Rabail Technologies
Sprinkler, Drip Irrigation & Solar Tube Wells

DESIGNING CONSIDERATION OF IRRIGATION SYSTEM HYDRAULICS

Sizing & capacity calculations of the motor-pump set – A case study

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Regional gathering
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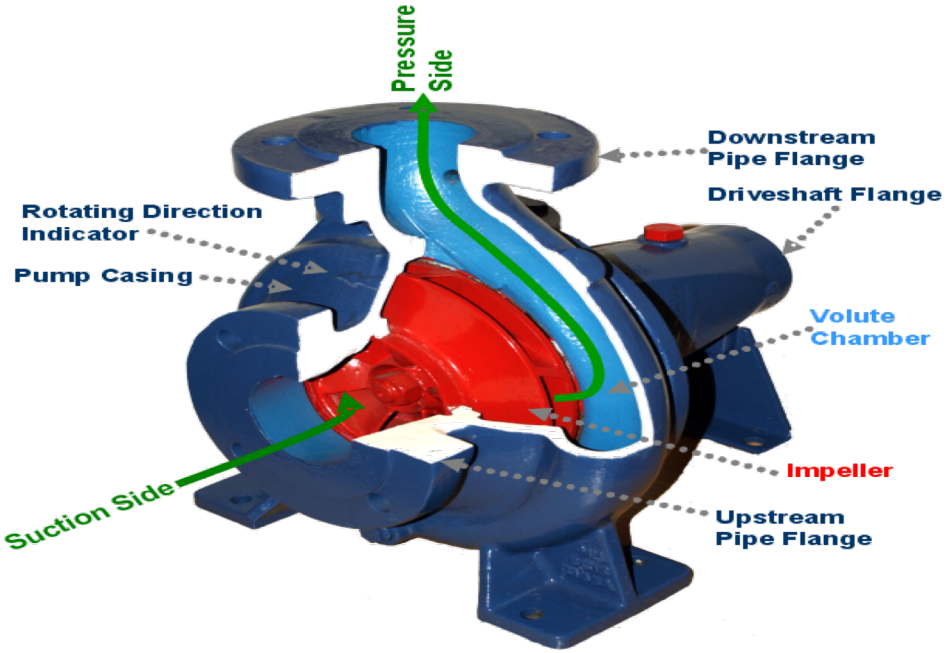
ITALIAN AGENCY FOR DEVELOPMENT COOPERATION

GLANCE FROM PREVIOUS TRAINING

- Pump, A Device which transfer fluid from one point to another; horizontally, vertically or both.
- Flow Rate: amount of fluid flow per unit time, like, m3/hr, ltrs/min etc
- Head: Maximum height to which a pump can lift water against gravity.
- LIFT : Elevation Differences or Work against Gravity or any External Force
- Friction Loss: Resistance offered by walls of pipe line, we need to calculate it
- Nozzle Pressure: Pressure Required at Nozzle to perform a specific job
- TDH, Total Dynamic Head: Total Head required to do a specific fluid job

