Republic of the Philippines
OFFICE OF THE SECRETARY
Elliptical Road, Diliman
1100 Quezon City

June 28, 2022

MEMORANDUM ORDER
No. 56
Series of 2022

SUBJECT : **ADOPTION OF TECHNICAL BULLETIN NO. 2, SERIES OF 2022 : DESIGN PREPARATION AND IMPLEMENTATION OF SOLAR POWERED IRRIGATION SYSTEM (SPIS)**

Pursuant to Section 24 of the R.A. 10601, also known as the *"Agricultural and Fisheries Mechanization (AFMech) Law"* the Bureau of Agriculture and Fisheries Engineering (BAFE) is mandated to prepare, evaluate, validate and recommend engineering plans, designs, and technical specifications on agri-fisheries mechanization and infrastructure projects. To operationalize this mandate, the BAFE prepared this Technical Bulletin to provide supplemental guidelines for the preparation of the design of Solar-Powered Irrigation System (SPIS) consistent with the Memorandum Order No. 13 "General Guidelines on the Implementation of Solar-Powered Irrigation System of the Department of Agriculture (DA)".

The Technical Bulletin aims to provide the DA Implementing Offices (IOs) with the standard validation form, selection criteria, guidance on the preparation of engineering plans, designs, and technical specifications, and procedures for the implementation of the project.

In accordance with the implementation of above-mentioned technical bulletin, further instructions to the IOs on the System Testing of the SPIS, the following parameters shall be provided to the testing authority to serve as reference:

a. Manufacturer's Specifications;
b. Required total discharge requirement of the system based on the design; and
c. Design operation hours.

This Memorandum Order shall take effect immediately upon approval.

For compliance.

WILLIAM D. DAR, Ph.D.
Secretary

Attached: a/s

DA-CO-OSEC-MO20220628-00008

A food-secure and resilient Philippines
with empowered and prosperous farmers and fisherfolk

Masaganang ANI
Mataas na KITA

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EPDSD-MESS-TB-22-06-02

TECHNICAL BULLETIN
No. 2
Series of 2022

SUBJECT : DESIGN PREPARATION AND IMPEMENTATION OF SOLAR-POWERED IRRIGATION SYSTEM (SPIS)

SECTION I. RATIONALE

The Solar Powered Irrigation System (SPIS) is one of the flagship programs of the Department of Agriculture (DA) under the Small-Scale Irrigation Projects (SSIPs). SPIS provides reliable, inexpensive, and sustainable energy, to irrigate rice, corn, and high-value crops production areas. Likewise, the implementation of this innovative technology is one of the strategies of DA in promoting renewable energy utilization in the country.

Pursuant to Section 24 of the R.A. 10601, also known as the *"Agricultural and Fisheries Mechanization (AFMech) Law"* the Bureau of Agriculture and Fisheries Engineering (BAFE) is mandated to prepare, evaluate, validate and recommend engineering plans, designs, and technical specifications on agri-fisheries mechanization and infrastructure projects. Hence, this Technical Bulletin is prepared to provide guidelines for the preparation of the design of SPIS, in line with the Memorandum Order No. 13 "General Guidelines on the Implementation of Solar-Powered Irrigation System of the Department of Agriculture (DA)". This will also serve as a guide to all Regional Field Offices, and other DA implementing offices in the preparation of engineering plans, designs, and technical specifications for the implementation of SPIS.

SECTION II. DEFINITION OF TERMS

The following terms shall apply to this Technical Bulletin:

Beneficiaries – group of farmers eligible to receive the SPIS, and shall be in-charge of the operation and maintenance of the system.

Implementing Office (IO) – refers to the DA bureaus, regional field offices, attached agencies and corporations, and other implementing units of the Department of Agriculture

Site or Location – refers to the land or property where the agri-fishery infrastructure will be installed.

Solar-Powered Irrigation System (SPIS) – an irrigation system powered by solar energy, consists of one or more solar panels (also known as solar modules or solar plates), a pump, electronic controls or a controller device to operate the pump, storage tank, and conveyance structures as applicable.

Sustainable water source – A source that is able to provide adequate water quantity and appropriate water quality for a given demand (e.g. agriculture, fisheries) without compromising the ability of the future to provide the same.

Hazard-prone areas – refers to areas where there are high risk and frequency of occurrence of natural disaster such as landslides, floods, earthquakes, that are potential danger to life, property and structures among others.

SECTION III. SCOPE AND COVERAGE

This Technical Bulletin shall apply to locally funded SPIS projects implemented by the bureaus, RFOs, attached agencies and corporations, and other IOs of the DA.

SECTION IV. OBJECTIVES

This Technical Bulletin aims to provide reference the IOs with the standard validation form, selection criteria, design procedures and considerations, and procedures for the implementation of the project.

SECTION V. SELECTION CRITERIA

CRITERIA	RICE/CORN	HIGH VALUE CROPS
Coverage Area	With a minimum service area of 10 ha	With a minimum service area of 3 ha
Qualified Beneficiaries	• Organized farmers or group of farmers with at least 15 members or who are willing to be organized and be registered to concerned government agencies • Research Centers/stations of DA, LGUs	• Organized farmers or group of farmers willing to be organized with at least 3 farmers with minimum 3 ha irrigable area • Research Centers/stations of DA, LGUs
Site Requirements	• Proposed area must have sustainable water source (open source and groundwater) and suitable for agriculture, and irrigation purposes.[1] • With validated proof of ownership of the land where the facility or infrastructure is proposed to be constructed. • Must not be installed in hazard-prone areas.[2]	
Program/Project Feasibility	Should be technically, and socio-economically viable.	

[1] DENR Administrative Order No. 2016-08: Water Quality guidelines and General Effluent Standards of 2016

[2] For the identification of hazard-prone areas, please refer to Hazard Hunter PH: https://hazardhunter.georisk.gov.ph/map

SECTION VI. IMPLEMENTATION PROCEDURES

1. **Site Validation of the Proposed Site** (see Annex A for the Site Validation Form for SPIS)

   Site validation is a critical stage for the preparation of the design of SPIS. This will ensure that the design will be site-specific based on the location of installation of SPIS components. This process involves the gathering of information about the service area and the irrigation requirements, possible water sources, among others.

   As part of the site validation, the following activities are recommended to be conducted, whose results will serve as basis in recommending the viability of the site for the intended project:
   - Clearing of crops and trees;
   - Conduct of pump testing to estimate the well performance, its capacity, and aquifer characteristics;
   - Conduct of geo-resistivity analysis to determine the availability of groundwater, determine the thickness of aquifers, and estimate its potential water-bearing capacity.

   Other activities may be identified by the validation team as deemed necessary based on the peculiarity of the site being validated.

2. **Topographic Survey**;

   Topographic survey is done to collect accurate information needed for the design and the proposed location for the different components of the system. These data will be used to determine the feasibility of the site, and determine the engineering measures to be undertaken to address the issues on site.

3. **Engineering Design and Program of Works (POW);**

   The SPIS will be designed based on the data gathered during the field visit and topographic survey. Using different applications/software, these data will be analyzed to come-up with detailed engineering design, and program of works (see Annex B). Guidance in the design consideration and procedures are provided in the following sections of this technical bulletin.

4. **Implementation**;

   This stage covers the procurement process, construction, up to the acceptance and turn-over of the system to the identified beneficiaries.

5. **Testing and Commissioning**

   This is done after the complete installation of the system to ensure that it is safe to operate and compliant with the design, specifications, and relevant standards.

   During the system testing, the solar irradiance, panel temperature, and other ambient conditions (Relative humidity and ambient temperature) will be measured, as well as the power requirement, total dynamic head, and pump discharge.

6. **Operation and Maintenance**

After the turn-over of the project, the beneficiaries will be in-charge of the operation and maintenance of the system. The maintenance may include the cleaning of the solar modules, and trash racks, and periodical checking of the electric components of the system.

7. **Facility Insurance**

In accordance with the Memorandum No. 13, Series of 2017, on the occurrence of natural damages and provision of insurance, "the recipient shall apply for insurance of the facility in the Philippine Crop Insurance Company (PCIC) of which DA shall shoulder the premium for the first year of operation which will be included in the total project cost".

(See Annex C for the Flowchart for Implementation of SPIS)

SECTION VII. SPIS COMPONENTS DESIGN CONSIDERATIONS AND PROCEDURES

Solar Powered Irrigation System design poses ample challenges due to complications that arise from variations in the water sources, water requirements and system configuration. However, site specific design should be considered to address the peculiarities of the proposed project sites.

In preparation of the SPIS design, there are two (2) important aspects that is needed to be considered:

1. Selection of most suitable and compatible system components based on the peculiarities in the area. This is crucial in providing a low maintenance, and long-life system; and
2. Proper matching of system components since this will dictate the performance of the system in terms of efficiency of operation.

In designing the system, the general approach is summarized as follows:

1. Determination of water requirement;
2. Determination of Total Dynamic Head;
3. Pump sizing and selection;
4. Solar PV Array Sizing;
5. Inverter Sizing; and
6. Wire Sizing

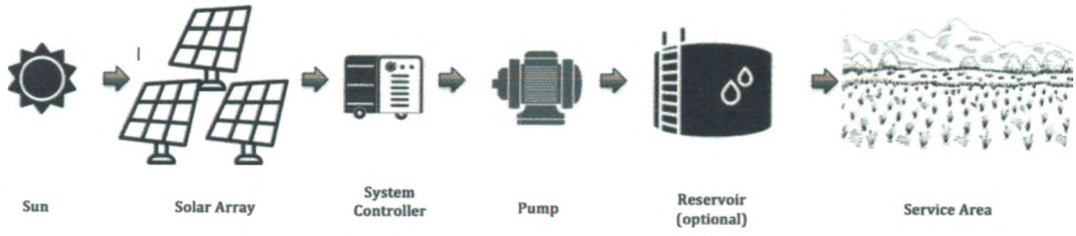

Figure 1. Basic component of Solar-Powered Irrigation System

1. DETERMINATION OF IRRIGATION WATER REQUIREMENT

Field Water Balance (FWB) is the process of accounting all quantities of water added to, subtracted from, and stored within a given volume of soil in a given period of time in a given system. This is done to account for the hydrologic cycle of a specific area at any period of time, considering the crop and soil moisture, to determine rainfall adequacy for crop production, and to establish the best cropping pattern and calendar in the proposed site.

The following factors should be considered in the FWB:

a. Rainfall (80% dependable)
b. Type of crops, and cropping pattern
c. Soil type
d. Evaporation rate

The spreadsheet from Bureau of Soils and Water Management for the FWB may be used for the determination of water requirement given that the required data are gathered during the field validation using the provided site validation form for SPIS.

Upon determination of the water requirement, the solar radiation should be considered since it varies from day to day, per location.

In determination of daily discharge rate this may be based on the average solar day, wherein the average daily water requirement will be delivered. It is recommended to choose the highest flow rate value, which represents the required daily water requirement in the worst month for solar radiation. With this, the system will pump excess quantities of water in other months which can be used to irrigate additional service area.

$$\text{Flow rate } (m^3/h) = \frac{\text{Irrigation Requirement}}{\text{Average daily PSH x n}}$$

Where:

Daily Flow rate = m3/h
Total daily water requirement = m3
Average PSH = Ave. Peak Sun Hours
n = Irrigation Efficiency (for pipe = 0.70)

2. DETERMINATION OF TOTAL DYNAMIC HEAD (TDH)

TDH = Static Head + Friction Losses + Pressure Head

- **STATIC HEAD -** It is the vertical distance between the water surface at the intake point (water surface) and the water surface at the delivery point (at service area/at the tank's water surface).

- **FRICTION HEAD LOSS**

$$hf = f\,(L/D)\ x(\ v^2 / 2g)$$

Where:

hf = head loss (m)
f = friction factor (manufacturer specific)
L = length of pipe work (m)
D = inner diameter of pipe (m)
v = velocity of fluid (m/s)
g = acceleration due to gravity (m/s^2)

This is the loss of pressure due to the friction of water as it flows through the pipes and fittings. Factors to be considered are as follows:

a. Pipe Size (inside diameter of the pipe) - At constant flow rate, decreasing pipe size increases the velocity of water and increases friction;
b. Flow rate (velocity of water) - As the velocity increases, pressure losses increases;
c. Length of pipe – Pressure losses are cumulative as water travels through the length of pipe, thus the longer the pipe, the greater the friction losses; and
d. Roughness of inside of the pipe – This is manufacturer specific. The rougher the inside of the pipe, there will be more losses due to friction.

When the pumping head is very high, multi-stage pumping may be used. In general, maximum total head should not exceed 200 m.

3. PUMP SIZING AND SELECTION

The pump moves the water from the source to the service area or reservoir. There are two different types of pump that can be used for the system: surface pump and the submersible pump. The following equation may be used for the pump sizing:

$$P = \frac{Q * TDH * SG}{367 * n}$$

where:

P = Power, kW
Q = Flow rate, m^3/h
TDH = Total Dynamic Head, m
SG = Specific Gravity (SG_{water}= 1.0)
n = pump efficiency

After obtaining the size of pump (P), the suitable type of pump should be selected. Market research should be conducted on available pumps. Using the performance curve, the pump with power greater than the requirement and greater head should be selected.

Surface Pump

Surface pump is mounted on ground above water level and is suitable for shallow well areas. This is designed for high flow rates and low heads.

Submersible Pump

Submersible pump is designed for high head and medium flow rates. However, this type of pump is very sensitive to dry run thus, the sustainability of the water source should be ensured.

- If the source for the system is surface water, it is necessary to construct an intake structure with trash rack/s to protect the pump from damage due to high water current and entry of foreign matters and sediments which may cause clogging and consequently damage the pump.

- The following factors should be considered in designing the trash rack:[3]

  - Accessibility and provision for cleaning - The racks should be installed in a slanting position, and the slope should be 1 vertical to 1/3 or ½ horizontal for manual raking.
  - Maximum size of debris that can be allowed to pass through – consider the sensitivity of the pump to debris
  - Corrosion - It is recommended that trashracks be painted with corrosion-resistant coating.

- If the pump to be used is a submersible pump with built-in motor, the following features should be present:
  a. Main switch incorporated
  b. Maximum Power Point Tracking
  c. Fault Indication
  d. Protection against overheating
  e. Protection against overloading
  f. Protection against voltage transient
  g. Protection against too low and too high voltage input
  h. Protection against dry runs

- Pump/control house
  - It should be constructed in a flood-free area where the mechanical and electrical equipment should be placed.
  - This should be accessible for both construction phase, and operation and maintenance.
  - The door should be at least 2.1 m x 0.9m.
  - Windows should be at least 10% of the floor area of the pump house.
  - For ventilation purposes, Louver-type door and window may be used.
  - The roof should have an overhang of at least 1m.
  - There should be at least 1m concrete pavement around the pump house.

- The pump should be selected based on the available water source, required volume of discharge (Q) and TDH.

[3] Water control Structures – Selected Design Guidelines. (2004)

4. SOLAR PHOTOVOLTAIC (PV) ARRAY

The solar PV array is composed of PV modules connected in combination of series and parallel connections, which convert energy from the sun into electrical energy. The following equation may be used for the computation of total power of the solar PV Array:

$$P_{SA}\,(kW) = \frac{P_{pump}\,(hp)\,x\,SF}{0.746}$$

Where:

P_{pump} = Capacity based on market availability, hp
SF = Safety factor (at least 1.6 to consider temperature derating factor, and load mismatch)
P_{SA} = Solar Array total Power, kW

Design consideration for the installation of solar PV Array:

- The solar PV modules should be installed **facing south**, with an angle of inclination of **10-15°.**[4] This is to optimize the amount of direct solar radiation received by a solar module and for maintenance purposes (self-cleaning).[5]
- The solar PV array/s shall be installed in an area that is unshaded at any time of the year.
- Uniform type and specifications of PV modules shall be used for the whole array.
- For the design of solar PV array, safety factor for the load mismatch and temperature derating factors should be considered (e.g., load mismatch factor: 0.8, temperature derating factor for array power loss due to heat: 0.8 for warm climate, 0.9 for cool climate)[6] or you may use **at least 1.6 safety factor.**
- If the solar PV array is installed above the reservoir, an access ladder and pathway/s should be provided for cleaning and maintenance purposes.
- A minimum of **20 cm** spacing between solar PV strings can be provided for cooling purposes, and may be adjusted depending on the space available.
- The minimum string size should be the minimum number of solar PV modules connected in series that is required to keep the inverter running at the minimum
- The number of solar PV modules to be connected in series should have an output voltage and current within the range of the input voltage and current of the selected inverter
- The solar modules to be installed should have a third-party certification to ensure that it complies with relevant standards.
- Steel frames, preferably GI pipe or angular bars that are either primed, hot-dipped galvanized, or double coated with non-corrosive paint, should be used for the solar mounting structure.
- The connection between the steel frames should be nuts and bolts for easier assembly and dismantling.

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[4] Department of Energy. (2009). Manual for Solar PV Training. Philippines.

[5] NSW Farmers, GSES. (2015). Solar-powered pumping in agriculture: A guide to system selection and design. NSW Farmers

[6] Shreshtha, J.N. et. Al. (2014). Training Manual Solar PV Pumping System. Nepal.

5. INVERTER/ SOLAR CONTROLLER

Inverter

The inverter is an equipment used to change voltage level or waveform, or both, of electrical energy and changes DC input to an AC output.[7] This may be built-in or assembled separately with the pump.

The inverters may have a sine wave filter which minimizes the switching noise from the motor, and reduces losses because sinusoidal voltage is fed to the motor. Also, it protects the motor against voltage peaks, which prolongs its useful life.

- The solar inverter is sized by matching the output power of the solar PV array with the input power of the pump.
- The capacity of the inverter should be at least equal to or 25 % higher than the capacity of the pump.[8]
- The controller/inverter must be installed in a covered area to protect from extreme weather conditions.
- To reduce the risk of lightning damage, the inverter/controller must be installed near the solar array (e.g. under the solar array), with a lightning arrester.

Maximum Power Point Tracker (MPPT)/ Solar Controller

This is installed between the solar PV array and the electric motor to match the power output of the solar array with the required current or voltage for the operation of the motor/pump. This is an electronic DC to AC power converter. If the system is without MPPT, it would be necessary to oversize the solar PV array to provide sufficient start-up current requirement.[9]

Pump Controller

This can be a simple controller that switches the pump on and off as needed. But it can also contain MPPT, which maximizes the pump's operation based on the generated solar power.[10] Another type of controller is the variable frequency drive (VFD) wherein it controls the electric motor by varying the frequency and voltage. It has the capacity to control the surge of the motor during start-up or shut-off. [11]

Float switch may also be included in the system, if applicable. This is used to regulate the level of water in the reservoir and/or prevent dry running of pump when water level in the pump sump is low.

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[7] Ibid.

[8] DOE Simple PV Sizing Calculations (Sibayan, F.S.), 2017.

[9] Shreshtha, J.N. et. Al. (2014). Training Manual Solar PV Pumping System. Nepal.

[10] Ibid.

[11] https://www.danfoss.com/en/about-danfoss/our-businesses/drives/what-is-a-variable-frequency-drive/

6. RESERVOIR (OPTIONAL)

- A reservoir may be constructed to balance the supply and demand of water. An elevated reservoir can be constructed to provide the suitable pressure for the distribution system.

- The reservoir shall have the following inlets/outlets:

  a. Inlet pipe – the pipe from the pump to the reservoir
  b. Outlet pipe – the pipe from the reservoir to the service area
  c. Drain pipe – pipe for cleaning and maintenance purposes
  d. Overflow pipe – pipe used to prevent the water from overflowing from the reservoir

- The flooring of the tank should have at least 2% slope for drainage purposes.

- It is also necessary to provide an access ladder for the inside and outside of the tank, which may be permanent or detachable. A safe landing with handrail should be provided for safety.

7. WIRE SIZING AND ELECTRICAL INSTALLATION[12]

Two factors should be considered in selecting wire size:

- **Ampacity based sizing**

  The size of the wire will be based on the current handling capacity. It is recommended that the wire to be selected should be at least 25% greater than the maximum load current that will flow through the wire.

