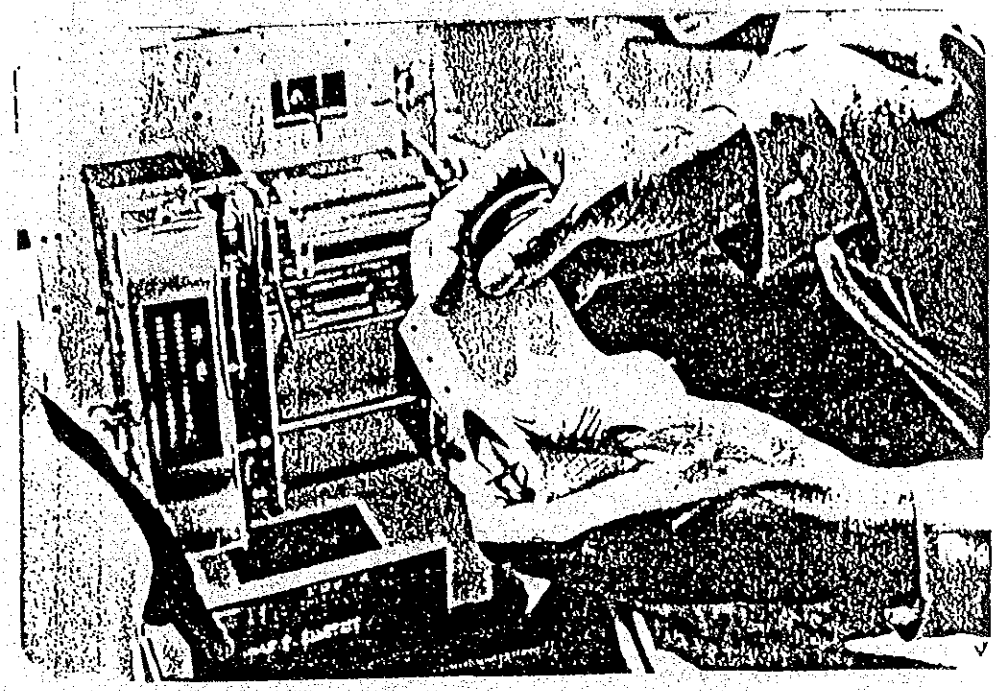
١. افتح القفل ومدور السلندر الكبير باتجاه اليسار (يميناً) ثم ارفعه الى اعلى بجذر خالص الخارجي.
٢. تأكد من نظافته ومنع الماء.
٣. افتح الازرار الجانبية الاربعة
٤. افتح الباب الزجاجي الى الخارجي
٥. اجعل القلم عند الورق بعد وضع عدسته (نقطة)
٦. سجل في الورق، التاريخ، الوقت، اسم الفني، اسم المحطة (RAIN)
٧. لف الورق القديم على البكرة السفلى.
٨. فك المسمار على يمين البكرة السفلى ثم اخرجه البكرة.
٩. اخرج الورق القديم، ضع مكانه بكرة ورق جديد.
١٠. ضع بكرة جديدة (البكرة العليا) ثم ادخل رأس الورق من تحت الاسطوانة
١١. عند ظهور رأس الورق اسحبه بجذر ثم ادخله في شق خاص في البكرة السفلى لعمله حوالي ٤-٥ مرات حتى يثبت.
١٢. أعد البكرة الى مكانها مبتدياً من جهة اليسار ثم ذلك ادخال فتحتي البكرة الجانبيتين مكانهما ثم الجهة اليمنى ثم ثبت المسمار الايمن تماماً.
١٣. تغيير البطاريات يتم كما يلي: اسحب صندوق البطاريات الى الخارج ثم فك المسمارين على جانبي صندوق البطاريات
١٤. غير كل الطقم (٥ بطاريات) حسب الاقطاب السالبة والموجبة (+، -)
١٥. غط الصندوق ثم ثبت المسمارين ثم اعد الصندوق الى مكانه حتى النهاية.
١٦. انزل القلم ماضغاً نقطة البداية وسجل عليها: تاريخ اليوم، الوقت، اسم الفني وتوقيعه.
١٧. اغلق باب الجهاز ثم الازرار الاربعة الجانبية وارجع السلندر الكبير مكانه.

RG-1

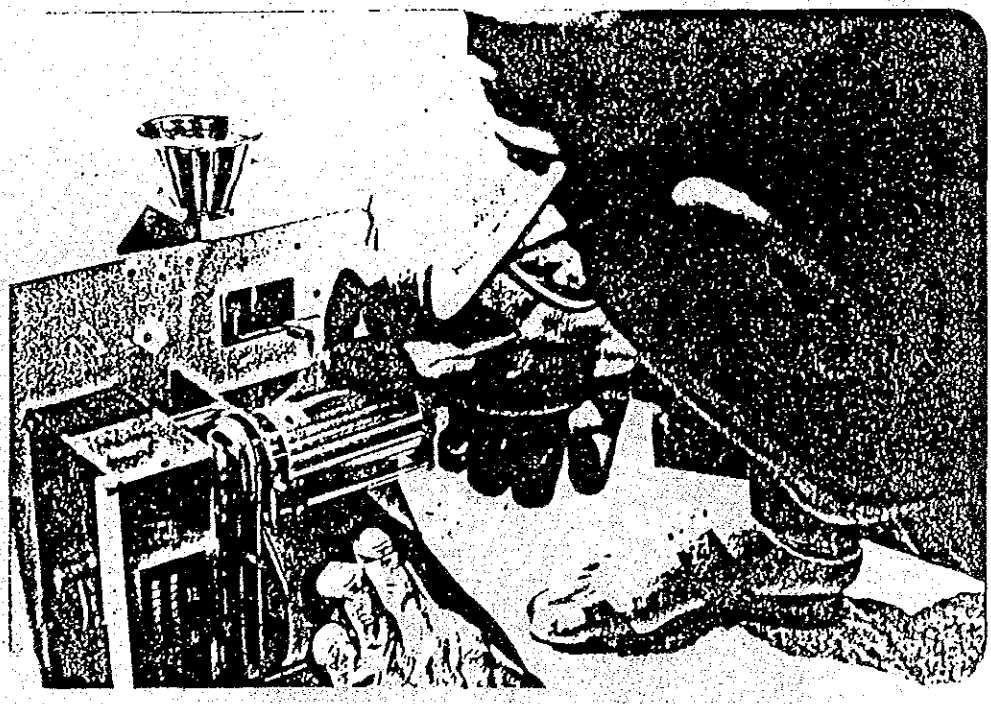
RG-2



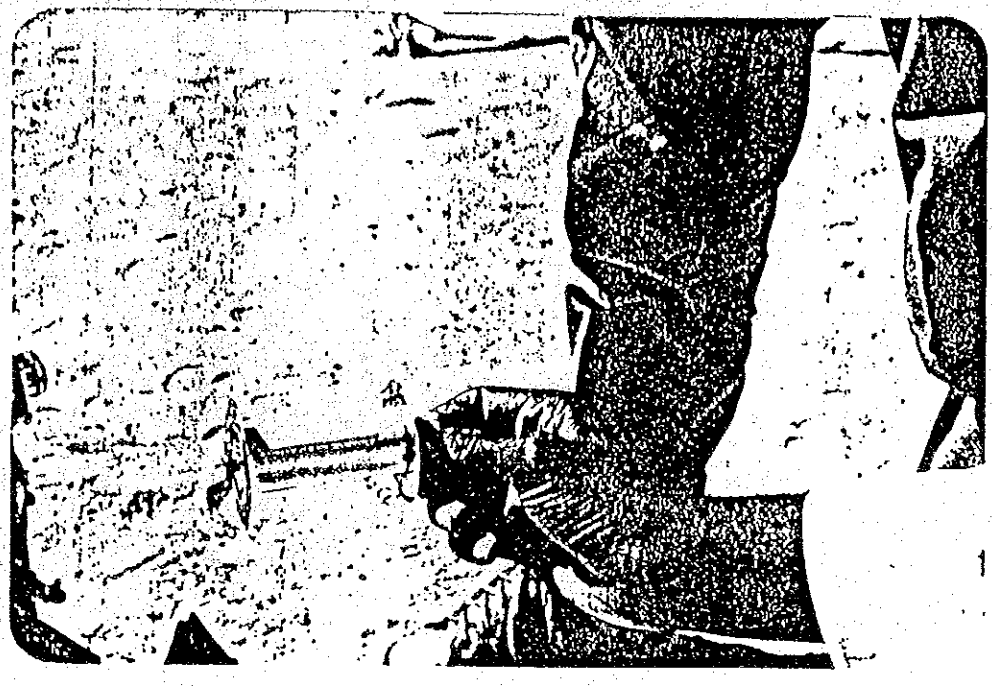
RG-3



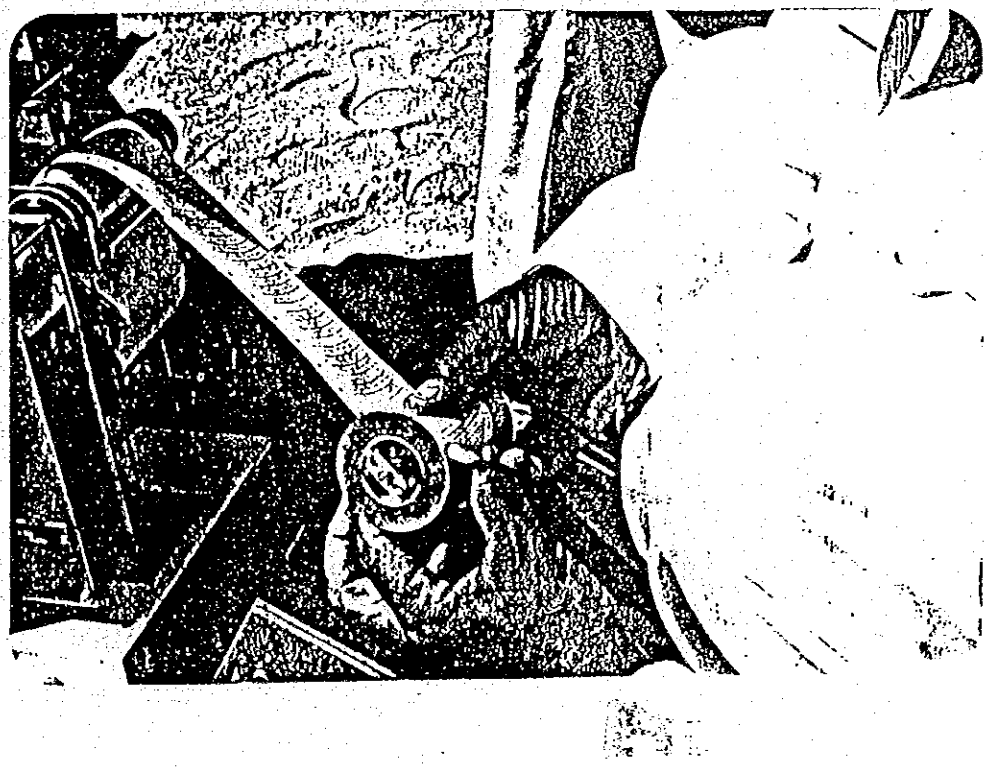
RG-4



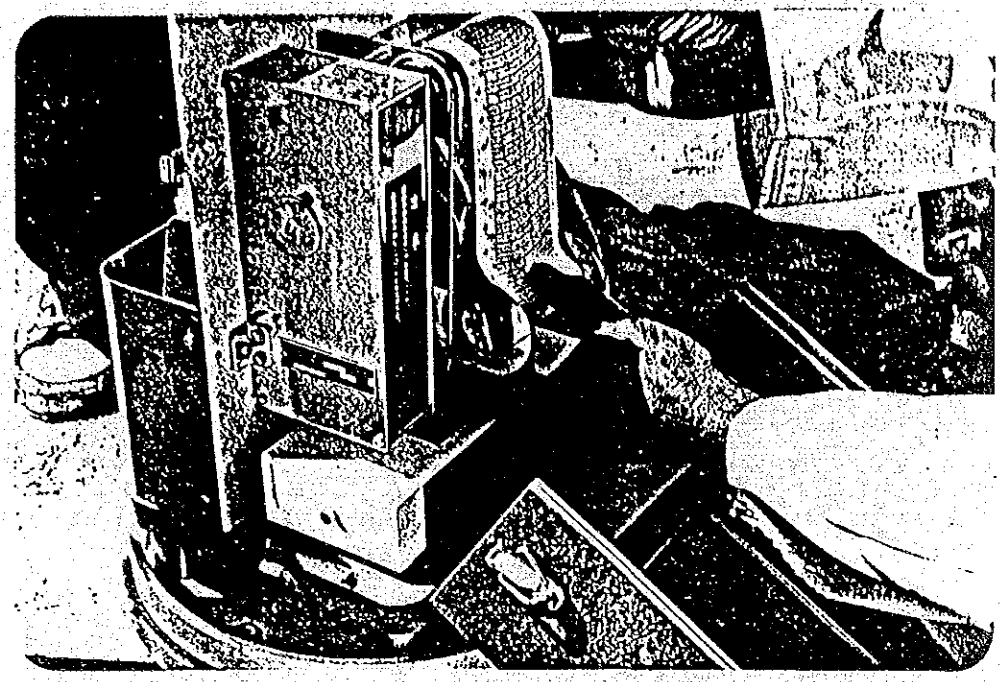
RG-5



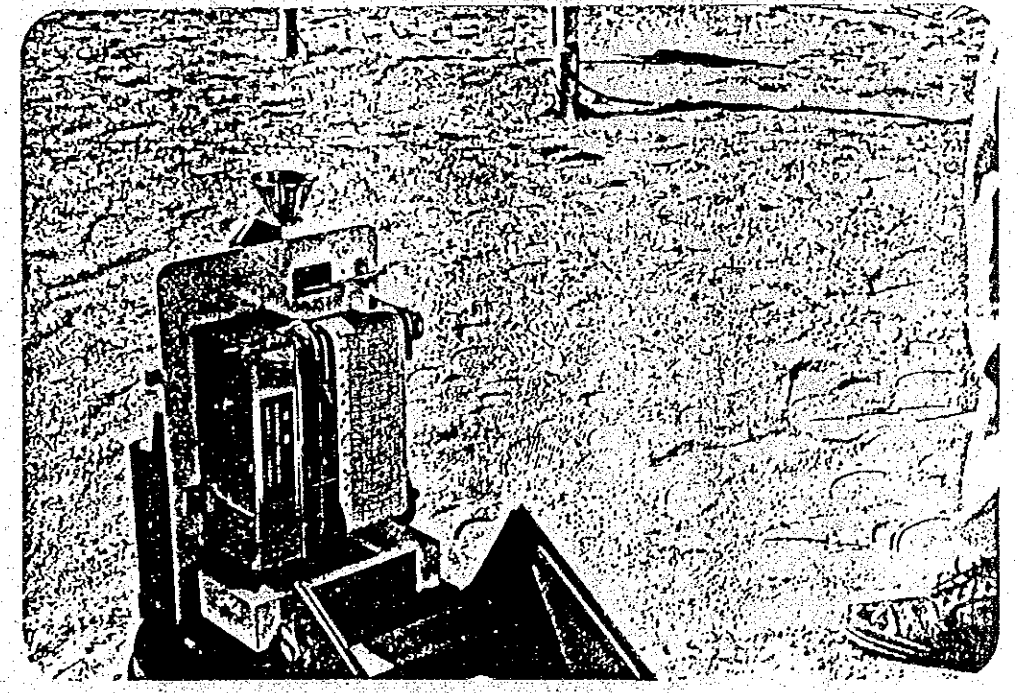
RG-6



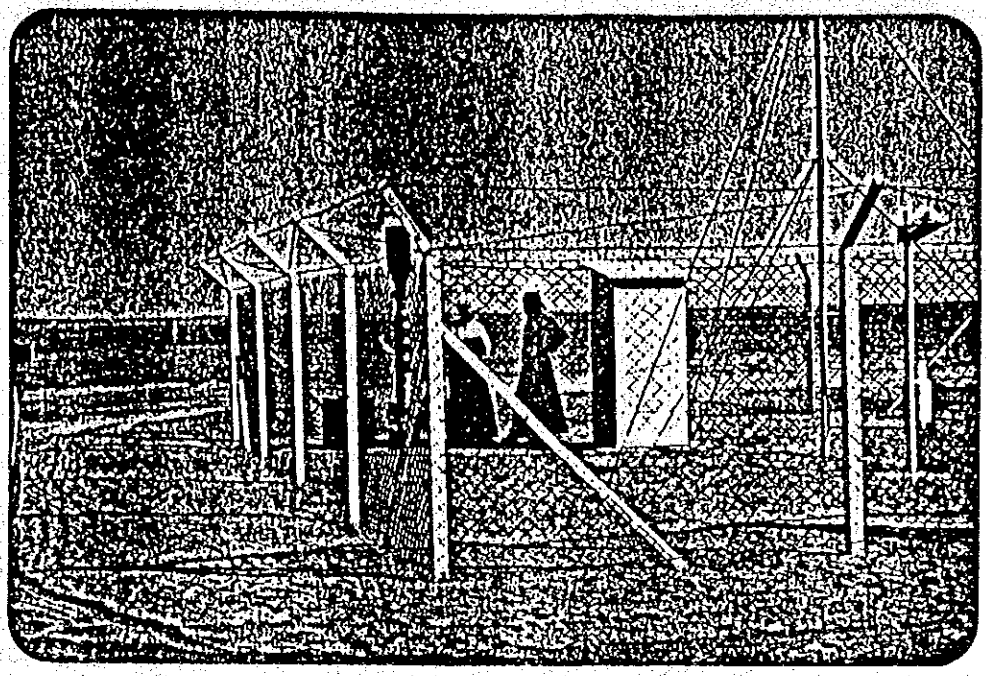
RG-7



RG-8

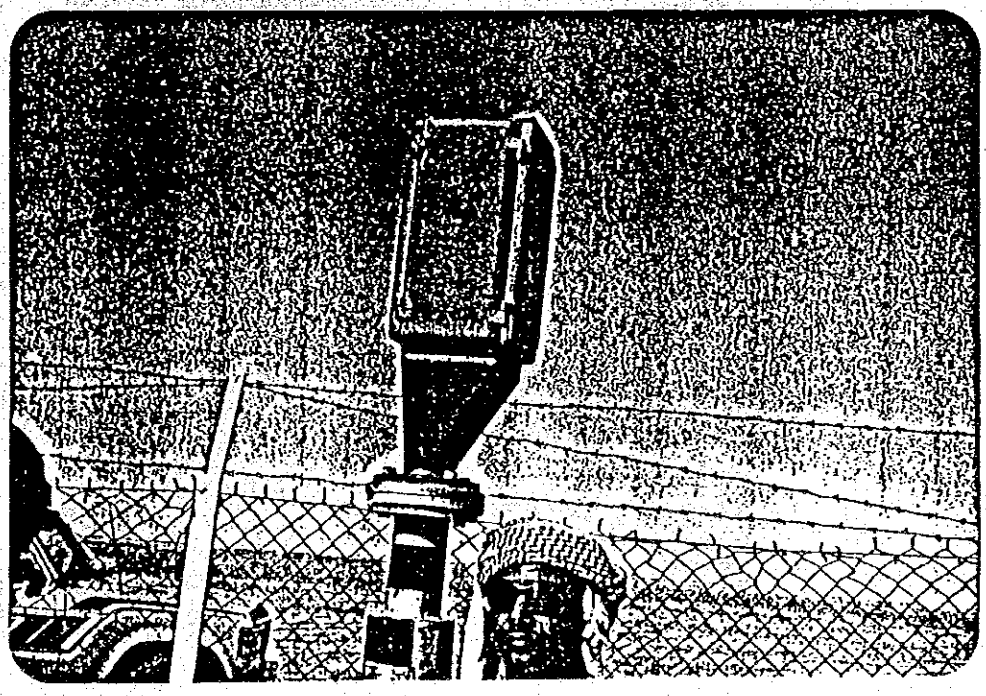


Meteorological Station at NJD-3

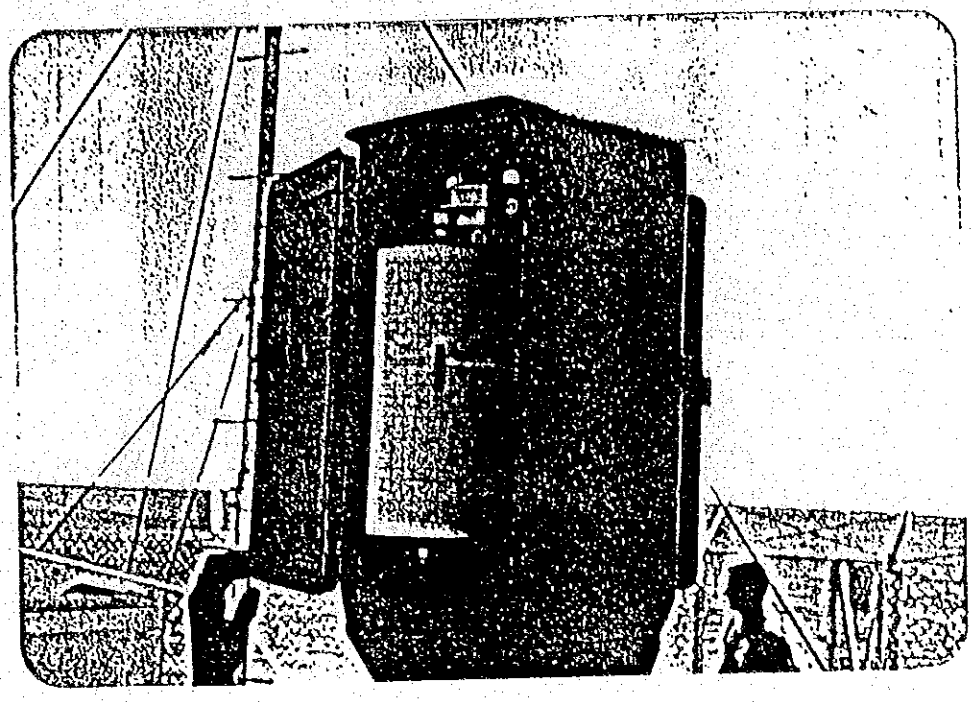


Well Water-level Recorder at NJD-3

WW-1



WW－2



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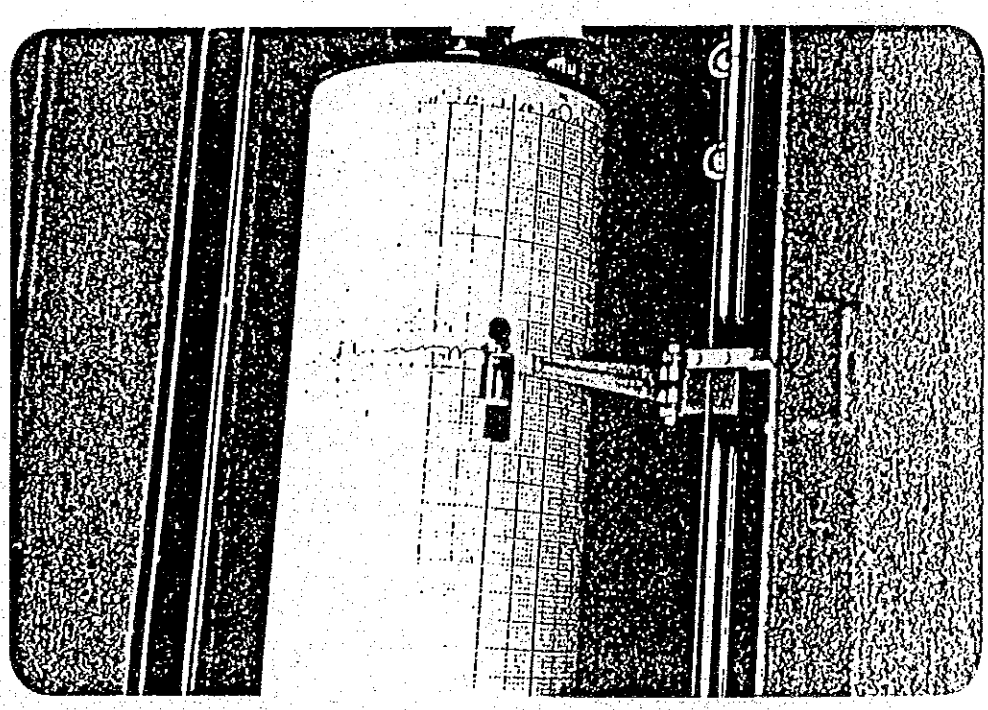