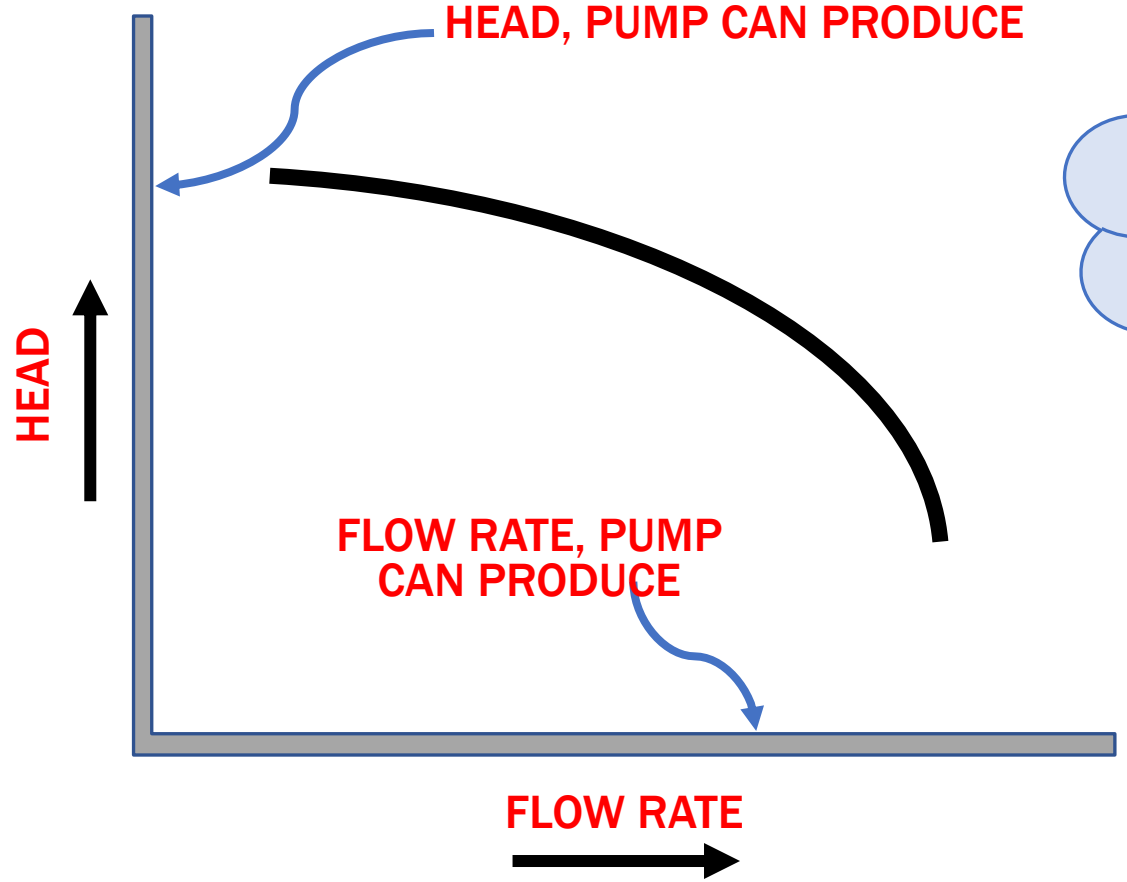
GLANCE FROM PREVIOUS TRAINING

- Centrifugal pumps: Negative Displacement pumps (which deliver variable flow with every rpm), Constant Head Pumps
- It can be Submersible, Surface or Turbine Pump

