Irrigation Modernization and Design of Pipe Distribution Networks

PUMPS, PIPEWORK, AND CIVIL WORKS

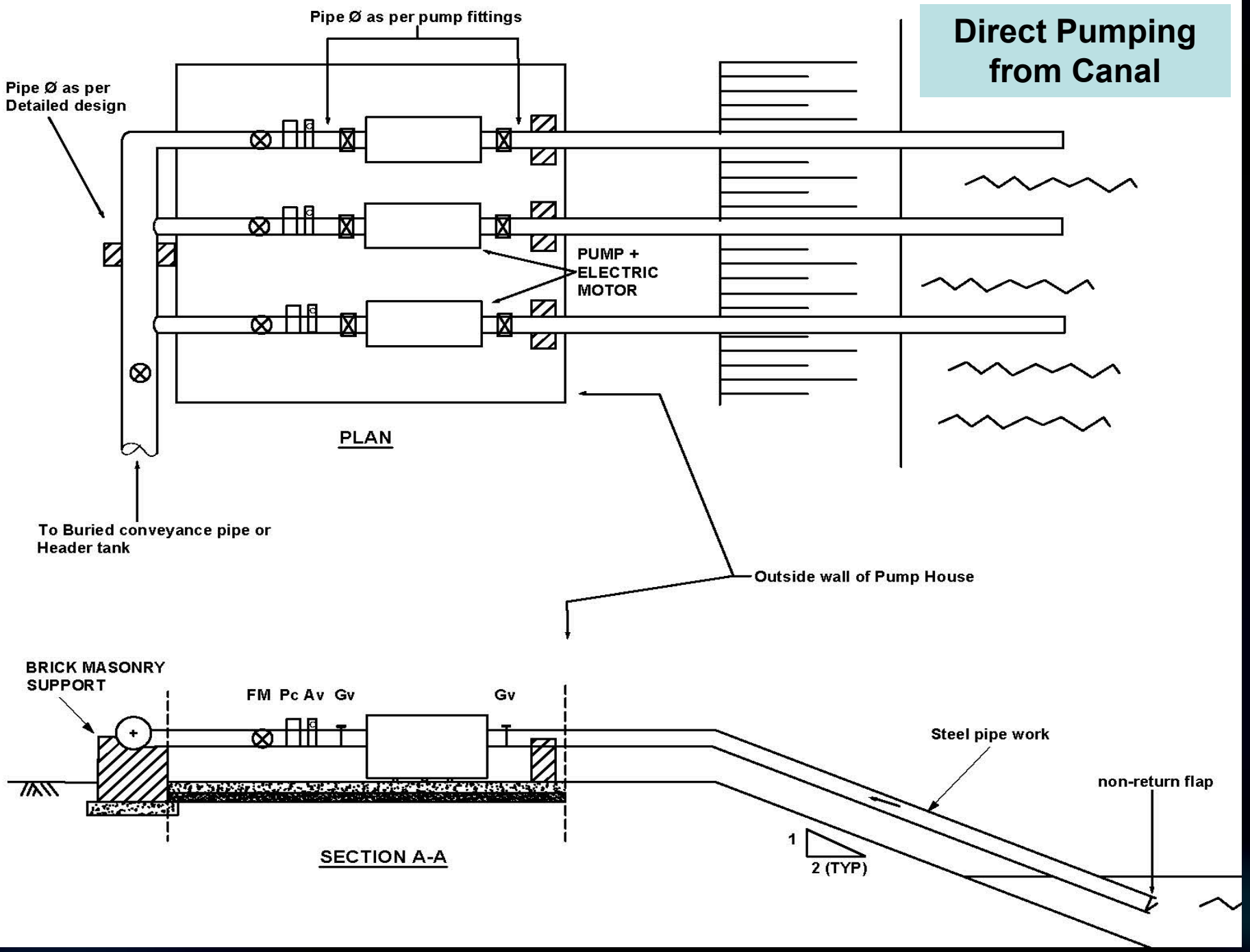
nhc

water resource specialists

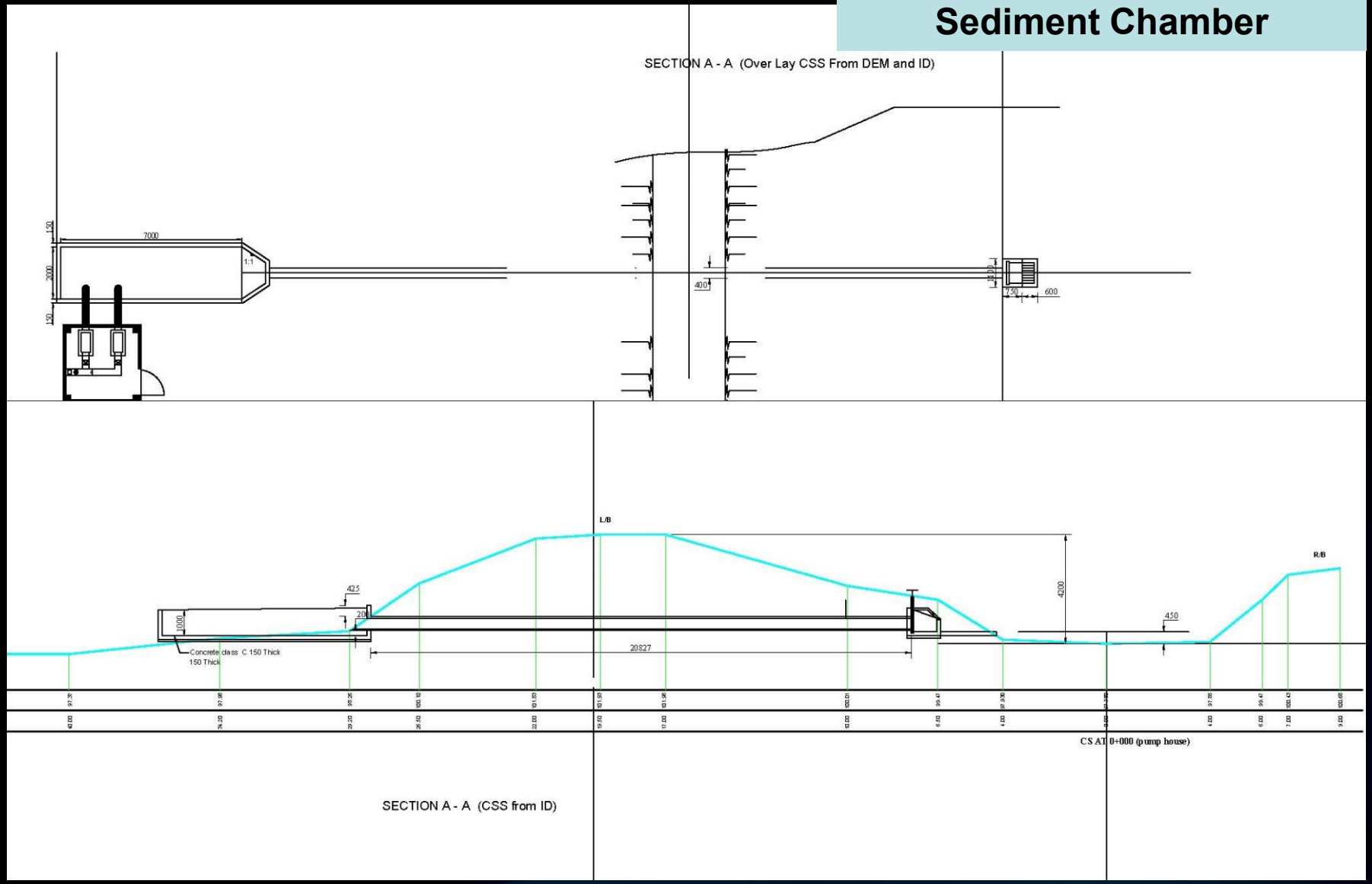
Pressure Pipe Distribution Network – Pumping Facility

- Pumps Selection
- Pumping Control System
- Suction pipework and control devices
- Discharge pipework and control devices
- Other considerations
- Civil works