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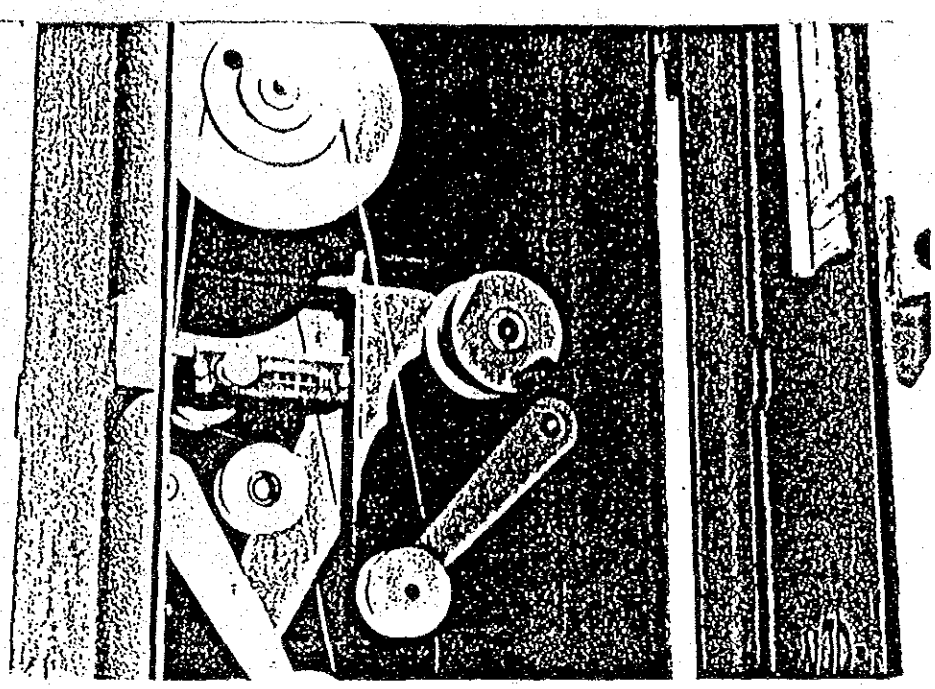

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PILOT FARM PLAN

6 PILOT FARM PLAN

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(None)

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(None)

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Project Formulation

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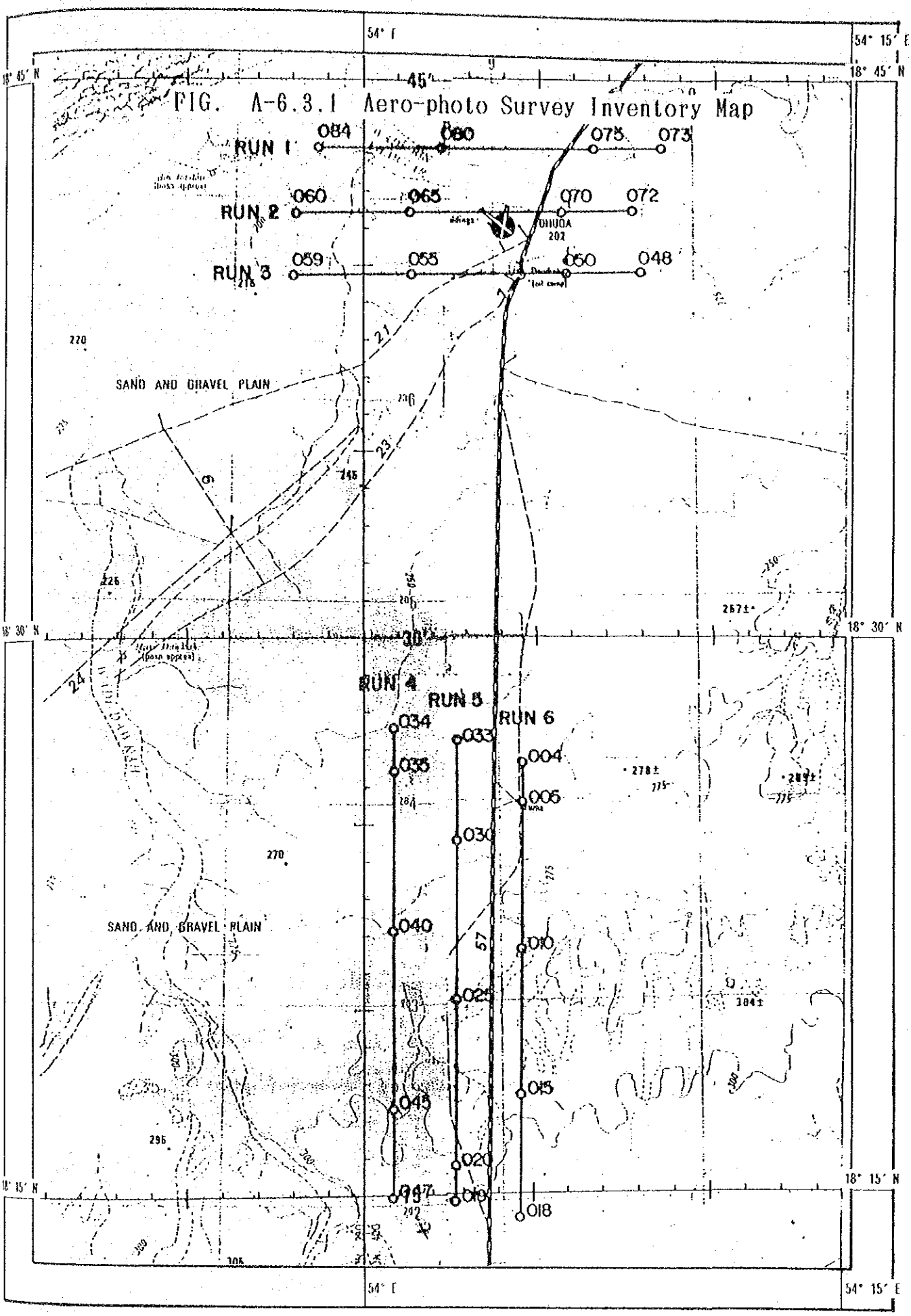
FIG. A-6.3.1 Aero-photo Survey Inventory Map



6.3.2 Estimation of Crop Water Requirement for Pilot Farm

Different types of crops will be experimented at the pilot farm. The water requirement of the pilot farm is estimated as shown in this section, with the consideration of different crops:

(1) Evapotranspiration (ETo)

Using the available climatological data, evapotranspiration is computated based on three methods as shown in the following TABLE A-6.3.1.

TABLE A-6.3.1 Summary of Evapotranspiration

unit: mm/day

Month / Method 2/	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total (mm/yr)
Blaney-Criddle	4.7	6.0	7.2	8.2	8.5	11.2	8.9	8.6	8.4	7.5	5.5	4.6	2717.0
Radiation	8.7	9.7	10.9	11.7	12.1	12.1	12.1	11.9	11.2	10.2	9.0	8.3	3894.6
Penman	5.9	8.0	11.5	11.7	13.1	13.9	12.7	13.0	10.8	9.0	6.6	5.6	3708.8
Mean	6.4	7.9	9.9	10.5	11.2	12.4	11.2	11.2	10.1	8.9	7.0	6.2	3444.2

1/: Thumrait meteorological data

2/: FAO Irrigation & Drainage Paper No.24

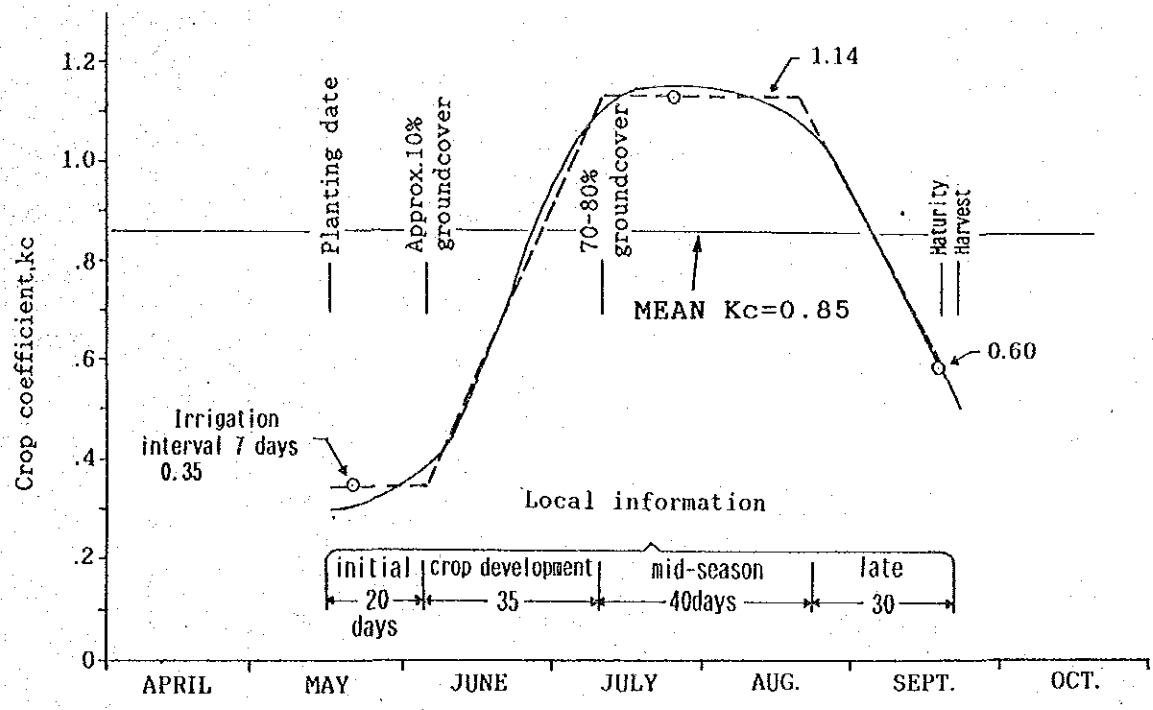
The computational formula can only be applied under well-ordered conditions and moreover, the applicability of these formulae can't be confirmed until the actual observation of evapotranspiration for several years.

Therefore, the average value of these three formulae is adopted as the representative evapotranspiration value in the study.

The evapotranspiration in summer season (May - Aug.) is almost twice as that of winter season (Nov. - Mar.)

This is mainly due to high temperature and strong wind in summer season.

FIG. A-6.3.2 Example of Crop Coefficient Curve



Example of crop coefficient curve

Source:FAO,Crop Water requirements,paper No.24,pp39

TABLE A-6.3.2(1) Crop Coefficient (Kc) for Field & Vegetable Crops for Different Stages of Crop Growth and Prevailing Climatic Condition

Crop	Humidity		RHmin	>70%	RHmin	<20%
	Wind m/sec		0-5	5-8	0-5	5-8
	Crop stage					
All field crops	initial	1				
	crop dev.	2				
Artichokes (perennial-clean cultivated)	mid-season	3	.95	.95	1.0	1.05
	at harvest or maturity	4	.9	.9	.95	1.0
Barley		3	1.05	1.1	1.15	1.2
		4	.25	.25	.2	.2
Beans (green)		3	.95	.95	1.0	1.05
		4	.85	.85	.9	.9
Beans (dry)		3	1.05	1.1	1.15	1.2
Pulses		4	.3	.3	.25	.25
Beets		3	1.0	1.0	1.05	1.1
		4	.9	.9	.95	1.0
Carrots		3	1.0	1.05	1.1	1.15
		4	.7	.75	.8	.85
Castorbeans		3	1.05	1.1	1.15	1.2
		4	.5	.5	.5	.5
Celery		3	1.0	1.05	1.1	1.15
		4	.9	.95	1.0	1.05
Corn (sweet)		3	1.05	1.1	1.15	1.2
(maize)		4	.95	1.0	1.05	1.1
Corn (grain)		3	1.05	1.1	1.15	1.2
(maize)		4	.55	.55	.6	.6
Cotton		3	1.05	1.15	1.2	1.25
		4	.65	.65	.65	.7
Crucifers (cabbage, cauliflower, broccoli, Brussels sprout)		3	.95	1.0	1.05	1.1
		4	.80	.85	.9	.95
Cucumber		3	.9	.9	.95	1.0
Fresh market		4	.7	.7	.75	.8
Machine harvest		4	.85	.85	.95	1.0
Egg plant		3	.95	1.0	1.05	1.1
(aubergine)		4	.8	.85	.85	.9
Flax		3	1.0	1.05	1.1	1.15
		4	.25	.25	.2	.2
Grain		3	1.05	1.1	1.15	1.2
		4	.3	.3	.25	.25
Lentil		3	1.05	1.1	1.15	1.2
		4	.3	.3	.25	.25
Lettuce		3	.95	.95	1.0	1.05
		4	.9	.9	.9	1.0
Melons		3	.95	.95	1.0	1.05
		4	.65	.65	.75	.75
Millet		3	1.0	1.05	1.1	1.15
		4	.3	.3	.25	.25

Source : FAO, Crop water requirements, paper no.24, pp.40

TABLE A-6.3.2(2) Crop Coefficient (Kc) for Field & Vegetable Crops for Different Stages of Crop Growth and Prevailing Climatic Condition

Crop	Humidity		RHmin >70%		RHmin <20%	
	Wind m/sec		0-5	5-8	0-5	5-8
Oats	mid-season	3	1.05	1.1	1.15	1.2
	harvest/ maturity	4	.25	.25	.2	1.1
Onion(dry)		3	.95	.95	1.05	1.2
		4	.75	.75	.8	.85
(green)		3	.95	.95	1.0	1.05
		4	.95	.95	1.0	1.05
Peanuts(Groundnuts)		3	.95	1.0	1.05	1.1
		4	.55	.55	.6	.6
Peas		3	1.05	1.1	1.15	1.2
		4	.95	1.0	1.05	1.1
Peppers(fresh)		3	.95	1.0	1.05	1.1
		4	.8	.85	.85	.9
Potato		3	1.05	1.1	1.15	1.2
		4	.7	.7	.75	.75
Radishes		3	.8	.8	.85	.9
		4	.75	.75	.8	.85
Safflower		3	1.05	1.1	1.15	1.2
		4	.25	.25	.2	.2
Sorghum		3	1.0	1.05	1.1	1.15
		4	.5	.5	.55	.55
Soybeans		3	1.0	1.05	1.1	1.15
		4	.45	.45	.45	.45
Spinach		3	.95	.95	1.0	1.05
		4	.9	.9	.95	1.0
Squash		3	.9	.9	.95	1.0
		4	.7	.7	.75	.8
Sugarbeet		3	1.05	1.1	1.15	1.2
		4	.9	.95	1.0	1.0
	no irrigation last month	4	.6	.6	.6	.6
Sunflower		3	1.05	1.1	1.15	1.2
		4	.4	.4	.35	.35
Tomato		3	1.05	1.1	1.2	1.25
		4	.6	.6	.65	.65
Wheat		3	1.05	1.1	1.15	1.2
		4	.25	.25	.2	.2

(2) Crop Coefficient

Crop coefficient (Kc) is used to convert ETo to crop evapotranspiration (ETcrop). The Kc value presents evapotranspiration of a crop grown under optimum conditions and producing optimum yields. Factors affecting the value of the crop coefficient Kc are mainly the crop characteristics, crop planting or sowing date, rate of crop development and length of growing season, climatic conditions and others.

Different crops/cropping pattern will be experimented at the pilot farm and hence the Kc value will vary according to the type of the crop. Besides the Kc value also varies with respect to crop stage as shown in FIG A-6.3.2. The Kc values of different crops are shown in TABLE A-6.3.2.

As it can be seen from FIG.A-6.3.2 and TABLE A-6.3.2, Kc value ranges from 0.4 - 1.1. Hence considering a full crop growing season with all stages, an average Kc value of 0.85 is assumed, which can be used for all the crops at all the stages.

(3) Crop Water Requirement (ETcrop)

Crop water requirement (ETcrop) can be calculated by multiplying the crop coefficient Kc by evapotranspiration ETo and the calculated ETcrop is shown in the following TABLE A-6.3.3.

TABLE A-6.3.3 Crop Water Requirement

Unit : mm/day

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL AVE.
5.4	6.7	8.2	8.9	9.5	10.5	9.7	9.5	8.6	7.6	6.0	5.3	8.0

6.3.3 Planning of Centre Pivot Irrigation System for 30 ha

This section will explain the planning of Centre Pivot System for 30 ha area in Pilot Farm.

1. Area to be irrigated : A = 30ha

   Radius of coverage : $R = [(30 \times 10^4 \times 4 / 3.14)^{1/2}]/2$
   $= 309m$

2. Crop water need at the peak period : P = 10mm/day

3. Irrigation efficiency - E = 75% (assumed)

4. Outflow required at pivot $Q = 0.42PA/E$
   $= 0.42 \times 10 \times 30 / 0.75$
   $= 168$cubic.m/h

5. Number of towers for an outflow of 168cubic.m = 8
   (FIG. A-6.3.3)

6a. Minimum pressure recommended at the pivot to obtain 4bars at the sprinkler = 4.6bar (FIG A-6.3.3)

6b. Minimum pressures recommended at the pivot with 8 towers (TABLE A-6.3.4)

   i) Fixed spacing = 4.57bar
   ii) Variable spacing = 4.22bar

   From 6a) and 6b) it can be concluded that centre pivot of 8 towers and 309m radius requires 5bars at the pivot, for an outflow of 168cubic.m.