- **Voltage Drop based Size**

  The voltage drop for the wire to be used for low voltage high current applications is another factor needed to be considered. The voltage drop in wire causes less voltage applied to the load from the array which may result in unstable operation of the load.

$$\Delta\, Voltage = I_{max}\ x\ L_{wire} x\ Voltage\ factor$$

$$S_W = \frac{0.3\ x\ L_{wire} x\ I_{max}}{\Delta\, Voltage}$$

[12] National Electrical Code of the Philippines.

Where:

Δ Voltage = maximum allowable voltage drop (%)
Imax = maximum current (A)
Lwire = Length of wire (m)
Voltage factor = 1.06 for 10-25 deg. C ambient temperature (PEC)
Sw = required wire size (sq. m)

Design considerations for the Electrical Installation:

- The circuit conductor and overcurrent devices shall be sized to carry not less than 125% of the maximum current
- The outdoor wiring should be protected from human activities, weather conditions, and animals by using strong, high quality outdoor cable, or by using electrical conduit.
- Cable wirings should be heavy duty with resistive losses less than 5%.
- All array wiring should be attached to a support structure with nylon tie wires, and should be grounded.
- The Photovoltaic power source should be labeled with warning signs
- For a photovoltaic power source, one conductor of a 2-wire system rated over 50 volts and a neutral conductor of a 3-wire system should be solidly grounded.
- The DC circuit grounding connection should be made at any single point on the photovoltaic output circuit. Locating the grounding connection point as close as practicable to the photovoltaic source will better protect the system from voltage surges due to lightning.
- Exposed noncurrent-carrying metal parts of module frames, equipment, and conductor enclosures should be grounded regardless of voltage.

VIII. GENERAL NOTES

- Perimeter fence is essential for protection against theft, entry of unwanted persons and damage from wandering animals.
- If possible, the system should be constructed away from main roads and public access.
- There should be a provision for slope protection or erosion control measure, where applicable.

For reference and guidance.

ENGR. ARFODEAR C. RICO
Director IV

Attached: a/s

SITE VALIDATION FORM	Date:
	Time:

SOLAR-POWERED IRRIGATION SYSTEM (SPIS)

A. BACKGROUND INFORMATION	*Include who requested and joined in the site visit. (name/designation), Farmer leader, etc. Please include contact numbers*	
B. ORGANIZATIONAL PROFILE	Name of Project:	
	Location:	*(Barangay, Municipality,Province, Region)*
	Name of organization (if there's any):	
	Potential Number of Beneficiaries:	
	Tenural Status (owner/tenant):	

	SERVICE AREA	Area (ha)	Average yield (Mt/ha): 1ST CROP	2ND CROP	3RD CROP	Remarks (Indicate if privately owned, or provided by the government)
C. PRODUCTION AREA DATA	1. Existing Irrigated Area (ha) (Total):					
	1.1. Irrigated Area (NIS, CIS, etc.)					
	1.2. Irrigated by SSIPs (PISOS, STW, SWIP, etc.)					
	2. Rainfed Area (ha):					
	2.1 Target Service Area (ha)					

D. METEOROLOGICAL AND CROPPING DATA	Type of climate: *(Rainfall pattern)*	☐ Type 1 ☐ Type 2 ☐ Type 3 ☐ Type 4		
	Wind Velocity and Direction	*(Typhoon intensity/ Frequency/Maximum and average Wind velocity)*		
	Soil Texture/Type of Soil			
	Activities	**1st Cropping**	**2nd Cropping**	**3rd Cropping**
	Crops/Cropping pattern			
	Cropping Calendar *(Starting month – End Month)*			

E. WATER SOURCE DATA	Water Source:	
	Distance from other existing irrigation facility using the same source (for open source):	
	Watershed Area (ha):	

F. COMPONENTS COORDINATES AND ELEVATION:

Components	Coordinates (WGS 84, in decimal degrees) Longitude	Latitude	Elevation (m)
Water Source			
Pump			
Solar Panel			
Reservoir (if applicable)			
Service Area (lowes and highest point, farthest point, centroid)			

G. OTHER OBSERVATIONS AND FINDINGS: *(e.g. Presence of signs of erosion, and other geotechnical features)*	

H. SOCIAL AND ENVIRONMENTAL ACCEPTANCE AND RECEPTION	YES	NO	Remarks
Does the proposed SPIS project benefits small farmers within the community?			
Are the beneficiary farmers willing to be organized and clustered?			
Are the Land acquisition and Right of Way issues has been settled and secured fully from the landowners and claimants by the concerned agencies or proponent? If not, are the landowners willing to donate or			

undertake other modes of ROW acquisition?			
Is the local government unit (LGU) willing to assist in the planning, construction, and operation and maintenance of the project (e.g. provide personnel or other resources in the social preparation for the project, provision of security arrangement)?			
Are the beneficiary farmers willing to be trained for the operation and maintenance of the system?			
Are the beneficiary farmers willing to shoulder the operation and maintenance expenses for the system?			
Is the proposed SPIS project location of its components will have a negative impact to the environment?			
Is the SPIS targeted area considered to be generally peaceful and orderly?			
Other Issues:			

I. RECOMMENDATIONS *(to include future activities, resolutions of issues and potential constraints, decisions whether feasible or not and why, etc):*	

J. PHOTO DOCUMENTATIONS (to include **date** and **name of photographer**):
Layout of the potential service area(google earth images), Water Source , Possible location of solar panels and tank, geotagged photos of STWs/Well within ___ km of the proposed area,

K. DATA REQUIRED FOR THE WATER SOURCE (Open Source)

Parameters	Findings
Name of River/Creek:	
Coordinates/Location	
Stable discharge of water source (m^3/hr)	
Discharge Method used	
Minimum water level from creek/river bed	
Maximum water level from creek/river bed	
Type of soil in the river bank	
River bank height	
Average River width (average of 3 measurements if irregular shape)	
Flood marks height from river bed	
Other water users (specify if assn, etc.)	
Water permitees (volume granted) downstream of proposed site	
Presence of saline intrusion	
Presence of Siltation	
Other information	

K. DATA REQUIRED FOR THE WATER SOURCE (Groundwater)

Parameters:	**Results/Findings:**

Well depth, (m)	
Coordinates of the well and elevation	
Well size, (mm)	
Well casing size (mm)	
Static water level below ground (m)	
Recharge rate (drawdown)	
Proximity to adjacent wells (m)	
Withdrawal rate of adajcent wells	
Water quality	
Distance from point of delivery (m)	
Presence of saline intrusion	
Others	
L. TOOLS, GADGETS AND MATERIALS TO BE USED DURING THE VALIDATION	GPS Device, Altimeter, Range Finder, and Flow Meter., Measuring tape (meter) *and rope or sounder if available, Printed Map (topo or from google earth), Field* Notebooks and pen, Camera/cellphone, Two-way radio

M. VALIDATED BY:		
Name/Signature/Date	Name/Signature/Date	Name/Signature/Date

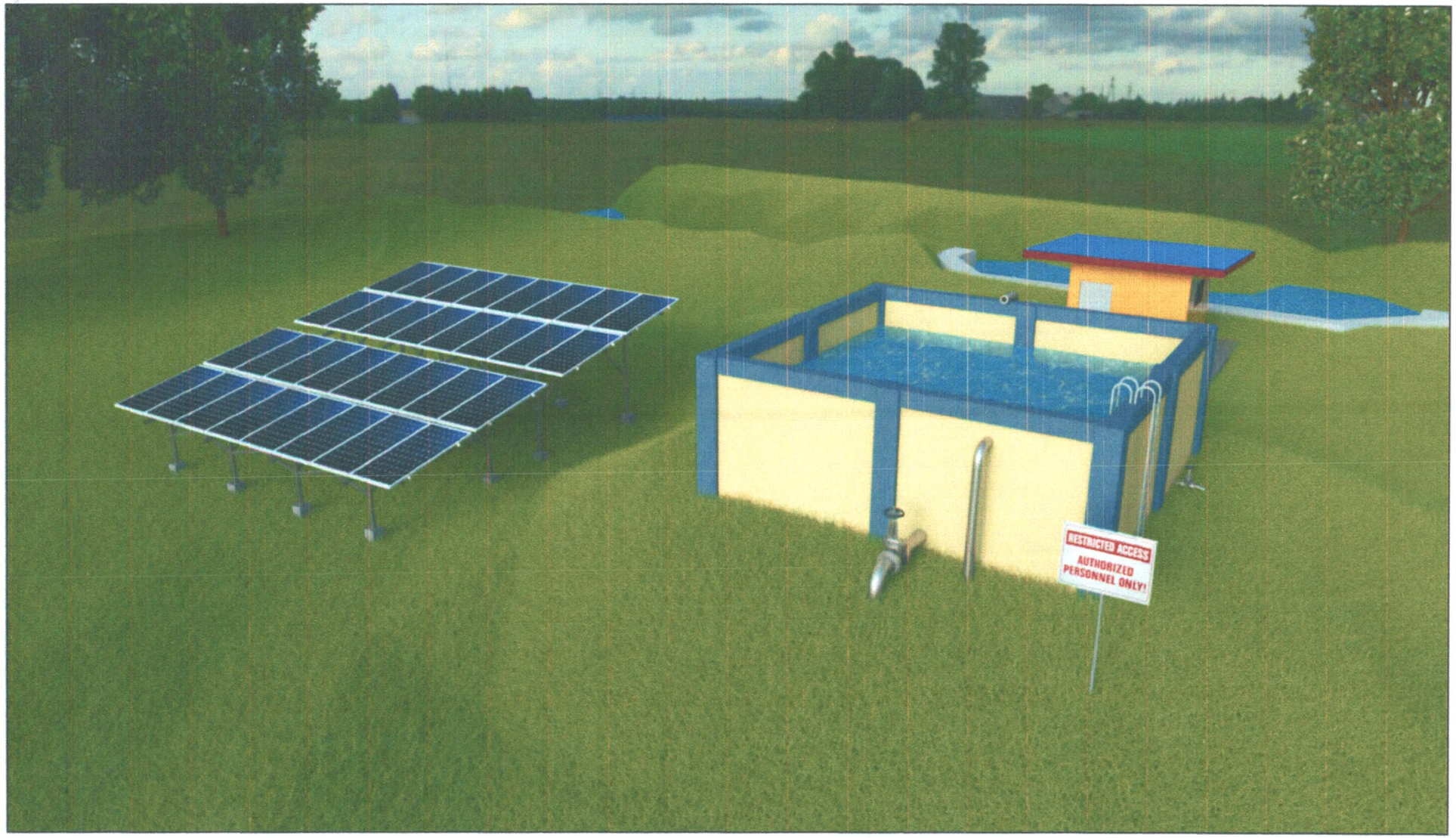
REPUBLIC OF THE PHILIPPINES

DEPARTMENT OF AGRICULTURE

BUREAU OF AGRICULTURAL AND FISHERIES ENGINEERING

ANNEX B

MODULAR DESIGN OF SOLAR POWERED IRRIGATION SYSTEM



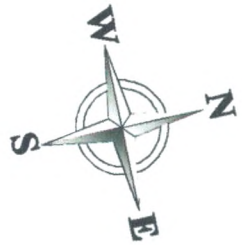
PERSPECTIVE VIEW

A
1-1

SOLAR POWERED IRRIGATION SYSTEM - OPEN SOURCE, SURFACE PUMP

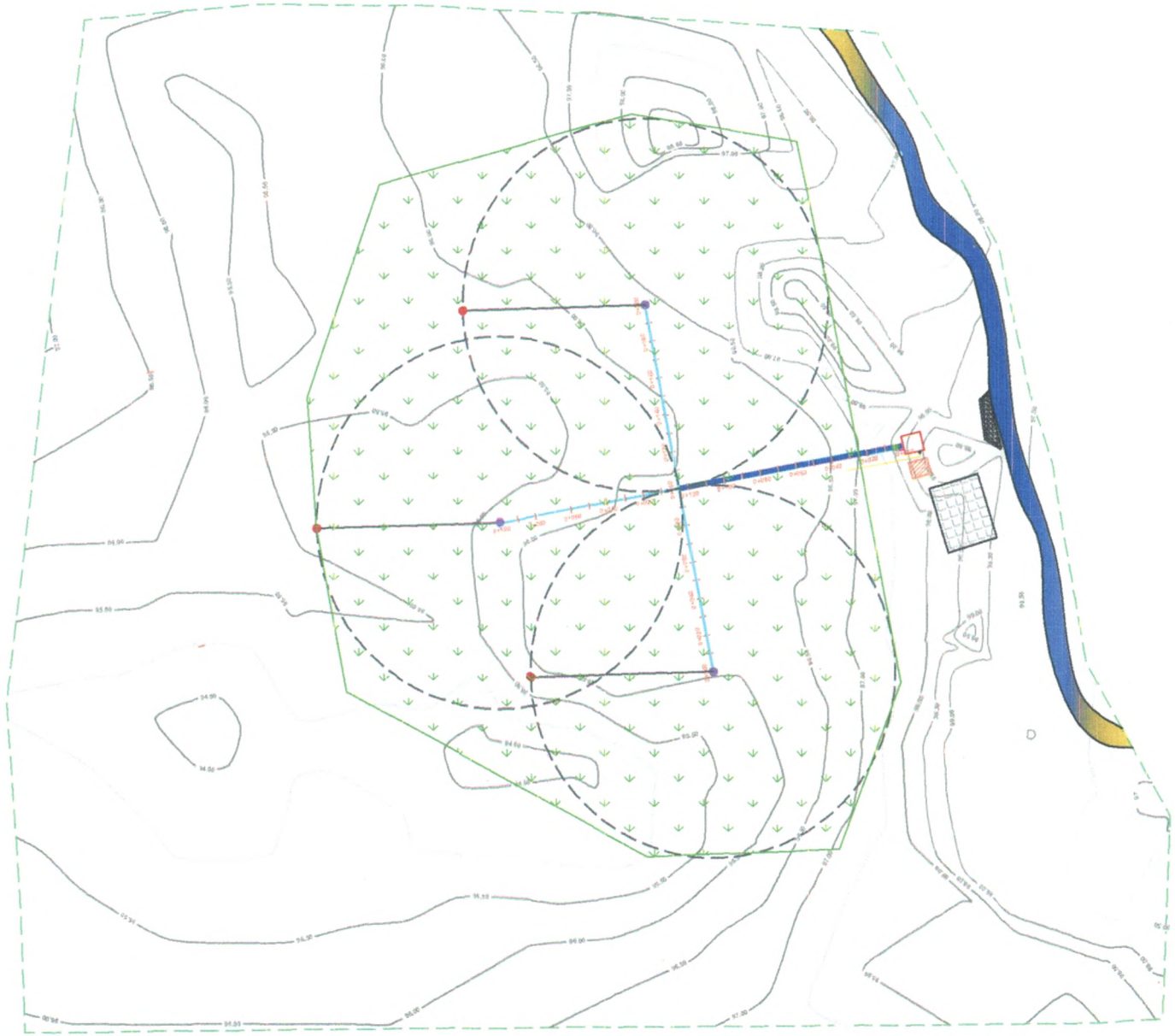
SCALE: NTS

PROJECT TITLE	Sheet Content:	Sheet No.:
MODULAR DESIGN FOR SOLAR POWERED IRRIGATION SYSTEM	PERSPECTIVE VIEW - OPEN SOURCE WITH ELEVATED TANK AND SURFACE PUMP	A-01
PROJECT LOCATION		



Legend:

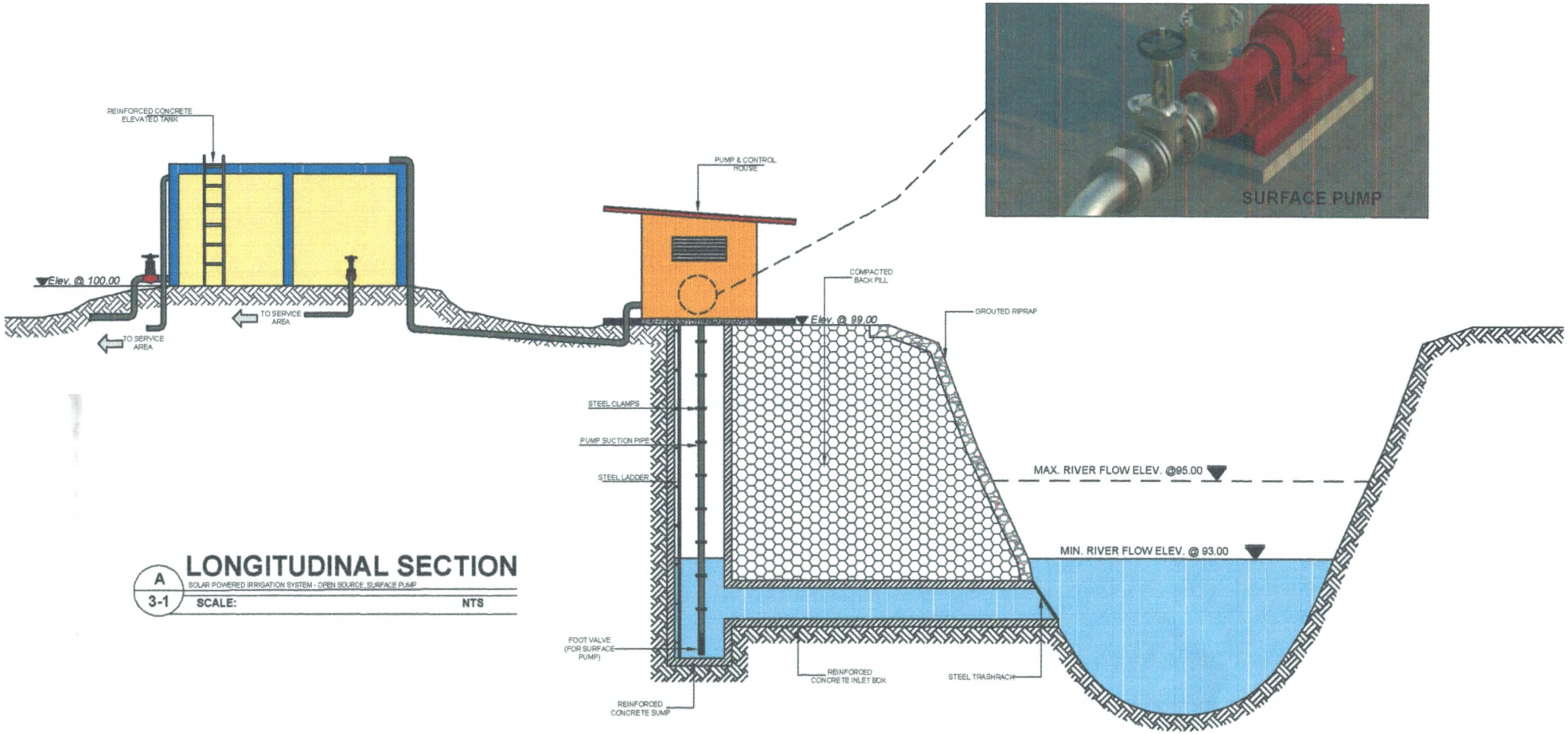
- Control/Pump House
- Elevated Tank
- Grouted Riprap
- Solar Panels
- Main Pipeline
- Lateral Pipeline
- Overflow Pipeline
- Drain Pipeline
- Flexible Water Hose



A 2-1 SAMPLE FARM PLAN

Scale: 1:2500

PROJECT TITLE	Sheet Content:	Sheet No.:
MODULAR DESIGN FOR SOLAR POWERED IRRIGATION SYSTEM	SAMPLE FARM PLAN - OPEN SOURCE WITH ELEVATED TANK AND SURFACE PUMP	A-02
PROJECT LOCATION		