Direct Pumping from Canal

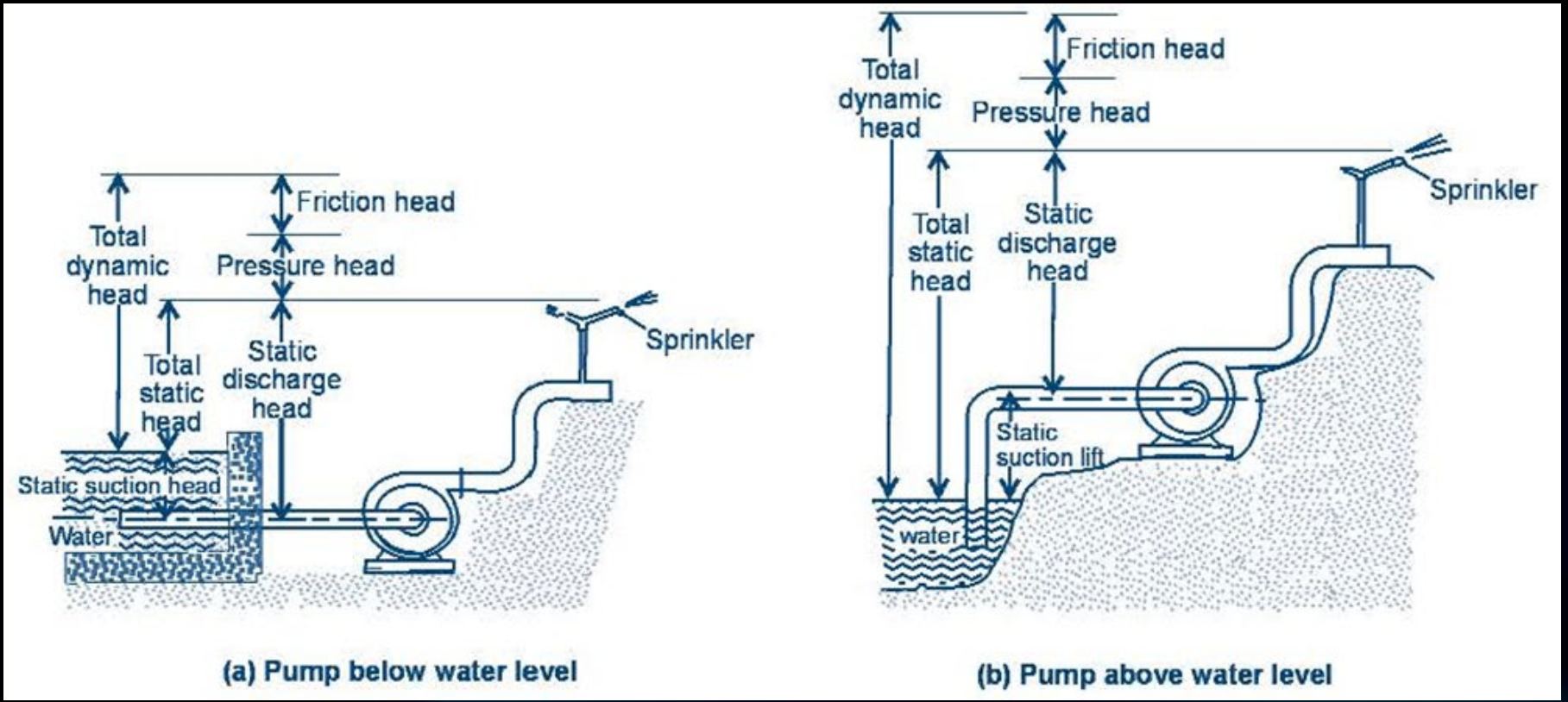


Pumping from Sump/ Sediment Chamber



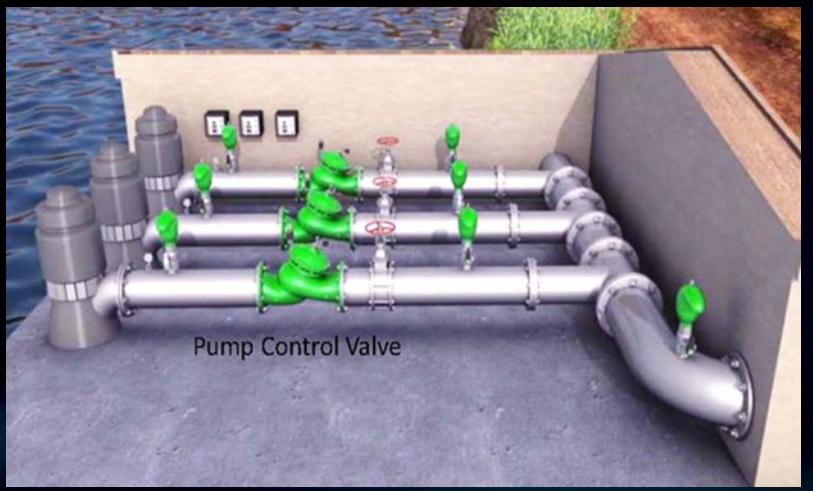
Pump(s) Selection

- Position suction or negative suction?

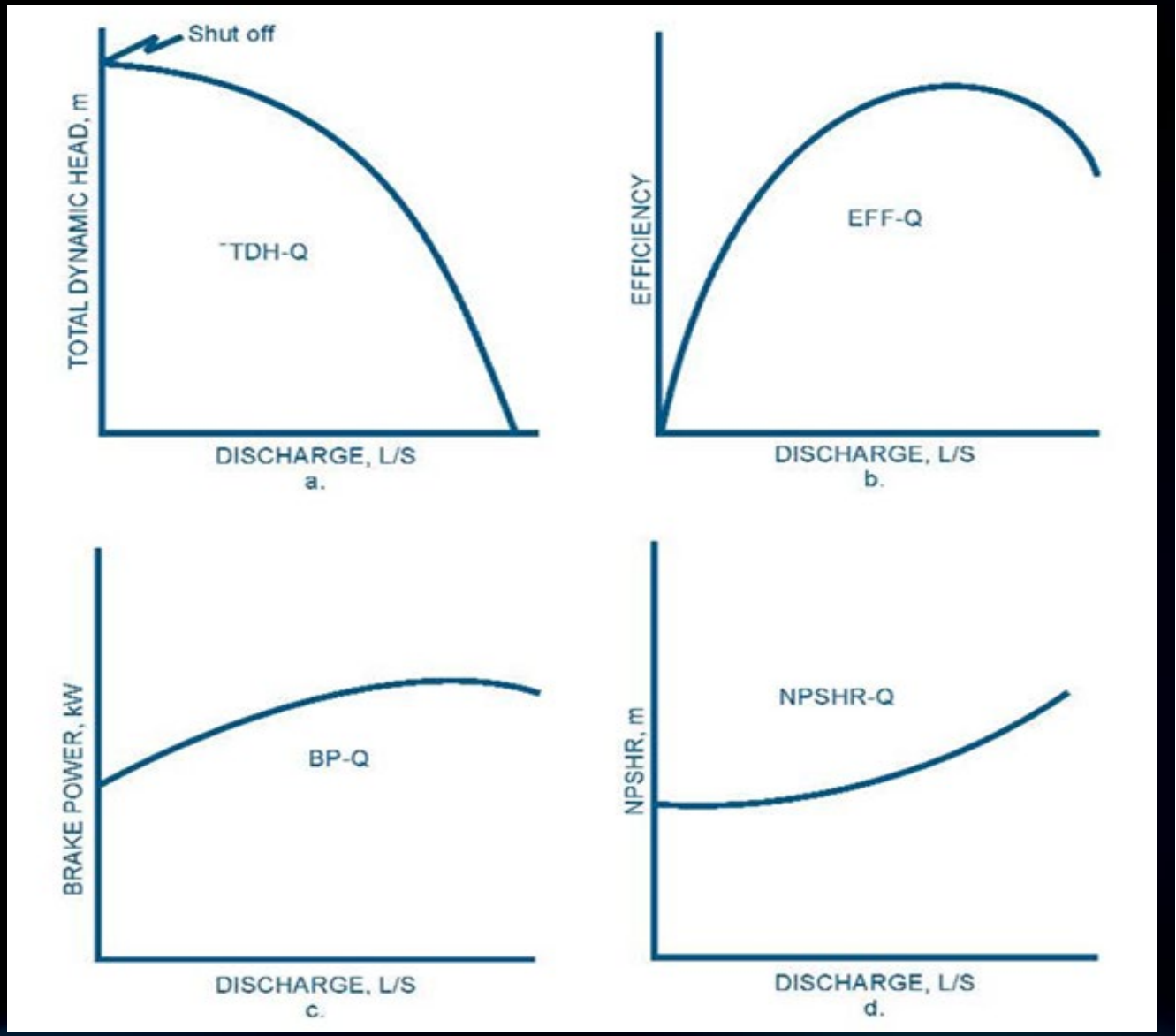


cont.