7. For a lateral length of 309m and speed of end tower (S) at 6ft/min (1.8m/min - assumed) approximate time required for one complete rotation is given by the equation, $T = 2 \times \pi \times R / S$

   = 2 x 3.14 x 309 / (6ft/min x 0.305m/ft x 60hr/min) = 18 hrs

   (0.305 is conversion factor of feet into meter)

8. Number of possible rotations in one month = 720/18 = 40

9. Water to be applied in one rotation = 300/40 = 7.5mm

10. Length covered by the end tower in one hour

    = (6ft/min x 0.305m/ft) x 60min/hr

    = 109.8m

    Area covered by the end tower in 1 hour

    = 109.8m x 30ha/(2 x 3.14 x 309m) = 1.6966ha

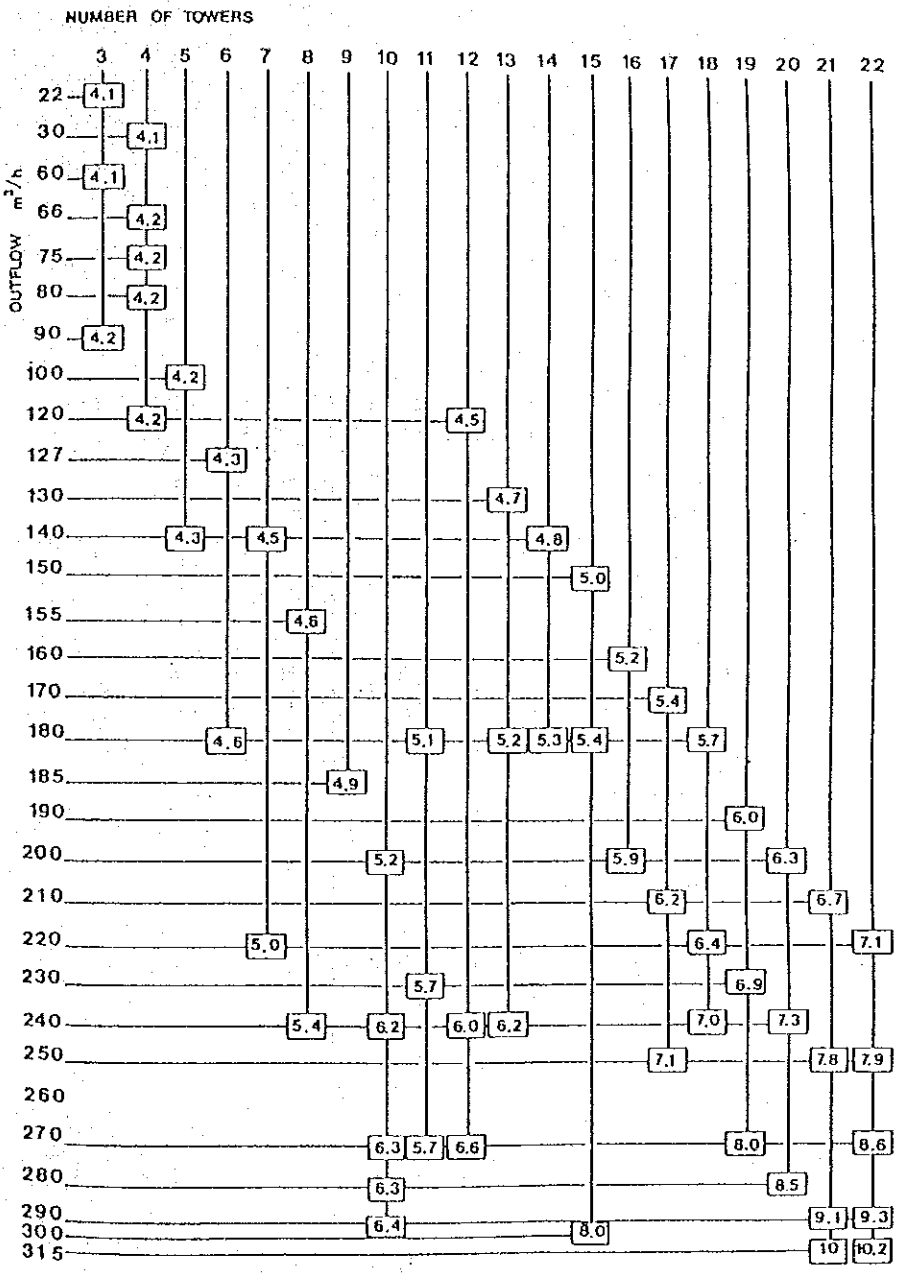
    Depth of water applied in 1 hour

    = total water applied/area

    = 168 x 1000 / (1.6966ha x 10000) = 9.9mm

    Hence, if the basic intake rate of soil is >10mm/hr then there is no problem of ponding. But the permeability of the soil is not constant through out the irrigation period and it reduces with respect to time. And hence the safer permeability level can be considered as >20-30mm/hr.

FIG. A-6.3.3 Minimum Pressures Recommended at the Pivot to obtain 4 bars at the End Sprinkler



Source: FAO Irrigation and Drainage Paper,
Mechanized sprinkler irrigation,
Paper No.35, PP.309

TABLE A-6.3.4 Minimum Pressures Recommended at the Pivot

m³/h	Fixed spacing m	Variable spacing m	Spray nozzle mm	Fixed spacing m	Variable spacing m	Spray nozzle mm	Fixed spacing m	Variable spacing m	Spray nozzle mm	Fixed spacing m	Variable spacing m	Spray nozzle mm	Fixed spacing m	Variable spacing m	Spray nozzle mm
340.65															
317.94															
295.23															
272.52													5.98	5.63	3.87
249.81										5.63	5.28	3.52	5.63	5.28	3.52
227.10							4.93	4.57	2.82	5.28	4.93	3.17	5.28	4.93	3.17
204.39				4.93	4.57	2.82	4.93	4.47	2.82	4.93	4.57	2.82	4.93	4.47	2.82
181.68	4.57	4.22	2.48	4.57	4.22	2.46	4.57	4.22	2.46	4.57	4.22	2.46	4.57	4.22	2.46
158.97	4.22	3.87	2.11	4.22	3.87	2.11	4.57	4.22	2.46	4.57	4.22	2.46	4.57	4.22	2.46
136.25	4.22	3.87	2.11	4.22	3.87	2.11	4.22	3.87	2.11	4.57	4.22	2.46	4.57	4.22	2.46
113.55	4.22	3.87	2.11	4.22	3.87	2.11	4.22	3.87	2.11	4.22	3.87	2.11	4.22	3.87	2.11
90.84	4.22	3.87	2.11	4.22	3.87	2.11	4.22	3.87	2.11						
No. of towers	5			6			7			8			9		
Lengch metres	204.83			242.93			281.33			319.43			357.84		

m³/h	Fixed spacing m	Variable spacing m	Spray nozzle mm	Fixed spacing m	Variable spacing m	Spray nozzle mm	Fixed spacing m	Variable spacing m	Spray nozzle mm	Fixed spacing m	Variable spacing m	Spray nozzle mm	Fixed spacing m	Variable spacing m	Spray nozzle mm	Fixed spacing m	Variable spacing m	Spray nozzle mm
340.65	7.39	7.03	5.28	7.74	7.39	5.63	8.09	7.74	5.98	8.44	8.09	6.34	8.79	8.44	6.68	9.14	8.79	7.03
317.94	7.03	6.68	4.93	7.39	7.03	5.28	7.39	7.03	5.28	7.74	7.39	5.03	8.09	7.74	5.98	8.44	8.09	6.33
295.23	6.68	6.33	4.57	6.68	6.33	4.57	7.03	6.68	4.93	7.39	7.03	5	7.39	7.03	5.28	7.74	7.39	5.63
272.52	6.33	5.98	4.22	6.33	5.98	4.22	6.68	6.33	4.57	6.68	6.33	4.57	7.03	6.68	4.93	7.03	6.68	4.93
249.81	5.98	5.63	3.87	5.98	5.63	3.87	6.33	5.98	4.22	6.33	5.98	4	6.68	6.33	4.57			
227.10	5.63	5.28	3.52	5.63	5.28	3.52	5.98	5.63	3.87	5.98	5.63	3						
204.39	5.28	4.93	3.17	5.28	4.93	3.17	5.63	5.28	3.52									
181.68	4.57	4.22	2.46	4.93	4.57	2.82												
158.97	4.57	4.22	2.46	4.57	4.22	2.46												
136.25	4.57	4.22	2.46															
113.55																		
90.84																		
No. of towers	10			11			12			13			14			15		
Lengch metres	396.24			434.34			472.75			511.15			549.25			587.66		

Source: FAO Irrigation and Drainage Paper, Mechanized Sprinkler Irrigation, Paper No.35, PP.310-311

6.3.4 Basic Intake Rate

As discussed in the previous section, the basic intake rate of the soil should be more than 20-30mm/hr for planning a centre pivot irrigation system. The basic intake rate of the soil in the study area was measured during the field work in 1989. Observation was done after selecting 3 (three) test points, which were located in east, center and west-side, and observation was made for 3 (three) times observation at each place both at the ground surface and at 50cm-below the ground surface. According to the result shown in TABLE A-6.3.5 the basic intake rates are summarized as follows:

Test Points	Surface		50cm-below surface	
1. East-side	44-65mm/hr	X=53.2	44-52mm/hr	X=48.4
2. Center	13-18mm/hr	X=15.4	13-16mm/hr	X=14.4
3. West-side	20-24mm/hr	X=21.5	23-25mm/hr	X=24.1

In general it may be said that the basic intake rate will not be a constraint in selection of irrigation method except for centre-side.

Methodology

Double ring method was applied with two rings of 60cm and 40cm diameter.

The pairs of cylinders were installed at the sites, driven into the soil to approximately 15cm depth.

The cylinders were filled with water to a depth of about 10cm and the time and the height of the water in the inner cylinder were recorded using a stop watch and a hook gauge. But burlar cloth was not used in this measurement. The soil with high silt content was interrupted at the outface at every time of watering, and consequently, the silt covered the surface and prevented the infiltration movement.

In addition to this, the soil was not plowed before the test, and was hardened like a virgin soil.

During the field survey, it was observed that there was no ponding problem at the Dauka farm which has been using centre pivot irrigation system. Because of these reasons, the actual intake rate at the site is expected to be more than the measured intake rate.

Hence it can be concluded that there is no ponding problem for the use of center pivot irrigation system.

TABLE A-6.3.5 Basic Intake Rate Result

Test Points		Equation of Intake Rate		Basic Intake Rate mm/hr
Surface	E-1	I = 407.2 T	-0.383	50.7
	E-2	I = 209.5 T	-0.302	43.6
	E-3	I = 331.0 T	-0.310	65.4
				X = 53.2
Sub-Surface	E-1	I = 377.9 T	-0.371	44.2
	E-2	I = 284.5 T	-0.322	52.0
	E-3	I = 344.3 T	-0.362	49.0
				X = 48.4
Surface	W-1	I = 179.0 T	-0.403	19.6
	W-2	I = 123.1 T	-0.365	23.5
	W-3	I = 152.4 T	-0.365	21.3
				X = 21.5
Sub-Surface	W-1	I = 124.9 T	-0.306	25.3
	W-2	I = 123.2 T	-0.315	23.6
	W-3	I = 123.1 T	-0.316	23.5
				X = 24.1
Surface	C-1	I = 229.9 T	-0.453	18.2
	C-2	I = 188.7 T	-0.476	12.8
	C-3	I = 245.6 T	-0.488	15.3
				X = 15.4
Sub-Surface	C-1	I = 243.1 T	-0.494	14.6
	C-2	I = 246.8 T	-0.486	15.7
	C-3	I = 213.5 T	-0.492	13.0
				X = 14.4

6.3.5 Windbreak Facilities

Two types of wind break facilities will be provided at the Pilot Farm in order to prevent the damage against strong wind. One is windbreak trees and the other is windbreak fence. Windbreak trees will be useful for several years after the planting. Windbreak fence will be constructed during the farm construction and will function as the windbreak especially during the period of tree growing.

(1) Windbreak trees

1) Selection of Windbreak tree

The following six varieties are normally planted as windbreak trees

1. Casuarina sp.
2. Conocarpis sp.
3. Prosopis sp.
4. Acacia sp.
5. Eucalypus sp.
6. Tamarisk sp.

Recently, Eucalypus sp. has been prohibited for planting in Oman, though this variety is very popular for anti-desertification all over the world. Hence Eucalyptus sp. can not be selected as windbreak trees. Among the others, Conocarpis sp. has hard trunk and grows up to about 15 meters height. Conocarpis sp. is circular corn shape and its lower portion can not prevent the wind because of the lack of branches. Hence this Conocarpis sp. trees can be planted at the centre of the rows and the remaining four varieties are planted on both the sides of the Conocarpis sp.

2) Layout of windbreak trees

Windbreak trees will be planted in 3 lines using the above mentioned five varieties. Conocarpis sp. will be planted at the centre line of the belt and the others will be planted along both the sides. The cross sectional width is 4 meters and the length between each tree is 2.5 meters with cross-planting. The height of the trees after growing up is assumed as 5 meters, and the effective distance between two belts of trees is 50 meters, since the windbreak is effective for a distance of 10 to 15 times of its height.

3) Irrigation for the tree

The number of the trees are estimated as 120 species/100 meters of the longitudinal section. Since the number of trees in the farm is relatively more, a drip irrigation system is recommended to reduce the amount of water and keep proper water management. Data of water requirement for one tree is not available for the Nejd. An anti-desertification study report explains that a range of approximately 30 liters per day will be required for one tree in U.A.E.

(2) Windbreak fence

Windbreak fence will be useful as a short term counter measure against the wind for the period between project commencement to the growing-up of trees.

1) Basic assumptions

a) Standard wind velocity (U_A)

Standard wind velocity is defined as the velocity which causes damage to the plants in the area. According to the meteorological data of Thumrait, the value is 28 Kt (= 14.4 meter/sec at the height of 10 meters from ground level), which is the maximum among the recorded monthly mean velocity.

b) Crop

The crops which should be prevented from wind hazard are assumed as fodder grass, and vegetables whose height are about 1.0 meter.

c) Critical velocity (U_L)

Critical velocity is defined as the maximum value of wind tolerance of the crop. Using the windbreaks the Standard wind velocity should be reduced to the level of critical wind velocity. When the wind tolerance of the crop is categorized as medium range, the critical velocity (U_L) is quoted as follows based on the experimental results shown in FIG A-6.3.4.

U_L = Critical Velocity = 8.7 - 11.7 m/s = approx. 10.0 m/sec

(2) Design of windbreak fence

a) Reduction ratio (Rr)

$$Rr = \frac{U_A - U_L}{U_A} = \frac{14.4 - 10.0}{14.4} = 0.31 \text{ (= approx. 30\%)}$$

Hence the reduction ratio of the windbreak fence should be equal to (or) more than 30% to reduce from the standard velocity (U_A) to critical velocity (U_L).

b) Screening area of the windbreak fence

According to an experiment regarding the relation between windbreak height and the effective distance, a windbreak net with 50.2% screening area (i.e area of windbreak wires with respect to total area of the windbreak fence) can reduce U_A to U_L by 30%.

c) Height of windbreak net

The windbreak fence will be effective for the length of 10 times of its height. Hence the height of net, i.e., the height of pillar is proposed as 5.0 meters, which will be effective for a length of 50 m.

d) Material of windbreak fence

Net of iron wire fixed to the iron-pipe pillar will be used as windbreak fence. Screening area of windbreak net is 50.2% with 4mm mesh space.

e) Spacing of windbreak fence

Windbreak fence of 5 m height can reduce the velocity for a length of 50.0 meter range. The spacing of the installation is proposed as 50.0 meters.

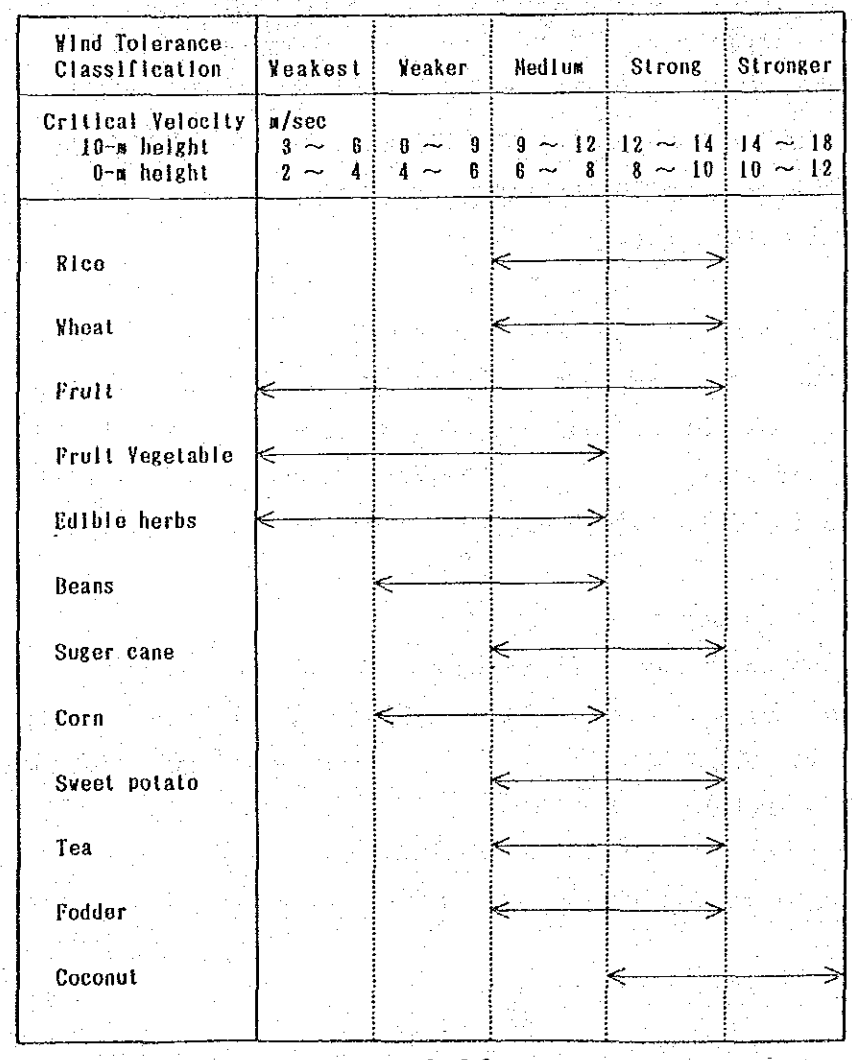
f) Windbreak structure

a. Basement : 0.7(B) x 0.7(L) x 0.4m(H) concrete for Pillar
0.7(B) x 0.7(L) x 0.4m(H) " Support

b. Pillar : 90mm(O.D) x 3.5t x 5.4(L)

c. Support : 34mmO.D x 2.3t x 4.3(L)

FIG. A-6.3.4 Wind Tolerance by Crop



APPENDIX A-6.4
Pilot Farm Construction and Management Plan

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6.4 Pilot Farm Construction and Management Plan

In the main report, the construction and management of different farm facilities like irrigation facilities, windbreak facilities, farm roads etc. were discussed in detail. In this section the supporting figures and tables of these facilities are presented.

FIG.A-6.4.1 Topographical Map around the Pilot Farm

This survey map was prepared by the JICA study team and tte compiled map is attached at the end of appendix.