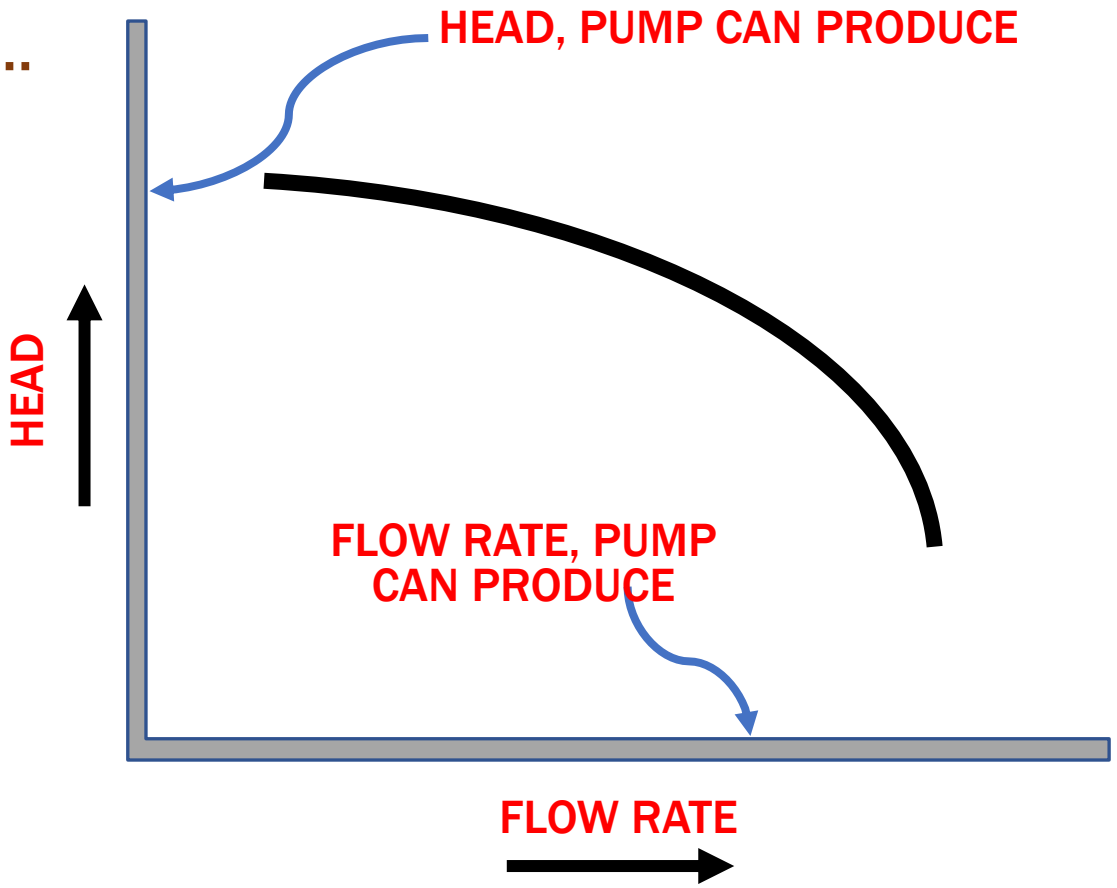


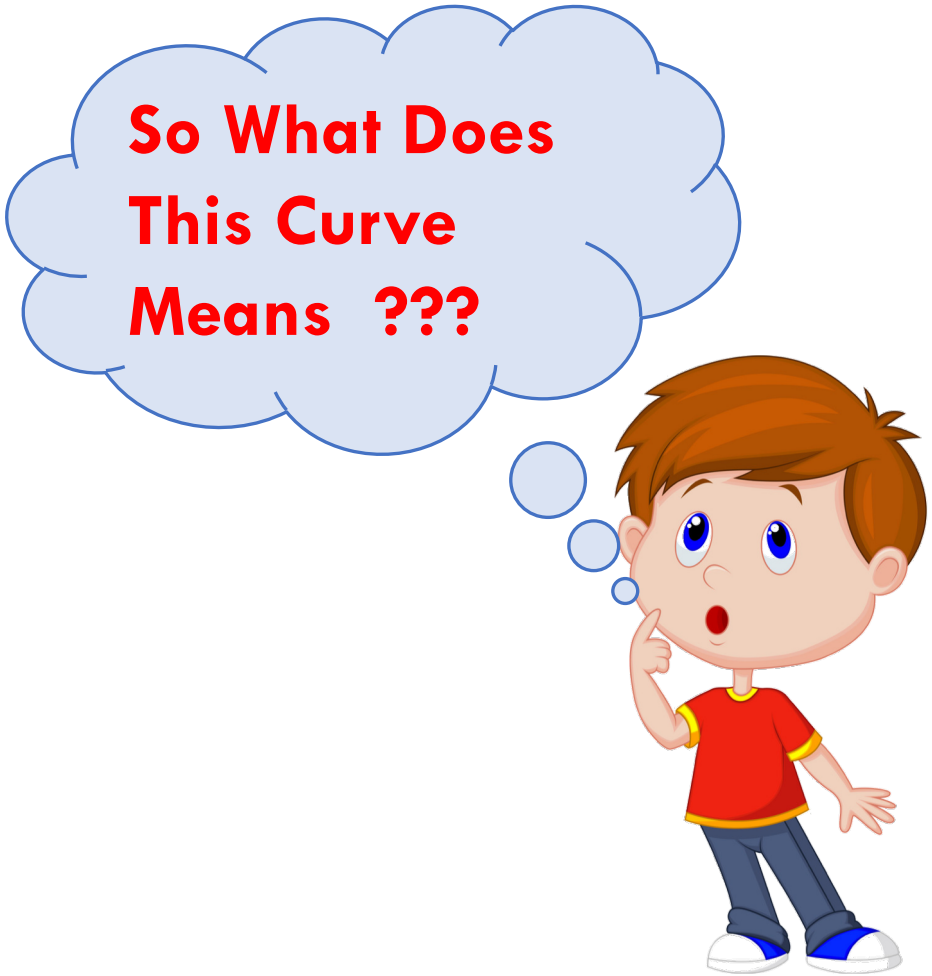
GLANCE FROM PREVIOUS TRAINING

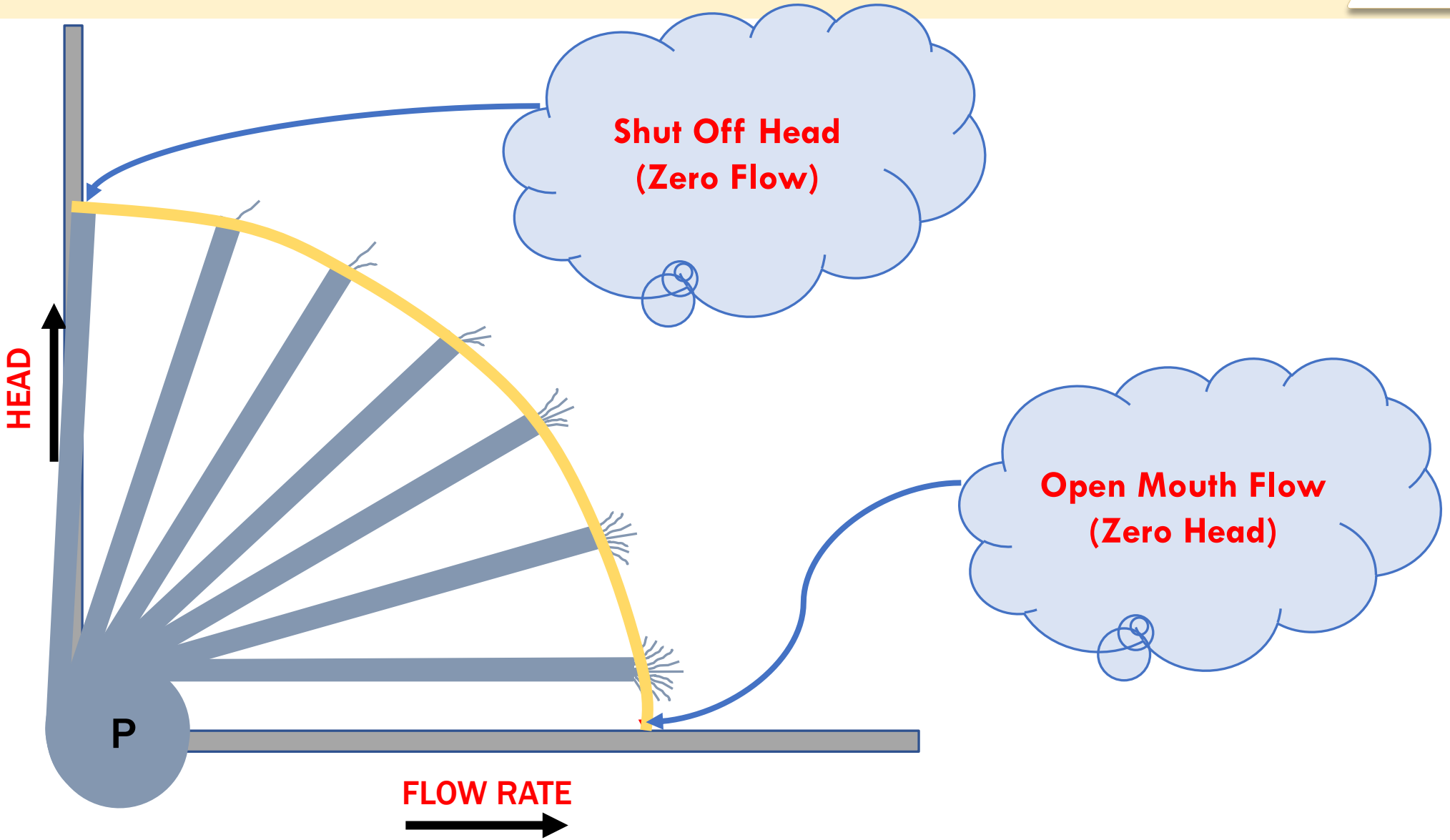
- Pump Curve is the chart which shows behavior of a Centrifugal pump with change in flow rate.