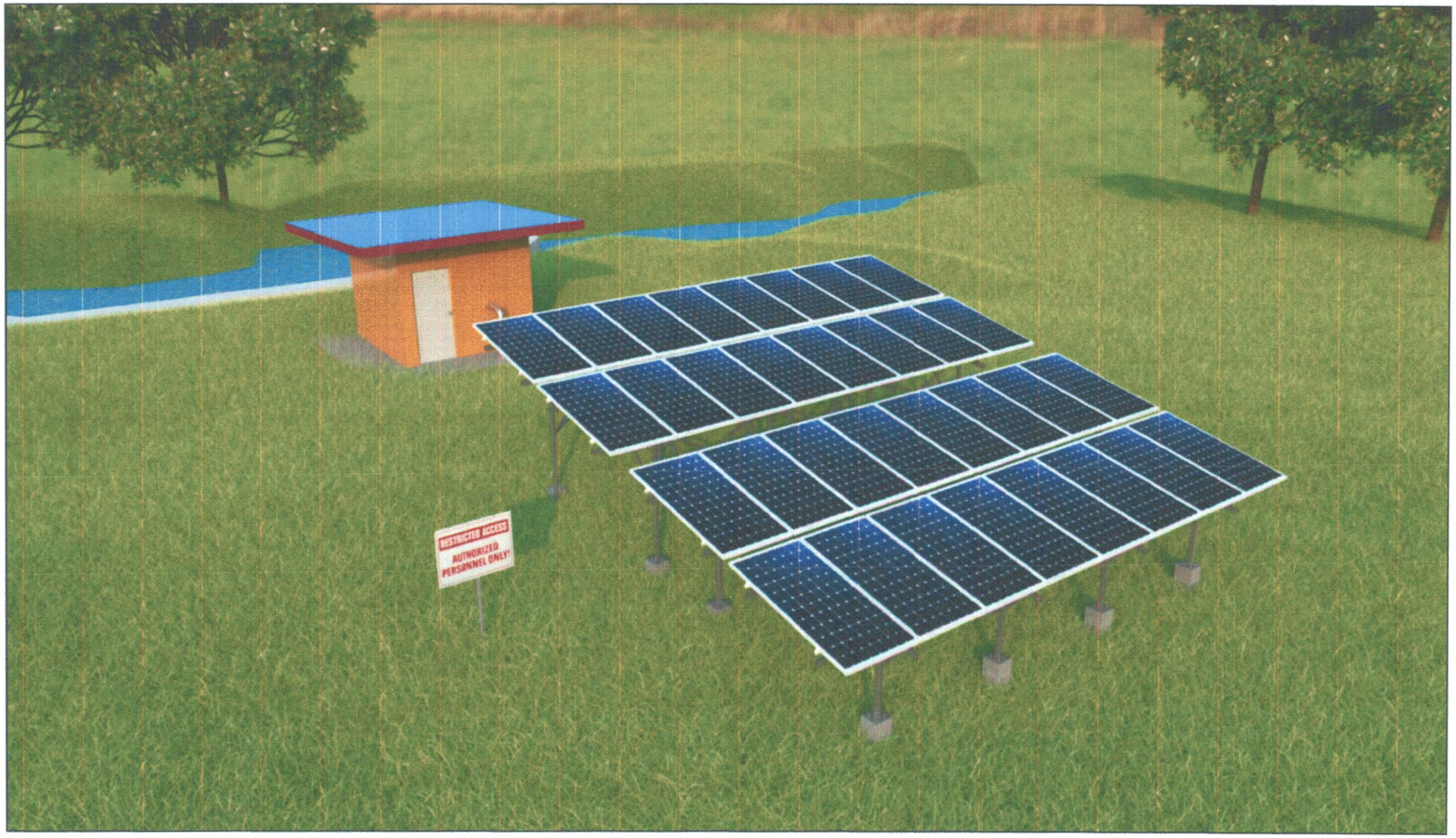


A 3-1 **LONGITUDINAL SECTION**
SOLAR POWERED IRRIGATION SYSTEM - OPEN SOURCE, SURFACE PUMP
SCALE: NTS

GENERAL NOTES:

- THE LONGITUDINAL SECTION SHOWS AN OPEN SOURCE SPIS WITH ELEVATED CONCRETE TANK AND SURFACE PUMP.
- THE DIMENSIONS OF PUMP SUMP AND INLET CANAL WILL DEPEND ON THE PECULIARITIES OF THE SITE AND ASSESSMENT OF THE DESIGNER.
- THE DIMENSION OF PUMP SUMP MUST PROVIDE ENOUGH VOLUME OF WATER TO SUSTAIN CONTINUOUS FLOW FROM SUMP TO ELEVATED TANK.
- STEEL MESH IN TRASHRACK SHALL AT LEAST BE DOUBLED WITH FINE MESH TO PREVENT ENTRY OF SOLID WASTES THAT MAY PENETRATE THE INLET CANAL.
- THE PUMP SUCTION PIPE MUST BE CLAMPED ON THE WALL OF PUMP SUMP USING STEEL CLAMPS.

PROJECT TITLE	Sheet Content:	Sheet No.:
MODULAR DESIGN FOR SOLAR POWERED IRRIGATION SYSTEM	LONGITUDINAL SECTION - OPEN SOURCE WITH ELEVATED TANK AND SURFACE PUMP	A-03
PROJECT LOCATION		



PERSPECTIVE VIEW

A

4-1

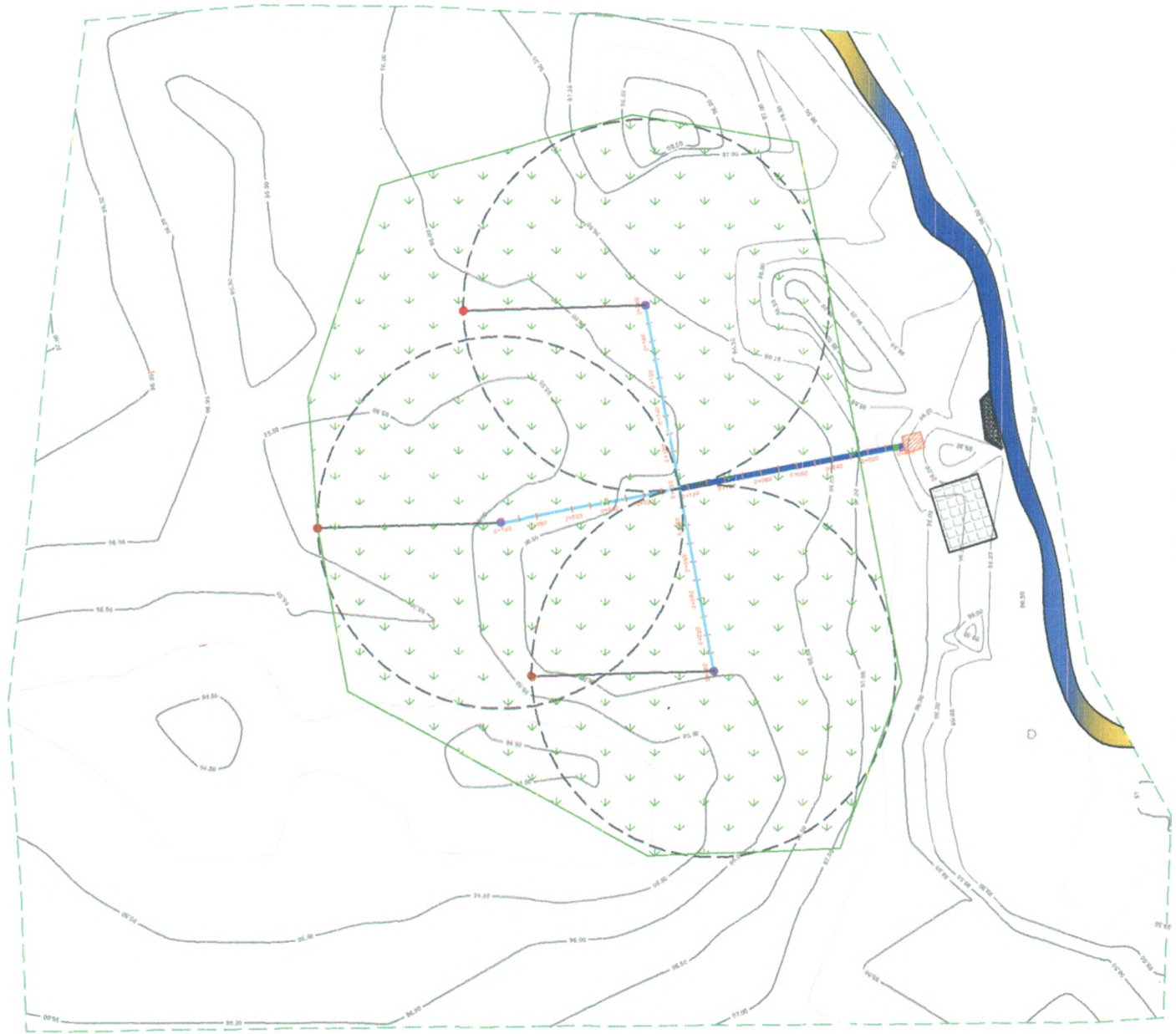
SOLAR POWERED IRRIGATION SYSTEM - OPEN SOURCE, SUBMERSIBLE PUMP

SCALE: NTS

PROJECT TITLE	Sheet Content:	Sheet No.:
MODULAR DESIGN FOR SOLAR POWERED IRRIGATION SYSTEM	PERSPECTIVE VIEW - OPEN SOURCE, SUBMERSIBLE PUMP	A-04
PROJECT LOCATION		

Legend:

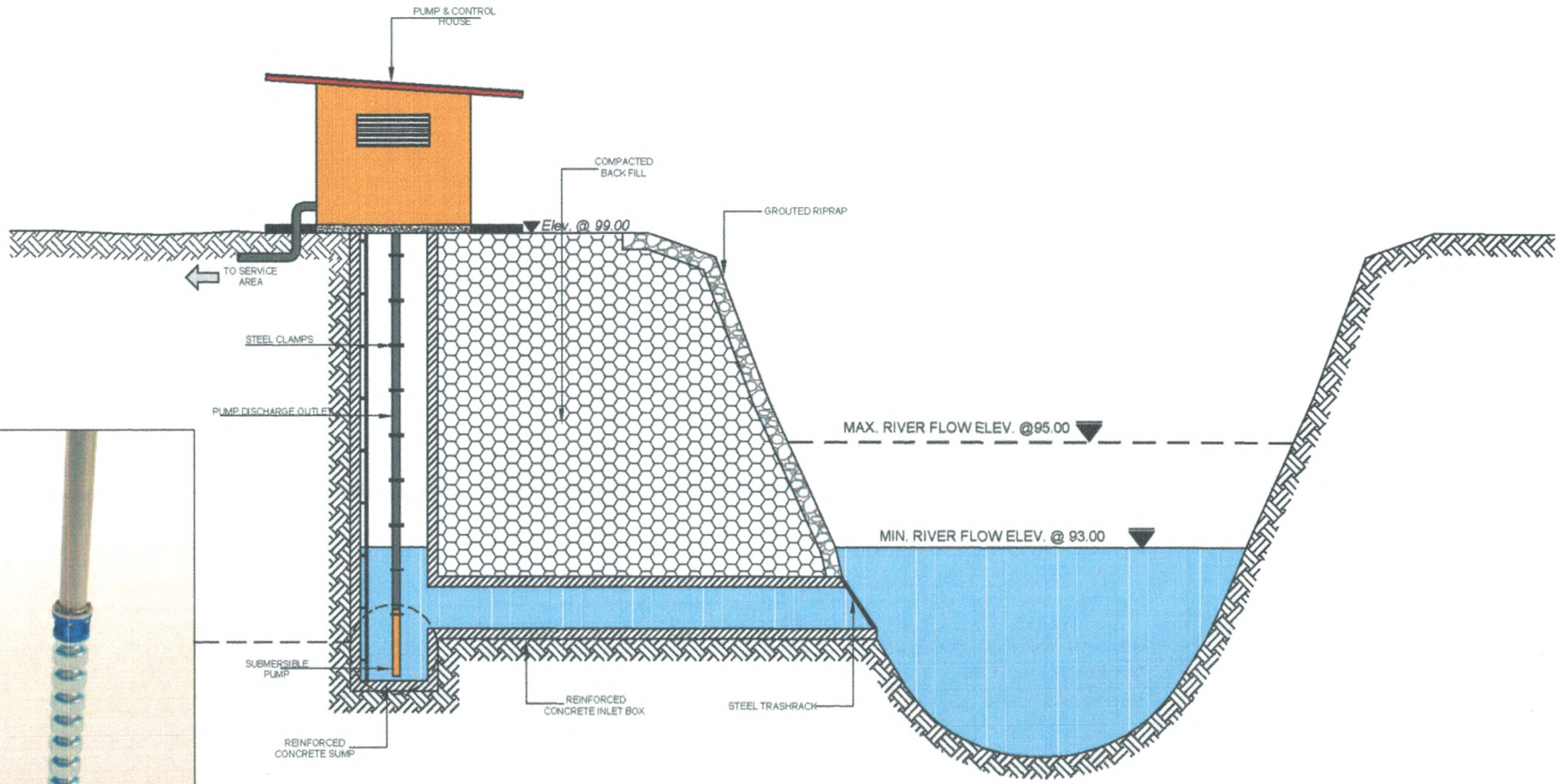
- Control/Pump House
- Grouted Riprap
- Solar Panels
- Main Pipeline
- Lateral Pipeline
- Overflow Pipeline
- Drain Pipeline
- Flexible Water Hose

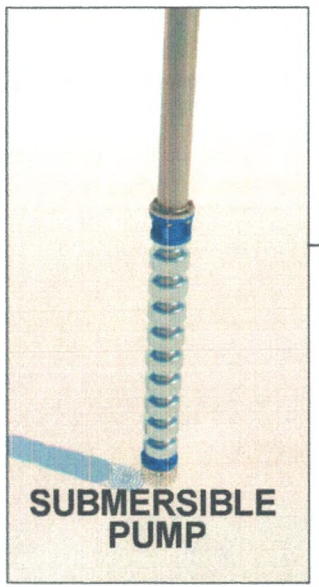


A / 5-1 SAMPLE FARM PLAN

Scale: 1:2500

PROJECT TITLE	Sheet Content:	Sheet No.:
MODULAR DESIGN FOR SOLAR POWERED IRRIGATION SYSTEM	SAMPLE FARM PLAN - OPEN SOURCE, SUBMERSIBLE PUMP	A-05
PROJECT LOCATION		





A
6-1

LONGITUDINAL SECTION

SOLAR POWERED IRRIGATION SYSTEM - OPEN SOURCE, SUBMERSIBLE PUMP

SCALE: NTS

GENERAL NOTES:

- THE LONGITUDINAL SECTION SHOWS AN OPEN SOURCE SPIS WITH SUBMERSIBLE PUMP.
- THE DIMENSIONS OF PUMP SUMP AND INLET CANAL WILL DEPEND ON THE PECULIARITIES OF THE SITE AND ASSESSMENT OF THE DESIGNER.
- THE DIMENSION OF PUMP SUMP MUST PROVIDE ENOUGH VOLUME OF WATER TO SUSTAIN CONTINUOUS FLOW FROM SUMP TO THE SERVICE AREA.
- STEEL MESH IN TRASHRACK SHALL AT LEAST BE DOUBLED WITH FINE MESH TO PREVENT ENTRY OF SOLID WASTES THAT MAY PENETRATE THE INLET CANAL.
- THE PUMP DISCHARGE PIPE MUST BE CLAMPED ON THE WALL OF PUMP SUMP USING STEEL CLAMPS.

PROJECT TITLE	Sheet Content:	Sheet No.:
MODULAR DESIGN FOR SOLAR POWERED IRRIGATION SYSTEM	LONGITUDINAL SECTION - OPEN SOURCE, SUBMERSIBLE PUMP	A-06
PROJECT LOCATION		

PERSPECTIVE VIEW

A
7-1

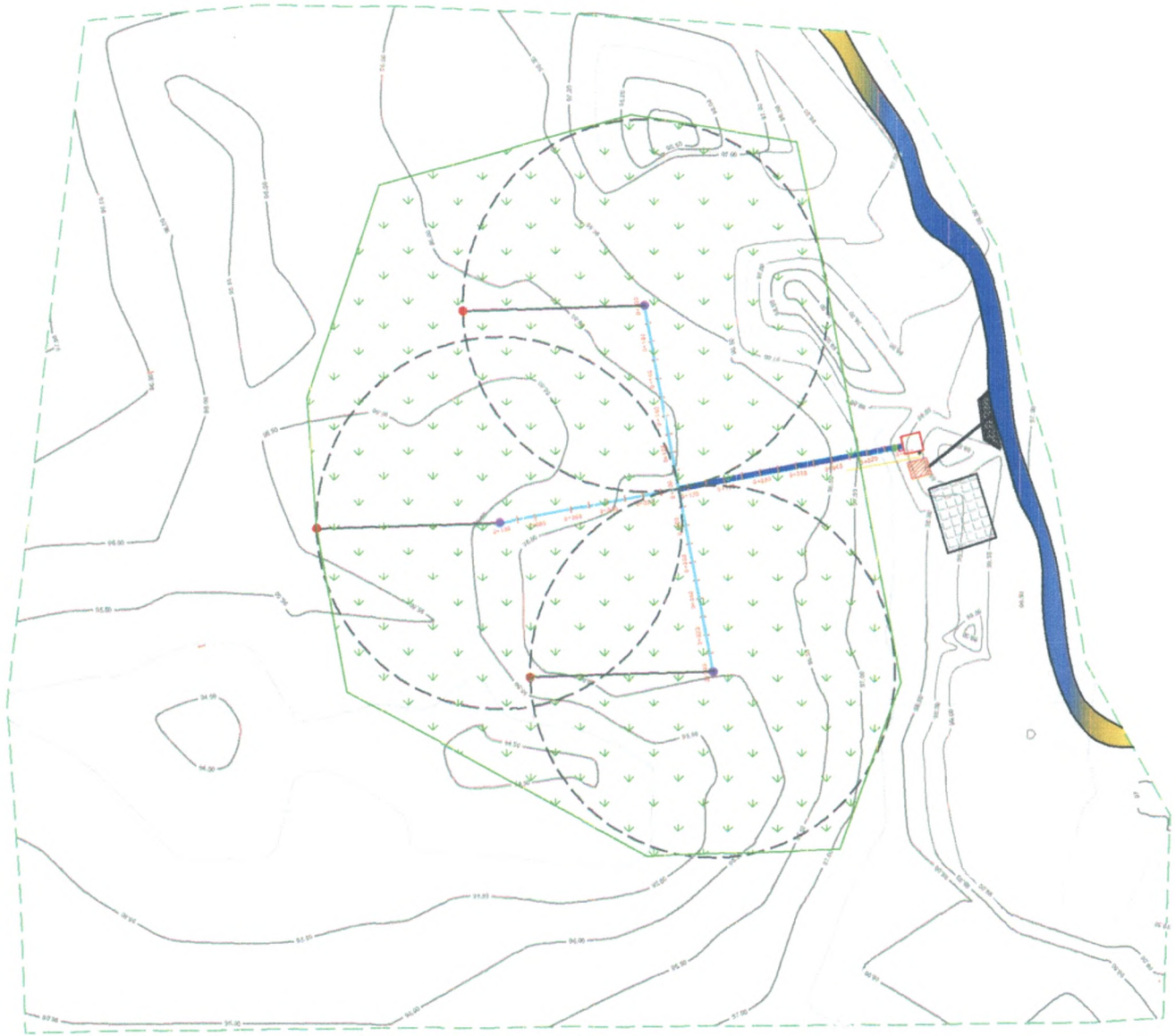
SOLAR POWERED IRRIGATION SYSTEM - OPEN SOURCE, SURFACE PUMP (WITHOUT INTAKE CANAL)

SCALE: NTS

PROJECT TITLE	Sheet Content:	Sheet No.:
MODULAR DESIGN FOR SOLAR POWERED IRRIGATION SYSTEM	PERSPECTIVE VIEW - OPEN SOURCE WITH ELEVATED TANK AND SURFACE PUMP (WITHOUT INTAKE CANAL)	A-07
PROJECT LOCATION		

Legend:

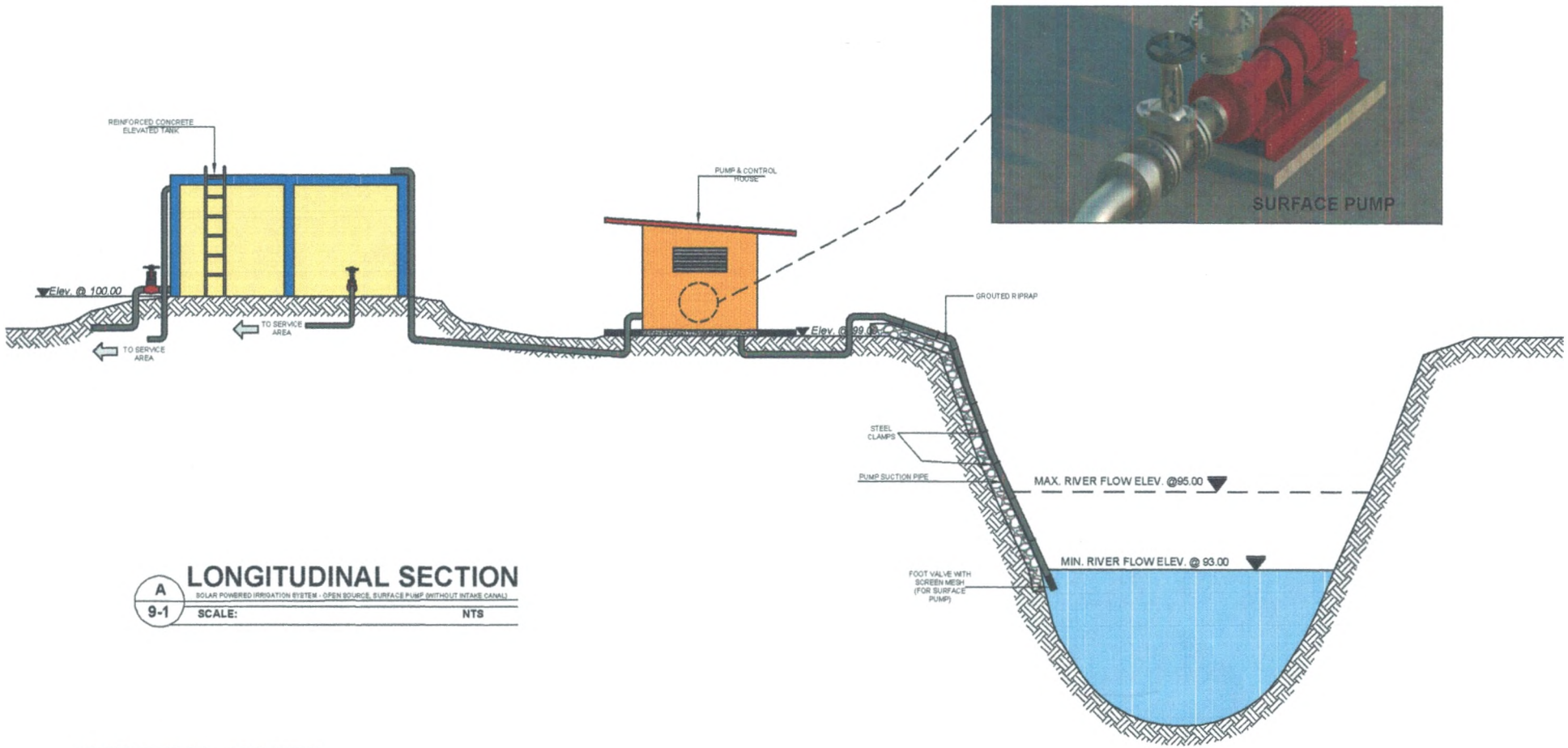
- Control/Pump House
- Elevated Tank
- Grouted Riprap
- Solar Panels
- Suction Pipeline
- Main Pipeline
- Lateral Pipeline
- Overflow Pipeline
- Drain Pipeline
- Flexible Water Hose



A 8-1 SAMPLE FARM PLAN

Scale: 1:2500

PROJECT TITLE	Sheet Content:	Sheet No.:
MODULAR DESIGN FOR SOLAR POWERED IRRIGATION SYSTEM	SAMPLE FARM PLAN - OPEN SOURCE WITH ELEVATED TANK AND SURFACE PUMP (WITHOUT INTAKE CANAL)	A-08
PROJECT LOCATION		



A 9-1 **LONGITUDINAL SECTION**
SOLAR POWERED IRRIGATION SYSTEM - OPEN SOURCE, SURFACE PUMP (WITHOUT INTAKE CANAL)
SCALE: NTS

GENERAL NOTES:

- THE LONGITUDINAL SECTION SHOWS AN OPEN SOURCE SPIS WITH ELEVATED CONCRETE TANK AND SURFACE PUMP
- THERE SHOULD BE AN SLOPE PROTECTION (E.G. GROUTED RIPRAP) OR OTHER EROSION CONTROL STRUCTURE.
- THE PUMP SUCTION PIPE MUST BE CLAMPED ON THE SURFACE OF SLOPE PROTECTION USING STEEL CLAMPS.
- THE FOOT VALVE MUST HAVE SCREEN MESH TO PREVENT ENTRY OF SOLID WASTES THAT MAY PENETRATE THE SUCTION PIPE.

PROJECT TITLE	Sheet Content:	Sheet No.:
MODULAR DESIGN FOR SOLAR POWERED IRRIGATION SYSTEM	LONGITUDINAL SECTION - OPEN SOURCE WITH ELEVATED TANK AND SURFACE PUMP (WITHOUT INTAKE CANAL)	A-09
PROJECT LOCATION		

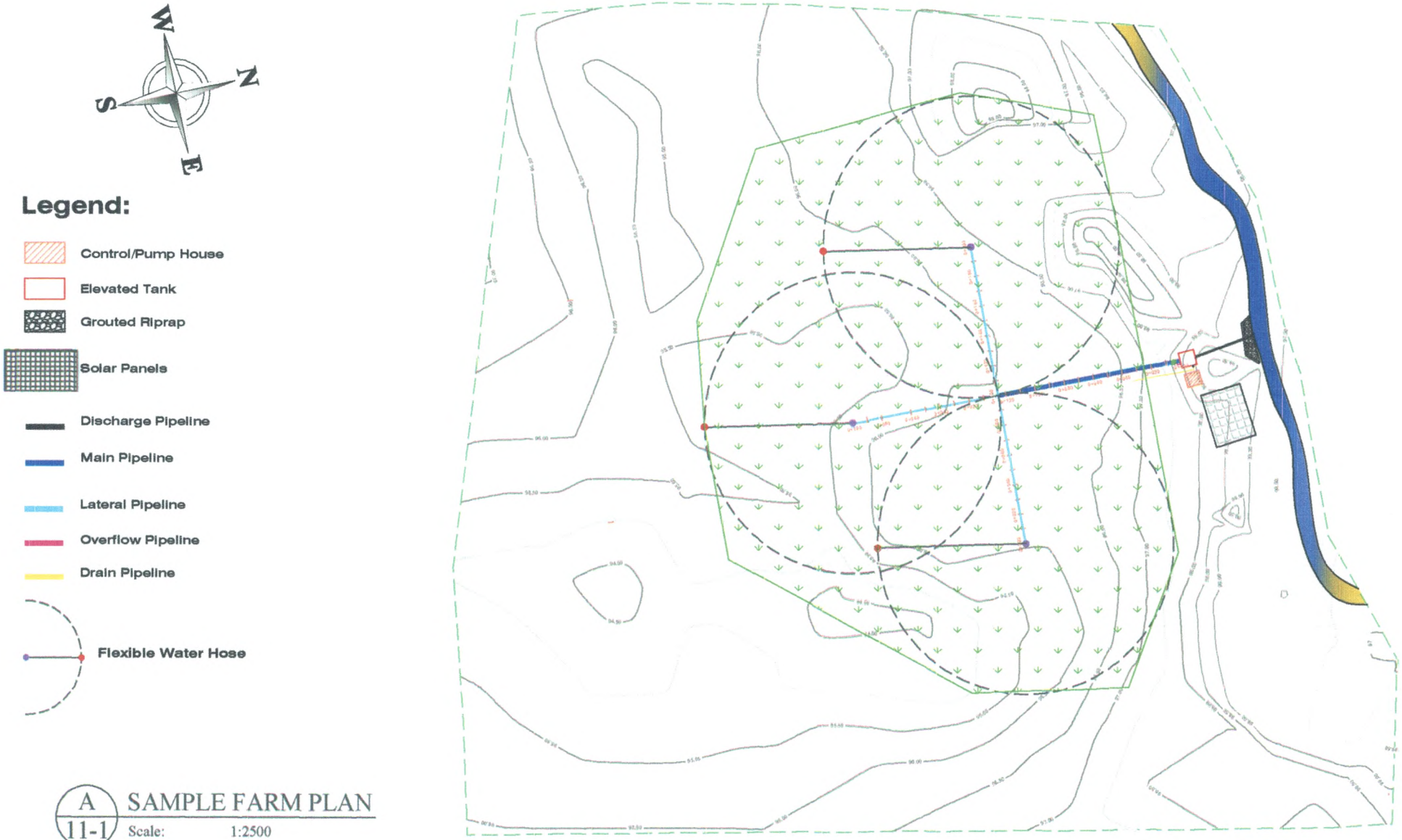
PERSPECTIVE VIEW

A
10-1

SOLAR POWERED IRRIGATION SYSTEM - OPEN SOURCE, SUBMERSIBLE PUMP (WITHOUT INTAKE CANAL)

SCALE: NTS

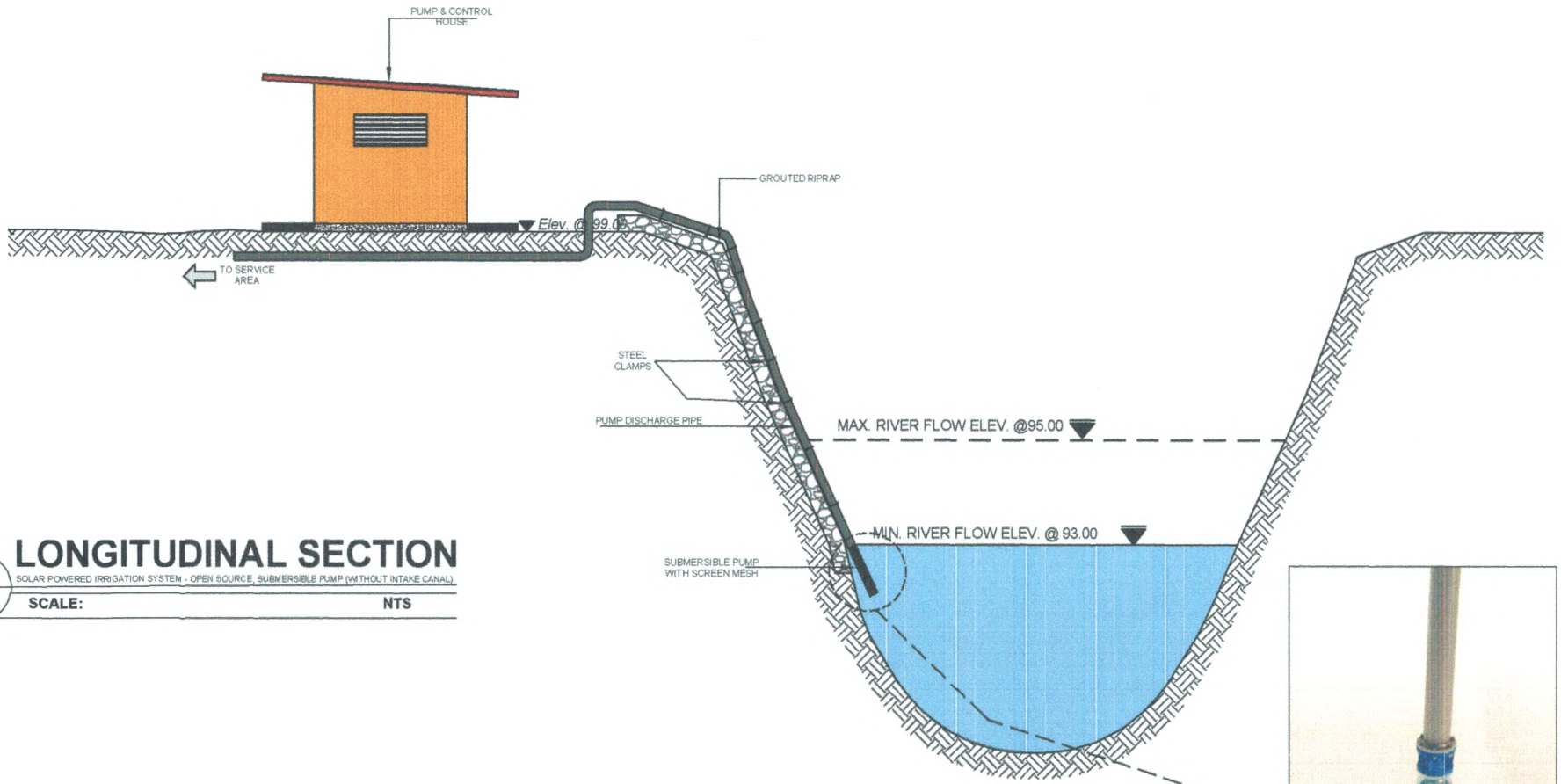
PROJECT TITLE	Sheet Content:	Sheet No.:
MODULAR DESIGN FOR SOLAR POWERED IRRIGATION SYSTEM	PERSPECTIVE VIEW - OPEN SOURCE WITH ELEVATED TANK AND SUBMERSIBLE PUMP (WITHOUT INTAKE CANAL)	A-10
PROJECT LOCATION		



A 11-1 SAMPLE FARM PLAN

Scale: 1:2500

PROJECT TITLE	Sheet Content:	Sheet No.:
MODULAR DESIGN FOR SOLAR POWERED IRRIGATION SYSTEM	SAMPLE FARM PLAN - OPEN SOURCE WITH ELEVATED TANK AND SUBMERSIBLE PUMP (WITHOUT INTAKE CANAL)	A-11
PROJECT LOCATION		

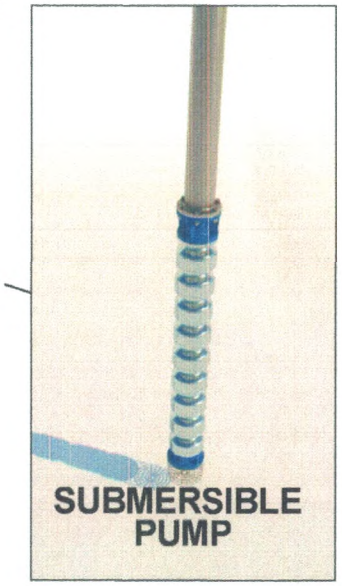


A
12-1

LONGITUDINAL SECTION

SOLAR POWERED IRRIGATION SYSTEM - OPEN SOURCE, SUBMERSIBLE PUMP (WITHOUT INTAKE CANAL)

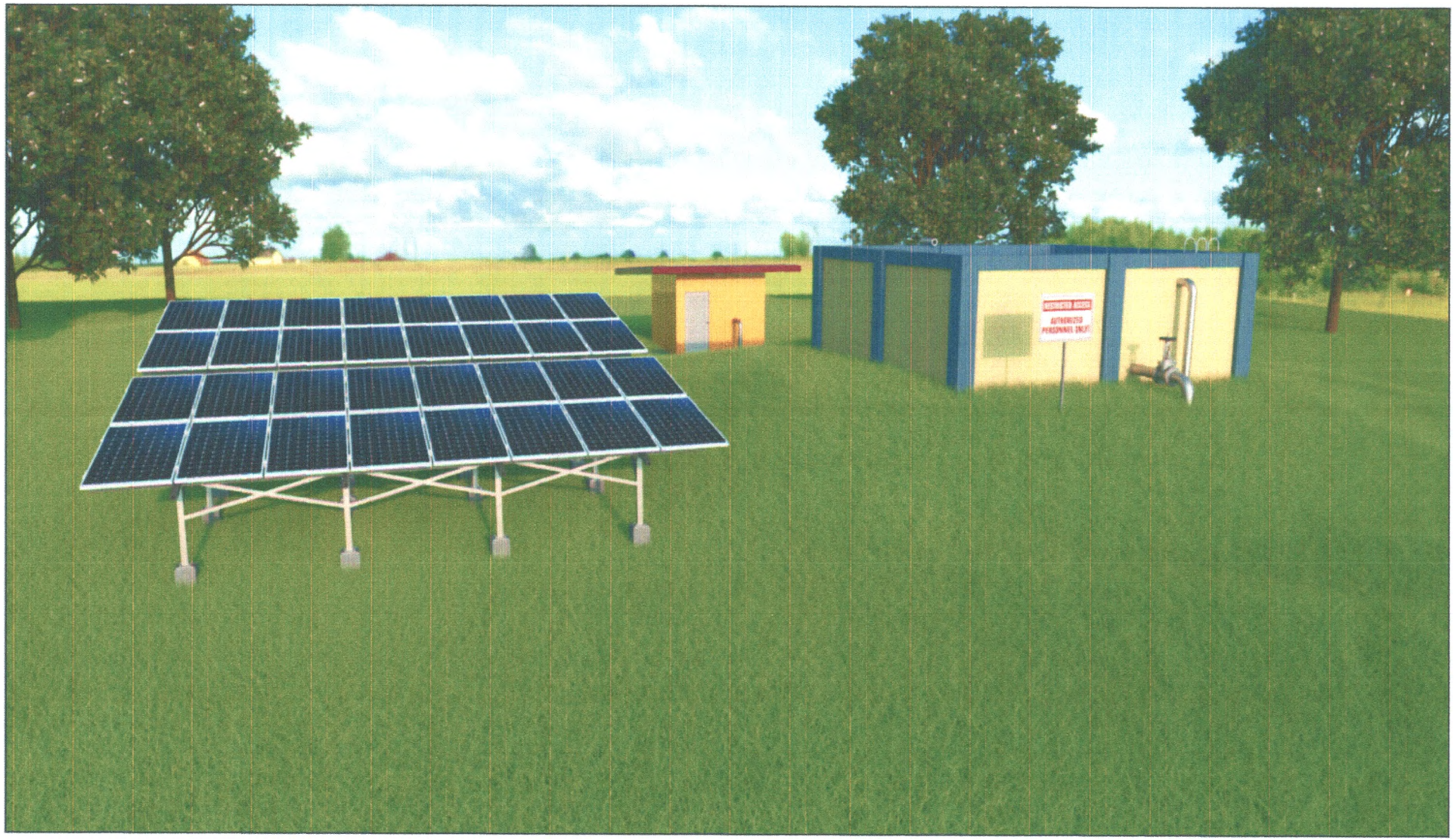
SCALE: NTS



GENERAL NOTES:

- THE LONGITUDINAL SECTION SHOWS AN OPEN SOURCE SPIS WITH ELEVATED CONCRETE TANK AND SUBMERSIBLE PUMP
- THERE SHOULD BE A SLOPE PROTECTION (E.G. GROUTED RIPRAP) OR OTHER EROSION CONTROL STRUCTURE.
- THE PUMP SUCTION PIPE MUST BE CLAMPED ON THE SURFACE OF SLOPE PROTECTION USING STEEL CLAMPS.
- THE SUBMERSIBLE PUMP MUST HAVE SCREEN MESH TO PREVENT ENTRY OF SOLID WASTES THAT MAY PENETRATE THE DISCHARGE PIPE.