FIG. A-6.4.2

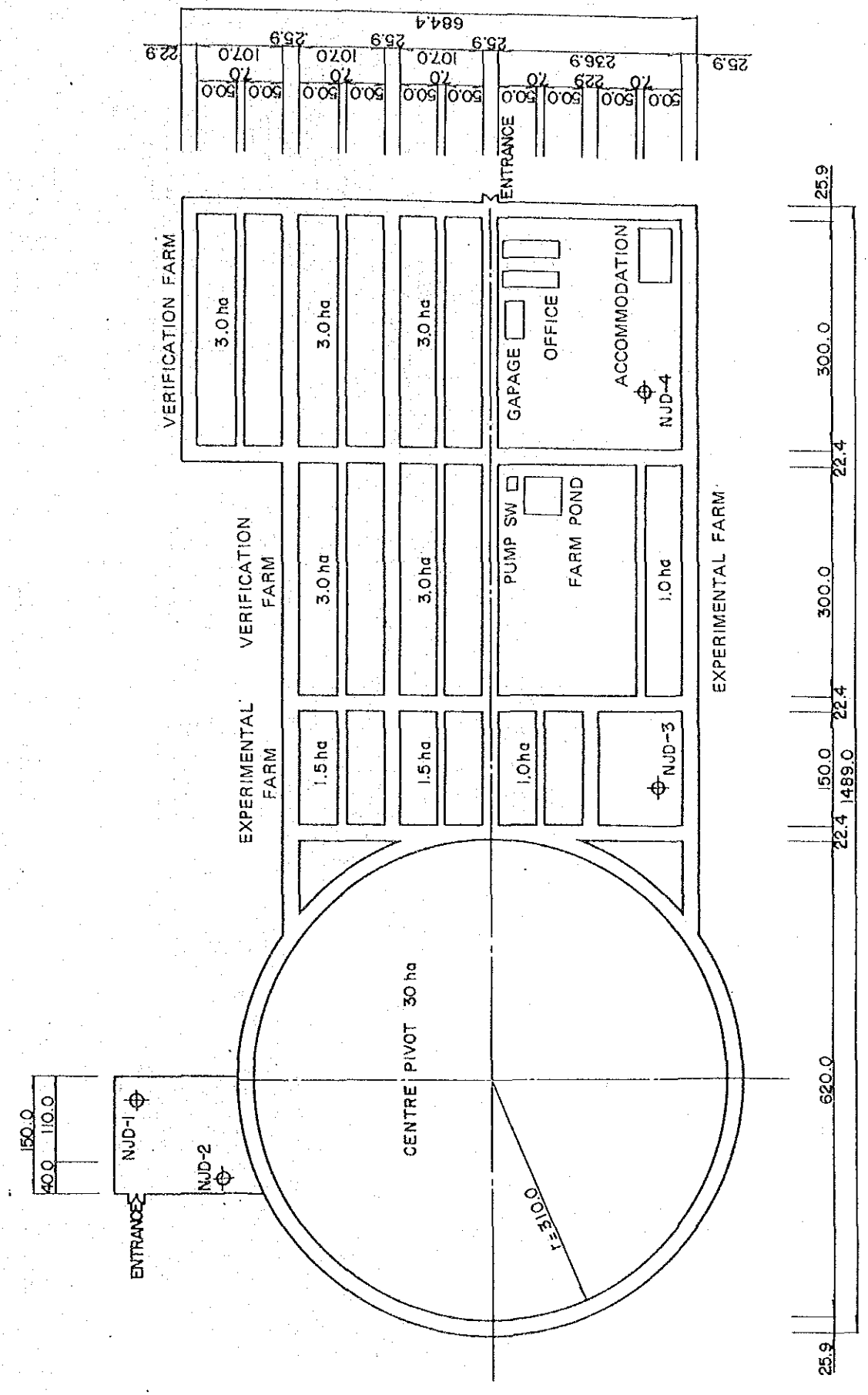


FIG. A-6.4.2 Pilot Farm General Layout

FIG. A-6.4.3

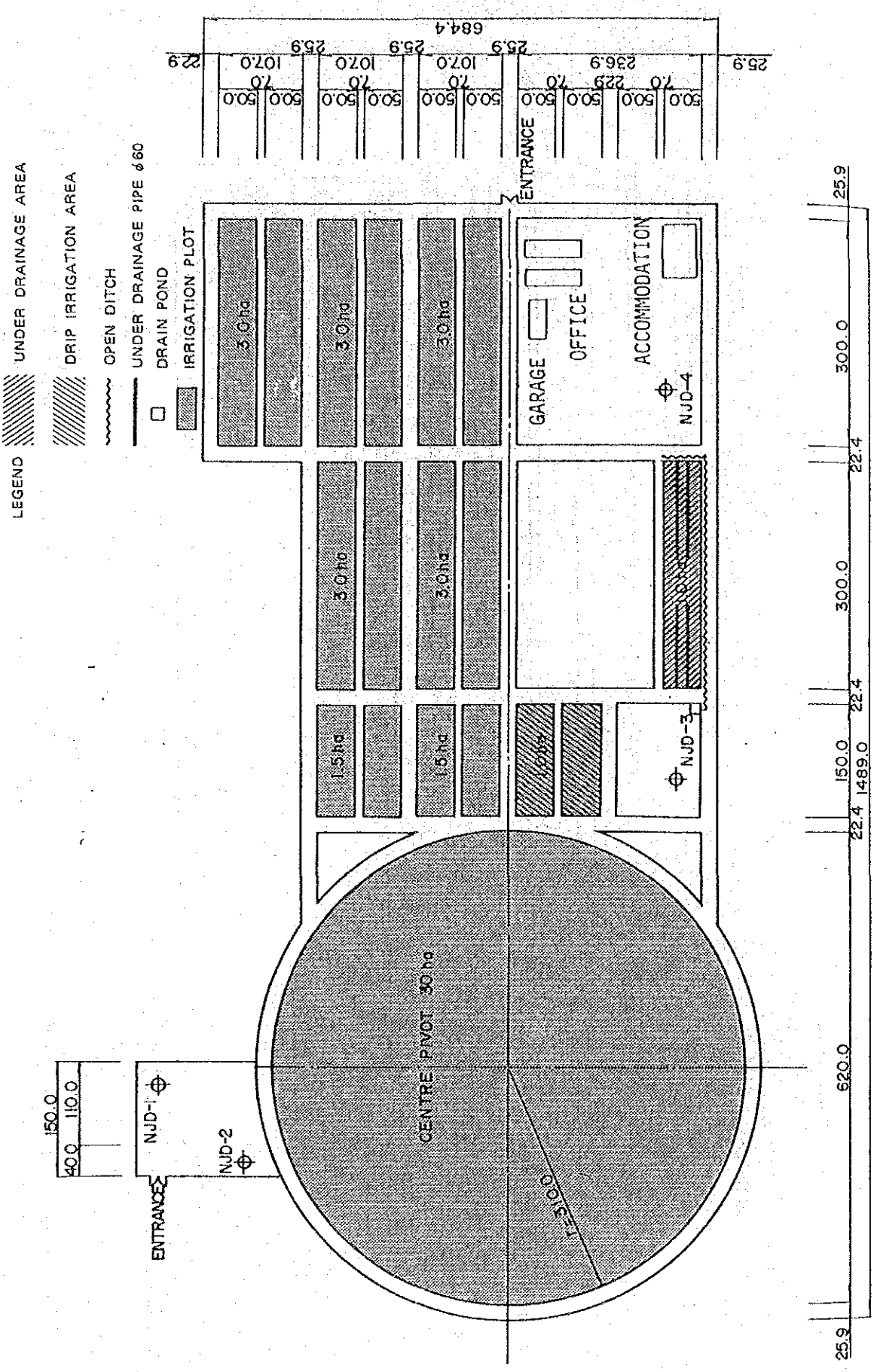


FIG. A-6.4.3 Irrigation Plot Layout

FIG. A-6.4.4 Submersible Pump Installation

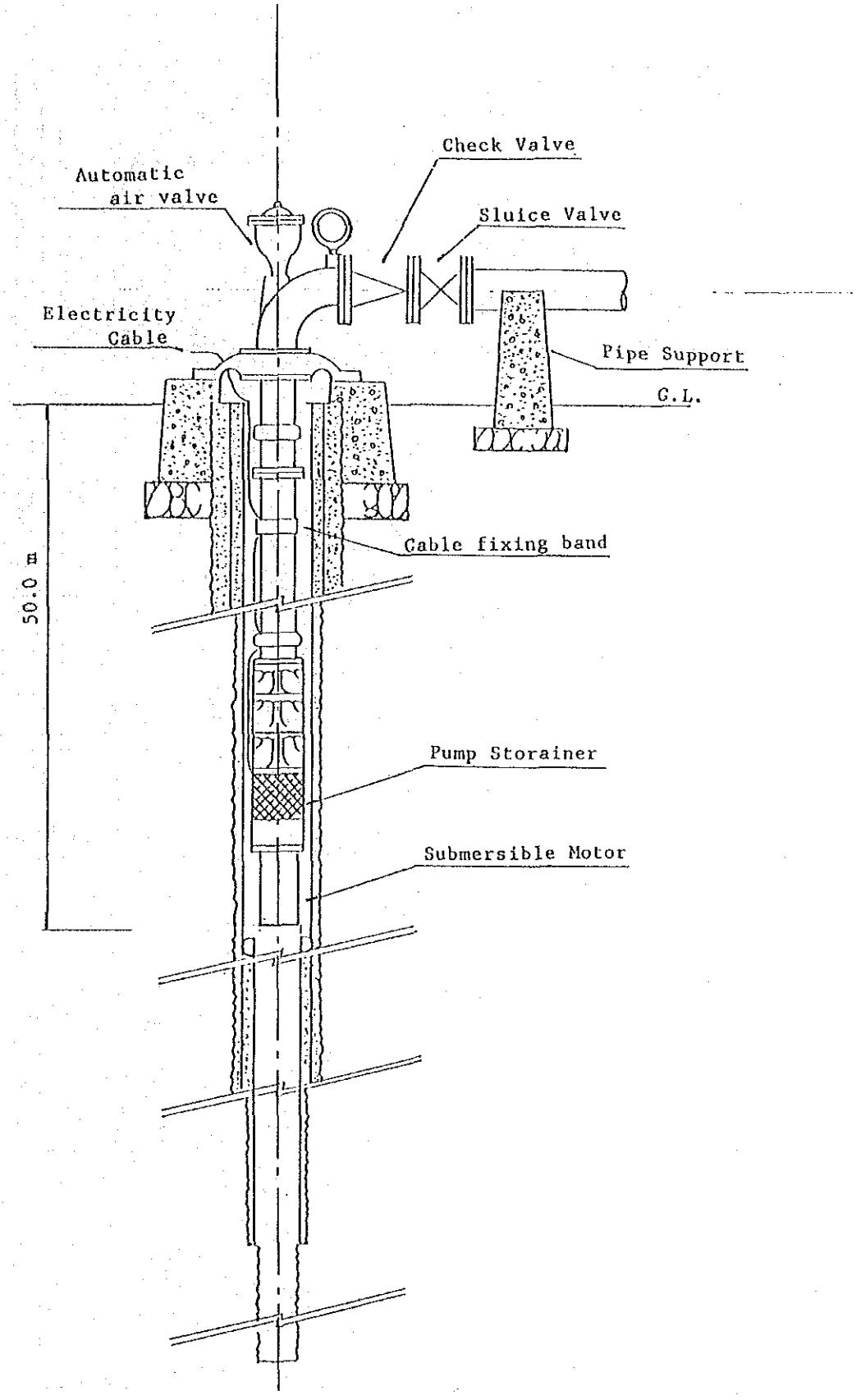


FIG. A-6.4.5 Farm Pond

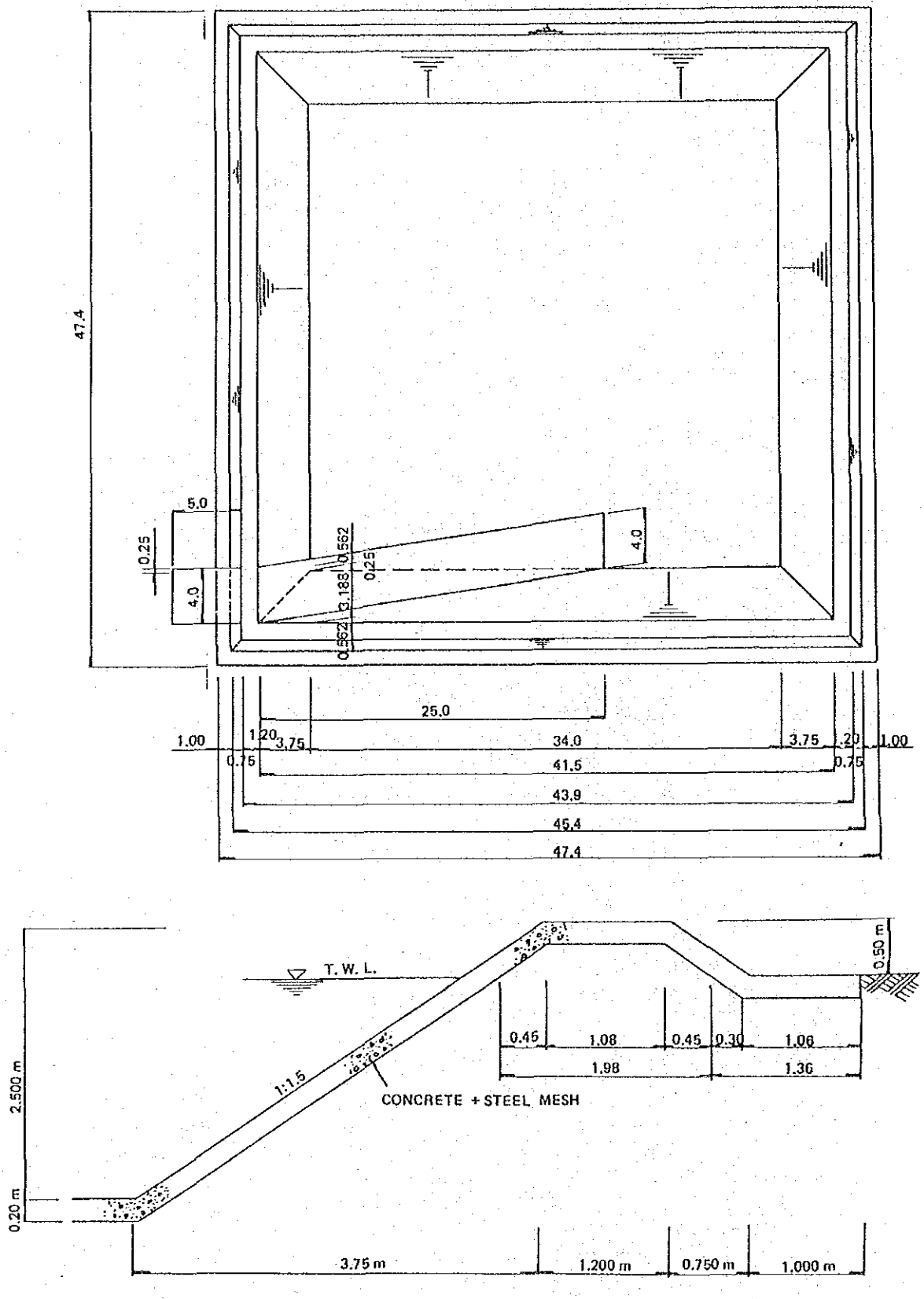
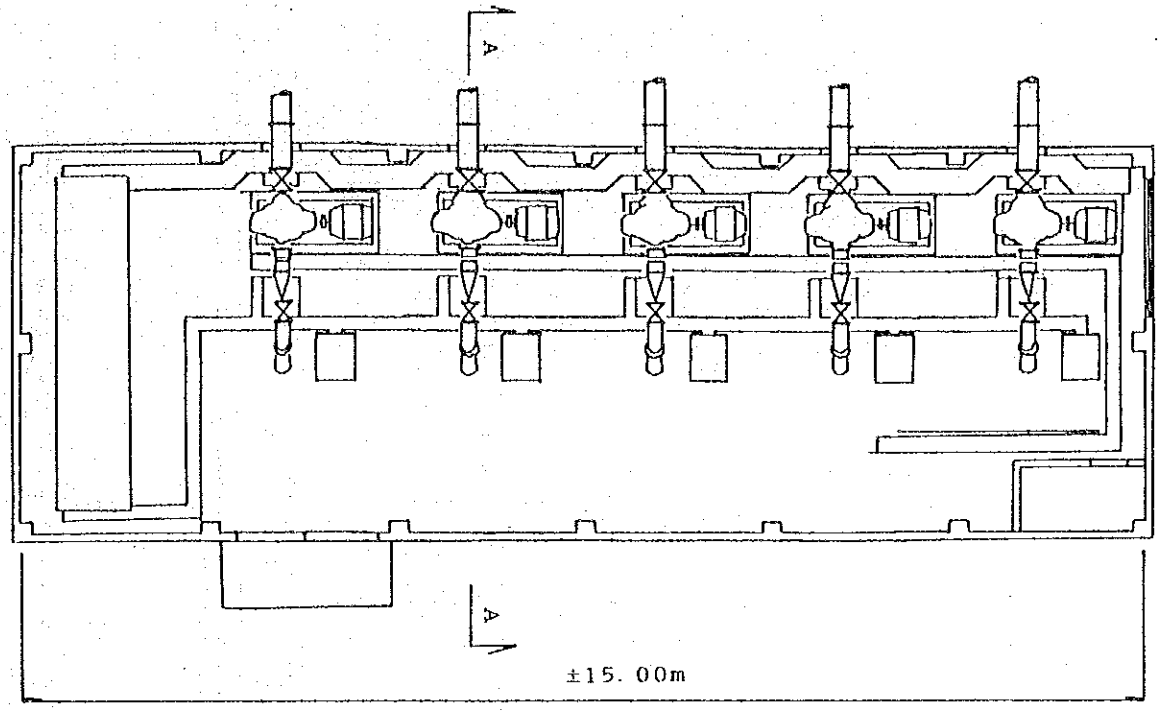


FIG. A-6.4.6 Layout of Booster Pump Station



A-A Section

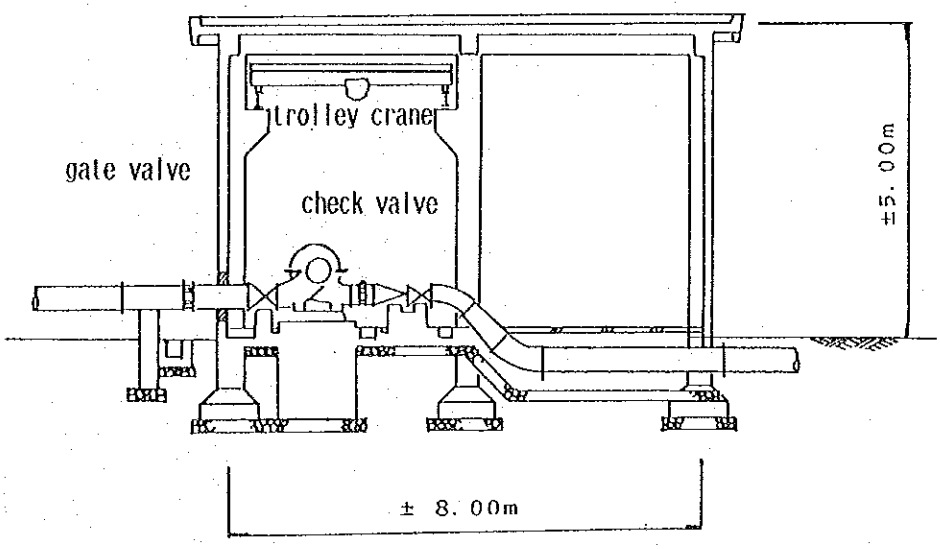
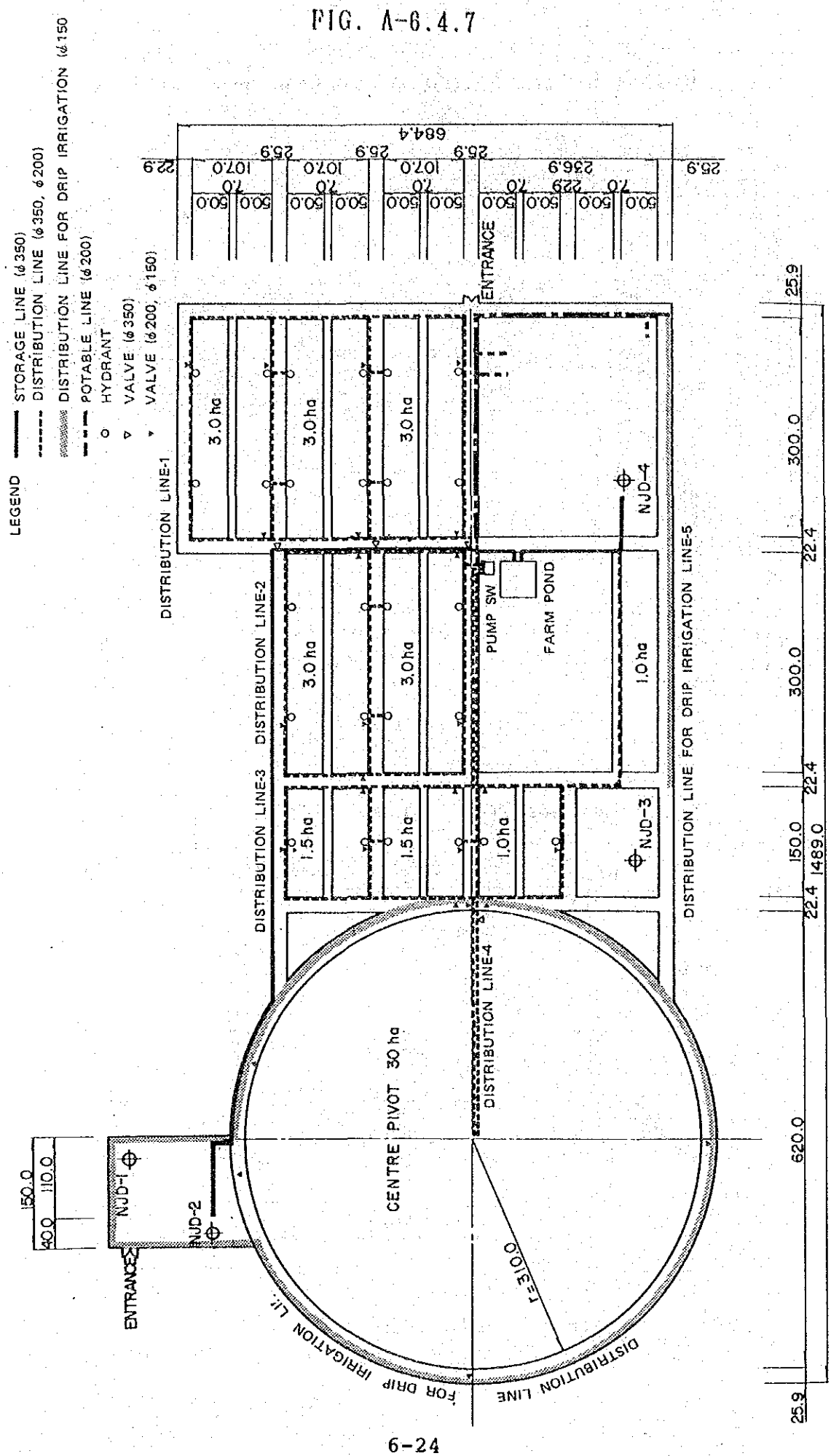