- Pump Curve is the chart which shows behavior of a Centrifugal pump with change in flow rate.
- It look like...

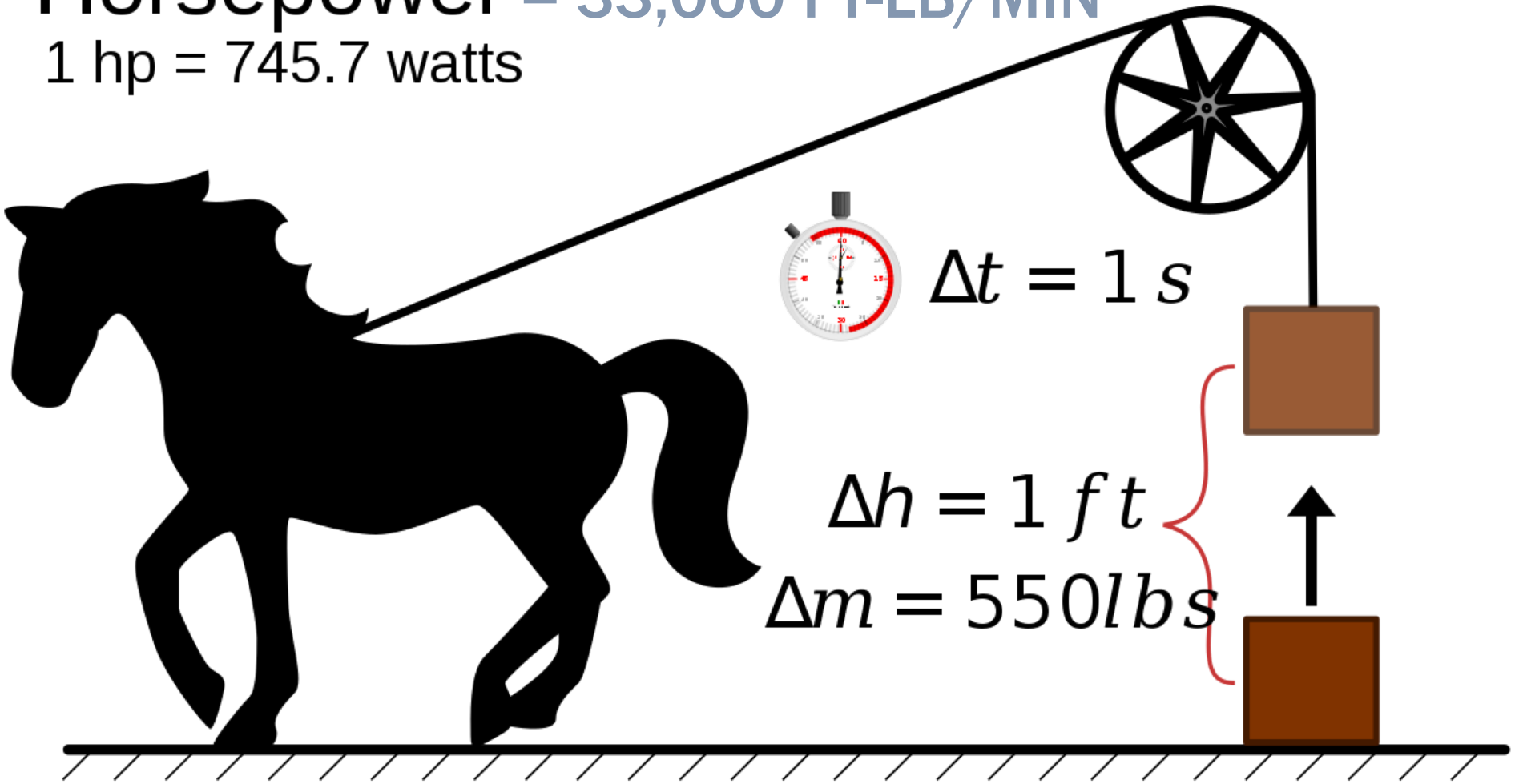





Shut Off Head
(Zero Flow)
HEAD
Open Mouth Flow
(Zero Head)
P
FLOW RATE

Horsepower = 33,000 FT-LB/MIN

1 hp = 745.7 watts



Water HP<Pump HP< Motor Rated HP< Motor Actual HP