- Types of pumps for irrigation usually: (i) centrifugal, (ii) vertical turbine
- Submersible
- Variable speed (frequency drive) pumps – soft startup/ shut down

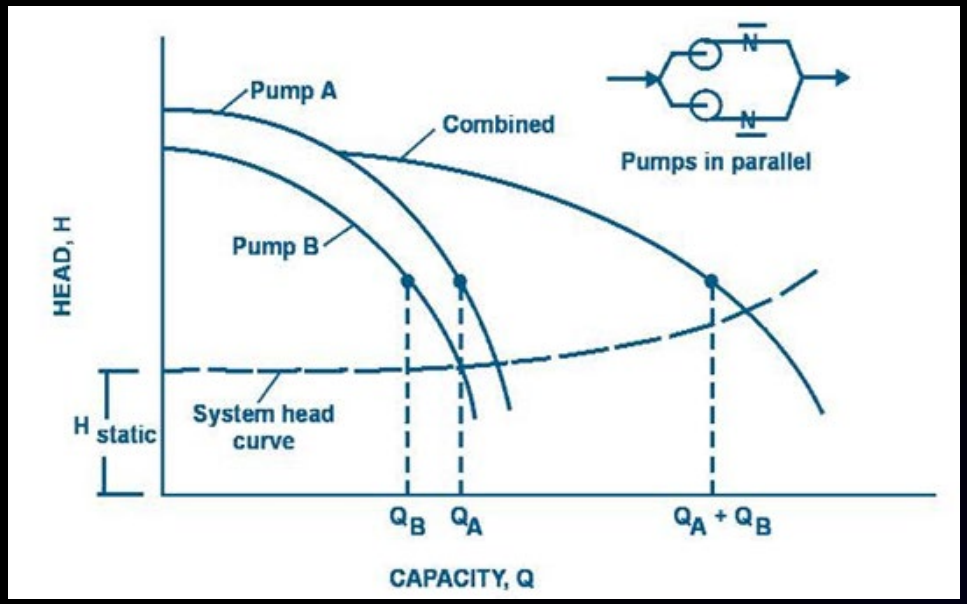


Pump Characteristic Curves



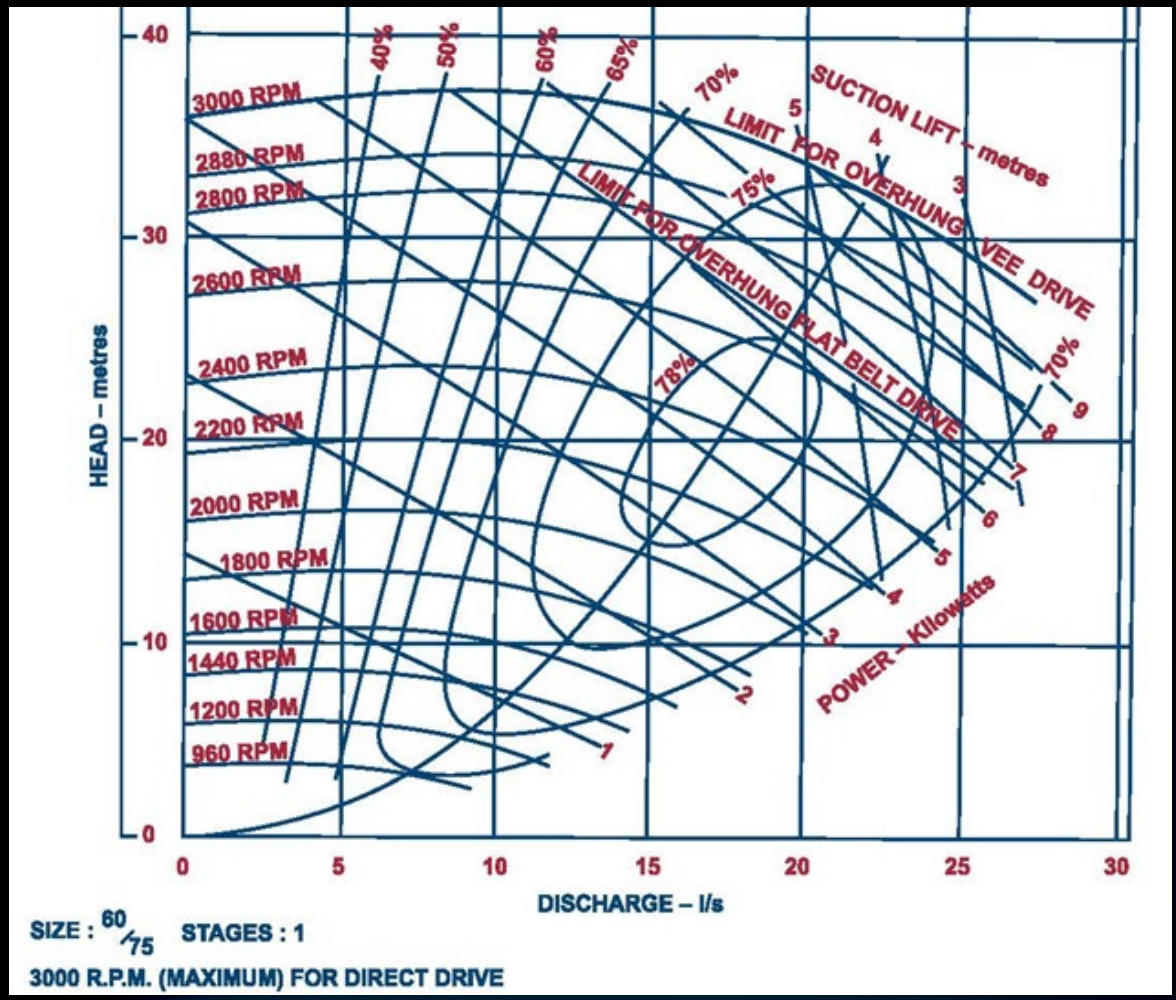
Often several Pumps in Parallel are adopted

Having several pumps connected in parallel enables variable demands to be met. However, as discharge increases the (friction) head is likely to increase as per the system curve for the pipe distribution network.