FIG. A-6.4.7

FIG. A-6.4.7 Irrigation Pipe Networks



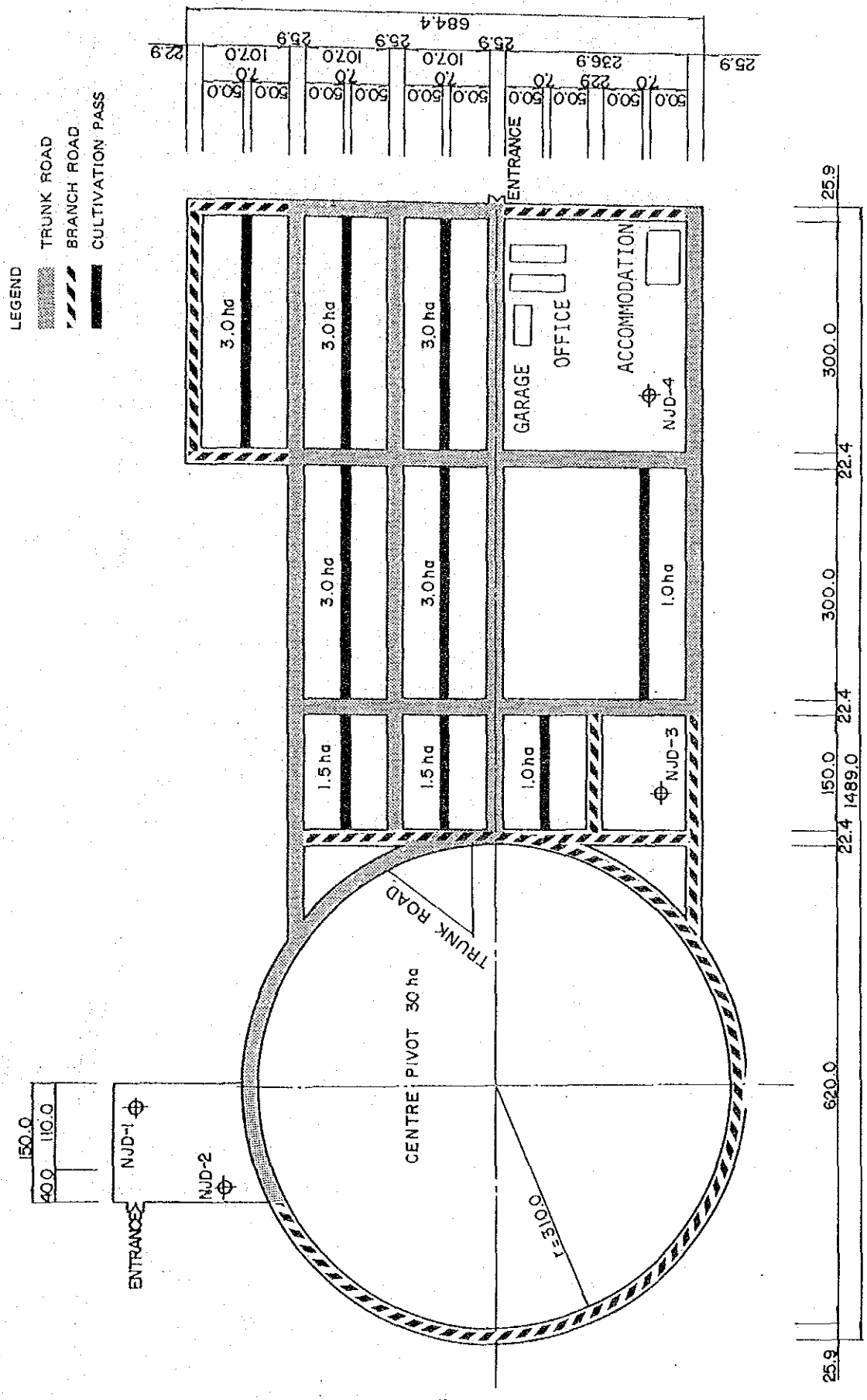


FIG. A-6.4.8 Road Networks in the Pilot Farm

FIG. A-6.4.9 Layout of Windbreaks

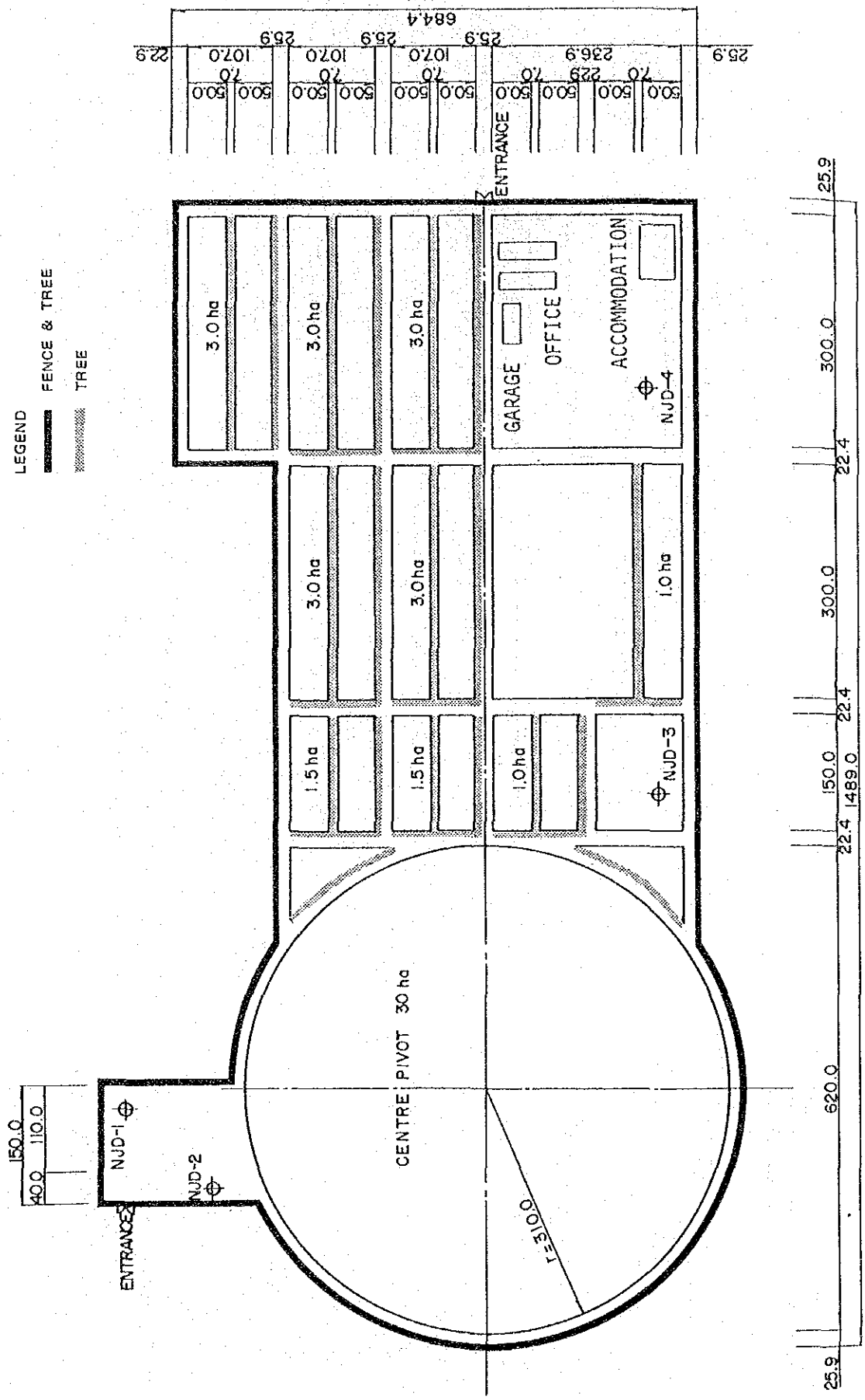


FIG. A-6.4.10 Section Map

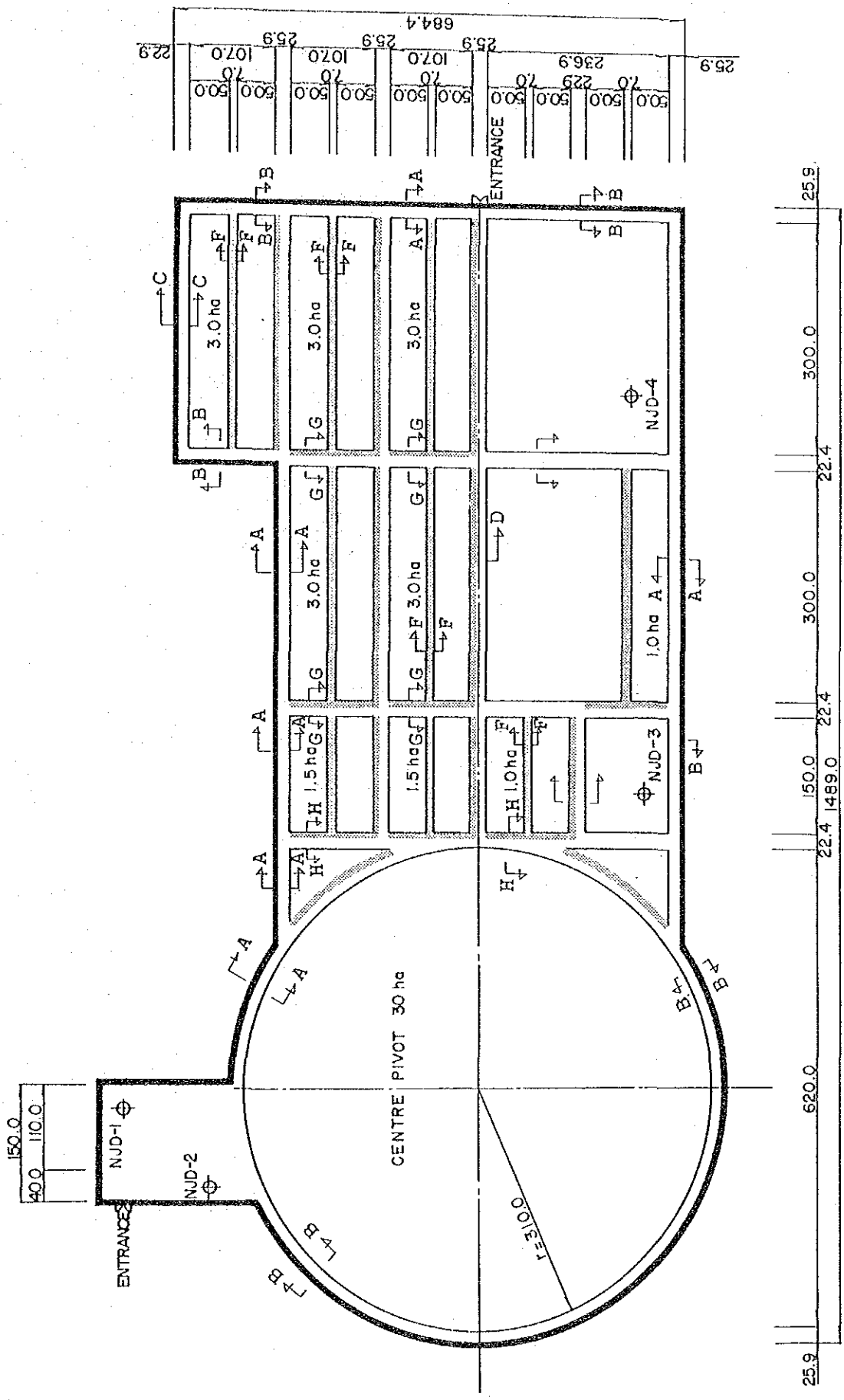


FIG. A-6.4.11 Cross-sections of Road and Windbreak

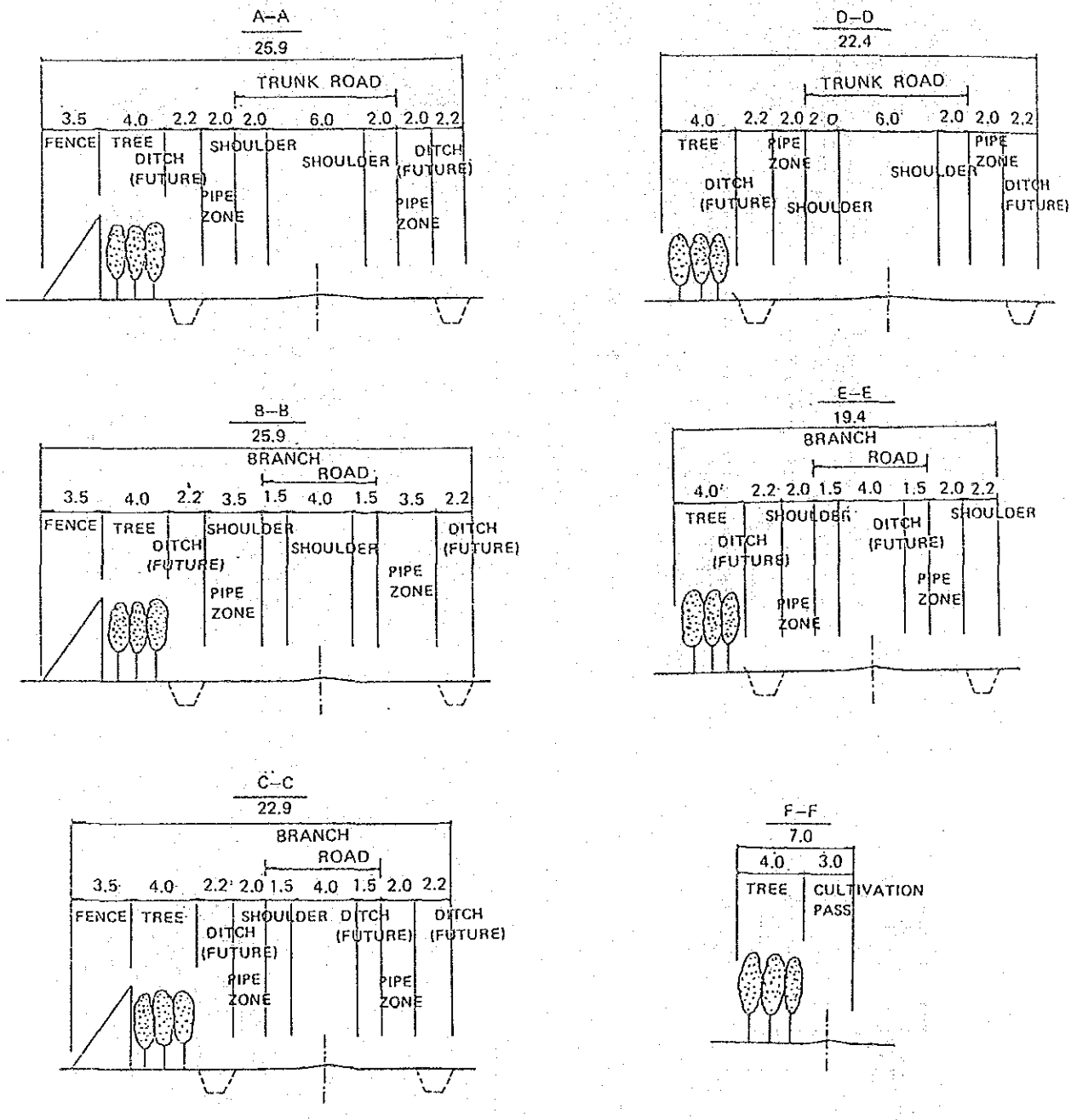


FIG. A-6.4.11

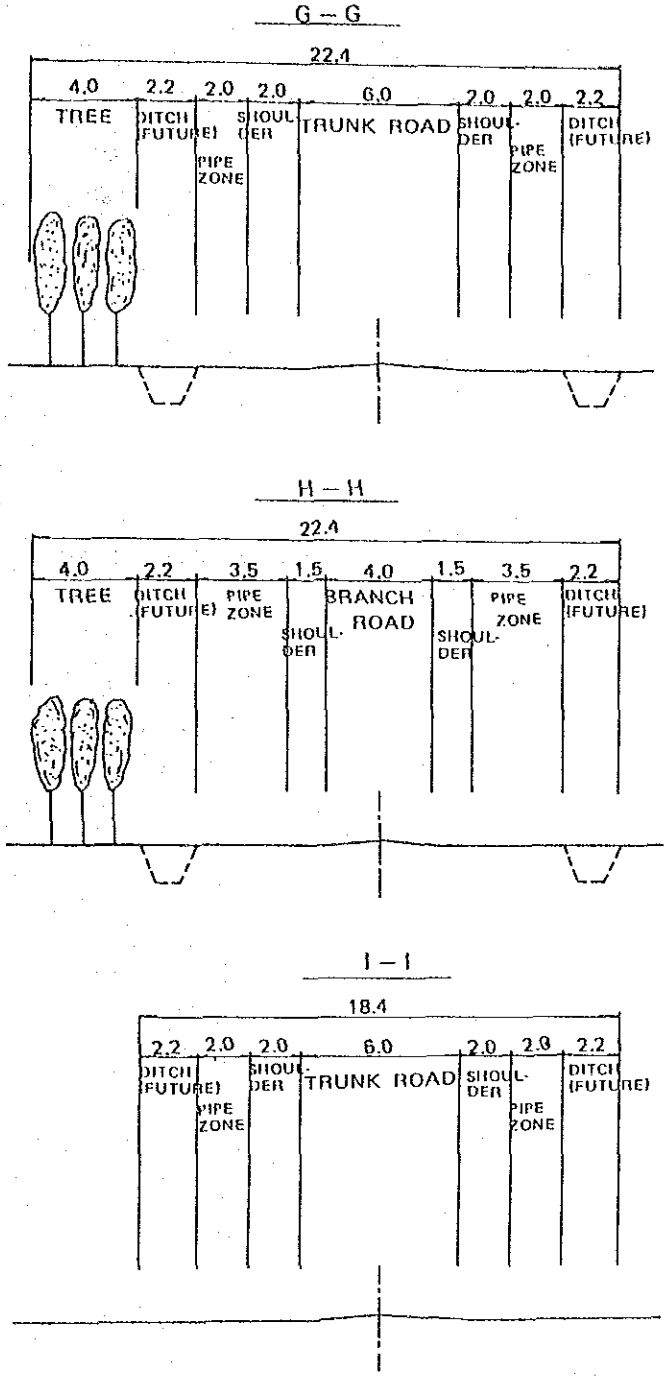

G – G
22.4
4.0
2.2
2.0
2.0
6.0
2.0
2.0
2.2
TREE
DITCH (FUTURE)
PIPE ZONE
SHOULDER
TRUNK ROAD
SHOULDER
PIPE ZONE
DITCH (FUTURE)
H – H
22.4
4.0
2.2
3.5
1.5
4.0
1.5
3.5
2.2
TREE
DITCH (FUTURE)
PIPE ZONE
SHOULDER
BRANCH ROAD
SHOULDER
PIPE ZONE
DITCH (FUTURE)
I – I
18.4
2.2
2.0
2.0
6.0
2.0
2.0
2.2
DITCH (FUTURE)
PIPE ZONE
SHOULDER
TRUNK ROAD
SHOULDER
PIPE ZONE
DITCH (FUTURE)

FIG. A-6.4.12 Detail of Windbreak Fence

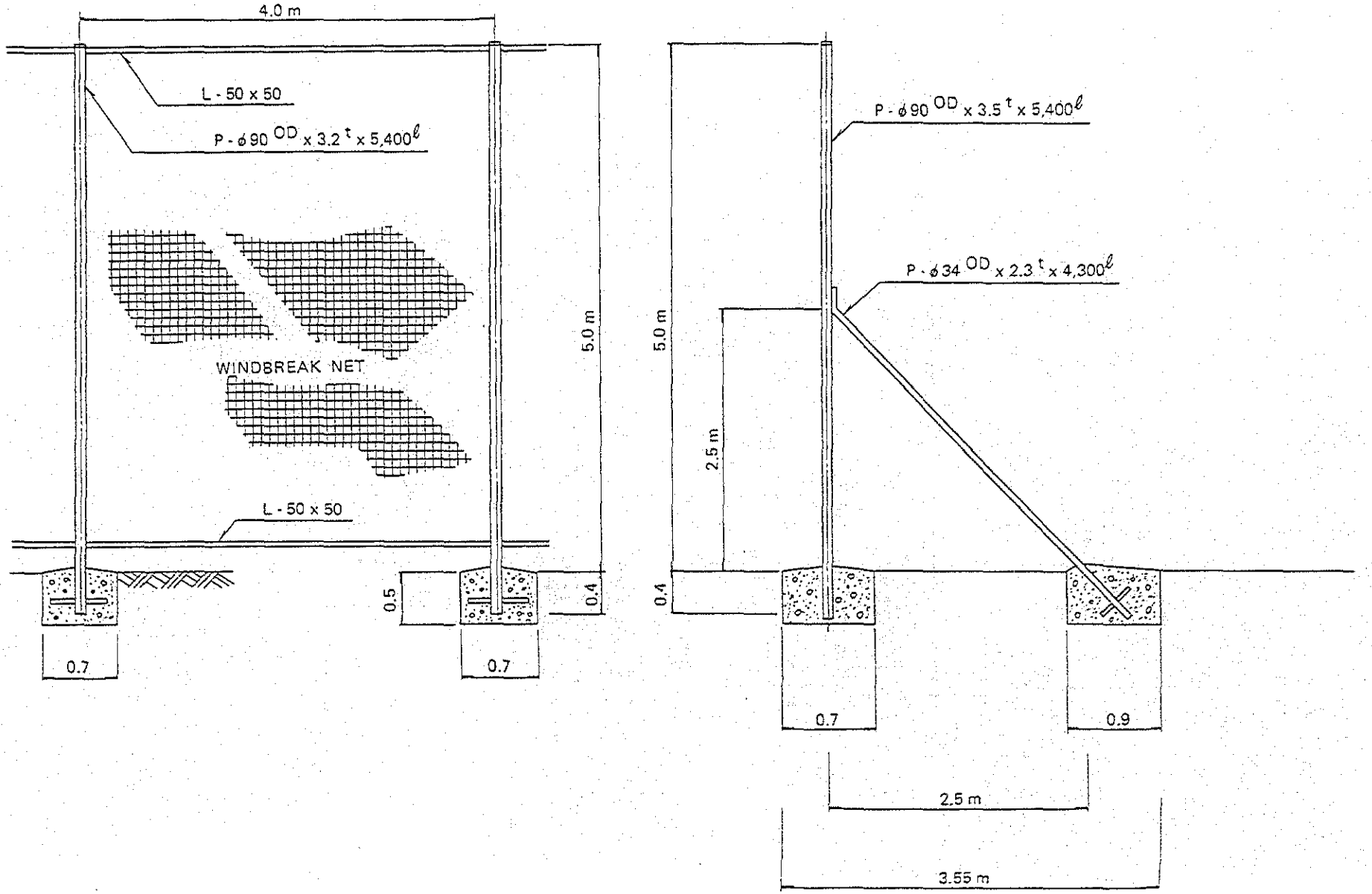
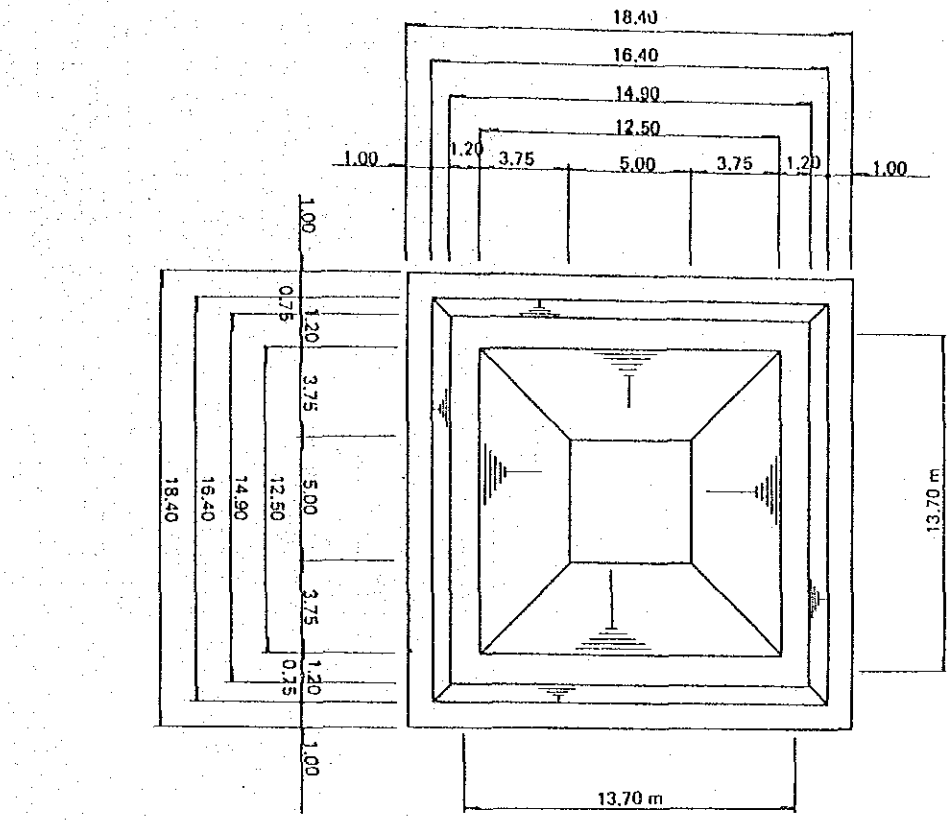
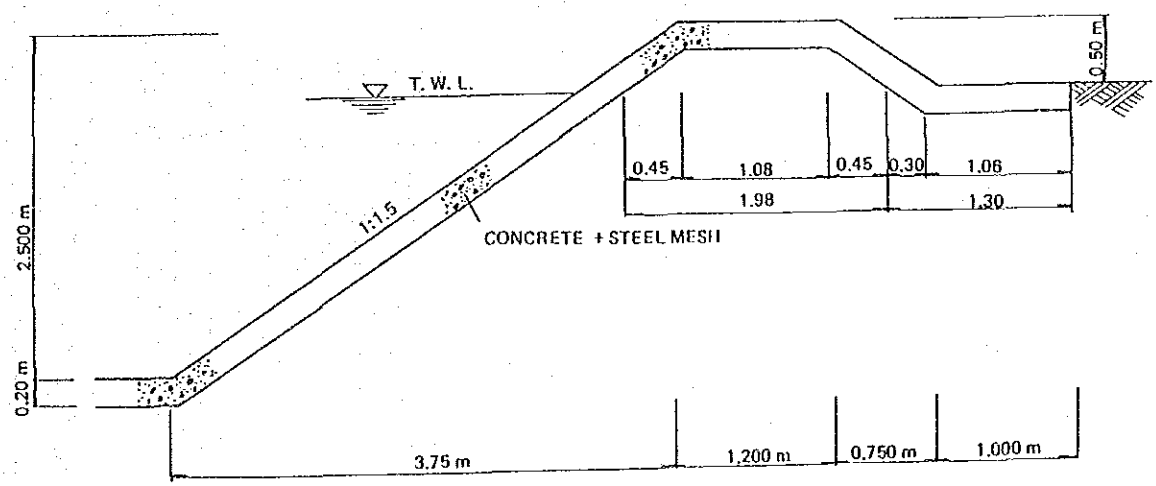