PROJECT TITLE	Sheet Content:	Sheet No.:
MODULAR DESIGN FOR SOLAR POWERED IRRIGATION SYSTEM	LONGITUDINAL SECTION - OPEN SOURCE WITH ELEVATED TANK AND SUBMERSIBLE PUMP (WITHOUT INTAKE CANAL)	A-12
PROJECT LOCATION		



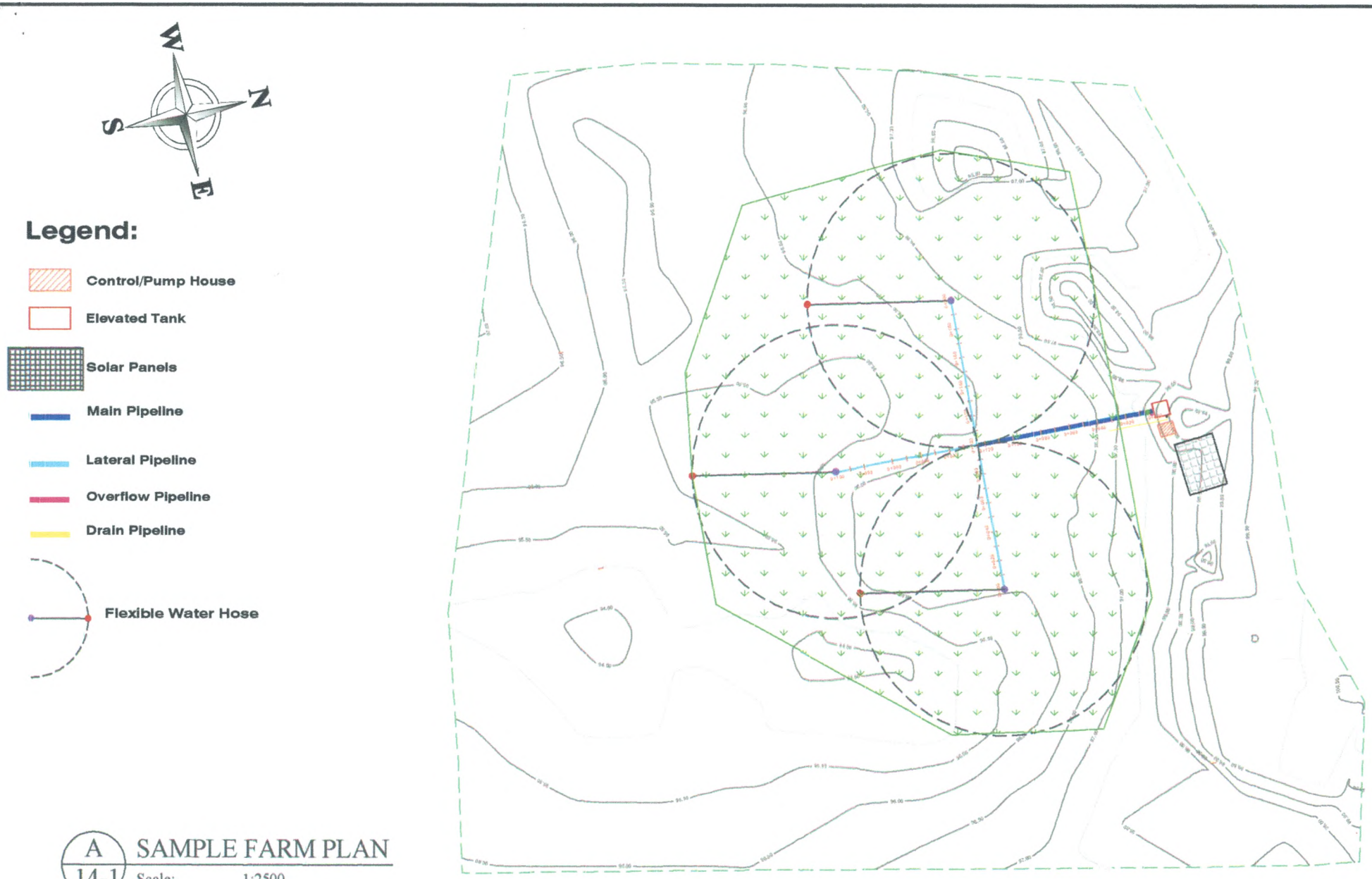
PERSPECTIVE VIEW

A
13-1

SOLAR POWERED IRRIGATION SYSTEM - UNDERGROUND SOURCE; SURFACE PUMP

SCALE: NTS

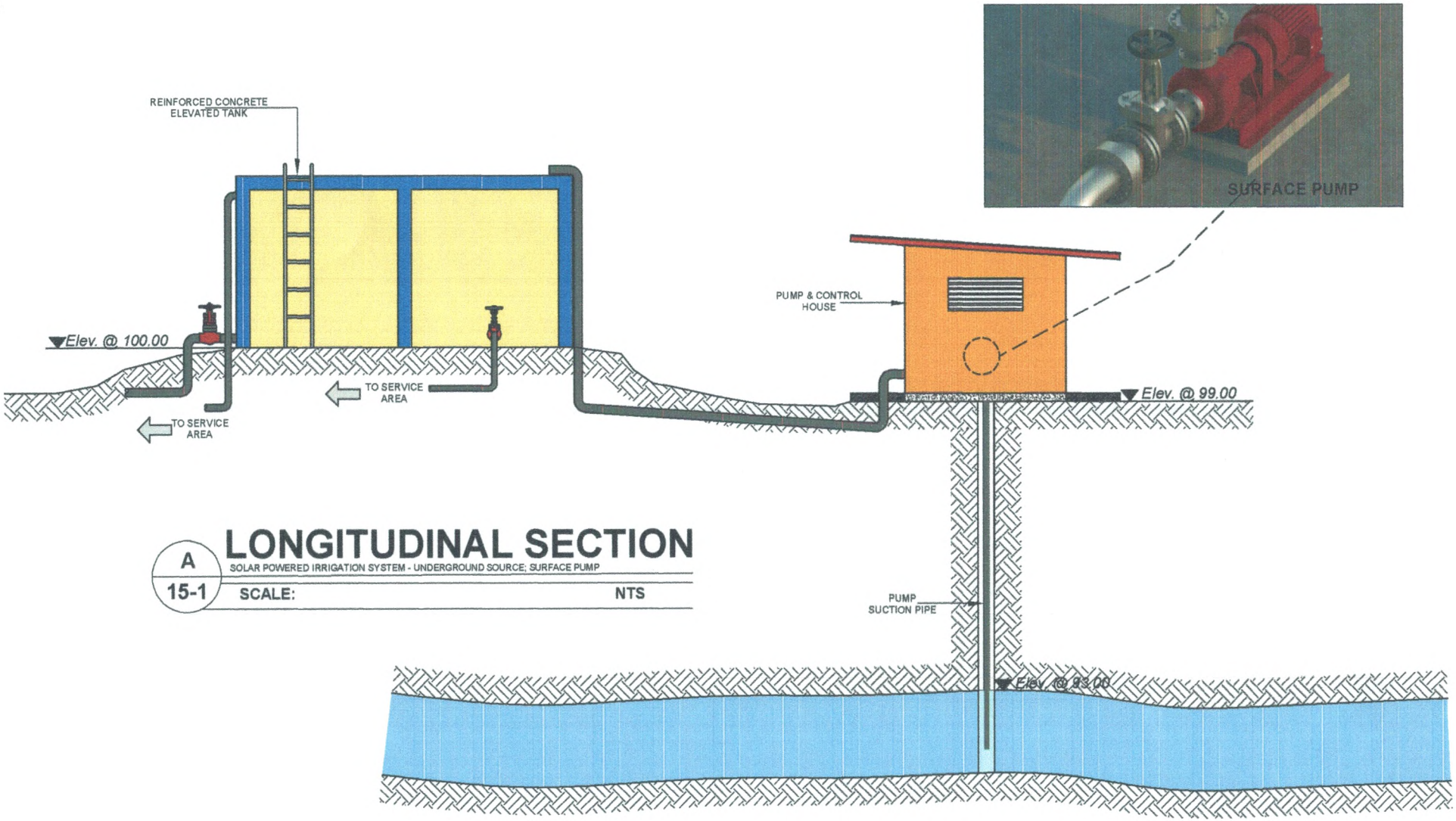
PROJECT TITLE	Sheet Content:	Sheet No.:
MODULAR DESIGN FOR SOLAR POWERED IRRIGATION SYSTEM	PERSPECTIVE VIEW - UNDERGROUND SOURCE WITH ELEVATED TANK AND SURFACE PUMP	A-13
PROJECT LOCATION		



A 14-1 SAMPLE FARM PLAN

Scale: 1:2500

PROJECT TITLE	Sheet Content:	Sheet No.:
MODULAR DESIGN FOR SOLAR POWERED IRRIGATION SYSTEM	SAMPLE FARM PLAN - UNDERGORUND SOURCE WITH ELEVATED TANK AND SURFACE PUMP	A-14
PROJECT LOCATION		



A
15-1

LONGITUDINAL SECTION

SOLAR POWERED IRRIGATION SYSTEM - UNDERGROUND SOURCE; SURFACE PUMP

SCALE: NTS

GENERAL NOTES:

- THE LONGITUDINAL SECTION SHOWS AN UNDERGROUND SOURCE SPIS WITH ELEVATED CONCRETE TANK AND SURFACE PUMP.

PROJECT TITLE	Sheet Content:	Sheet No.:
MODULAR DESIGN FOR SOLAR POWERED IRRIGATION SYSTEM	LONGITUDINAL SECTION - UNDERGROUND SOURCE WITH ELEVATED TANK AND SURFACE PUMP	A-15
PROJECT LOCATION		

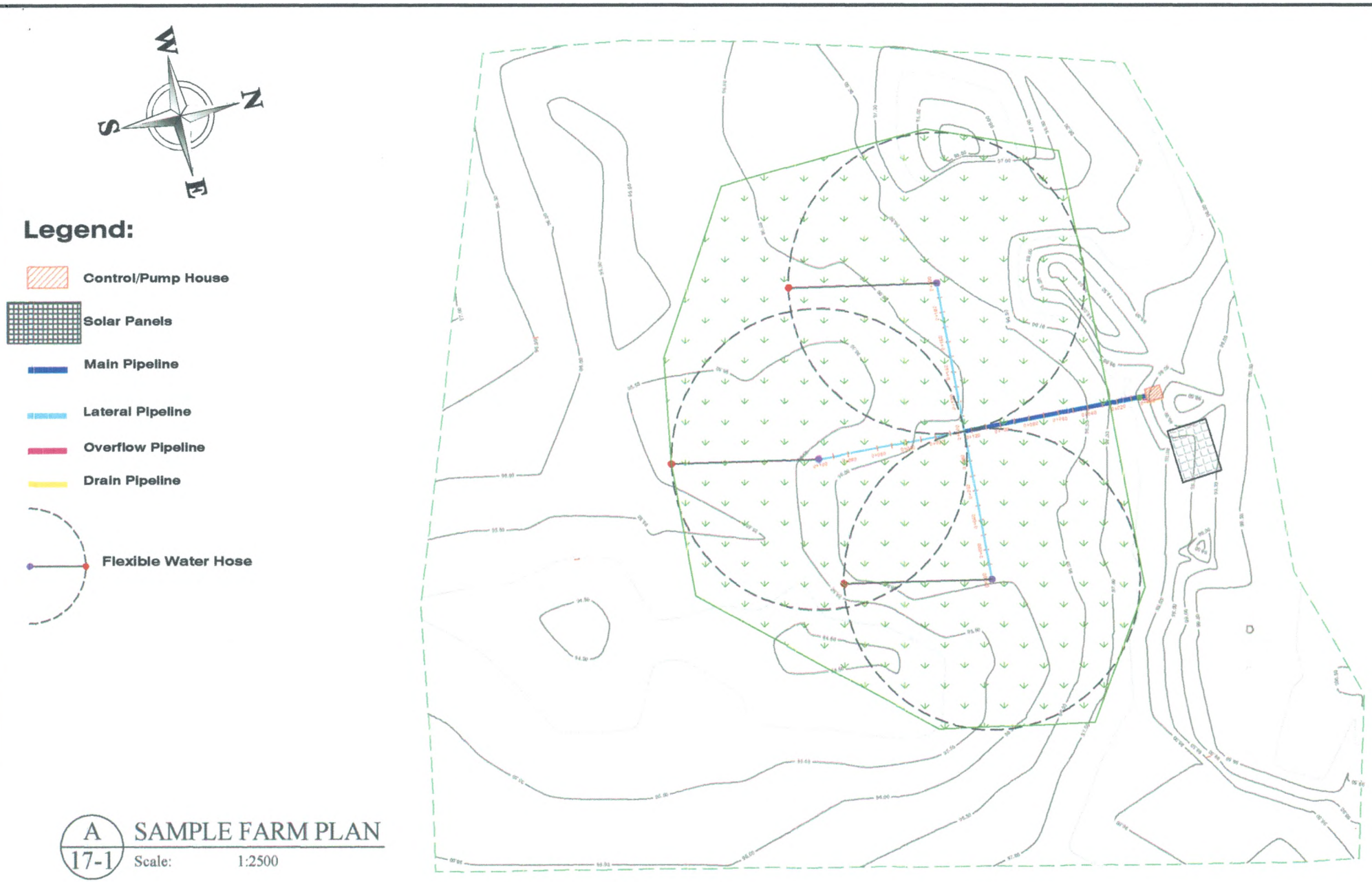
PERSPECTIVE VIEW

A
16-1

SOLAR POWERED IRRIGATION SYSTEM - UNDERGROUND SOURCE, SUBMERSIBLE PUMP

SCALE: NTS

PROJECT TITLE	Sheet Content:	Sheet No.:
MODULAR DESIGN FOR SOLAR POWERED IRRIGATION SYSTEM	PERSPECTIVE VIEW - UNDERGROUND SOURCE, SUBMERSIBLE PUMP	A-16
PROJECT LOCATION		

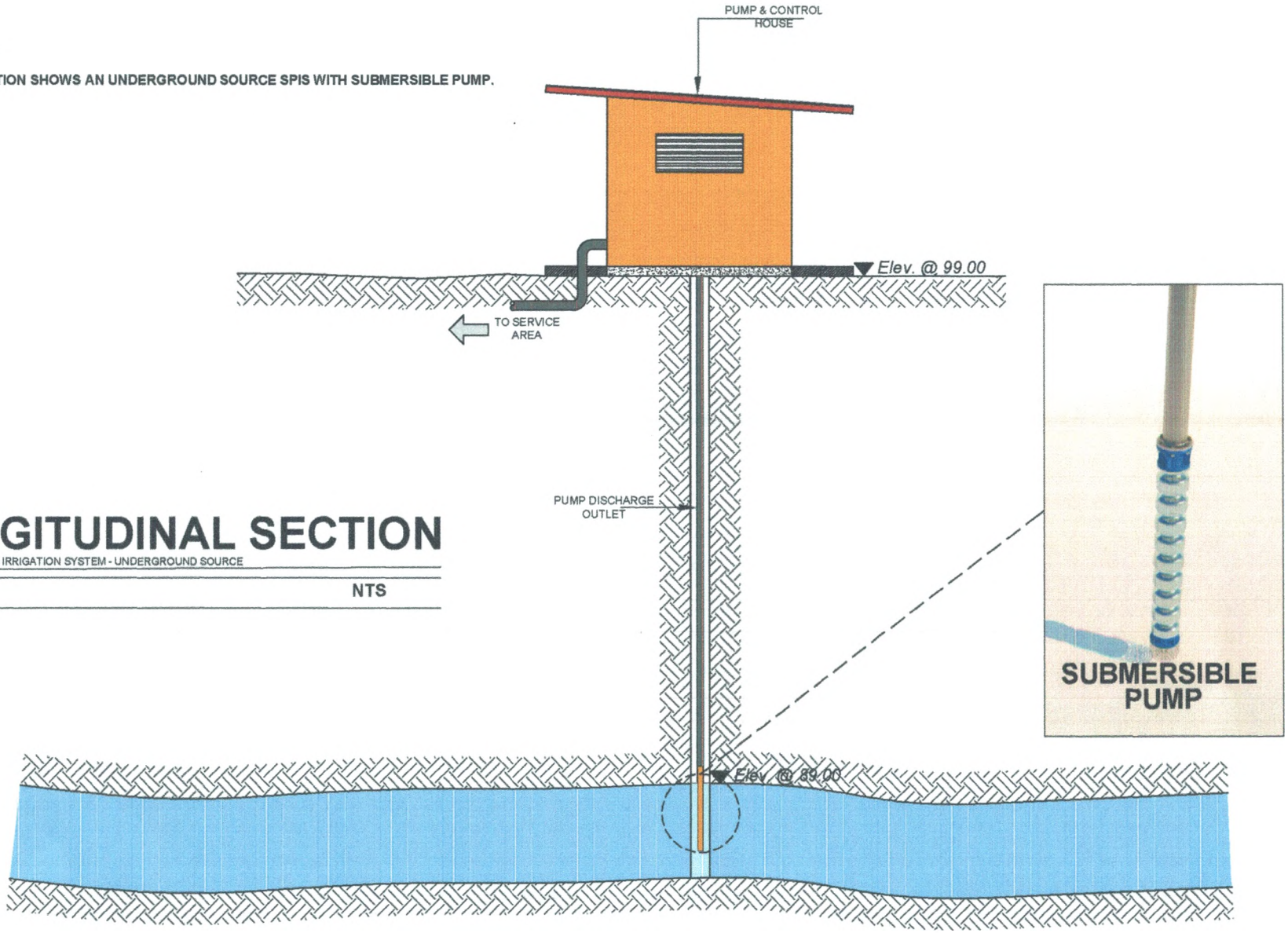


A
17-1
SAMPLE FARM PLAN
Scale: 1:2500

PROJECT TITLE	Sheet Content:	Sheet No.:
MODULAR DESIGN FOR SOLAR POWERED IRRIGATION SYSTEM	SAMPLE FARM PLAN - UNDERGROUND SOURCE, SUBMERSIBLE PUMP	A-17
PROJECT LOCATION		

GENERAL NOTES:

- **THE LONGITUDINAL SECTION SHOWS AN UNDERGROUND SOURCE SPIS WITH SUBMERSIBLE PUMP.**



A
18-1

LONGITUDINAL SECTION

SOLAR POWERED IRRIGATION SYSTEM - UNDERGROUND SOURCE

SCALE: NTS

PROJECT TITLE	Sheet Content:	Sheet No.:
MODULAR DESIGN FOR SOLAR POWERED IRRIGATION SYSTEM	LONGITUDINAL SECTION - UNDERGROUND SOURCE, SUBMERSIBLE PUMP	A-18
PROJECT LOCATION		

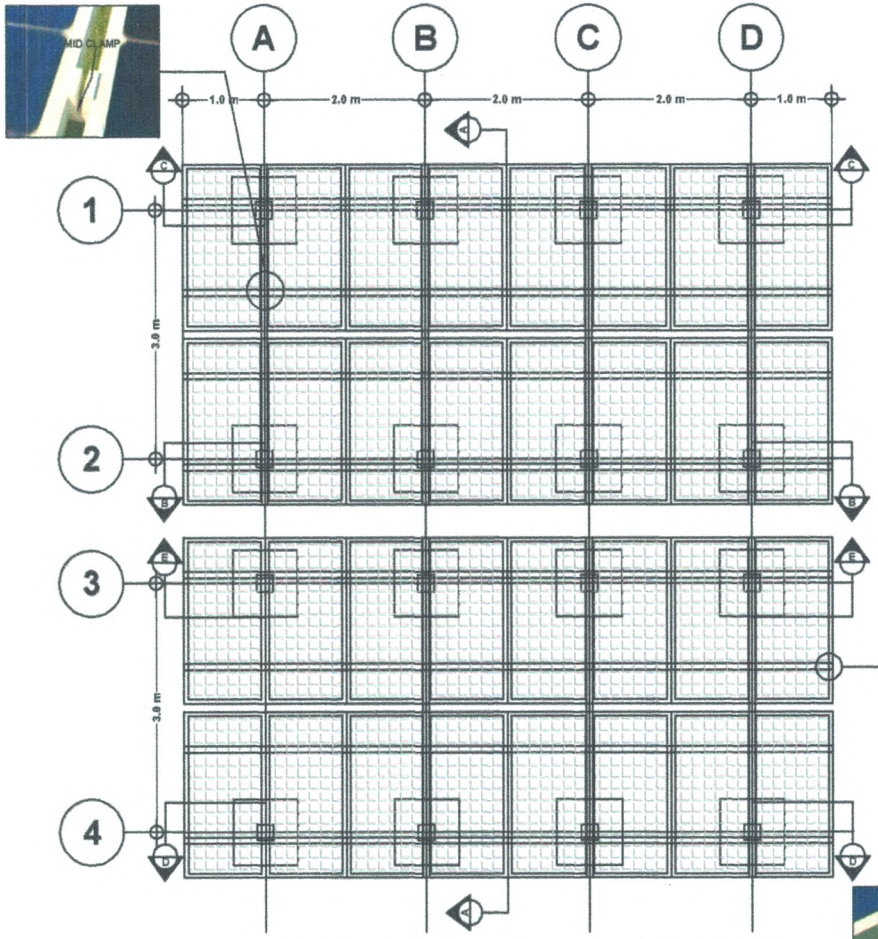
GENERAL NOTES:

- STEEL FRAMES, MADE OF EITHER GALVANIZED IRON (GI) PIPES OR ANGULAR BARS, SHOULD BE USED FOR SOLAR MOUNTING STRUCTURE.
- GALVANIZED IRON (GI) PIPES AND ANGLE BARS SHOULD EITHER BE PRIMED, HOT DIPPED GALVANIZED WITH MINIMUM OF 5 MILS OR DOUBLE-COATED WITH NON-CORROSIVE PAINT.
- CONNECTION BETWEEN STEEL FRAMES SHOULD BE NUTS AND BOLTS FOR EASIER ASSEMBLY AND DISMANTLING.
- THE SPECIFICATION OF SOLAR ARRAY SHOULD DEPEND ON THE REQUIREMENT AND AVAILABILITY IN THE MARKET.
- NOTE THAT THE DESIGN FOR SOLAR MOUNTING STRUCTURE IS A SAMPLE AND THE DESIGNER MAY OPT TO CHOOSE ANY DESIGN BASED ON HIS/HER DESIGN CALCULATION AND PREFERENCE.