Variable Frequency Drive (Speed) Pumps

VFD pumps can operate at high efficiency for a range of speeds (and discharges)



Pump(s) Selection

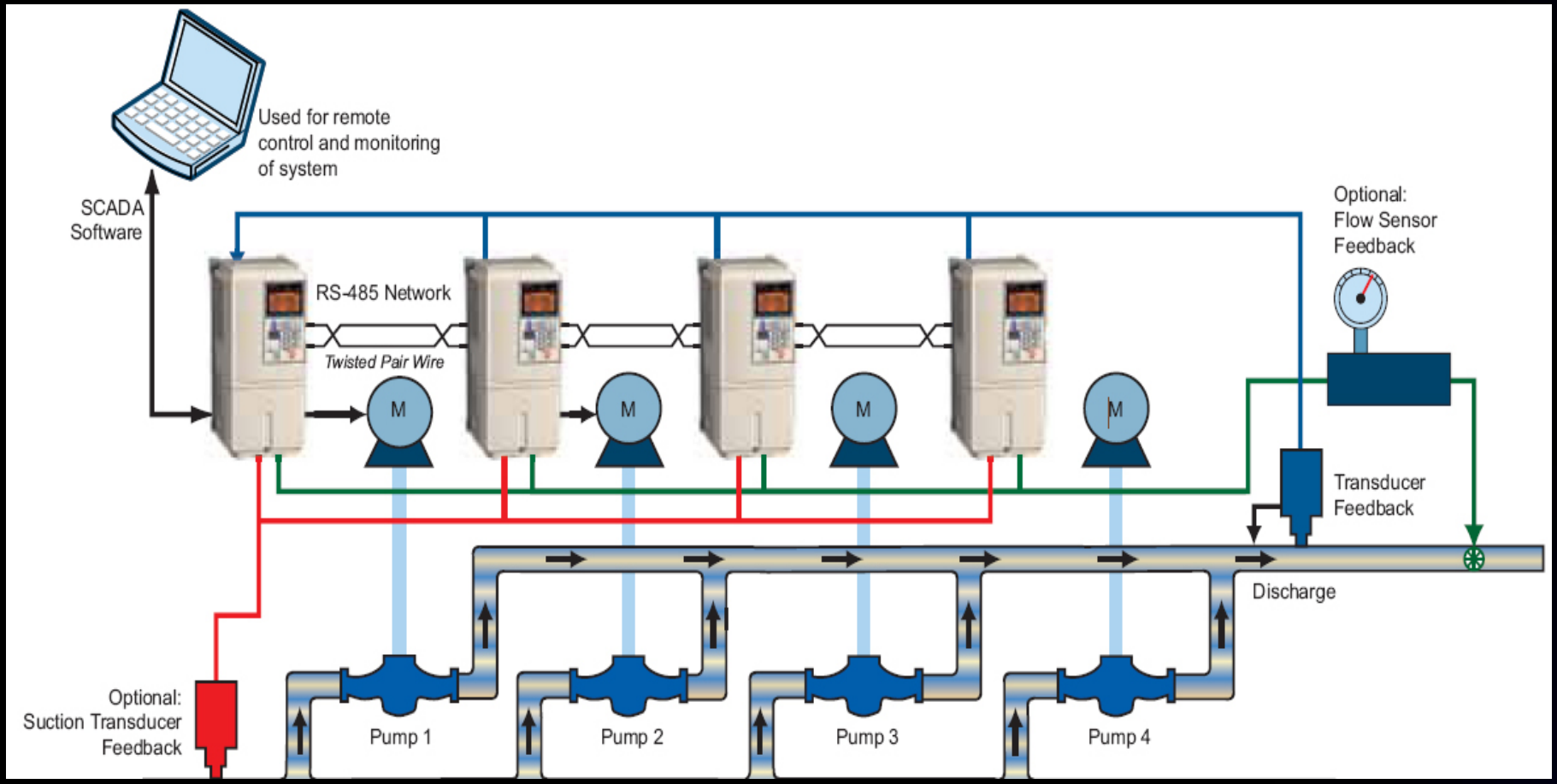
Select pumps to give high efficiency for the required head(s) and discharge(s). For several (3 or more) pumps selected to work in parallel, the change in head with change in discharge needs to be considered.

After selection of the pump(s) the NPHSR-Q curve is checked to ensure that there is no danger of cavitation occurring. To avoid cavitation, (i) the suction lift should not exceed about 5-7 m, and (ii) friction losses in the suction pipework should be low.

Pumping Control System

The pumping control system will:

- Control the pumps and pump speed based on pressure in the outlet manifold. The control system shall provide flows varying from ~25 - ~110% of the design flow.
- Protect the pumps for current overload, no water in canal, high temperature, etc (shut down/ warning light, etc)



Systems can be configured for use with multiple feedback transducers for redundant backup. A minimum of one feedback transducer is required for system operation.

Suction Pipework and Devices – negative suction condition

- Diameter usually one size larger than pump
- Velocity in suction pipe <= 2.0 m/s suggested.
- Priming of pump may be facilitated by small header tank (unless self-priming pump adopted).
- Adopt eccentric type reducer with straight on upper side of pipeline, inclined on lower side.
- Minimize no of bends and adopt large bend radius.
- Straight distance from bend to pump >= 10 pipe dia.