FIG. A-6.4.13 Dralnage Pond





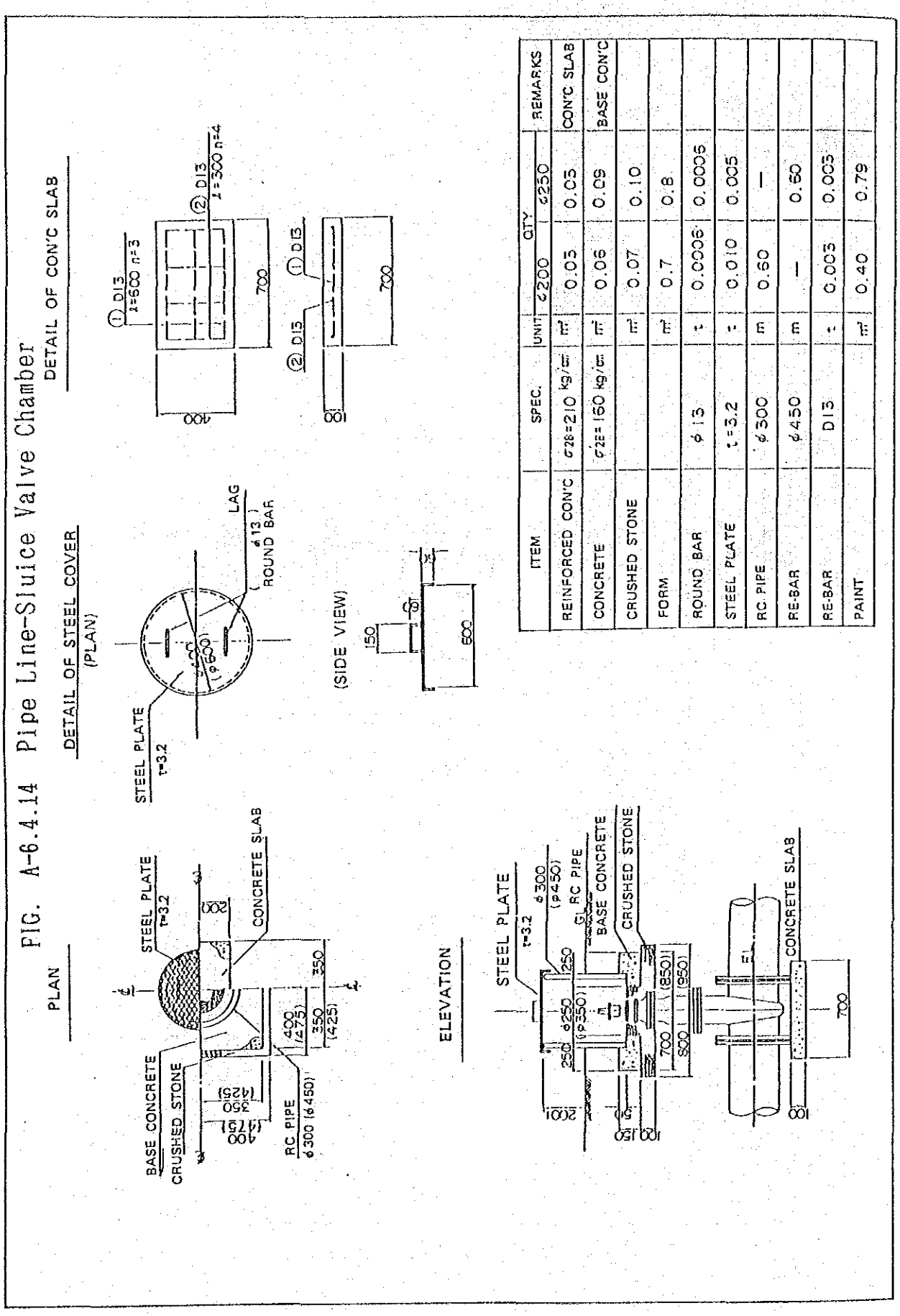
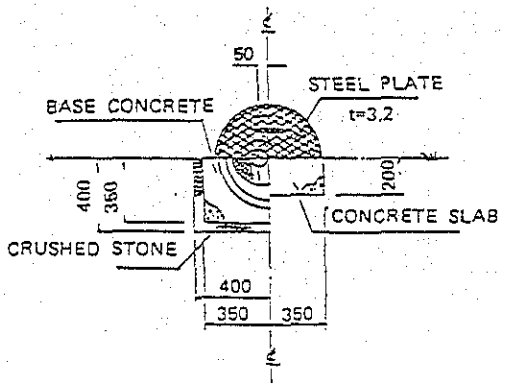


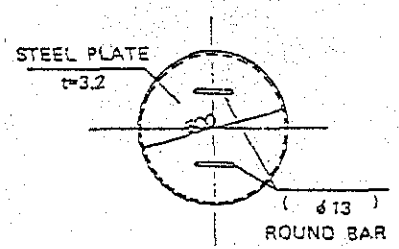
FIG. A-6.4.14 Pipe Line-Sluice Valve Chamber
PLAN
DETAIL OF STEEL COVER
(PLAN)
DETAIL OF CON'C SLAB
(SIDE VIEW)
ELEVATION
STEEL PLATE
t=3.2
LAG
ROUND BAR
CONCRETE SLAB
BASE CONCRETE
CRUSHED STONE
RC PIPE
ITEM
SPEC.
UNIT
QTY
REMARKS
REINFORCED CON'C
CONCRETE
CRUSHED STONE
FORM
ROUND BAR
STEEL PLATE
RC PIPE
RE-BAR
PAINT
CON'C SLAB
BASE CON'C

FIG. A-6.4.15 Pipe Line-Air Valve Protection

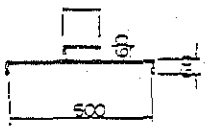
PLAN



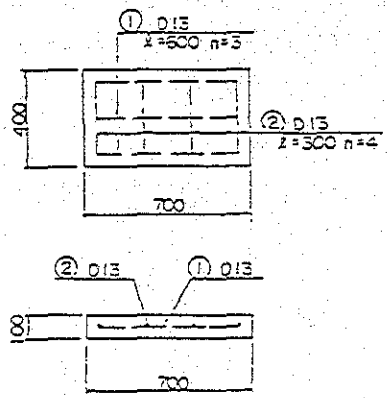
DETAIL OF STEEL COVER
(PLAN)



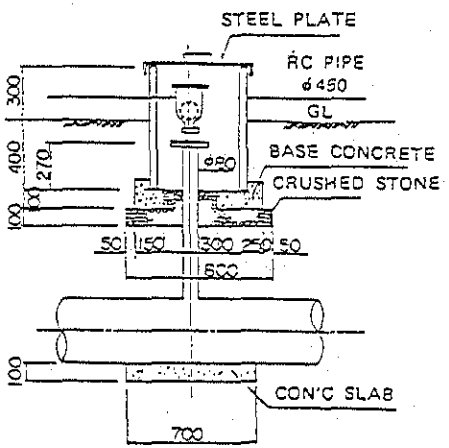
(SIDE VIEW)



DETAIL OF CON'C SLAB



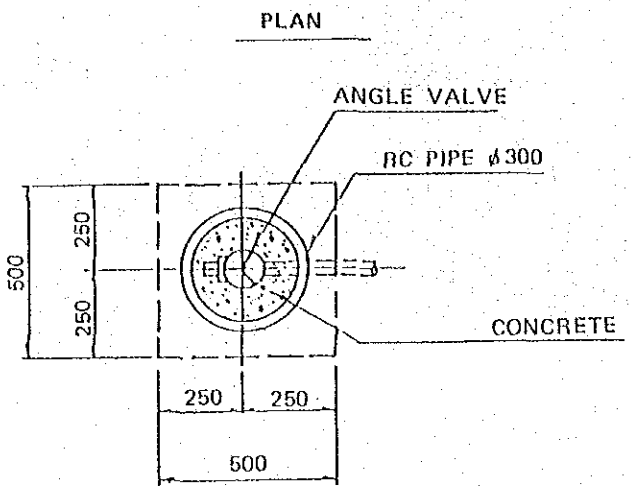
ELEVATION

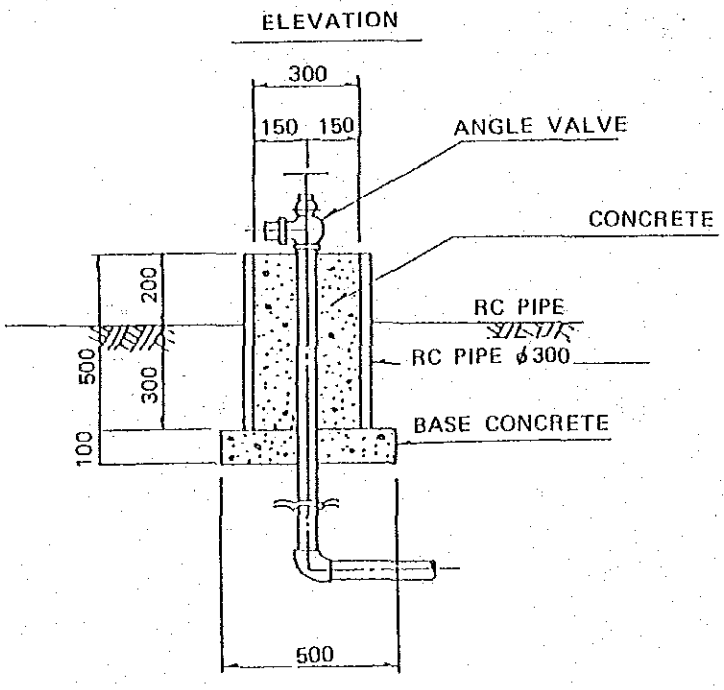


ITEM	SPEC.	UNIT	QTY	REMARKS
REINFORCED CON'C	σ_{28} = 210 kg/cm²	m³	0.03	CON'C SLAB
CONCRETE	σ_{28} = 160 kg/cm²	m³	0.06	BASE CON'C
CRUSHED STONE		m³	0.07	
FORM		m²	0.7	
ROUND BAR	ϕ13	t	0.0006	
STEEL PLATE	t=3.2	t	0.010	
RE-BAR	ϕ450	m	0.70	
RC PIPE	D13	t	0.003	
PAINT		m²	0.80	

FIG. A-6.4.15

FIG. A-6.4.16 Pipe Line-Hydrant Protection





ITEM	SPEC.	UNIT	QTY.
R.C. PIPE	ϕ 300	m	0.5
CONCRETE	σ_{28}= 160 kg/cm²	m³	0.06

TABLE A-6.4.1 Summary of Cost Estimate of the Pilot Farm Project

Unit : Rials Omani

	ITEMS	SPECIFICATION	UNIT	QTY	COST
1	CONSTRUCTION & EQUIPMENTS				
	** CONSTRUCTION **				
	1- 1 Preparation Work	Preparation work for Pilot Farm Construction	L.S		7,500
	1- 2 Land Reclamation		sq.m	500,000	600
	1- 3 Intake Facility				
	a Pump & Insta'n	45KW SUBMERSIBLE PUMP	Set	2	26,328
	b Pump Hut	4mx4m-size Hut for Pump	Set	2	3,840
	c Storage Line	Storage Line from Wells to Farm-pond	m	1,690	70,817
	* SUM				100,985
	1- 4 Irrigation Facility				
	a Farm Pond	2400 Cu.m Capa., 35m(L)x35m(B)x2.5m(H)	Set	1	31,282
	b B-Pump & Instal'n	S.S.V-Booster pump - 5Nos.	Set	1	120,768
	c B-P Hut	Booster pump station 15 x 8m	Set	1	11,520
	d D-Line/C.P	Distribution line for Center Pivot	m	800	32,625
	e D-Line/Hyrdrants	Distribution line for Hydrants	m	6,364	159,195
	f D-Line/Drip	Distribution line for Drip system on Experimental Plot	m	3,133	58,883
	g Drip System	For 1ha	Set	1	12,000
	h C.P & Instal'n	620m dia., Centre Pivot for 30ha & its installation	Set	1	24,000
	i Side Wheel & Instal'n	Side wheel type sprincler for 6ha & its installation	Set	4	6,048
	j Rain Gun	Rain-gun type sprincler for 14ha	Set	12	6,000
	* SUM				462,321
	1- 5 Drainage System				
	a Subsurfce drainge	For 1ha experimental plot	Set	1	3,800
	b Ditch	Ditch for 1ha experimental plot	m	380	6,244
	c Drainage Pond	13m(L)x13m(B)x2.5m(H)	Set	1	3,959
	* SUM				14,003
	1- 6 Road Works				
	a Trunk Road	10m width	m	5,104	48,996
	b Branch Road	7m width	m	3,335	22,011
	c Cultivation Pass	3m width	m	2,307	8,305
	* SUM				79,312
	1- 7 Windbreaks				
	a Windbreak Tree	3-line tree belt with 4m width	m	9,735	61,267
	b Windbreak Fence	5m hight steel pole with 4m span	m	4,400	135,314
	c Drip-S/Tree	Drip system for Windbreak tree	set	1	62,027
	* SUM				258,608
	1- 8 Water Supply				
	a Purific'n Plant	Purification plant for drinking water	Set	1	4,980
	b D-Line	Distribution line for potable water	m	695	6,622
	* SUM				11,602
	1- 9 Buildings	Offices & Accomodation	L.S		218,400
	1-10 Generator				
	a Generator	100KVA - 5Nos	Set	1	28,620
	b Generator hut	100 m²	Set	1	12,000
	* SUM				40,620
	*SUM OF CONSTRUCTION				1,193,951*
	** EQUIPMENTS **				
	1-11 Machinery				
	a Seeding	Machinery for seeding	L.s		20,420
	b Harvesting	Machinery for harvesting	L.S		75,990
	* SUM				96,410
	1-12 Meteorological	Automatic observation robot & its installation	Set	1	4,080
	1-13 Vehicle				
	a Motor-cycle	Motor cycle - 3Nos.	L.S		1,050
	b 4WD Car	4WD station-wagon - 5Nos.	L.s		35,000
	* SUM				36,050
	1-14 Office Equipments	Copy-machine, Interior-telephone, Radio, Computer, etc.	L.S		12,500
	*SUM OF EQUIPMENTS				149,040*
	TOTAL				1,342,991
2	PROJECT FACILITIES				9,400
3	ADMINISIRATION				5,700
4	CONSULTING SERVICE				186,000
5	SUB-TOTAL	1+2+3+4			1,544,091
6	CONTINGENCY	5 x 0.1			154,409
7	GRAND-TOTAL	5 + 6			1,698,500

TABLE A-6.4.2(1) Detailed Cost Estimate of the Pilot Farm Project

UNIT : R.O

ITEMS	SPECIFICATIONS	UNIT	QTY.	UNIT RATE	TOTAL
I CONSTRUCTION & EQUIPMENTS					
1. PREPARATORY WORK					7500.00
a) Mobilization		Each	1	5000.00	5000.00
b) Demobilization		Each	1	2500.00	2500.00
2. LAND RECLAMATION					600.00
Ploughing		m^2	500000	0.001	500.00
Overhead					100.00
3. INTAKE FACILITY					
3a) Pump & Installation					
45KW Submergible pump		Each	2	10620.00	21240.00
Installation cost		Each	2	350.00	700.00
Overhead					4388.00
Total					26328.00
3b) Pump station	4.0m x 4.0 m	Each	2	1600.00	3200.00
Overhead					640.00
Total					3840.00
3c) Storage line					
i) Soil work					
Excavation		m^3	3420.00	1.80	6156.00
Backfill	Sand	m^3	860.08	1.50	1290.12
Backfill	Gened soil	m^3	2357.00	0.50	1178.50
ii) Piping work					
Storage line, D.I.Pipe	Dia. 350	m	1690.00	26.00	43940.00
Sluice valve	Dia. 350	Each	4	978.00	3912.00
Air valve	Dia. 75	Each	2	244.00	488.00
Blow off valve	Dia. 150	Each	2	268.00	536.00
Warning tape		m	1690.00	0.01	16.90
iii) Concrete work					
Crushed stone		m^3	4.14	5.00	20.70
Level conc.	CK = 160Kg	m^3	2.07	25.00	51.75
Concrete	CK = 210Kg	m^3	29.03	30.00	870.90
Lev. Conc. Form		m^2	4.29	3.50	15.02
Form		m^2	78.08	3.50	273.28
Re-bar	SD30	ton	0.88	300.00	265.20
Sub-total					59014.37
Over head					11802.87
Total					70817.24
4. IRRIGATION FACILITY					
4a) FARM POND					
i) Soil work					
Excavation		m^3	3133.47	1.80	5640.25
Banking		m^3	78.40	0.50	39.20
Concrete		m^3	569.11	30.00	17073.30
ii) Conc. work					
Form		m^2	93.81	3.50	328.34
Steel mesh		m^2	2388.10	0.90	2149.29
Elastic. mat		m^2	41.89	5.00	209.45
Water stop		m	209.47	3.00	628.41
Sub-total					26068.23
Over-head					5213.65
Total					31281.88
4b) BOOSTER PUMP					
Booster pump		Each	5 Nos.	20128.00	100640.00
Over-head					20128.00
Total					120768.00
4c) PUMP STATION	15.0m x 8.0m	Each	1No.	9600.00	9600.00
Over-head					1920.00
Total					11520.00

TABLE A-6.4.2(2) Detailed Cost Estimate of the Pilot Farm Project

UNIT : R.O

ITEMS	SPECIFICATIONS	UNIT	QTY.	UNIT RATE	TOTAL
4d) DISTRIBUTION LINE FOR CENTER PIVOT IRRIGATION SYSTEM					
i) Soil work					
Excavation		m^3	1610.00	1.80	2898.00
Backfill	Sand	m^3	408.72	1.50	613.08
Backfill	Gened soil	m^3	1108.00	0.50	554.00
ii) Piping work					
Distribution line	D.I.P, Dia. 350	m	800.00	26.00	20800.00
Sluice valve	Dia. 350	Each	1.00	978.00	978.00
Air valve	Dia. 75	Each	2.00	244.00	488.00
Blow off valve	Dia. 150	Each	1.00	268.00	268.00
Warning tape		m	800.00	0.01	8.00
iii) Concrete work					
Crushed stone		m^3	1.61	5.00	8.05
Level Conc.	CK = 160Kg	m^3	0.81	25.00	20.25
Concrete	CK = 210Kg	m^3	11.29	30.00	338.70
Lev conc form		m^2	1.63	3.50	5.71
Form		m^2	29.83	3.50	104.41
Re-bar	SD30	ton	0.34	300.00	103.20
Sub-total					27187.40
Over-head					5437.48
Total					32624.88
4e) DISTRIBUTION LINE FOR HYDRANT					
i) Soil work					
Excavation		m^3	8645.00	1.80	15561.00
Backfill	Sand	m^3	1606.02	1.50	2409.03
Backfill	Gened soil	m^3	6662.00	0.50	3331.00
ii) Pipe net work					
Distribution line	Dia. 200	m	6364.00	14.00	89096.00
Hydrant		Each	28.00	75.00	2100.00
Sluice valve	Dia. 200	Each	22.00	563.00	12386.00
Air valve	Dia. 50	Each	13.00	208.00	2704.00
Blow off valve	Dia. 150	Each	4.00	268.00	1072.00
Warning tape		m	6364.00	0.01	63.64
iii) Concrete work					
Crushed stone		m^3	14.96	5.00	74.80
Level conc.	CK = 160kg	m^3	7.48	25.00	187.00
Concrete	CK = 210kg	m^3	61.45	30.00	1843.50
Lev conc form		m^2	21.50	3.50	75.25
Form		m^2	247.40	3.50	865.90
Re-bar	SD30	ton	2.98	300.00	893.10
Sub-total					132662.22
Over-head					26532.44
Total					159194.66
4f) DISTRIBUTION LINE FOR DRIP IRRIGATION SYSTEM					
i) Soil work					
Excavation		m^3	3970.00	1.80	7146.00
Backfill	Sand	m^3	705.46	1.50	1058.19
Backfill	Gened soil	m^3	3185.00	0.50	1592.50
ii) Piping work					
Drip irrigation line	Dia. 150	m	3133.20	11.00	34465.20
Sluice valve	Dia. 150	Each	9.00	268.00	2412.00
Air valve	Dia. 25	Each	6.00	98.00	588.00
Blow off valve	Dia. 150	Each	2.00	268.00	536.00
Warning tape		m	3133.20	0.01	31.33
iii) Concrete work					
Crushed stone		m^3	4.95	5.00	24.75
Level conc	CK = 160kg	m^3	2.48	25.00	62.00
Concrete	CK = 210kg	m^3	18.80	30.00	564.00
Lev conc form		m^2	6.90	3.50	24.15
Form		m^2	75.02	3.50	262.57
Re-bar	SD30	ton	1.01	300.00	302.10
Sub-total					49068.79
Over-head					9813.76
Total					58882.55