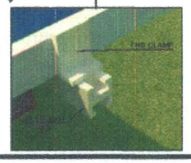
ASSUMPTIONS:

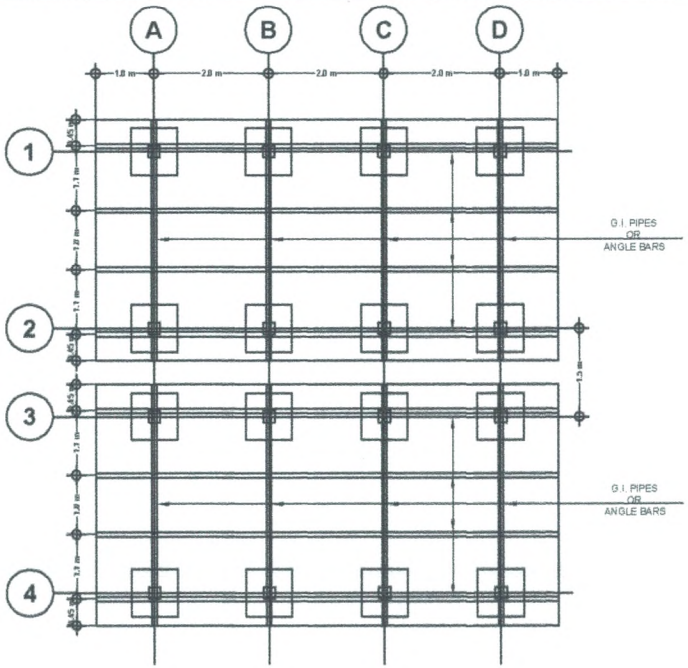
FOR THE SAMPLE DESIGN

- DESIGN PUMP CAPACITY = 10HP
- DESIGN SOLAR PV MODULES CAPACITY = 12000W (@ 375 Wp PER PV MODULE AND S.F. = 1.6)
- 4 STRINGS; 8 SOLAR PV MODULES PER STRING
- SOLAR PV MODULES MUST BE CONSTRUCTED FACING THE SOUTH DIRECTION TILTED AT 10°-15°.
- SOLAR INVERTER DESIGN CAPACITY = 15HP (WITH S.F. = 1.25 OF THE DESIGN PUMP CAPACITY)
- SPATIAL DISTANCE BETWEEN EACH PV MODULES SHOULD AT LEAST BE 20 mm

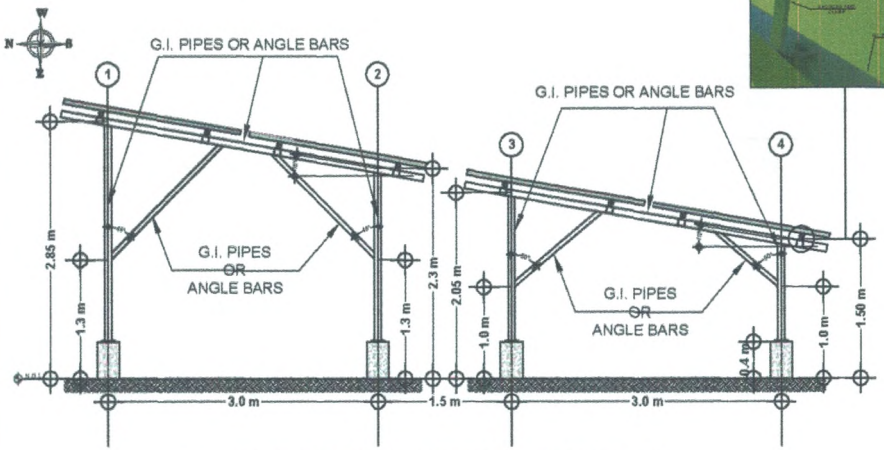


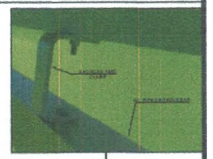
A 19-1 SOLAR ARRAY DETAILED PLAN
SCALE: NTS





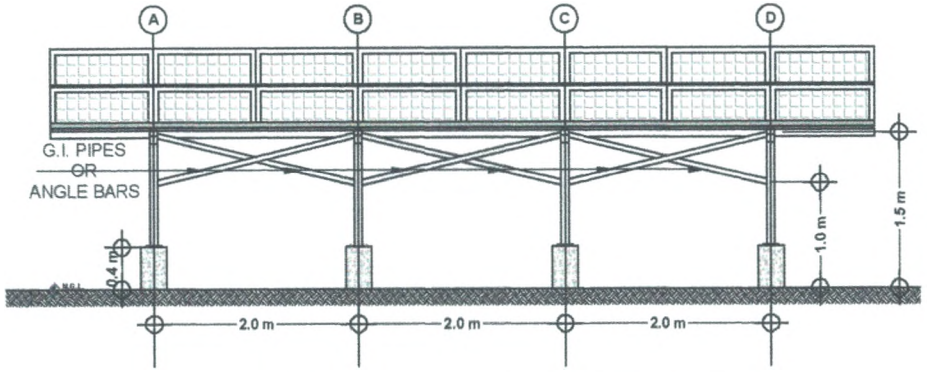
A 19-2 SOLAR ARRAY FRAME PLAN
SCALE: NTS





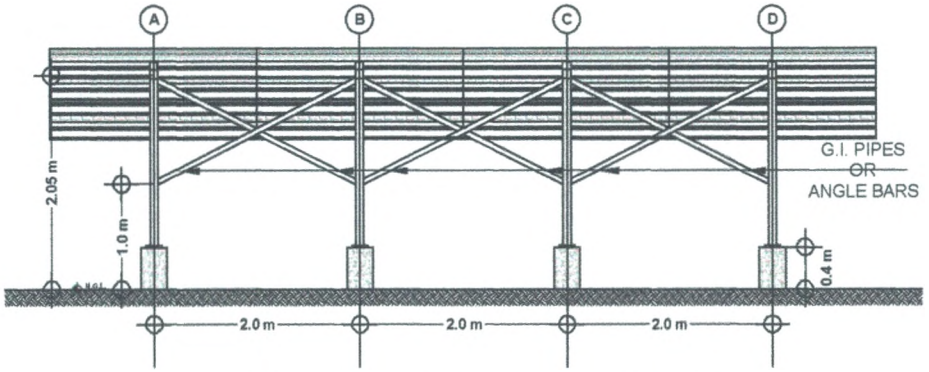
A 19-3 SOLAR ARRAY SECTION A-A
SCALE: NTS

PROJECT TITLE	Sheet Content:	Sheet No.:
MODULAR DESIGN FOR SOLAR POWERED IRRIGATION SYSTEM PROJECT LOCATION	SOLAR ARRAY DETAILED PLAN SOLAR ARRAY FRAME PLAN SOLAR ARRAY SECTION A-A	A-19



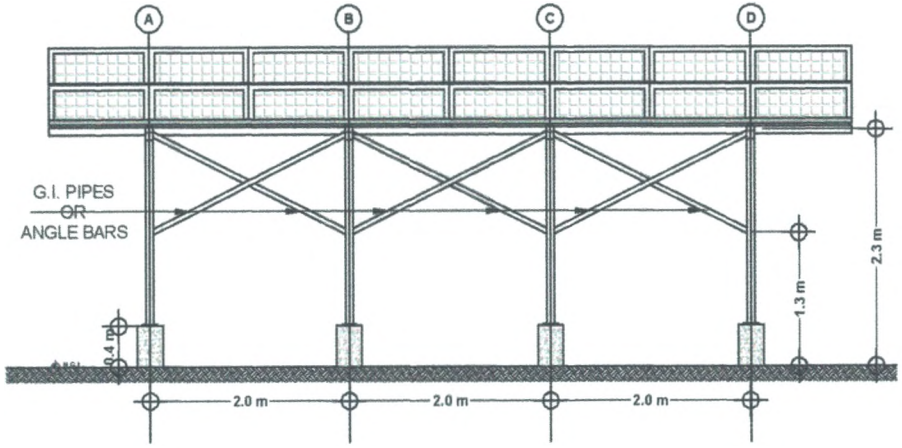
A 20-1 **SOLAR ARRAY SECTION B-B**

SCALE: NTS



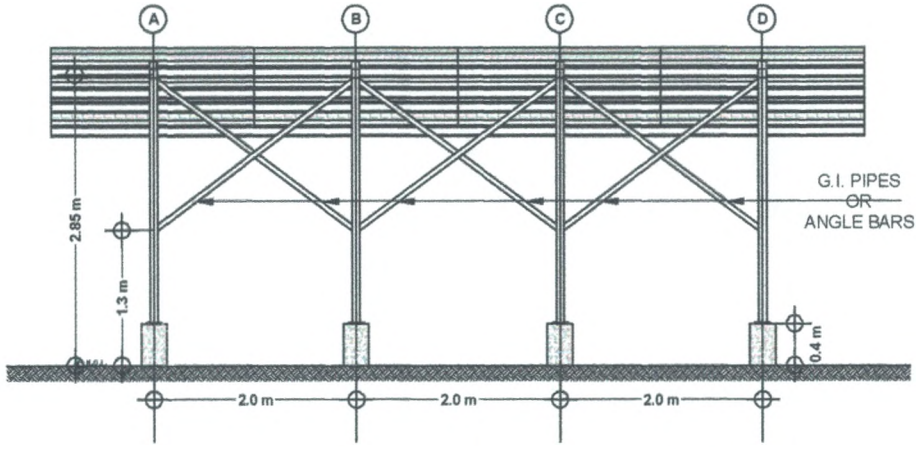
A 20-2 **SOLAR ARRAY SECTION C-C**

SCALE: NTS



A 20-3 **SOLAR ARRAY SECTION D-D**

SCALE: NTS



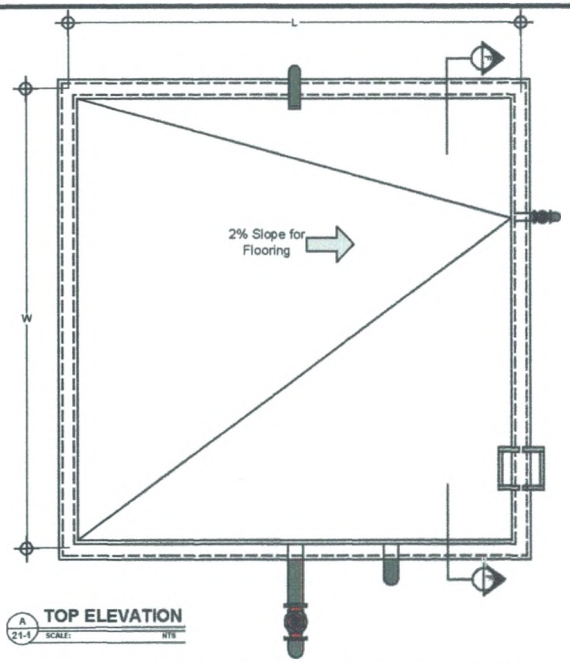
A 20-4 **SOLAR ARRAY SECTION E-E**

SCALE: NTS

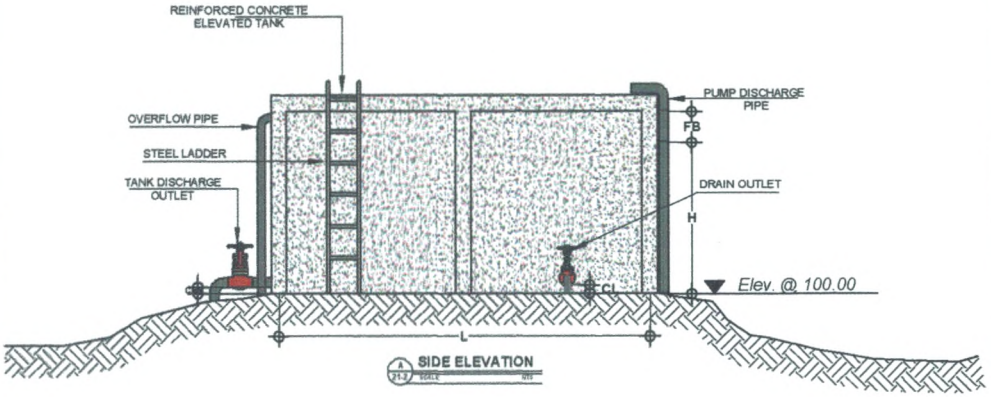
	PROJECT TITLE	Sheet Content:	Sheet No.:
	MODULAR DESIGN FOR SOLAR POWERED IRRIGATION SYSTEM	SOLAR ARRAY DETAILED PLAN - SECTIONAL VIEWS	A-20
	PROJECT LOCATION		

GENERAL NOTES:

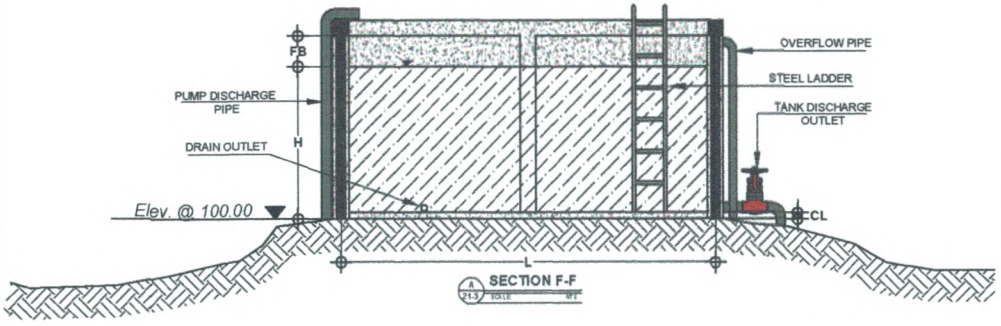
- H = HEIGHT OF THE TANK; FB= FREEBOARD; L= LENGTH OF THE TANK;
  W = WIDTH OF THE TANK; CL= CLEARANCE OF VALVE FROM THE GROUND (AT LEAST 100mm)
- THE DIMENSION OF THE TANK SHALL DEPEND ON THE CALCULATED HEIGHT NEEDED TO DELIVER SUFFICIENT PRESSURE TO THE SERVICE AREA. IN ADDITION, IT DEPENDS ON THE CALCULATED MOTION ANALYSIS BETWEEN INFLOW AND OUTFLOW OF WATER SUCH THAT THE HEIGHT OF WATER TO DELIVER ENOUGH PRESSURE IS MAINTAINED.
- SIZES OF THE PIPELINES SHALL DEPEND ON THE DESIGN CALCULATION OF THE DESIGNER.
- SELECTION OF MATERIALS FOR THE PIPE SYSTEM (i.e. G.I. PIPES OR HDPE PIPES) SHALL DEPEND ON THE DESIGNER BEARING IN MIND THAT THE SELECTED MATERIALS SHALL NOT COMPROMISE THE DESIGN PARAMETERS AND QUALITY OF THE PROJECT.
- THE DIAMETER OF TANK DISCHARGE PIPE SHALL BE LARGER THAT THE DIAMETER OF OVERFLOW PIPE.
- THE FLOORING OF THE TANK SHALL HAVE AT LEAST 2% SLOPE LEANING TOWARDS THE DRAIN OUTLET.
- OPTIONAL: PROVISION FOR STEEL GUARD RAILINGS AT THE TOP BEAM OF ELEVATED WATER TANK.
- STEEL LADDERS, STEEL RAILINGS, AND TANK MUST BE PAINTED WITH NON-CORROSIVE AND WATERPROOF PAINT.
- THERE SHALL BE A WARNING SIGN WITHIN THE VICINITY OF THE TANK AND PUMP HOUSE STATING "AUTHORIZE PERSONNEL ONLY"



A 21-1 TOP ELEVATION
SCALE: NTS

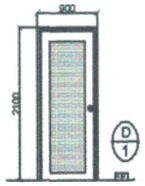


A 21-2 SIDE ELEVATION
SCALE: NTS

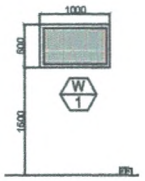


A 21-3 SECTION F-F
SCALE: NTS

PROJECT TITLE	Sheet Content:	Sheet No.:
MODULAR DESIGN FOR SOLAR POWERED IRRIGATION SYSTEM	ELEVATED CONCRETE TANK DETAILS	A-21
PROJECT LOCATION		

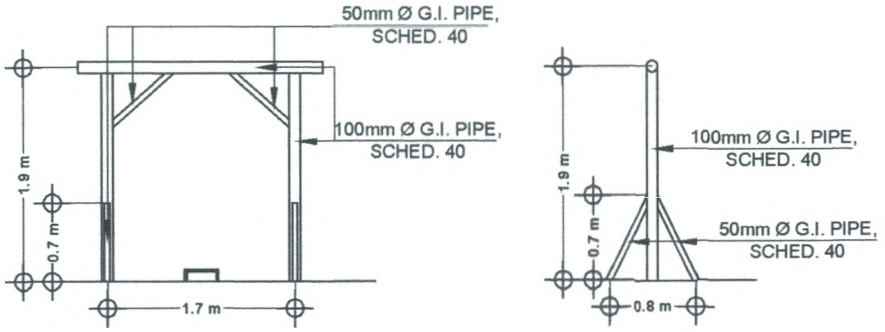


DESCRIPTION:
STEEL DOOR (LOUVER TYPE) WITH JAMB IN EPOXY PRIMER AND FINISH; COMPLETE LOCKSET
LOCATION: SEE FLOOR PLAN



DESCRIPTION:
STEEL WINDOW (LOUVER TYPE) WITH JAMB IN EPOXY PRIMER AND FINISH;
LOCATION: SEE FLOOR PLAN

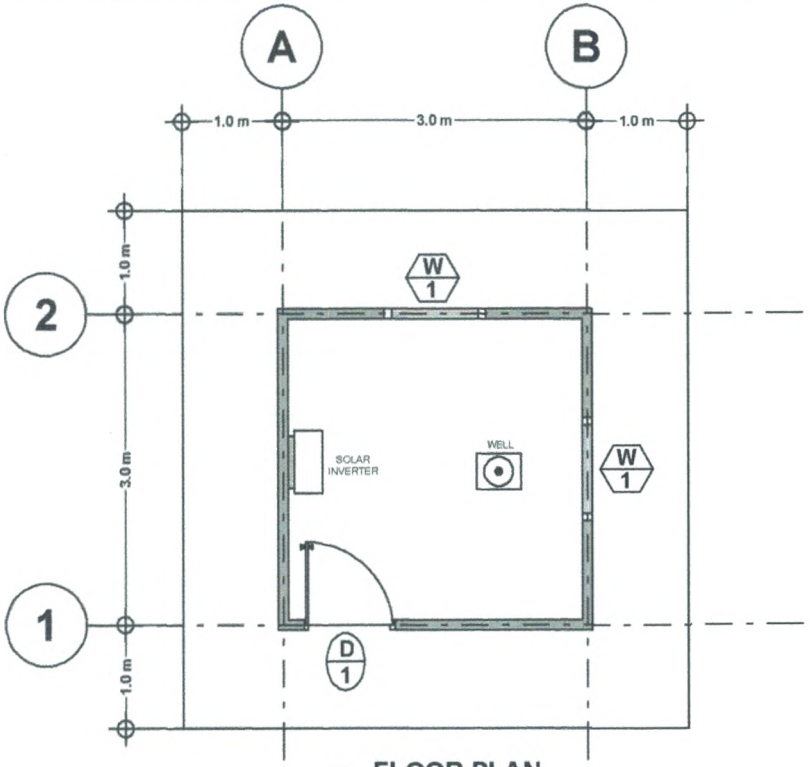
A 22-1 **SCHEDULE OF DOOR AND WINDOW**
SCALE: NTS