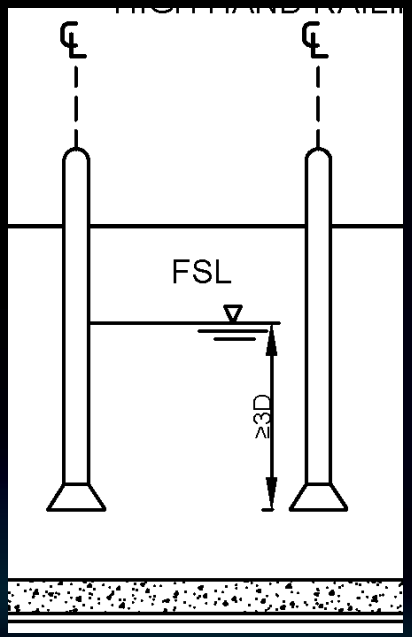
- Pipe to slope upwards to pump, suggest 6%.
- No isolation (gate) valve is required.
- Foot valve and are screen required.
- Suction head should not be so high as to cause vapor forming in pump. The pump NPSHR is to be exceeded. Typically, suction static lift = 9.8 – NPSH required (about 3) - losses in suction pipework (2 say), giving about 5 m.

Suction Pipework and Devices – positive suction condition

- Diameter usually one size larger than pump
- Priming is easy (water flows to pump).
- Flow velocity in pipeline <= 2.5 (3.0) m/s.
- Adopt eccentric type reducer with straight on lower side of pipeline, inclined on upper side.
- Provide isolation (gate) valve in suction pipeline for maintenance (valve to be closed when pumps are all off).
- Pipe to slope downwards to the pump by ~3%.
- Straight distance from valve to pump >= 10 pipe dia.

Pumping basin or sump

- Flow velocity in sump to each pump to be < 0.5 m/s
- To avoid a vortex forming, submergence of pipe intake (S) >= 3 x pipe dia., or calculate by: $S / D = 1.0 + 2.3 F$ where $F = V/(gD)^{0.5}$
- Clear depth below pipe intake: 2 x pipe dia.
- Clear distance between adjacent pipes >= 1.5 x pipe dia. (or adopt baffle walls).