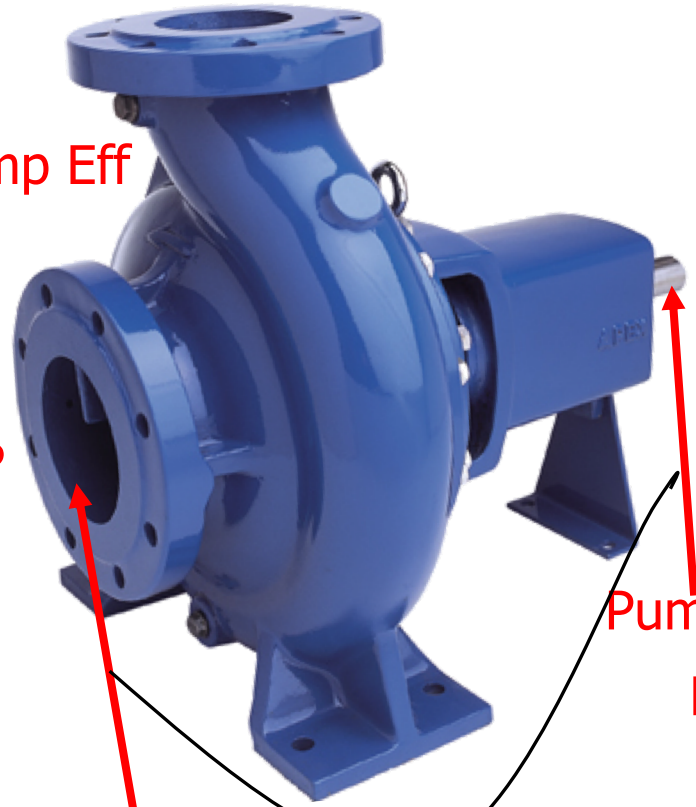
Design System for Motor Input HP

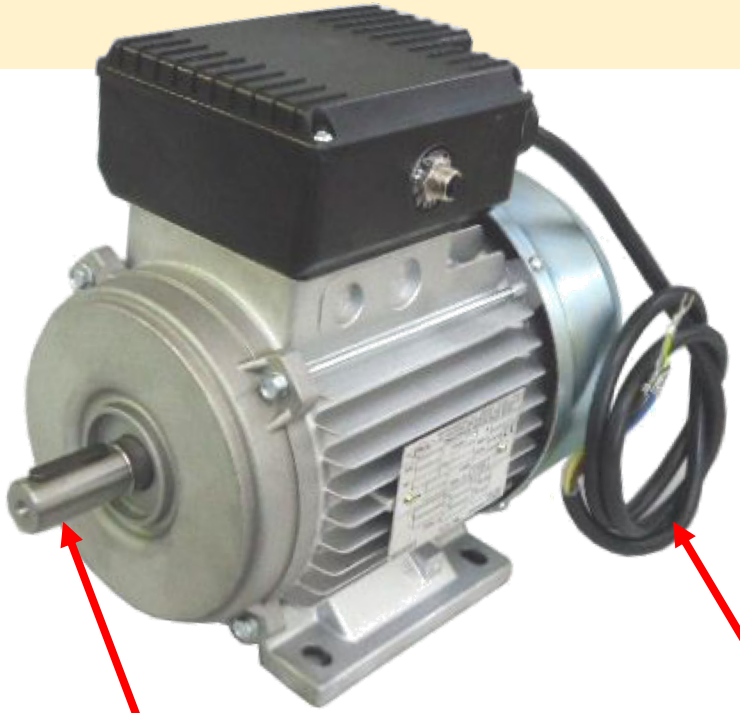
Water HP= Q*H

Pump HP (BHP), P2= WHP/Pump Eff

Motor Rated HP, P2 = Pump HP

Motor Input HP =P2/Motor Eff





Water HP

Pump Efficiency

Pump HP P2

Motor Rated HP P2