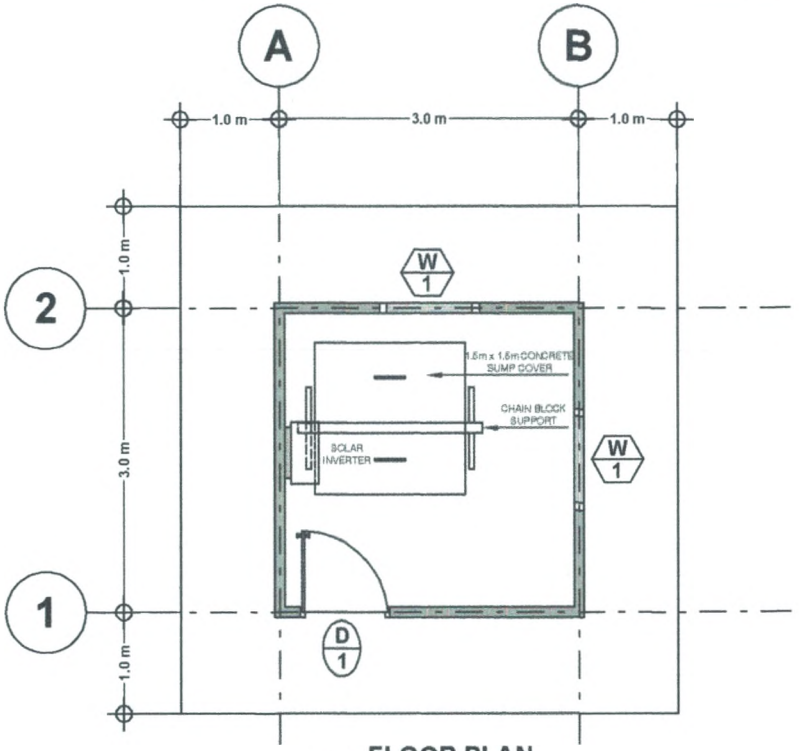
GENERAL NOTE:

- CHAIN BLOCK CAN BE INCLUDED FOR MAINTENANCE PURPOSES OF THE PUMP.

A 22-2 **CHAIN BLOCK SUPPORT DETAILS**
SCALE: NTS

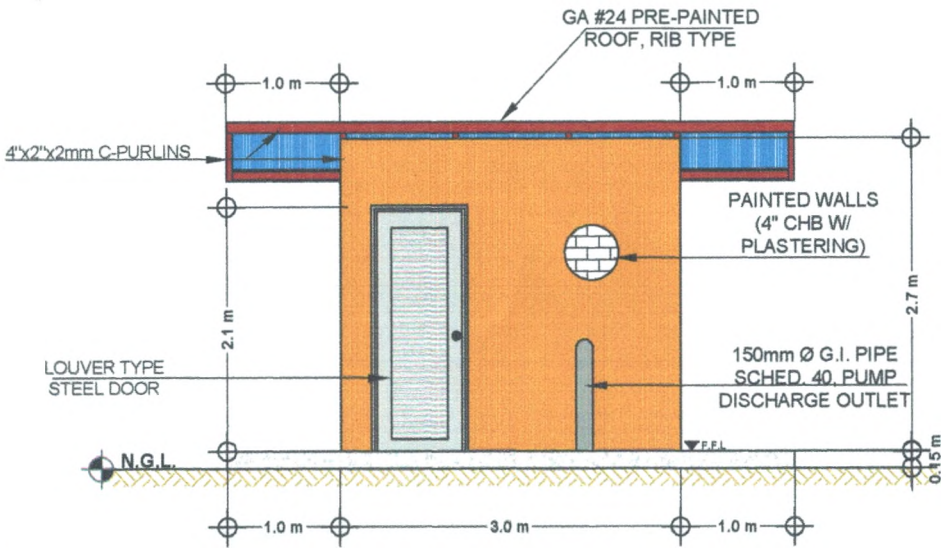


A 22-3 **FLOOR PLAN**
UNDERGROUND WATER SOURCE
SCALE: NTS

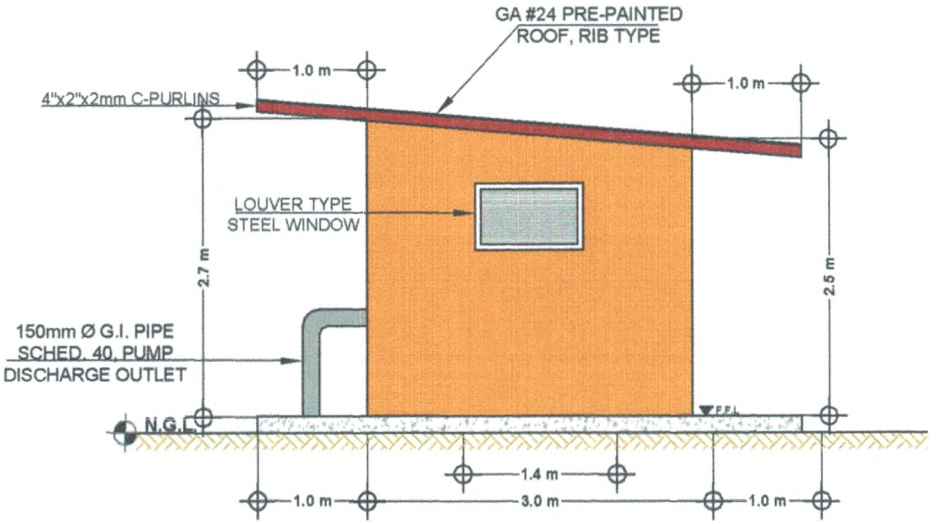


A 22-4 **FLOOR PLAN**
OPEN WATER SOURCE
SCALE: NTS

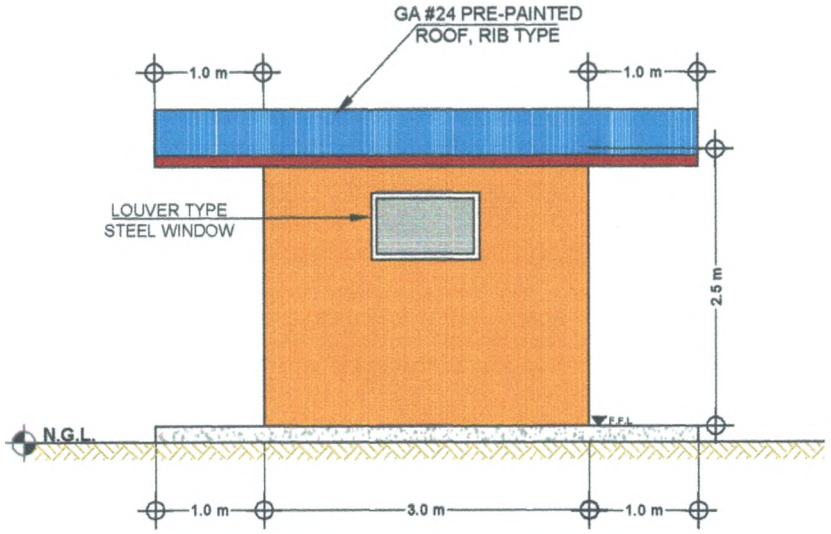
PROJECT TITLE	Sheet Content:	Sheet No.:
MODULAR DESIGN FOR SOLAR POWERED IRRIGATION SYSTEM	PUMP/CONTROL HOUSE FLOOR PLANS CHAIN BLOCK SUPPORT DETAILS SCHEDULE OF DOORS AND WINDOWS	A-22
PROJECT LOCATION		



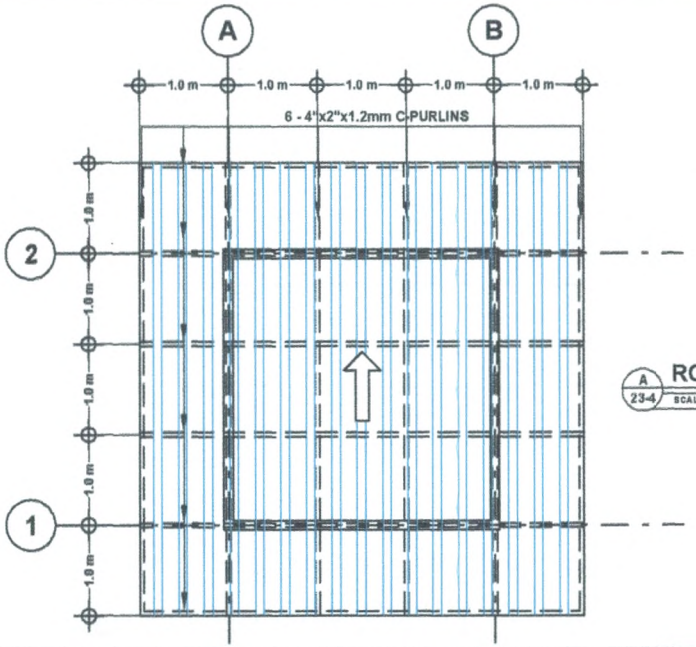
A 23-1 FRONT ELEVATION
SCALE: NTS



A 23-2 RIGHT SIDE ELEVATION
SCALE: NTS



A 23-3 REAR ELEVATION
SCALE: NTS



A 23-4 ROOF PLAN
SCALE: NTS

PROJECT TITLE	Sheet Content:	Sheet No.:
MODULAR DESIGN FOR SOLAR POWERED IRRIGATION SYSTEM	PUMP/CONTROL HOUSE ELEVATIONS PUMP/CONTROL HOUSE ROOF PLAN	A-23
PROJECT LOCATION		

GENERAL NOTES

1. IN THE INTERPRETATION OF THE DRAWING, INDICATED DIMENSIONS SHALL GOVERN AND DISTANCES AND SIZES SHALL NOT BE SCALED FOR CONSTRUCTION PURPOSES.
2. IN REFERENCE TO OTHER DRAWINGS, SEE ARCHITECTURAL DRAWINGS FOR DEPRESSIONS IN FLOOR SLABS, OPENINGS IN THE WALLS AND SLABS, INTERIOR PARTIONS, LOCATION OF DRAINS ETC.
3. IN CASE OF DISCREPANCIES AS TO THE LAYOUT, DIMENSIONS, AND ELEVATIONS BETWEEN THE STRUCTURAL PLANS, AND ARCHITECTURAL DRAWINGS, THE CONTRACTOR SHALL NOTIFY BOTH THE STRUCTURAL ENGINEER AND THE ARCHITECT.
4. ALL CONCRETE WORK SHALL BE DONE IN ACCORDANCE WITH THE ACI 318 95 BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE AND ALL STRUCTURAL STEEL WORK ACCORDING WITH AISC SPECIFICATION (9th EDITION) IN SO FAR AS THEY DO NOT CONFLICT WITH THE LOCAL BUILDING CODE REQUIREMENT.
5. ACI REFERS TO AMERICAN CONCRETE INSTITUTE, AISC TO AMERICAN INSTITUTE OF STEEL CONSTRUCTION AND ASTM TO AMERICAN SOCIETY FOR TESTING MATERIALS.
6. CONSTRUCTION NOTES AND TYPICAL DETAILS APPLY TO ALL DRAWINGS UNLESS OTHERWISE SHOWN OR NOTED. MODIFY TYPICAL DETAILS AS DIRECTED TO MEET SPECIAL CONDITIONS
7. SHOP DRAWINGS WITH ERECTION AND PLACING DIAGRAMS OF ALL STRUCTURAL STEELS, MISCELLANEOUS IRON, PRE-CAST CONCRETE, ETC SHALL BE SUBMITTED FOR ENGINEERS APPROVAL BEFORE FABRICATION.
8. CONTRACTOR SHALL NOTE AND PROVIDE ALL MISCELLANEOUS CURBS, SILLS, STOOLS, EQUIPMENT'S AND MECHANICAL BASES THAT ARE REQUIRED BY THE ARCHITECTURAL, ELECTRICAL, AND MECHANICAL DRAWINGS.
9. ALL RESULTS OF MATERIAL TESTING FOR CONCRETE, REINFORCING BARS, & STRUCTURAL STEEL MUST BE NOTED & APPROVED BY THE STRUCTURAL DESIGNER

NOTES ON CONCRETE MIXES & PLACING

1. ALL CONCRETE SHALL DEVELOP A MIN. COMPRESSIVE STRENGTH AT THE END OF TWENTY EIGHT (28) DAYS W/ CORRESPONDING MAXIMUM SIZE AGGREGATE & SLUMPS AS FOLLOWS

LOCATION	28 DAYS STRENGTH		MAX. SIZE OF MAX. AGGREGATE	SLUMP
ALL OTHERS, INCLUDING SUSPENDED SLABS,	4000 PSI	(27.6 MPa)	20mm	100mm
COLUMNS	4000 PSI	(27.6 MPa)	20mm	100mm
BEAMS, SLABS	4000 PSI	(27.6 MPa)	20mm	100mm
SLAB ON FILL	4000 PSI	(27.6 MPa)	20mm	100mm

2. MAINTAIN MINIMUM CONCRETE COVER FOR REINFORCING STEEL AS FOLLOWS
   - SUSPENDED SLABS ---------- 20mm
   - SLAB ON GRADE ---------- 40mm
   - WALLS ABOVE GRADE ---------- 25mm
   - BEAM STIRRUPS AND COLUMN TIES ---------- 40mm
   - WHERE CONCRETE IS EXPOSED TO EARTH BUT POURED AGAINST FORMS ---------- 50mm
   - WHERE CONCRETE IS DEPOSITED DIRECTLY AGAINST EARTH ---------- 75mm
3. CONCRETE SHALL BE DEPOSITED IN ITS FINAL POSITION WITHOUT SEGREGATION. RE-HANDLING OR PLACING SHALL BE DONE PREFERABLY WITH BUGGIES, BUCKETS OR WHEELBARROWS, NO CHUTES WILL BE ALLOWED EXCEPT TO TRANSFER CONCRETE FROM HOPPERS TO BUGGIES, WHEELBARROWS OR BUCKETS IN WHICH CASE THEY SHALL NOT EXCEED SIX (6) METERS IN AGGREGATE LENGTH
4. NO DEPOSITING OF CONCRETE SHALL BE ALLOWED WITHOUT THE USE OF VIBRATORS UNLESS AUTHORIZED IN WRITING BY THE DESIGNERS AND ONLY FOR UNUSUAL CONDITIONS WHERE VIBRATIONS ARE EXTREMELY DIFFICULT TO ACCOMPLISH.
5. ALL ANCHOR BOLTS, DOWELS, AND OTHER INSERTS, SHALL BE PROPERLY POSITIONED & SECURED IN PLACE PRIOR TO PLACING OF CONCRETE.
6. ALL CONCRETE SHALL BE KEPT MOIST FOR A MINIMUM OF SEVEN CONSECUTIVE DAYS IMMEDIATELY AFTER POURING BY THE USE OF WET BURLAP, FOG SPRAYING, CURING COMPOUNDS OR OTHER APPROVED METHODS.
7. STRIPPING OF FORMS AND SHORES.
   - FOUNDATION ---------- 24 HRS.
   - SUSPENDED SLAB EXCEPT WHEN ADDITIONAL LOADS ARE IMPOSED ---------- 8 DAYS
   - WALLS ---------- 21 DAYS
   - BEAMS ---------- 14 DAYS
   - COLUMNS ---------- 21 DAYS
8. THE CONTRACTOR SHALL SUBMIT THE SCHEDULE OF POURING AND THE LOCATION OF THE CONSTRUCTION JOINTS TO THE STRUCTURAL ENGINEER AT LEAST (4) DAYS PRIOR TO THE POURING FOR APPROVAL.
9. THE CONTRACTOR SHALL FURNISH AND MAINTAIN ADEQUATE FORMS AND SHORINGS UNTIL THE CONCRETE MEMBERS HAVE ATTAINED THEIR WORKING CONDITION AND STRENGTH.

NOTES ON FOOTINGS

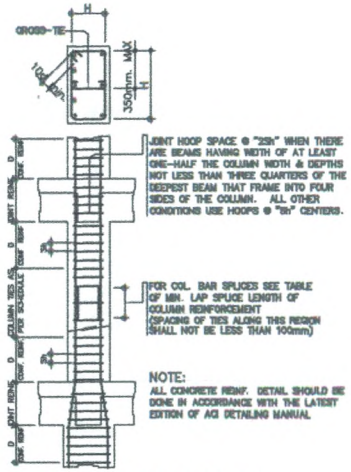
1. FOOTINGS ARE DESIGNED FOR AN ALLOWABLE SOIL BEARING PRESSURE OF 95 KPa (2000 psf) .CONTRACTOR SHALL REPORT TO THE ENGINEER, IN WRITING, THE ACTUAL SOIL CONDITIONS UNCOVERED AND CONFIRM ACTUAL BEARING CAPACITY OF SOIL BEFORE DEPOSITING CONCRETE.
2. FOOTING SHALL REST AT LEAST 600mm BELOW NATURAL GRADE LINE UNLESS OTHERWISE INDICATED IN PLANS. NO FOOTING SHALL REST ON FILL.
3. MINIMUM CONCRETE PROTECTION FOR REINFORCEMENTS SHALL BE 75 mm CLEAR FOR CONCRETE DEPOSITED THE GROUND AND 50mm FOR CONCRETE DEPOSITED AGAINST A FORMWORK.