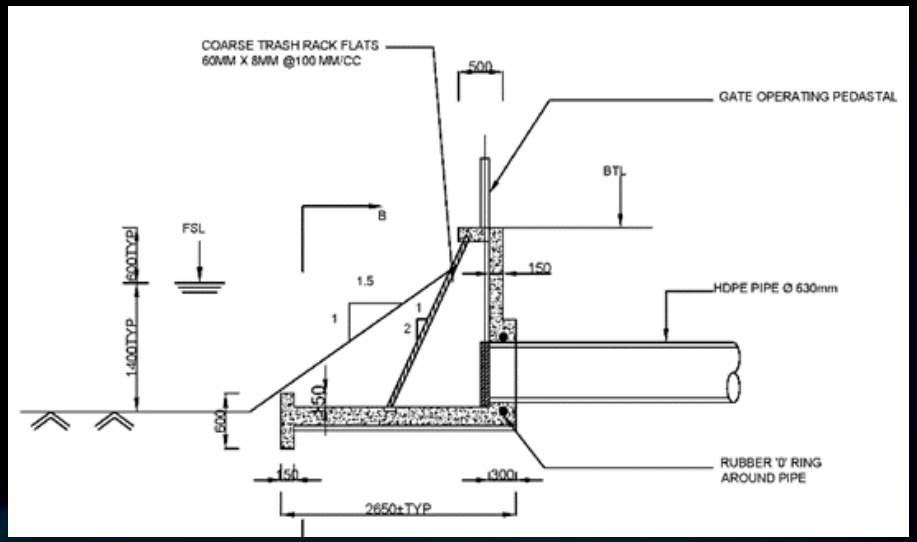


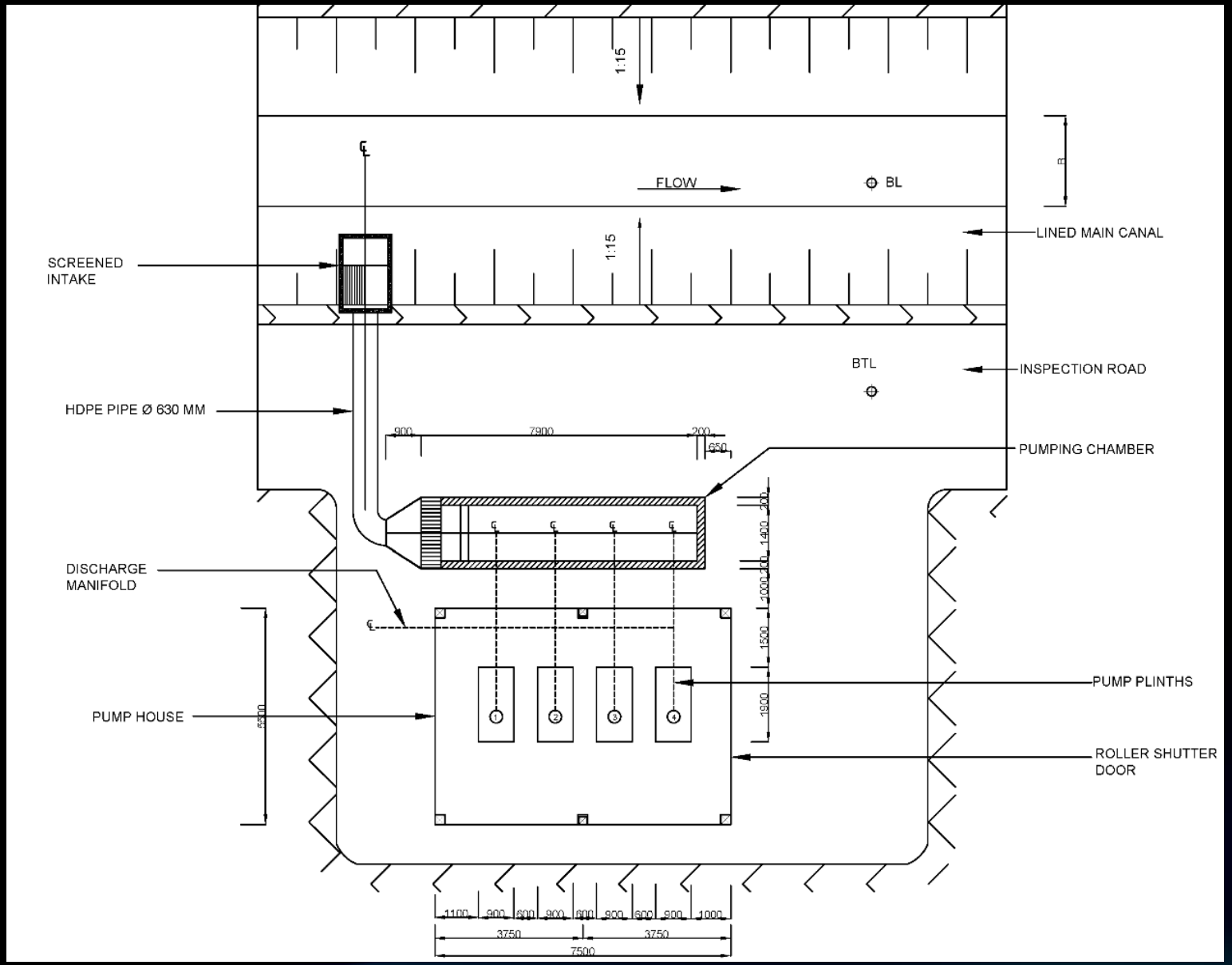
Discharge Pipework and Devices

- Diameter usually one size larger than pump outlet dia.
- Adopt concentric type diffuser
- Manifold diameter so that flow velocity < 2 m/s (2.4 m/s)
- Check (non-return) valve for each pump to prevent backflow to pump and possible damage.