TABLE A-6.4.2(3) Detailed Cost Estimate of the Pilot Farm Project

UNIT : R.O

ITEMS	SPECIFICATIONS	UNIT	QTY.	UNIT RATE	TOTAL
ONFARM IRRIGATION SYSTEM					
4g) DRIP IRRIGATION SYSTEM	For 1ha	Each	1No.	10000.00	10000.00
Over-head					2000.00
Total					12000.00
4h) CENTRE PIVOT SYSTEM	For 30ha	Each	1No.	20000.00	20000.00
Over-head					4000.00
Total					24000.00
4i) SIDE WHEEL SPRINKLER	For 6ha	Each	4set	1260.00	5040.00
Over-head					1008.00
Total					6048.00
4j) RAIN GUN	For 14ha	Each	12set	500.00	6000.00
5. DRAINAGE SYSTEM					
5a) SUBSURFACE DRAINAGE					
i) Soil work					
Excavation		m^3	630.00	1.80	1134.00
Crushed stone	Dia <10cm	m^3	43.80	5.50	240.90
Backfill	Gened soil	m^3	583.20	0.50	291.60
ii) Piping work					
Drain pipe	CV pipe D60	m	600.00	2.50	1500.00
Sub-total					3166.50
Over-head					633.30
Total					3799.80
5b) OPEN DITCH FOR 1HA EXPERIMENTAL PLOT					
i) Soil work					
Excavation		m^3	954.10	1.80	1717.38
Backfill		m^3	95.55	0.50	47.78
Surface plot		m^2	77.21	20.00	1544.20
ii) Concrete work					
Crushed stone		m^3	2.53	5.00	12.65
Level conc	CK = 160kg	m^3	1.26	25.00	31.50
Concrete	CK = 210kg	m^3	26.31	30.00	789.30
Lev conc form		m^2	3.16	3.50	11.06
Form		m^2	97.18	3.50	340.13
Re-bar	SD30	ton	0.86	300.00	259.20
iii) Pipe net work					
Hume pipe	Dia. 600	Each	9.00	50.00	450.00
Sub-total					5203.20
Over-head					1040.64
Total					6243.84
5c) DRAIN POND					
i) Soil work					
Excavation		m^3	146.17	1.80	263.11
Banking		m^3	25.15	0.50	12.58
ii) Conc. work					
Concrete	CK = 210kg	m^3	74.91	30.00	2247.30
Form		m^2	18.72	3.50	65.52
Steel mesh		m^2	374.55	0.90	337.10
Elastic. mat	W=20cm, T =2m	m^2	18.69	5.00	93.45
Water stop		m	93.47	3.00	280.41
Sub-total					3299.46
Over-head					659.89
Total					3959.35

TABLE A-6.4.2(4) Detailed Cost Estimate of the Pilot Farm Project

UNIT : R.O

ITEMS	SPECIFICATIONS	UNIT	QTY.	UNIT RATE	TOTAL
6. ROAD WORKS					
6a) Trunk road	5103.7m				
Grading		m^2	51037.00	0.50	25518.50
Crushed stone		m^3	3062.22	5.00	15311.10
Sub-total					40829.60
Over-head					8165.92
Total					48995.52
6b) Branch road	3335.0m				
Grading		m^2	23345.00	0.50	11672.50
Crushed stone		m^3	1334.00	5.00	6670.00
Sub-total					18342.50
Over-head					3668.50
Total					22011.00
6c) Cultivation pass	2306.9m				
Grading		m^2	6920.00	0.50	3460.35
Crushed stone		m^3	692.07	5.00	3460.35
Sub-total					6920.70
Over-head					1384.14
Total					8304.84
6d) Total					
Grading		m^2	81302.70	0.50	40651.35
Crushed stone		m^3	5088.29	5.00	25441.45
Sub-total					66092.80
Over-head					13218.56
Grand Total					79311.36
7a) WIND BREAK WORKS					
i) Tree work					
Tree		Each	11682.00	0.60	7009.20
ii) Soil work					
Excavation		m^3	18808.02	1.80	33854.44
Backfill		Each	17347.77	0.50	8673.89
Fertilization		m^3	11682.00	0.13	1518.66
Sub-total					51056.18
Over-head					10211.24
Total					61267.42
7b) WIND BREAK FENCE	4400m				
i) Steel work					
Steel pipe	Dia. 90 x 3.2	ton	40.30	300.00	12090.00
Steel pipe	Dia. 34 x 2.3	ton	8.50	300.00	2550.00
Angle	L 50x50x4	ton	39.10	150.00	5865.00
ii) Net		m^2	22000.00	1.50	33000.00
iii) Soil work					
Excavation		m^3	5920.00	1.80	10656.00
Backfill		m^3	5006.00	0.50	2503.00
iv) Concrete work					
Crushed stone		m^3	198.00	5.00	990.00
Level conc	CK = 160kg	m^3	99.00	25.00	2475.00
Concrete	CK = 210kg	m^3	616.00	30.00	18480.00
Lev conc form		m^2	418.00	3.50	1463.00
Form		m^2	5060.00	3.50	17710.00
Re-bar	SD30	ton	16.60	300.00	4980.00
Sub-total					112762.00
Over-head					22552.40
Total					135314.40
7c) DRIP LINE WORK					
i) Branch	Double	Each	31.00	300.00	9300.00
ii) Tree line branch	Single	Each	7.00	300.00	2100.00
iii) Work, tree line belt		m	30216.60	1.33	40288.80
Sub-total					51688.80
Over-head					10337.76
Total					62026.56

TABLE A-6.4.2(5) Detailed Cost Estimate of the Pilot Farm Project

UNIT : R.O

ITEMS	SPECIFICATIONS	UNIT	QTY.	UNIT RATE	TOTAL
8. WATER SUPPLY					
8a) POTABLE WATER FACILITY					
Potable water cleaner		Each	1.00	3750.00	3750.00
Installation cost		Each	1.00	400.00	400.00
sub-total					4150.00
Over-head					830.00
Total					4980.00
8b) POTABLE LINE					
i) Soil work					
Excavation		m^3	912.00	1.80	1641.60
Backfill	Sand	m^3	178.88	1.50	268.32
Backfill	Gened soil	m^3	710.00	0.50	355.00
ii) Piping work					
Potable line	Dia. 80	m	695.00	4.00	2780.00
Sluice valve	Dia. 80	Each	4.00	80.00	320.00
Warning tape		m	695.00	0.01	6.95
iii) Concrete work					
Crushed stone		m^3	0.56	5.00	2.80
Level conc.	CK = 160kg	m^3	0.28	25.00	7.00
Concrete	CK = 210kg	m^3	2.30	30.00	69.00
Lev conc form		m^2	0.78	3.50	2.73
Form		m^2	9.06	3.50	31.71
Re-bar	SD30	ton	0.11	300.00	33.00
Sub-total					5518.11
Over-head					1103.62
Total					6621.93
9. BUILDINGS					
Administration office		m^2	100.00	150.00	15000.00
Training/Education off		m^2	100.00	150.00	15000.00
Investigation house		m^2	100.00	150.00	15000.00
Test house		m^2	50.00	100.00	5000.00
Ware house		m^2	100.00	100.00	10000.00
Garage		m^2	120.00	100.00	12000.00
Staff quarters		m^2	500.00	150.00	75000.00
Dormitory		m^2	350.00	100.00	35000.00
Sub-total					182000.00
Over-head					36400.00
Total					218400.00
10. GENERATOR					
Generator	125KVA	Each	5.00	4620.00	23100.00
Installation		Each	5.00	150.00	750.00
Generator hut	100 m^2	Each	1.00	10000.00	10000.00
Sub-total					33850.00
Overhead					6770.00
Total					40620.00
11. MACHINERIES					
11a) SEEDING MACHINERY					
Tractor	60 p.s	Each	1No.	8000.00	8000.00
Bottom plough	14" x 3	Each	1No.	1100.00	1100.00
Disk harrow	20" x 24	Each	1No.	1500.00	1500.00
Tooth harrow	30 x 4 rows	Each	1No.	820.00	820.00
Manure spreader	V - shaft	Each	1No.	3000.00	3000.00
Front loader		Each	1No.	2300.00	2300.00
Broadcaster	660 lit	Each	1No.	750.00	750.00
packer seeder	2.4m	Each	1No.	2950.00	2950.00
Total					20420.00

TABLE A-6.4.2(6) Detailed Cost Estimate of the Pilot Farm Project

UNIT : R.O

ITEMS	SPECIFICATIONS	UNIT	QTY.	UNIT RATE	TOTAL
11b) HARVESTING MACHINERY					
Tractor	60 p.s	Each	2Nos.	8000.00	16000.00
Broadcaster	660 lit	Each	2Nos.	750.00	1700.00
Rotary mower	2.0 m	Each	2Nos.	2700.00	5400.00
Tedder	4 Rotors	Each	2Nos.	1650.00	3300.00
Rake	Cylinder	Each	2Nos.	1750.00	3500.00
Tight baler	40 x 40 x 50cm	Each	2Nos.	9300.00	18600.00
Front loader		Each	2Nos.	2300.00	4600.00
Field cubing machine	120 p.s	Each	2Nos.	1445.00	2890.00
Truck	4 ton	Each	2Nos.	10000.00	20000.00
Total					75990.00
12. METEOROLOGICAL FACILITIES					
Meorol. obser. robot		Each	1No.	3100.00	3100.00
Installation cost		Each	1No.	300.00	300.00
Sub-total					3400.00
Over-head					680.00
Total					4080.00
13. VEHICLES					
13a) Motor cycle		Each	3Nos.	350.00	1050.00
13b) 4WD		Each	5Nos.	7000.00	35000.00
Total					36050.00
14. OFFICE EQUIPMENTS Copy machine, Telephone, Radio tele graph, computer etc.		L.S			12500.00
15. I) PROJECT FACILITIES Site office etc.		L.S			9400.00
II) ADMINISTRATION Staff salary, Office equipments, Electricity etc.		L.S			5700.00
III) CONSULTING SERVICE		L.S			186000.00
Detailed design stage	(10 M/M)				
Tendering stage	(1 M/M)				
Supervision	(8 M/M)				
Oper. & maintenance	(12 M/M)				
Total					

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O/M Plan for Pilot Farm

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TABLE A-6.5.1 Summary of O/M cost of Pilot Farm

Unit : Rials Oman

ITEMS	SPECIFI-CATIONS	DURABLE PERIOD ①	MAINT RATIO ②	COST ③	DEPRE-CIATION ④=③/①	MAINT COST ⑤=③*②	FUEL COST ⑥	TOTAL ④+⑤+⑥	TOTAL ⑤+⑥
1. INTAKE FACILITY									
a)Pump & Insta'n	45KW-2NOS.	10	2.0%	26328	2632.8	526.6	0	3159.4	526.6
b)Pump Hut	4X4m-2Nos.	30	0.1%	3840	128.0	3.8	0	131.8	3.8
c) Storage Line	1690m	30	0.1%	70817	2360.6	70.8	0	2431.4	70.8
* SUM					5121.4	601.2	11918	5722.6	601.2
2. IRRIG. FACILITY									
a) Farm Pond		30	0.1%	31282	1042.7	31.3	0	1074.0	31.3
b)B-Pump&Instal'n		10	5.0%	120768	12076.8	6038.4	0	18115.2	6038.4
c) B-P Hut		30	0.1%	11520	384.0	11.5	0	395.5	11.5
d) D-line/Center Pivot		30	0.1%	32625	1087.5	32.6	0	1120.1	32.6
e) D-Line/Hydrants		30	0.1%	159195	5306.5	159.2	0	5465.7	159.2
f) D-line/Drip		30	0.1%	58883	1962.8	58.9	0	2021.6	58.9
g) Drip Irrigation		5	1.0%	12000	2400.0	120.0	0	2520.0	120.0
h) Center Pivot & Instal'n		10	3.0%	24000	2400.0	720.0	0	3120.0	720.0
i) Side wheel & Insta'n		10	3.0%	6048	604.8	181.4	0	786.2	181.4
j) Rain gun		10	3.0%	6000	600.0	180.0	0	780.0	180.0
* SUM					27865.1	7533.3	0.0	35398.4	7533.3
3. DRAINAGE SYSTEM									
a) Subsurface drainage		30	0.1%	3800	126.7	3.8	0	130.5	3.8
b) Ditch		30	0.1%	6244	208.1	6.2	0	214.4	6.2
c) Drain pond		30	0.1%	3959	132.0	4.0	0	135.9	4.0
* SUM					466.8	14.0	0	480.8	14.0
4. ROAD WORKS									
a) Trunk road		30	0.1%	48995	1633.2	49.0	0	1682.2	49.0
b) Branch road		30	0.1%	22011	733.7	22.0	0	755.7	22.0
c) Cultivation pass		30	0.1%	8305	276.8	8.3	0	285.1	8.3
* SUM					2643.7	79.3	0	2723.0	79.3
5. WIND BREAKS									
a) Wind Break Tree		30	0.1%	61267	2042.2	61.3	0	2103.5	61.3
b) Wind Break Net		10	1.0%	135314	13531.4	1353.1	0	14884.5	1353.1
c) Drip System/tree		5	1.0%	62027	12405.4	620.3	0	13025.7	620.3
* SUM					27979.0	2034.7	0	30013.7	2034.7
6. WATER SUPPLY									
a) Purification plant		10	1.0%	4980	498.0	49.8	0	547.8	49.8
b) Distribution line		30	0.1%	6622	220.7	6.6	0	227.4	6.6
* SUM					718.7	56.4	0	775.2	56.4
7. BUILDINGS		30	0.1%	218400	7280.0	218.4	0	7498.4	218.4
8. GENERATOR	125KVA -5NOS	10	5.0%	28620	2862.0	1431.0	48929	53222.0	50360.0
Generator Hut	5m X 5m	30	0.1%	12000	400.0	12.0	0	412.0	12.0
9.MACHINERY									
a) Seeding		5	10.8%	20420	4084.0	2197.0	574	6855.0	2771.0
b) Harvesting		5	5.1%	75990	15198.0	3875.5	4810	23883.5	8685.5
* SUM					19282.0	6072.5	5384	30738.5	11456.5
10. METEOROLOGICAL EQUIP.		10	3.0%	4080	408.0	122.4	0	530.4	122.4
11. VEHICLES									
a) Motor-Cycle		10	5.0%	1050	105.0	52.5	0	157.5	52.5
b) 4WD Car		10	5.0%	35000	3500.0	1750.0	1000	6250.0	2750.0
* SUM					3605.0	1802.5	1000	6407.5	2802.5
12. OFFICE EQUIPMENTS		10	3.0%	12500	1250.0	375.0	6000	7625.0	6375.0
GRAND TOTAL				1334890	99882	20353	61313	181547	81666

TABLE A-6.5.2 Salary of Pilot Farm Team Members

Item	Staff	No	Monthly Salary R.O./Month/E.A.	Total R.O./Month
1●	Team Leader	1	1,400	1,400
2●	Irrigation Engineers	2	1,000	2,000
3●	Agronomist	1	1,000	1,000
4●	Extension Workers	2	350	700
5●	Observation Workers	4	190	760
6●	Mechanics	2	200	400
7●	Machinery Operators	2	180	360
8○	Clerical Staff	1	500	500
9○	Office Worker	1	220	220
10○	Laborers	3	100	300
11○	Cook	1	120	120
Total				7,760

Note ; Annual total Budget R.O. 93,120/yr
●; Salary for farm management R.O. 75,120/yr
○; Salary for Office works R.O. 18,000/yr

TABLE A-6.5.3 Balance of Benefit & Cost of Pilot Farm

Income	R.O.100/ton x 40ton/ha/yr x 50ha x 90% = R.O.180,000	
Cost	Case-1	Case-2
	Including Depreciation	Excluding Depreciation
1 Intake Facility	5722.6	601.2
2 Irrigation Facility	35398.4	7533.3
3 Drainage Facility	480.8	14.0
4 Road	2723.0	79.3
5 Windbreaks	30013.7	2034.7
6 Water Supply	775.2	56.4
7 Building	7498.4	218.4
8 Generator	53222.0	50360.0
Generator Hut	412.0	12.0
9 Machinery	30738.5	11456.5
10 Meteorological	530.4	122.4
11 Vehicle	6407.5	2802.5
12 Office Equipments	7625.0	6,375.0
Sub-Total	181547.0	81666.0
13 Wages	93120.0	93120.0
Total	274667.0	174786.0
Balance	- 94667.0	+ 5214.0

APPENDIX A-6.6
A Case Study of Agricultural Development in the Nejd

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6.6 A Case Study of Agricultural Development in the Nejd

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6.6 A Case Study of Agricultural Development in the Nejd

6.6.1 Estimation of crop water requirement for rhodes grass

Rhodes grass will be grown at the newly developed farms in the agriculture development project. Hence the water requirement of rhodes grass is estimated as shown in this section.

(1) Evapotranspiration (ETo)

Using the available climatological data, evapotranspiration is computed based on three methods as shown TABLE A-6.3.1.

(2) Crop Coefficient

Rhodes grass will be the main crop for the development area, however, the observation or study related to the Kc value of the rhodes grass has never been done in and near the study area. Hence the momentous experimental results by F.A.O. in the Kingdom of Saudi Arabia were quotated as a similar conditioned area (GUIDE FOR CROP IRRIGATION REQUIREMENTS IN THE KINGDOM OF SAUDI ARABIA 1988) FIG A-6.6.1 shows the Kc value for Rhodes grass.

The growing season (days) and the number of harvesting are determined based on the field interview survey in the Study Area.

The growing days for 1 (one) cut fluctuates from 30 days in summer to 35 days in winter. The number of harvesting is planned to be 10 times annually.

As discussed in section 6.6, seeding will be carried out in two seasons over an area of 25 ha. Hence the Kc value of each plot at a particular time differs as shown in TABLE A-6.6.3. The shift in Kc value facilitate to decrease the peak water consumption. Besides, it is also useful to prevent the concentration of on-farm work such as fertilizing and/or harvest.

(3) Crop Water Requirement (ETcrop)

Crop water requirement (ETcrop) can be calculated by multiplying the crop coefficient Kc by related crop transpiration ETo.

Monthly peak crop water requirement is shown in the TABLE A-6.6.1.

TABLE A-6.6.1 Monthly Peak Crop Water Requirement

unit mm/day

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL PEAK
5.6	6.9	8.5	9.2	9.8	10.9	10.3	10.1	8.1	7.1	6.1	5.4	10.9

(4) Irrigation efficiency

An average field application efficiency of 0.8 and a conveyance efficiency of 0.9 is assumed.
Hence, irrigation efficiency = 0.8 x 0.9 = 0.72

(5) Net water requirement

Net water requirement is computed from crop water requirement and irrigation efficiency as shown in TABLE A-6.6.2.