NOTES ON REINFORCEMENT

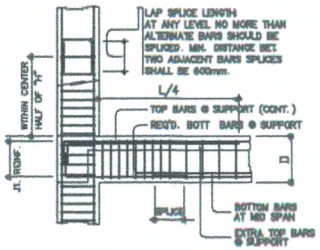
1. UNLESS OTHERWISE NOTED IN PLANS, THE YIELD STRENGTH OF REINFORCING BARS SHALL BE:
   - A. FOOTINGS, FOOTING BEAMS, GIRDERS ---------- fy = 275 MPa (40,000 psi)
   - B. COLUMNS AND SHEAR WALLS ---------- fy = 275 MPa (40,000 psi)
   - C. BEAMS AND GIRDER ---------- fy = 275 MPa (40,000 si)
   - D. NON-LOAD BEARING WALL PARTITIONS, BEDDED SLABS, FLOOR & ROOF SLABS, P PARAPETS, CATCH BASIN, SIDE WALK ---------- fy = 2275 MPa (33,000 psi)
2. ALL REINFORCING BARS SIZE 10mm OR LARGER SHALL BE DEFORMED IN ACCORDANCE WITH ASTM A 706. BARS SMALLER THAN 10mm MAY BE PLAIN.
3. SPLICES SHALL BE SECURELY WIRED TOGETHER & SHALL LAP OR EXTEND IN ACCORDANCE W/ TABLE A & TABLE B (TABLE OF LAP SPLICE & ANCHORAGE LENGTH) UNLESS OTHERWISE SHOWN ON DRAWINGS, SPLICES SHALL BE STAGGERED WHENEVER POSSIBLE

NOTES ON COLUMNS

1. PROVIDE EXTRA SETS OF TIES AT 100mm OC. FOR TIED COLUMN REINFORCEMENT ABOVE AND BELOW BEAM-COLUMN CONNECTIONS FOR A DISTANCE FROM FACE OF CONNECTION EQUAL TO THE GREATER OF THE OVERALL THICKNESS OF COLUMN, 1/6 THE CLEAR HEIGHT OF COLUMN OR 450mm.
2. COLUMN TIES SHALL BE PROTECTED EVERYWHERE BY A COVERING OF CONCRETE CAST MONOLITHICALLY WITH THE CORE WITH THE MINIMUM THICKNESS OF 40mm AND NOT LESS THAN 40 TIMES THE MAXIMUM SIZE OF COARSE AGGREGATE IN MILLIMETERS.
3. WHERE COLUMNS CHANGE IN SIZE, VERTICAL REINFORCEMENTS SHALL SHALL BE OFFSET AT A SLOPE OF NOT MORE THAN 1 IN 6 AND EXTRA 10mm TIES AT 100mm SHALL BE PROVIDED THRU OUT THE OFFSET REGION.
4. UNLESS OTHERWISE INDICATED IN THE PLANS, LAP SPLICES FOR VERTICAL COLUMN REINFORCEMENT SHALL BE MADE WITHIN THE CENTER HALF OF COLUMN HEIGHT, AND THE SPLICE LENGTH SHALL NOT BE LESS THAN 40 BAR DIAMETERS. WELDING OR APPROVED MECHANICAL DEVICES MAY BE USED PROVIDED THAT NOT MORE THAN ALTERNATE BARS ARE WELDED OR MECHANICALLY SPLICED AT ANY LEVEL AND THE VERTICAL DISTANCES BETWEEN THESE WELDS OR SPLICES OF ADJACENT BARS IS NOT LESS THAN 600mm



TYPICAL COLUMN ELEV. SHOWING DOWELS AND TIES SPACING



TYP. DETAIL OF COL LAP SPLICE & EXT. GIRDER TO COL CONNECT

NOTES ON BEAMS AND GIRDERS

1. UNLESS , OTHERWISE NOTED IN PLANS, CAMBER ALL BEAMS AND GIDER AT LEAST 6mm@ FOR EVERY 4.5 0M OF SPAN , EXCEPT CANTILEVERS FOR WHICH THE CAMBER SHALL BE AS NOTED IN PLANS OR AS ORDERED BY THE ENGINEER BUT IN NO CASE LESS THAN 20mm FOR EVERY 30M OF FREE SPAN .
2. TYPICAL BARS BENDING AND CUTTING DETAILS FOR BEAMS SHALL BE AS SHOWN IN FIG. B-1.

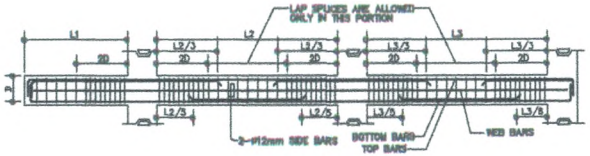


FIG. B-1

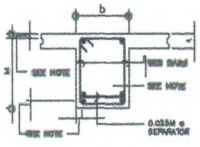
TABLE 'A' TENSION BARS EMBEDMENT LENGTHS AND LAPPED SPLICED IN MILLIMETERS				
BAR SIZE (DEFORMED)	fc'= 20 .7MPa(3000psi)		fc'= 27 .6MPa(4000psi)	
	EMBEDMENT	LAPPED	EMBEDMENT	LAPPED
10mm #	300	300	300	300
12mm #	300	300	300	300
16mm #	300	400	300	400
20mm #	400	550	350	500
25mm #	500	800	550	700
28mm #	750	1000	650	850
32mm #	950	1300	850	1150

NOTE : TOP PLAIN BARS , MULTIPLY VALUE BY 2

TABLE 'B' COMPRESSION BARS EMBEDMENT LENGTHS AND LAPPED SPLICED IN MILLIMETERS				
BAR SIZE (DEFORMED)	fc'= 20 .7MPa(3000psi)		fc'= 27 .6MPa(4000psi)	
	EMBEDMENT	LAPPED	EMBEDMENT	LAPPED
10mm #	225	300	200	300
12mm #	275	300	250	300
16mm #	350	400	325	400
20mm #	450	550	475	500
25mm #	550	625	550	625
28mm #	625	675	625	675
32mm #	700	775	700	775

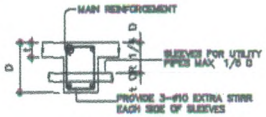
NOTE : TOP PLAIN BARS , MULTIPLY VALUE BY 2
VALUES GIVEN ABOVE CAN ALSO BE USED FOR COLUMNS.

3. IF THE BEAM REINFORCING BARS END IN A WALL THE CLEAR DISTANCE FROM THE BAR TO THE FARTHER FACE OF THE WALL NOT BE LESS THAN 25 mm EMBEDMENT LENGTH SHALL BE AS SHOWN IN A TABLE 'A' FOR TENSION BARS AND TABLE 'B' FOR COMPRESSION BARS UNLESS SPECIFIED IN PLAN. TOP BAR SHALL NOT BE SPLICED WITHIN THE COLUMN OR WITHIN A DISTANCE TWICE THE MEMBER DEPTH FROM THE FACE OF THE COLUMN, AT LEAST TWO STIRRUPS SHALL BE PROVIDED AT ALL SPLICES
4. IF THERE ARE TWO OR MORE LAYERS OF REINFORCING BARS, USE 25 mm# BAR SEPARATORS SPACED AT 1.0M ON CENTER IN NO CASE SHALL THERE BE LESS THAN TWO (2) SEPARATORS BETWEEN TWO LAYERS OF BARS
5. MINIMUM CONCRETE PROTECTION FOR REINFORCING BARS OR STEEL SHAPES SHALL BE AS SHOWN IN FIG. B-2 UNLESS SPECIFIED ELSEWHERE.



NOTE 1
20 mm CLEAR FOR JOIST
40 mm CLEAR FOR BEAMS AND GIRDERS

FIG. B-2



TYP. DET FOR SLEEVES THRU CONCRETE BEAM

FIG. B-3

6. WHEN A BEAM CROSSES A GIRDER, REST BEAM ON TOP OF GIRDER BARS, BEAM REINFORCING BAR SHALL BE SYMMETRICAL ABOUT CENTER LINE WHENEVER POSSIBLE
7. GENERALLY NO SPLICES SHALL BE PERMITTED AT POINTS WHERE CRITICAL BENDING STRESSES OCCUR. SPLICES WHERE SO PERMITTED SHALL BE INDICATED IN THE TABLE 'A' AND 'B'. WELDED SPLICES SHALL DEVELOP IN TENSION AT LEAST 125 % OF THE SPECIFIED YIELD STRENGTH OF THE BAR NOT MORE THAN 50% OF THE BARS AT ANY ONE SECTION IS ALLOWED TO BE SPLICED THEREIN.

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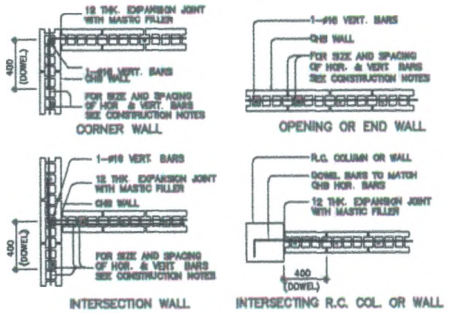
NOTES ON CONCRETE HOLLOW BLOCK WALLS

1. UNLESS OTHERWISE SHOWN IN PLANS ALL CONCRETE HOLLOW BLOCKS AND CERAMIC BLOCKS SHALL BE REINFORCED AS SHOWN IN THE SCHEDULE OF CONCRETE HOLLOW BLOCKS AND CERAMIC BLOCK REINFORCEMENT.
2. PROVIDE 150mm x 300mm STIFFENER COLUMN REINFORCED WITH 4-12mm WITH 6mm# TIES AT 150mm OR CENTER WHERE CONCRETE HOLLOW BLOCK TERMINATES AND AT EVERY 3.0M LENGTH OF CONCRETE HOLLOW BLOCK WALLS UNLESS NOTED IN STRUCTURAL PLANS.

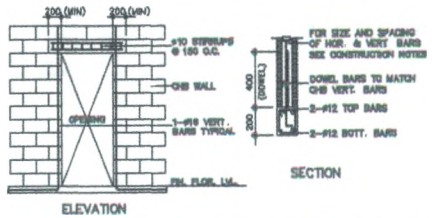
SCHEDULE OF CONCRETE HOLLOW BLOCK AND CERAMIC BLOCK REINFORCEMENT			
BLOCK THICKNESS	REINFORCEMENT		NOTES
	HORIZONTAL	VERTICAL	
75 mm	10mm# @ 600mm o.c.	10mm# @ 600mm o.c.	A. MINIMUM LAPS AT SPLICE = 0.30 M B. PROVIDE RIGHT ANGLED REINFORCEMENT AT CORNERS SEE LEGS C. WHERE CHB OR CER. BLK WALL DOWELS FOR EXT. RC. BEAMS AND WALL DOWELS WITH THE SAME SIZE AS VERT. OR HOR REINFORCEMENTS SHALL BE PROVIDED
125 mm	10mm# @ 600mm o.c.	10mm# @ 600mm o.c.	
150 mm	10mm# @ 600mm o.c.	10mm# @ 600mm o.c.	
200mm	10mm# @ 600mm o.c.	12mm# @ 600mm o.c.	

REINFORCING CONCRETE LINTEL BEAM IN CONCRETE BLOCK WALLS

LINTELS IN BLOCK WALLS						
CLEAR SPAN ("L")	TOTAL LOADING (L+0.45W)	MIN. W (kPa)	HEIGHT OF LINTEL (MM)	REINFORCEMENT		
				BOTTOM	TOP	STIRRUPS
1.20M 1.50M 1.80M	1.80M 1.95M 2.25M	14.0	200 200 200	1-#10 1-#10 1-#12	1-#10 1-#10 1-#10	#8mm @ 300mm #8mm @ 200mm #8mm @ 300mm
2.10M 2.40M 2.70M	2.25M 2.55M 2.70M	17.0	200 200 200	1-#12 1-#12 1-#12	1-#10 1-#10 1-#10	#8mm @ 300mm #8mm @ 200mm #8mm @ 300mm
3.00M 3.30M 3.60M	3.40M 3.70M 4.00M	20.0	300 300 300	1-#12 1-#12 1-#20	1-#12 1-#12 1-#12	#10mm @ 300mm #10mm @ 200mm #10mm @ 300mm



TYPICAL CONNECTION DETAIL OF MASONRY WALL



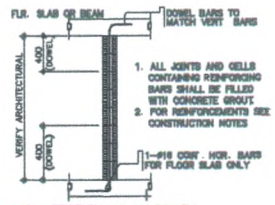
TYP. DET OF LINTEL BEAM AT CHB WALL OPENING

NOTES ON STRUCTURAL STEEL

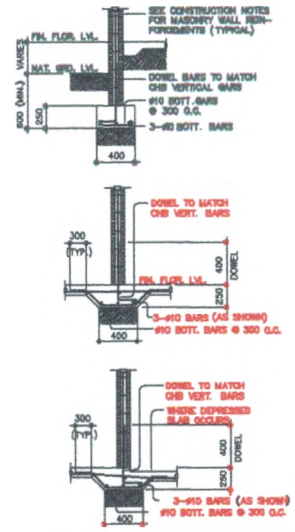
1. STRUCTURAL STEEL TO BE USED FOR FABRICATION AND ERECTION OF THIS STRUCTURE SHALL COMPLY WITH ALL THE PERTINENT PROVISION OF AISC SPECIFICATION FOR THE DESIGN, FABRICATION AND ERECTION OF STRUCTURAL STEEL FOR BUILDING LATEST EDITION.
2. ALL STRUCTURAL STEEL SHAPES SHALL CONFORM TO ASTM A36 STRUCTURAL STEEL UNLESS OTHERWISE INDICATED.
3. ALL WELDED CONNECTIONS SHALL DEVELOP THE FULL STRENGTH OF THE MEMBERS CONNECTED.
4. UNLESS OTHERWISE SPECIFIED ALL WELDING RODS SHALL CONFORM AWS E60 ELECTRODES
5. ALL BOLTS USED UNLESS OTHERWISE SPECIFIED SHALL BE ASTM A 307 BOLTS.

NOTES ON WELDS

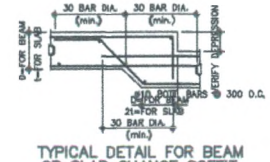
1. USE E70xx ELECTRODES FOR ALL MEMBERS WELDED.
2. WELDS SHALL DEVELOP THE FULL STRENGTH OF MEMBERS JOINED UNLESS OTHERWISE SHOWN OR DETAILED IN THE DRAWINGS



TYP. SECTION OF MASONRY PARTITION REINFORCEMENTS



TYPICAL CHB FOOTING DETAILS
(WHERE APPLICABLE)



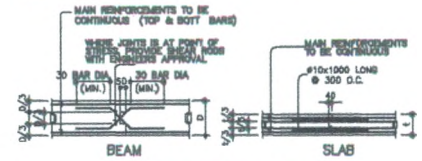
TYPICAL DETAIL FOR BEAM OR SLAB CHANGE SOFFIT

NOTES ON EMBEDED PIPES

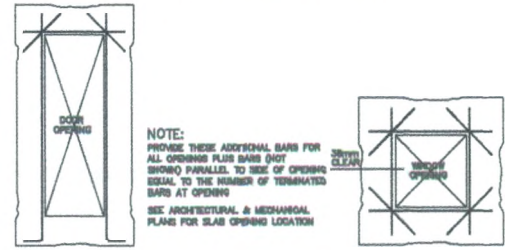
A. ALL EMBEDED PIPES FOR UTILITIES, ETC THAT PASS THRU BEAMS SHALL NOT EXCEED 100mm IN DIAMETER OR 1/3 BEAM DEPTH WHICHEVER IS LESS, UNLESS OTHERWISE APPROVED IN WRITING BY THE STRUCTURAL ENGINEER
B. NO PIPES SHALL BE ALLOWED TO PASS THRU BEAMS VERTICALLY
C. NO PIPES SHALL BE EMBEDED IN COLUMNS.

NOTES ON CONSTRUCTION JOINTS IN CONCRETE

1. WHERE A CONSTRUCTION JOINT IS TO BE MADE, THE SURFACE OF CONCRETE SHALL BE CLEANED AND ALL LATTANCE AND STANDING WATER REMOVED SHEAR KEY SHALL BE PROVIDED AT THE JOINT



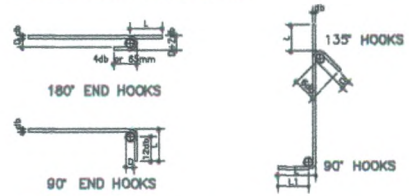
TYPICAL SLAB & BEAM CONSTRUCTION JOINT DET.



TYP. EXTERIOR WINDOW & DOOR OPENING

NOTES OF STIRRUPS

1. ALL REINFORCEMENT SHALL BE BENT COLD UNLESS OTHERWISE PERMITTED BY THE STRUCTURAL ENGINEER.
2. REINFORCEMENT PARTIALLY EMBEDED IN CONCRETE SHALL NOT BE FILLED BENT,EXCEPT AS SHOWN IN THE DESIGN DRAWINGS OR PERMITTED BY THE STRUCTURAL ENGINEER.
3. TIES & CLOSE STIRRUPS MUST BE BENT AT 135°



MAIN BAR END HOOKS (ALL GRADES)				
BAR SIZE (DEFORMED)	DIAMETER (mm)	180° HOOK		90° HOOK
		D+2db	L	L
10mm #	60	75	125	150
12mm #	75	100	150	200
16mm #	85	125	175	250
20mm #	115	150	200	300
25mm #	150	200	230	450
28mm #	240	300	350	550
32mm #	300	335	450	600

STIRRUP AND TIE HOOKS (ALL GRADES)				
BAR SIZE (DEFORMED)	DIAMETER (mm)	135° HOOK		90° HOOK
		D+2db	L	L
10mm #	40	125	85	100
12mm #	50	165	115	115
16mm #	65	220	140	150
20mm #	115	250	165	300
25mm #	150	365	230	405

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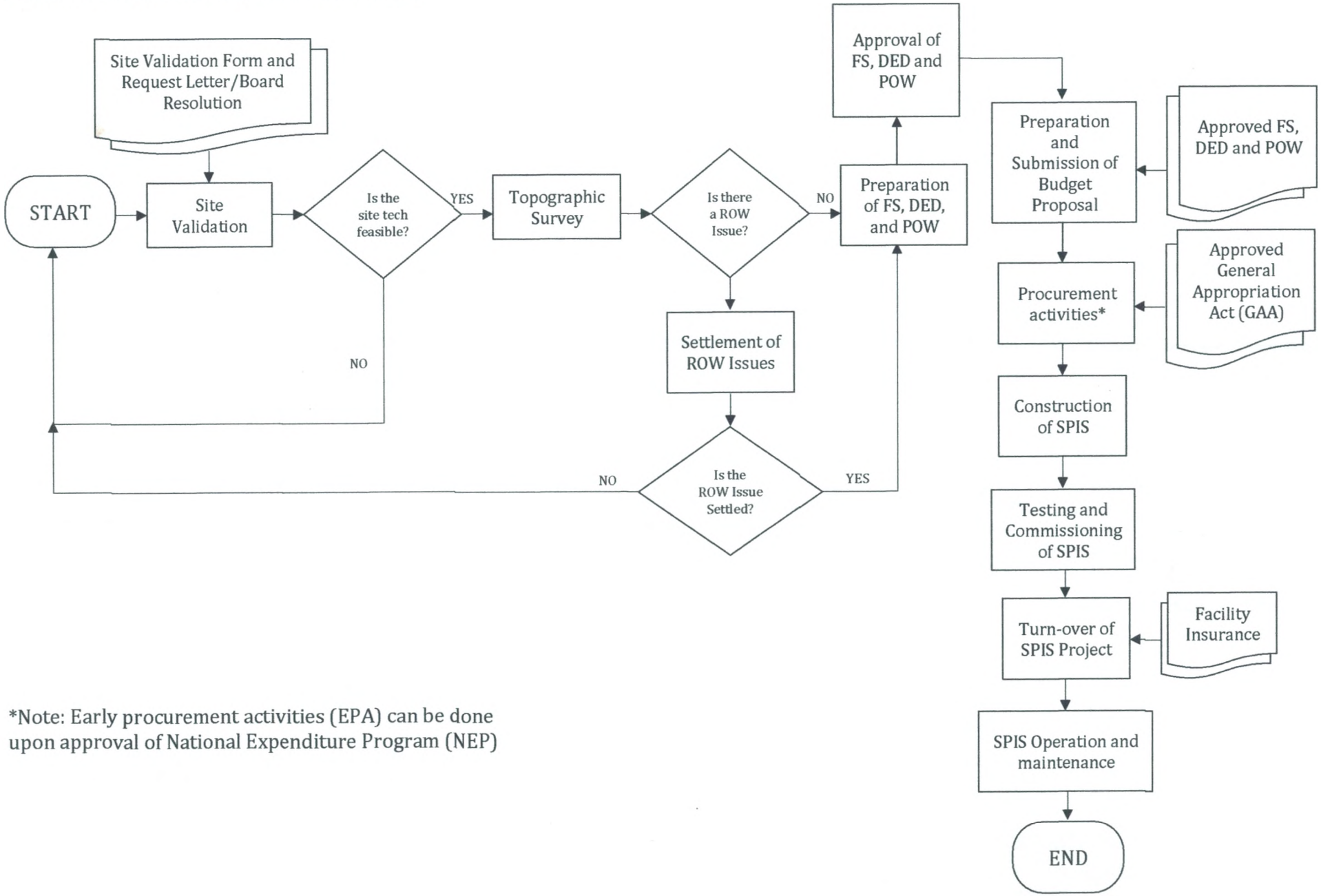
Annex C. Flowchart for Implementation of SPIS



*Note: Early procurement activities (EPA) can be done upon approval of National Expenditure Program (NEP)