- Isolation (gate) valve for each pump provided after the check (non-return) valve.
- Air valve and pressure gauge required.
- Flow/ volumetric meters as desired

Civil Works for Pumping Installations

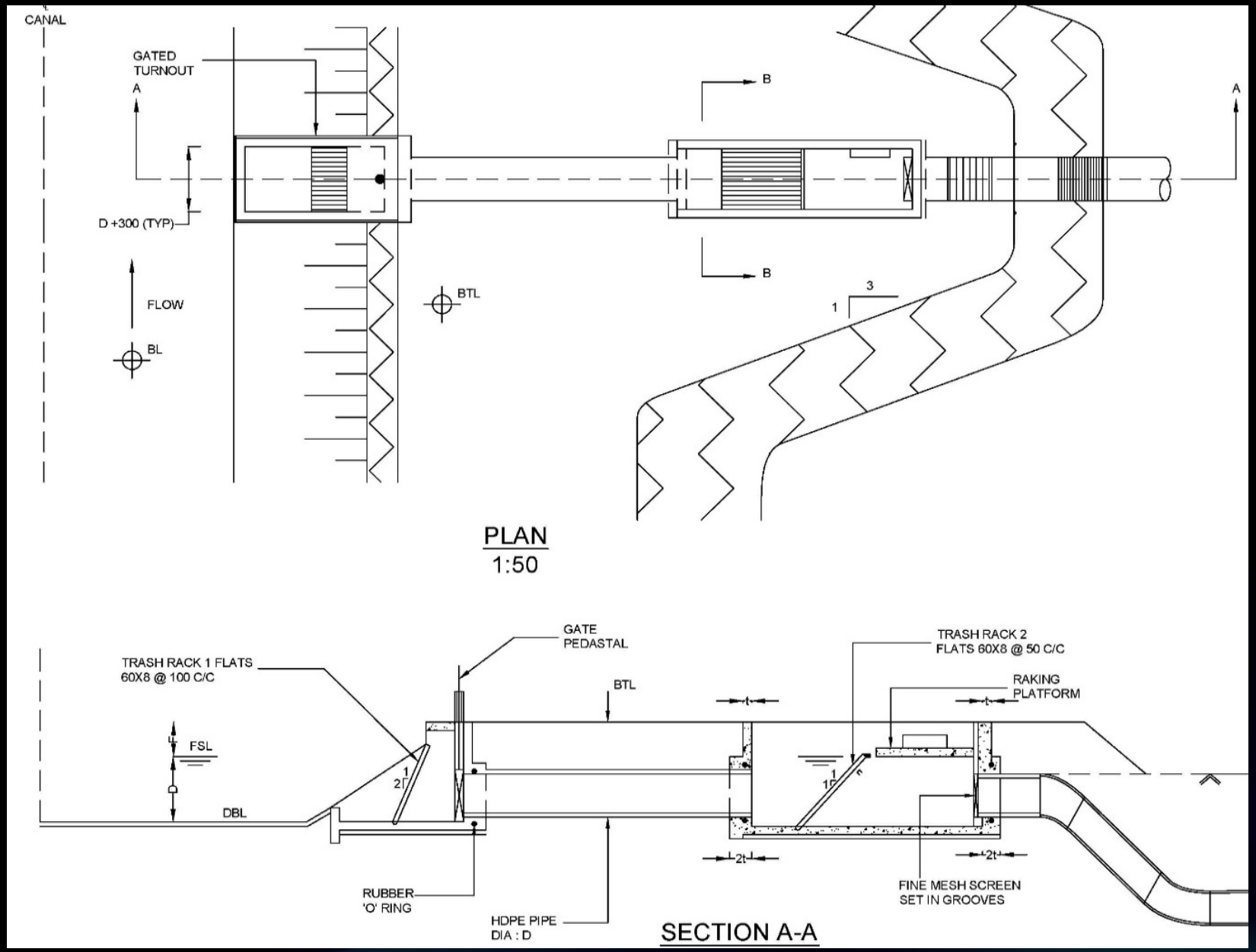
- Civil works include (i) an offtake (turnout), (ii) a pumping chamber/ sump, and (iii) the pump house building.