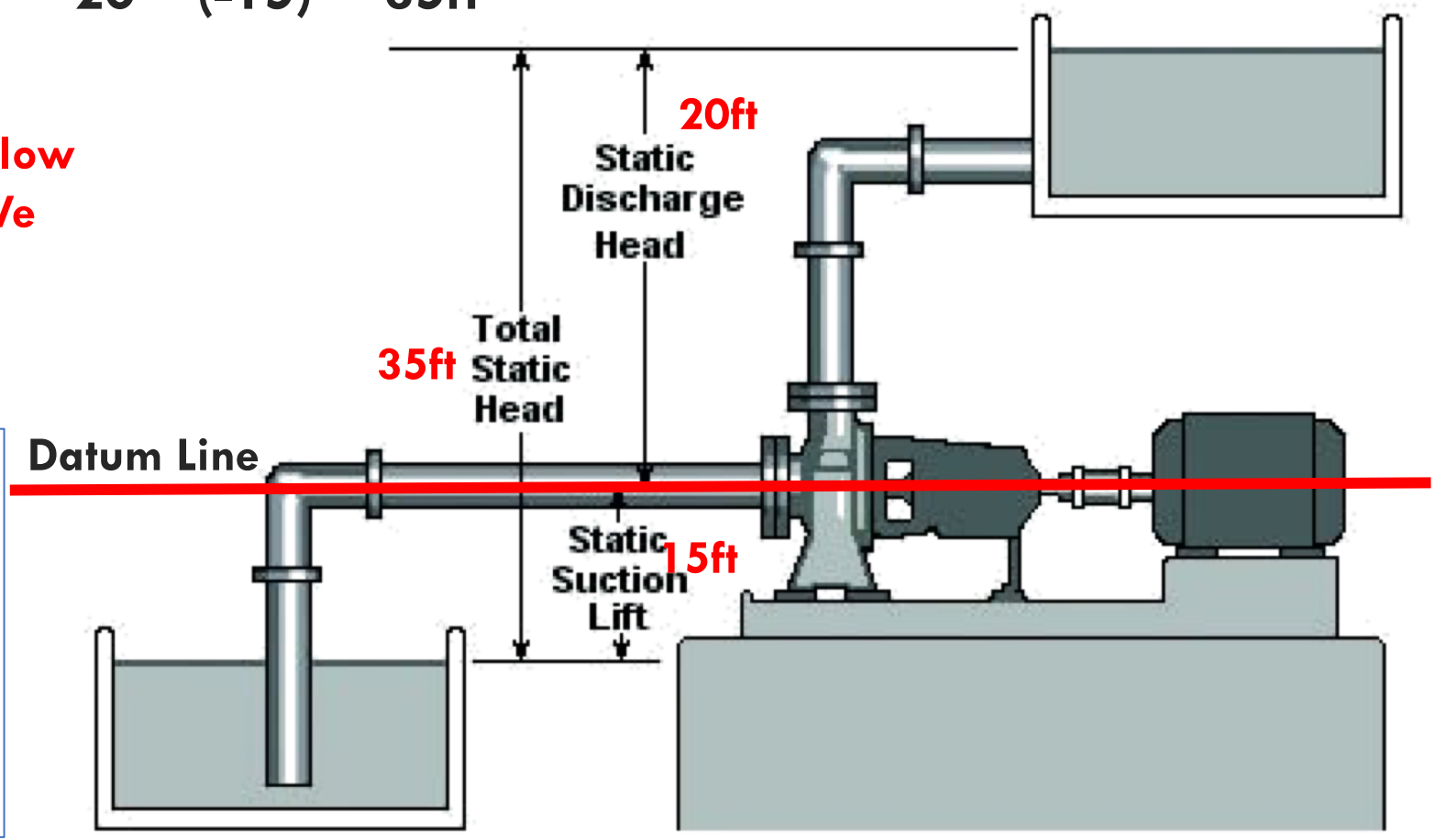
Motor Efficiency

Motor Input HP

Total Static Head = Outlet Elevation – Inlet Elevation

Total Static Head = 20 – (-15) = 35ft

Here Suction Head is Below Datum, so it will be -Ve



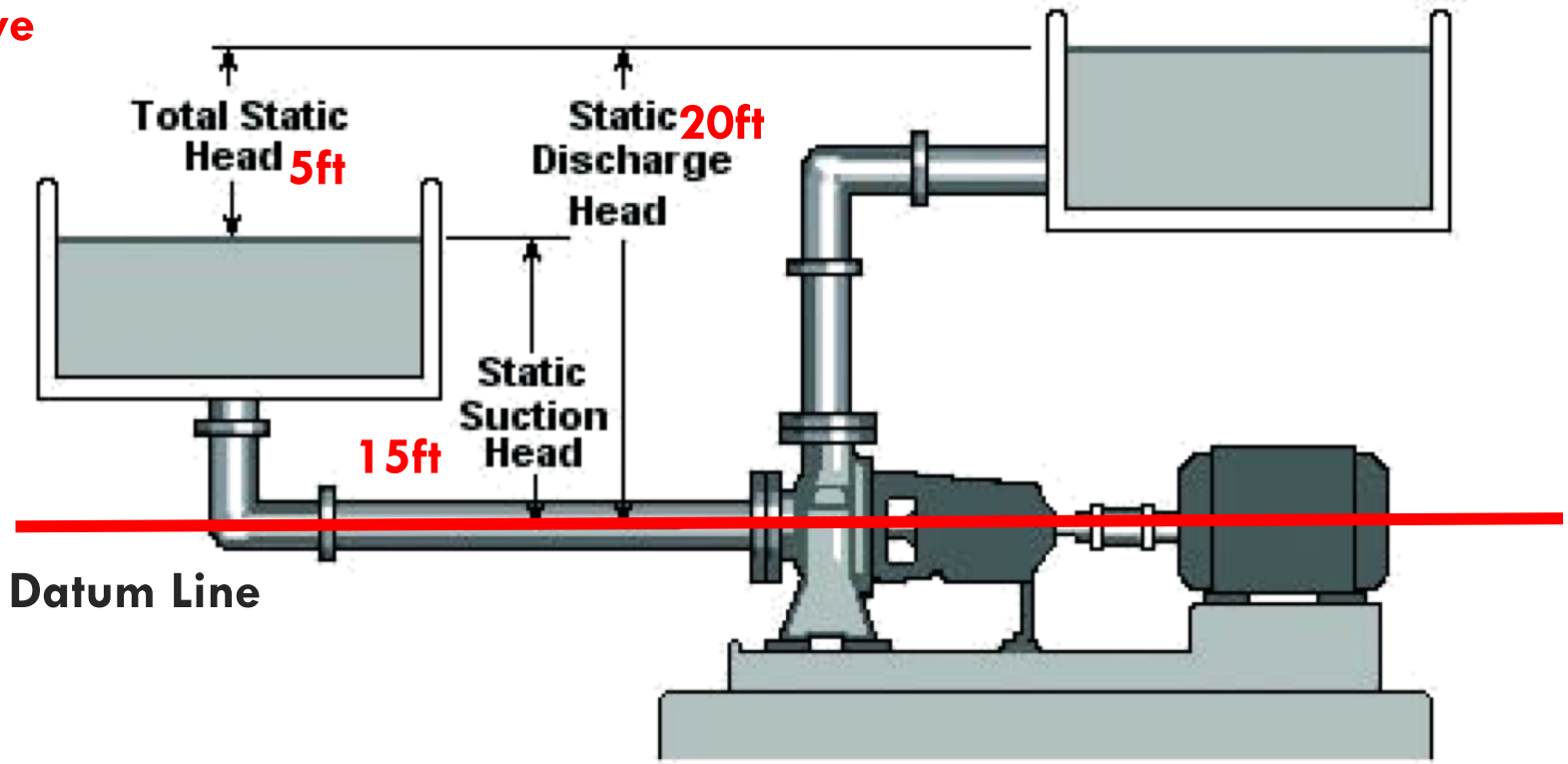
Static Head + Friction Loss = Dynamic Head