TABLE A-6.6.2 Net Water Requirement (Monthly Max)

Unit: mm/day

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual Max
N.W.R.	7.8	9.6	11.8	12.8	13.6	15.1	14.3	14.0	11.2	9.9	8.5	7.5	15.1

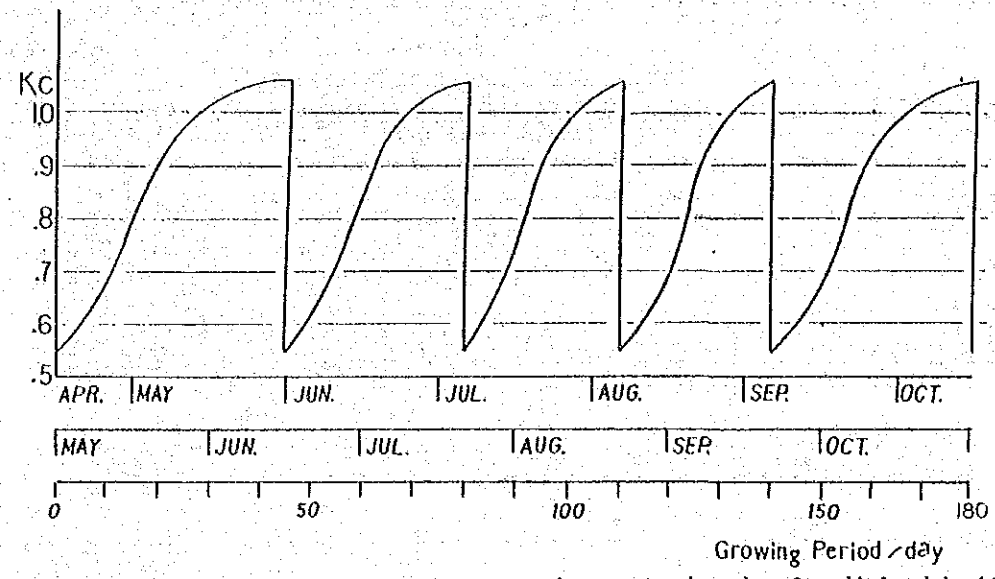
TABLE A-6.6.3 ETcrop Calculation Sheet

Month	S.No 5-day	ETo (mm/day)	Kc			ETcrop (mm/day)
			Plot-1	Plot-2	Mean	
JAN	1	6.400	1.000	0.750	0.875	5.600
	2	6.400	0.550	0.750	0.650	4.160
	3	6.400	0.550	0.750	0.650	4.160
	4	6.400	0.550	1.050	0.800	5.120
	5	6.400	0.750	1.000	0.875	5.600
	6	6.400	0.750	0.550	0.650	4.160
FEB	1	7.900	0.750	0.550	0.650	5.135
	2	7.900	1.050	0.550	0.800	6.320
	3	7.900	1.000	0.750	0.875	6.913
	4	7.900	0.550	0.750	0.650	5.135
	5	7.900	0.550	0.750	0.650	5.135
	6	7.900	0.550	1.050	0.800	6.320
MAR	1	9.900	0.750	1.000	0.875	8.488
	2	9.900	0.750	0.550	0.650	6.305
	3	9.900	0.750	0.550	0.650	6.305
	4	9.900	1.050	0.550	0.800	7.760
	5	9.900	1.000	0.750	0.875	8.488
	6	9.900	0.550	0.750	0.650	6.305
APR	1	10.500	0.550	0.750	0.650	6.825
	2	10.500	0.550	1.050	0.800	8.400
	3	10.500	0.750	1.000	0.875	9.188
	4	10.500	0.750	0.550	0.650	6.825
	5	10.500	1.050	0.550	0.800	8.400
	6	10.500	1.000	0.550	0.775	8.138
MAY	1	11.200	0.550	0.750	0.650	7.280
	2	11.200	0.550	0.750	0.650	7.280
	3	11.200	0.550	1.050	0.800	8.960
	4	11.200	0.750	1.000	0.875	9.800
	5	11.200	0.750	0.550	0.650	7.280
	6	11.200	1.050	0.550	0.800	8.960
JUN	1	12.400	1.000	0.550	0.775	9.610
	2	12.400	0.550	0.750	0.650	8.060
	3	12.400	0.550	0.750	0.650	8.060
	4	12.400	0.550	1.050	0.800	9.920
	5	12.400	0.750	1.000	0.875	10.850
	6	12.400	0.750	0.550	0.650	8.060

Month	S.No 5-day	ETo (mm/day)	Kc			ETcrop (mm/day)
			Plot-1	Plot-2	Mean	
JUL	1	11.200	1.050	0.550	0.800	9.120
	2	11.200	1.000	0.550	0.775	8.835
	3	11.200	0.550	0.750	0.650	7.410
	4	11.200	0.550	0.750	0.650	7.410
	5	11.200	0.750	1.050	0.900	10.260
	6	11.200	0.750	1.000	0.875	9.975
AUG	1	11.200	1.050	0.550	0.800	8.960
	2	11.200	1.000	0.550	0.775	8.680
	3	11.200	0.550	0.750	0.650	7.280
	4	11.200	0.550	0.750	0.650	7.280
	5	11.200	0.750	1.050	0.900	10.080
	6	11.200	0.750	1.000	0.875	9.800
SEP	1	10.100	1.050	0.550	0.800	8.080
	2	10.100	1.000	0.550	0.775	7.828
	3	10.100	0.550	0.750	0.650	6.565
	4	10.100	0.550	0.750	0.650	6.565
	5	10.100	0.550	1.050	0.800	8.080
	6	10.100	0.750	1.000	0.875	8.838
OCT	1	8.900	0.750	0.550	0.650	5.785
	2	8.900	1.050	0.550	0.800	7.120
	3	8.900	1.000	0.550	0.775	6.898
	4	8.900	0.550	0.750	0.650	5.785
	5	8.900	0.550	0.750	0.650	5.785
	6	8.900	0.550	1.050	0.800	7.120
NOV	1	7.000	0.750	1.000	0.875	6.125
	2	7.000	0.750	0.550	0.650	4.550
	3	7.000	0.750	0.550	0.650	4.550
	4	7.000	1.050	0.550	0.800	5.600
	5	7.000	1.000	0.750	0.875	6.125
	6	7.000	0.550	0.750	0.650	4.550
DEC	1	6.200	0.550	0.750	0.650	4.030
	2	6.200	0.550	1.050	0.800	4.960
	3	6.200	0.750	1.000	0.875	5.425
	4	6.200	0.750	0.550	0.650	4.030
	5	6.200	0.750	0.550	0.650	4.030
	6	6.200	1.050	0.550	0.800	4.960

TABLE A-6.6.3

FIG. A-6.6.1 Kc Value for Rhodes Grass



Source: Guide for Crop Irrigation Requirements in the Saudi Arabia,1988

(6) Irrigation water requirement

Irrigation water requirement is tentatively estimated as follows:

The maximum irrigation requirement is 15.1 mm/day in June and the minimum is 7.5 mm/day in December.

Using these values the daily water requirements for the 50ha farm is 7550 cu.m/day as the maximum and 3750 cu.m/day as the minimum. Total annual requirement is 1.79 MCM.

Consequently, the irrigation water requirement for the two pumping cases is summarised in the following TABLE A-6.6.4.

TABLE A-6.6.4 Pumping Requirement

Pumping Time	Max	Min	Mean
18 hrs	6.99 cu.m/min (116.5 lit/sec)	3.47 cu.m/min (57.9 lit/sec)	4.54cu.m/min (75.6 lit/sec)
24 hrs	5.24 cu.m/min (87.38 lit/sec)	2.60 cu.m/min (43.40/lit/sec)	3.40 cu.m/min (56.7 lit/sec)

The maximum requirement is 116.5 lit/sec and the pump capacity required for one production well in case of 18 hrs of pump operation is 58.25 lit/sec.

6.6.2 Planning of Centre Pivot Irrigation System for 50 ha

This section will explain the plan of Centre Pivot System for 50 ha farm.

A centre pivot irrigation system is designed to irrigate the pilot farm of 50ha area. The design details are developed as follows;

1. Area to be irrigated - A = 50ha

   Radius of coverage - $R = [(50 \times 10^4 \times 4 / 3.14)^{1/2}]/2$
   $= 400m$

2. Crop water need at the peak period - P = 10mm/day

3. Irrigation efficiency - E = 75% (assumed)

4. Outflow required at pivot $Q = 0.42PA/E$
   $= 0.42 \times 10 \times 50/0.75$
   $= 280$cubic.m/h

5. Number of towers for an outflow of 280cubic.m = 10
   (FIG.A-6.3.3)

6a. Minimum pressure recommended at the pivot to obtain 4bars at the sprinkler = 6.3bar (FIG A-6.3.3)

6b. Minimum pressures recommended at the pivot with 10 towers (TABLE A-6.3.4)

   i) Fixed spacing = 6.33bar
   ii) Variable spacing = 5.98bar

   From 6a) and 6b) it can be concluded that centre pivot of 10 towers and 400m radius requires 6-7bars at the pivot, for an outflow of 280cubic.m.

7. For a lateral length of 400m and speed of end tower at 6ft/min (1.8m/min - assumed) approximate time required for one complete rotation is given by the equation,

   T = 2 x 3.14 x R/S

   = 2 x 3.14 x 400/(6 x .305 x 60) = 23hrs.

   (0.305 is conversion factor of feet into meter)

8. Number of possible rotations in one month = 720/23 = 31

   Although 31 rotations are possible in one month, 30 rotations are sufficient enough to supply the crop water requirement.

9. Water to be applied in one rotation = 300/30 = 10mm

   This means that in one rotation, water required for one day can be supplied.

10. Length covered by the end tower in one hour

    = (6ft/min x 0.305m/ft) x 60min/hr = 109.8m

    Area covered by the end tower in 1 hour

    = 109.8m x 50ha/(2 x 3.14 x 400m) = 2.184ha

    Depth of water applied in 1 hour

    = total water applied/area

    = 280 x 1000 / (2.184ha x 10000) = 12.8mm

    Hence, if the basic intake rate of soil is >15mm/hr then there is no problem of ponding. But the permeability of the soil is not constant through out the irrigation period and it reduces with respect to time. And hence the safer permeability level can be considered as >25-30mm/hr.

6.6.3 Farm Machinery Plan for the Grassland Development and Grass Production Plan

1. Development area

Development area excluding pilot farm is planned as 500 ha.

2. Utilization plan of development regions

500 ha area will be divided into 2 areas, Nagha and Dauka area.

For soil improvement, Rhodes grass will be grown systematically for a period of ten years.

3. Grassland development plan

The works to be done for grassland development can be divided into the following two categories.

1) Land reclamation and seeding work and
2) Management, harvest and transport work.

1) Land reclamation and seeding work

This work includes compost spreading, plowing, harrowing, fertilizing and seeding combined with rolling works.

As per the investigation result, early spring (Feb.-April, 3 months) and autumn (Sep.-Nov., 3 months) are the suitable seasons for seeding of Rhodes grass.

2) Management, harvest and transport work

This work includes additional fertilization, reaping, turning over, gathering, packing, loading and transportation works. After seeding, the first harvest is possible after 3 months and 10 times of harvest is possible in one year.

After every 5 years of grass cultivation, the grass should be harvested completely and land reclamation and seeding work should be done once again. This work will be mentioned as 'renewal work' hereafter.

4. Farm Machinery selection for grassland development and grass production

1) Farm machinery selection

Machinery required for different farming operations of land reclamation, seeding, harvest and transport work is shown in FIG A-6.6.2.

2) Specifications of selected machinery

Specifications of selected machinery like manual labour required, machinery utilizing hours and oil consumption are shown in TABLE A-6.6.5.

5. Usable area of a tractor

1) Land reclamation and seeding work

(1) Seeding season

Spring : Feb. - April for 3 months
Autumn : Sept. - Nov. for 3 months

(2) Available time for tractor operation in one season

3 months x 30 days x 8 hours x 0.8 (actual utilizable time rate *) = 576 hours

* Days unsuitable for work because of bad weather or other reasons are taken into consideration.

(3) Usable area of a tractor

As per TABLE A-6.6.5-(1) the total machinery operating time for land reclamation and seeding work is 15.5 hrs/ha. Hence the area which can be reclaimed and seeded in one seeding season is 37 ha (576 hours/15.5 hours).

2) Management, harvest and transport works

(1) Additional fertilization and harvest period

As per the investigation result, the first harvest is possible after three months of seeding and ten times of reaping is expected in a year.
Therefore one cycle of harvest period is 36 days.
Additional fertilization is necessary after reaping.

(2) Available time for fertilization and harvest

36 days x 8 hours x 0.8 = 230 hours

(3) Usable area of a tractor

As per TABLE A-6.6.5-(2), the total machinery operating time for management, harvest and transport work is 8.8 hrs/ha (10.8 hours minus the transport time of a track, 2.0 hours).

The usable area of one tractor in one harvest period is 26 ha (230 hours/8.8 hours).

6. Introduction plan of tractor and other machineries

1) Land reclamation and seeding works

Systematic plan for land reclamation, management and harvest works is shown in FIG.A-6.6.3.

After land reclamation and seeding in spring at Nagha Farm-1A, reclamation and seeding will be done at Nagha Farm-1B. Successively land will be reclaimed at Dauka Farm-1A and Dauka Farm-1B in next spring and autumn respectively and in the next year, reclamation will be continued at Nagha Farms 2A and 2B.

These reclamation and seeding works can be practiced for the first five years with one set of machineries. However, from 6th year two sets of machineries will be required since the new Dauka Farm-3A and old Nagha Farm-1A should be reclaimed and seeded at the same time. Although the usable area of a tractor for land reclamation and seeding works is 37 ha, the area of tractor utilization is assumed as 25 ha considering the time required for transportation.

2) Management, harvest and transport works

One set of machineries will be required for 25 ha area for management, harvest and transport works.

3) Machineries disbursement plan

Annual machineries disbursement plan is shown in TABLE A-6.6.6 based on the land reclamation and grass production plan shown in FIG A-6.6.3.

7. Machineries investment plan

Annual investment plan of the machineries and their prices and fixed expenses are shown in TABLE A-6.6.6 and TABLE A-6.6.7 respectively.

The investment cost for 60 p.s. class riding tractor plus seven other machineries for the reclamation and seeding works is 20,420 R.O. in total. For the management, harvest and transport works it costs 26,550 R.O. for 60 p.s. class riding tractor plus six other machineries and 10,000 R.O. for one truck.

8. Running costs of machineries

1) Annual fixed expense

(1) Land reclamation and seeding works

As shown in TABLE A-6.6.7, the annual depreciation for one set of machineries is 3,676 R.O. assuming the endurance period as 5 years and final selling price as 10% of its original price. The annual depreciation per one farm is 1,838 R.O., since two farms are reclaimed in a year.

The maintenance cost for one set of machineries is estimated as 2,197 R.O. and for one farm it costs 1,098.5 R.O.

(2) Management, harvest and harvest works

As shown in TABLE A-6.6.7-(2), the annual depreciation and the maintenance cost for management, harvest and transport works including a truck for transportation is 6,579 R.O. and 1,859 R.O. respectively. Total annual fixed expense for management, harvest and transport is 8,438 R.O.

FIG. A-6.6.2 Farm Machinery Selection for Grassland Development

(tractor 50~60 p.s. class)

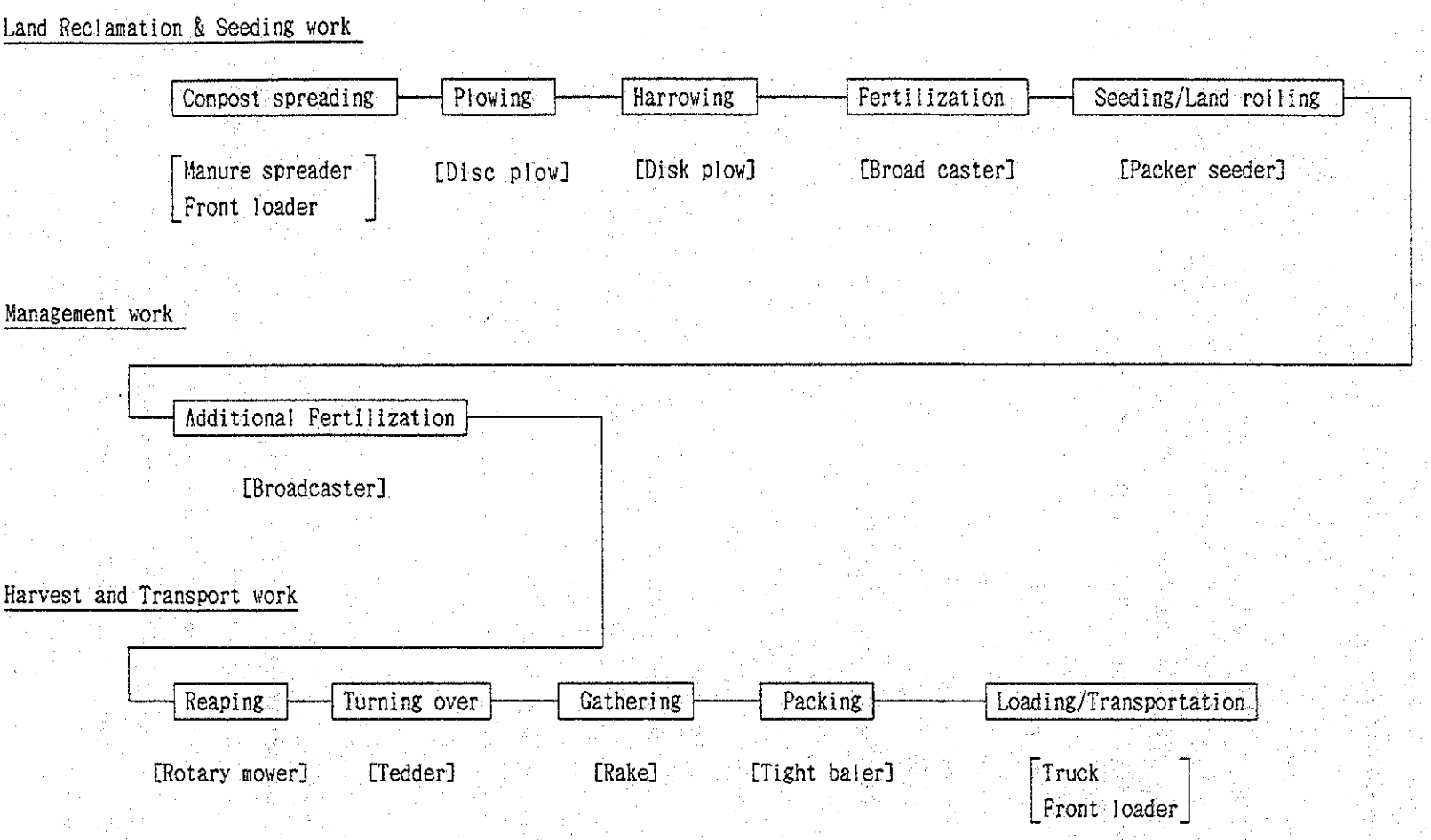


FIG. A-6.6.2

TABLE A-6.6.5 Details of Input Required in Different Farming Operations for Grassland Development

(1) Land Reclamation and Seeding Works (For 1ha)

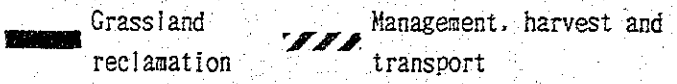
Type of Work	Machinery	Labour required		Machinery operating time		Labour hour		Oil Consumption	Remarks
		Operator	Assistant	Total usage time hr	Operating time hr	Operator hr	Assistant hr	ℓ	
Compost spreading	Manurl spreader	1	1	3.0	1.0	3.0	3.0	9.0	10t/ha
	Front loader				1.0			9.0	
Plowing	Disc plow	1	1	2.5	2.0	2.5	2.5	18.0	
Harrowing	Disk harrow	1	—	2.5	2.0	2.5	—	18.0	Twice vertically and horizontally
Leveling	Tooth harrow	1	—	1.5	1.0	1.5	—	9.0	Twice vertically and horizontally
Fertilization	Broadcaster	1	1	2.0	1.0	2.0	2.0	7.2	Chemical fertilizer 1~1.5t/ha
Seeding	Packer seeder	1	2	2.5	1.5	2.5	5.0	10.8	Seed 30kg/ha
Land rolling	Packer seeder	1	—	1.5	1.0	1.5	—	7.2	
Total		—	—	15.5	10.5	15.5	12.5	—	

(2) Management, Harvest and Transport Works (For 1 time of operation)

Type of Work	Machinery	Labour required		Machinery operating time		Labour hour		Oil Consumption	Remarks
		Operator	Assistant	Total usage time hr	Operating time hr	Operator hr	Assistant hr	ℓ	
Additional fertilization	Broadcaster	1	1	0.7	0.5	0.7	0.7	3.6	Chemical fertilizer 0.4~0.5t/ha
Reaping	Rotary mower	1	1	1.0	0.8	1.0	1.0	7.2	Quantity wet 15-20t/ha dry 4- 5t/ha
Turning over	Tedder	1	1	2.4	2.1	2.4	2.4	15.1	Three times of turning over per 1 or 2 days
Gathering	Rake	1	1	0.7	0.5	0.7	0.7	3.6	
Packing	Tight baler	1	4	2.0	1.0	2.0	8.0	9.0	300 packs/ha
Loading	Front loader	1	4	2.0	1.0	2.0	8.0	9.0	50 packs/step ×6steps =300 packs
	Truck	1	—	2.0	1.0	2.0	—	9.0	Loading height 2.4m
Total		—	—	10.8	6.9	10.8	20.8	—	
Transportation	Truck	1	2	6.0	4.0	6.0	12.0	36.0	Transportation distance one way —100km

TABLE A-6.6.5

FIG. A-6.6.3 Machinery Introduction Plan for Grassland Development



Region	Farm		Area	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year	8th year	9th year	10th year
Nagha Area 250ha	1	A	25 ha										
		B	25 ha										
	2	A	25 ha										
		B	25 ha										
	3	A	25 ha										
		B	25 ha										
	4	A	25 ha										
		B	25 ha										
	5	A	25 ha										
		B	25 ha										
Dauka Area 250ha	1	A	25 ha										
		B	25 ha										
	2	A	25 ha										
		B	25 ha										
	3	A	25 ha										
		B	25 ha										
	4	A	25 ha										
		B	25 ha										
	5	A	25 ha										
		B	25 ha										

FIG. A-6.6.3

TABLE A-6.6.6 Agriculture Machinery Disbursement Plan

	Area	New・Renewal	1-yr	2-yr	3-yr	4-yr	5-yr	6-yr	7-yr	8-yr	9-yr	10-yr	Total R. O.
Machinery for Land Reclamation and Seeding	Nagha & Dauka	New	set 1	—	—	—	—	1	—	—	—	—	40.840
		Renewal	set —	—	—	—	—	1	—	—	—	—	20.420
		Total	set 1	—	—	—	—	2	—	—	—	—	(3 set)
	Investment		20.420	—	—	—	—	40.840	—	—	—	—	61.260
Machinery for Management, Harvest and Transport	Nagha	New	set 2	—	2	—	2	—	2	—	2	—	365.500
		Renewal	set —	—	—	—	—	2	—	2	—	2	219.300
		Sub-Total	set 2		2		2	2	2	2	2	2	584.800
	Dauka	New	set —	2	—	2	—	2	—	2	—	2	365.500
		Renewal	set —	—	—	—	—	—	2	—	2	—	146.200
		Sub-Total	set	2	—	2	—	2	2	2	2	2	511.700
	Total		set 2	2	2	2	2	4	4	4	4	4	(30 set)
	Investment		73.100	73.100	73.100	73.100	73.100	146.200	146.200	146.200	146.200	146.200	1.096.500
	Total-Investment		93.520	93.520	73.100	73.100	73.100	187.040	146.200	146.200	146.200	146.200	1.157.760