1:15
FLOW
BL
LINED MAIN CANAL
SCREENED INTAKE
1:15
BTL
INSPECTION ROAD
HDPE PIPE Ø 630 MM
900
7900
200
650
PUMPING CHAMBER
DISCHARGE MANIFOLD
PUMP PLINTHS
PUMP HOUSE
ROLLER SHUTTER DOOR
1100
900
600
900
600
900
600
900
1000
3750
3750
7500

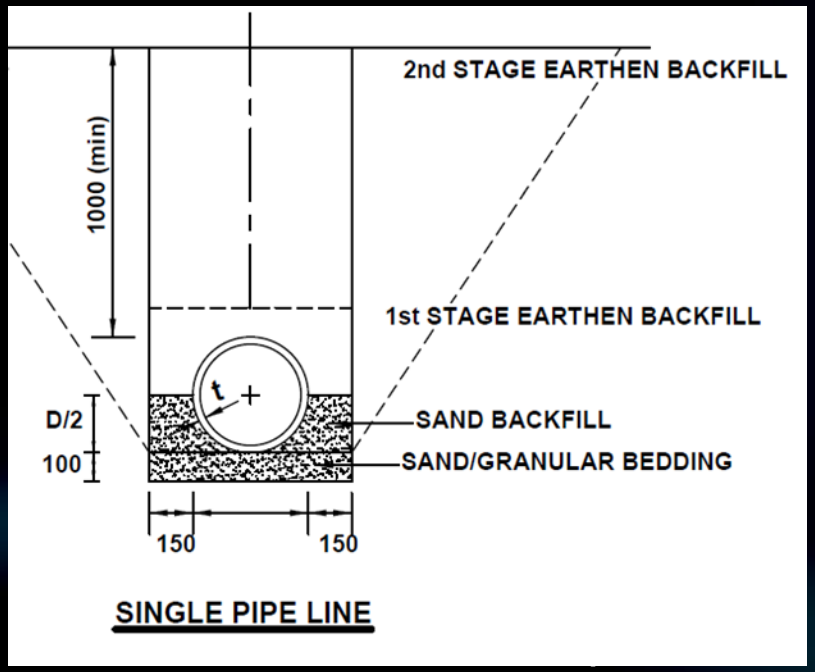
Turnout for Gravity Pipe System

- Measures to prevent trash and coarse and fine sediments entering the pipeline are very important
- A gate is usually provided to enable maintenance.
- The lip of the culvert in the turnout, and of the off-taking pipe(s) in the sump must be submerged to ensure against “gulping” and air entering the pipeline. The submergence should be at least 1.78 $V^2/2g + 0.075$.


CANAL
GATED
TURNOUT
A
D +300 (TYP)
FLOW
BL
BTL
B
B
A
3
1
PLAN
1:50
TRASH RACK 1 FLATS
60X8 @ 100 C/C
GATE
PEDASTAL
BTL
TRASH RACK 2
FLATS 60X8 @ 50 C/C
RAKING
PLATFORM
FSL
DBL
1
2
1
1
2t
2t
2t
RUBBER
'O' RING
HDPE PIPE
DIA : D
FINE MESH SCREEN
SET IN GROOVES
SECTION A-A

Pipeline Trench Construction

- Sand bedding and backfill depending on pipe type and soil & loading conditions
- Pipes to have 1.0 m (min.) cover
- Trench and pipe grade:
  - 1 in 500 in direction of flow
  - 1 in 200 against flow
- Air valves at high points



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Power and Energy - Electrification & Solar

- State Electricity Company:
  - HT connection
  - Transformer 33 or 11 to 0.415 kV; Power 100, 150, 200 kVA
  - Energy Meter
- Scheme:
  - 415 V, 3 phase transmission lines
  - VFD pumps, sensors
  - Control panel

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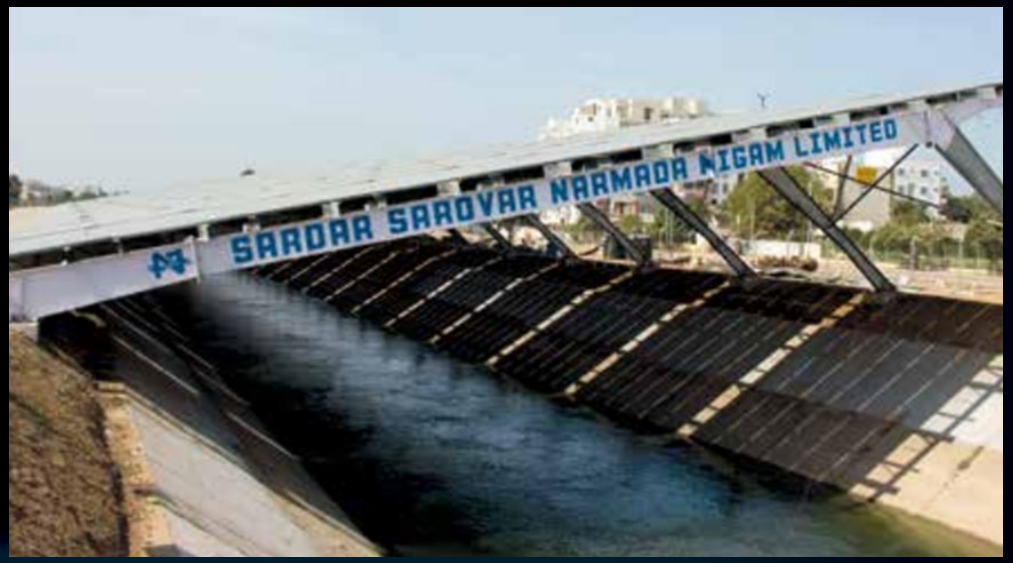
Grid connected solar

- Solar power with backup mains
- Components:
  - Solar panels: mounted alongside or over channel
  - PV Combiner Box
  - Controller - Inverter – for 3 phase output



Thank you