Total Static Head = Outlet Elevation – Inlet Elevation

Total Static Head = 20 – 15 = 05ft

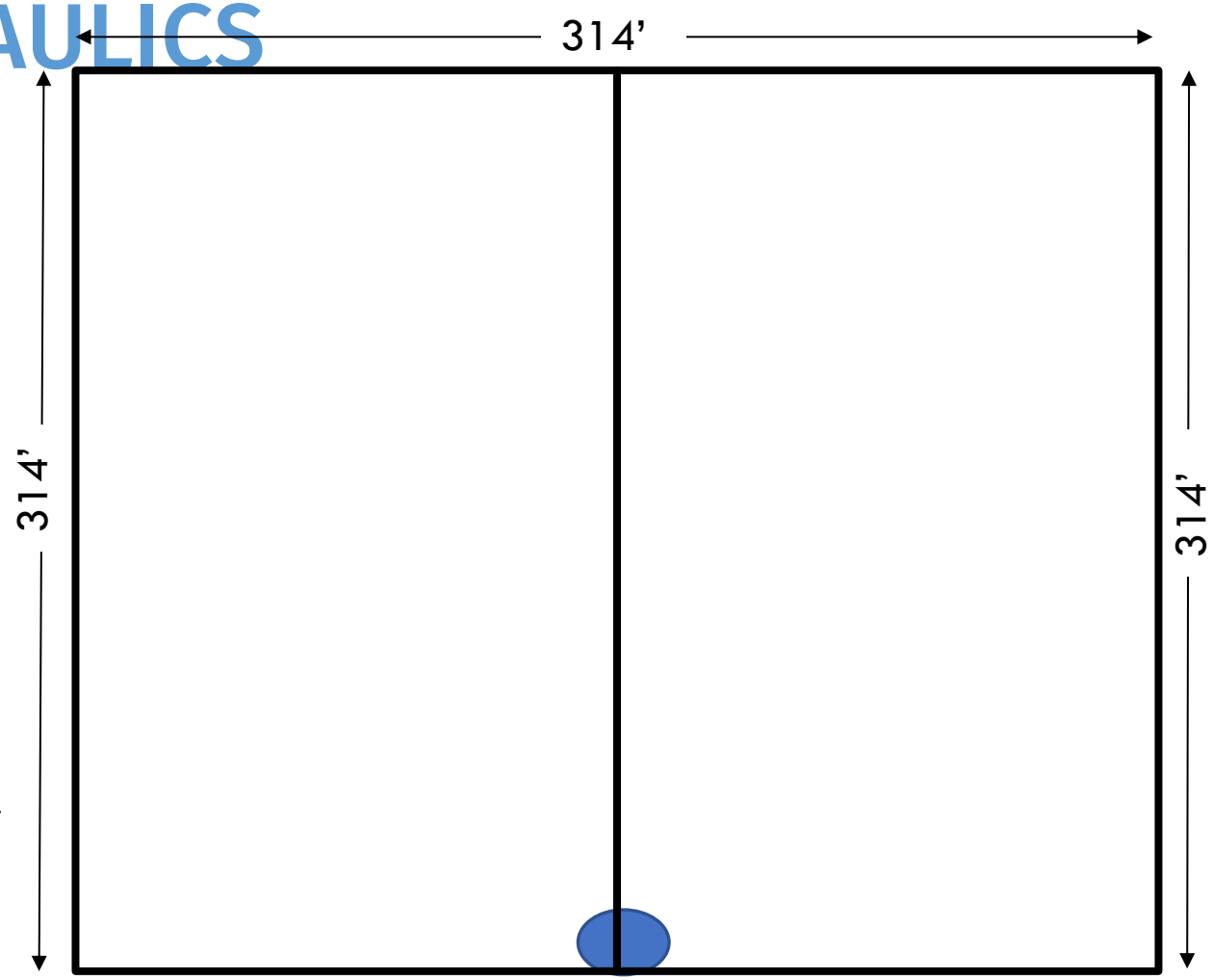
Here Suction Head is Above Datum, so it will be +Ve

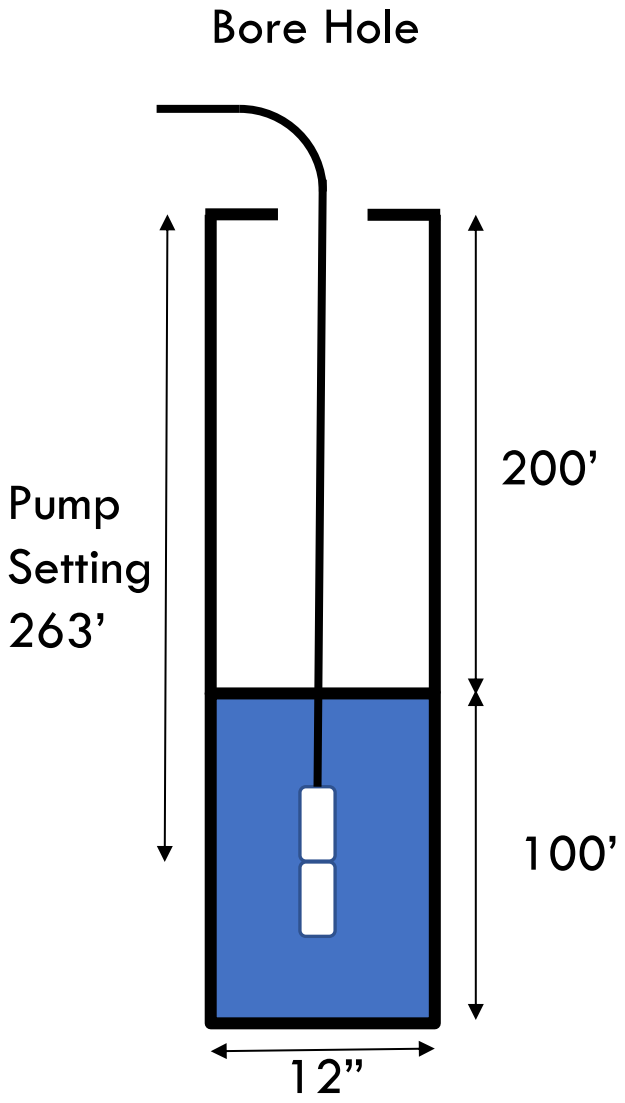
Static Head + Friction Loss = Dynamic Head

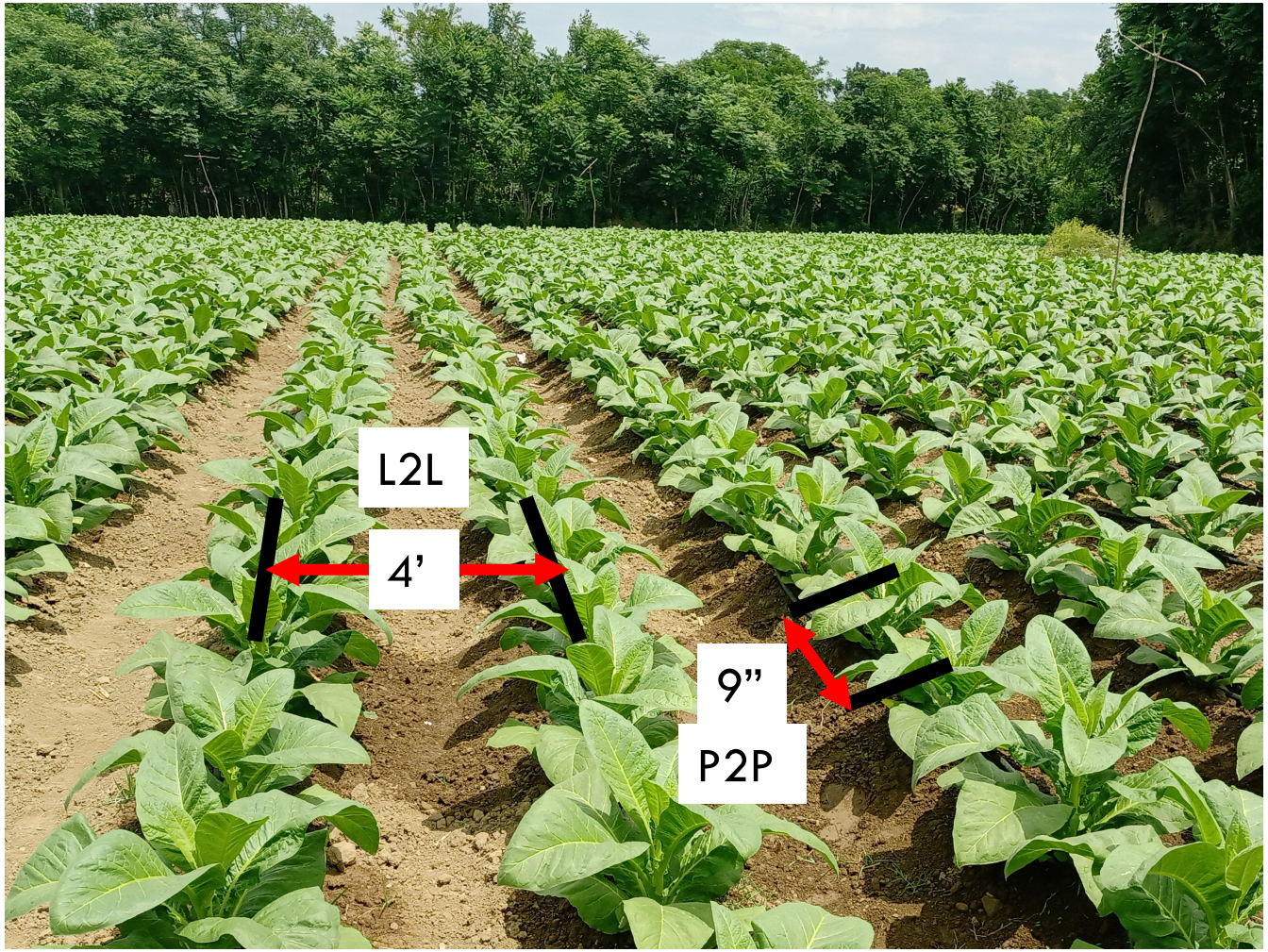


CASE STUDY: SYSTEM HYDRAULICS

- Total Site Area: 2.25 Acres (9104 Sq m)
- Crop: Vegetables
- Plant to Plant Distance: (P2P): 9 inch
- Row to Row Distance: (R2R): 4 ft
- Location: Hazro, Pakistan
- Power Source: Solar
- Water Source: Under Ground, Water Table 200ft
- Pump: Submersible



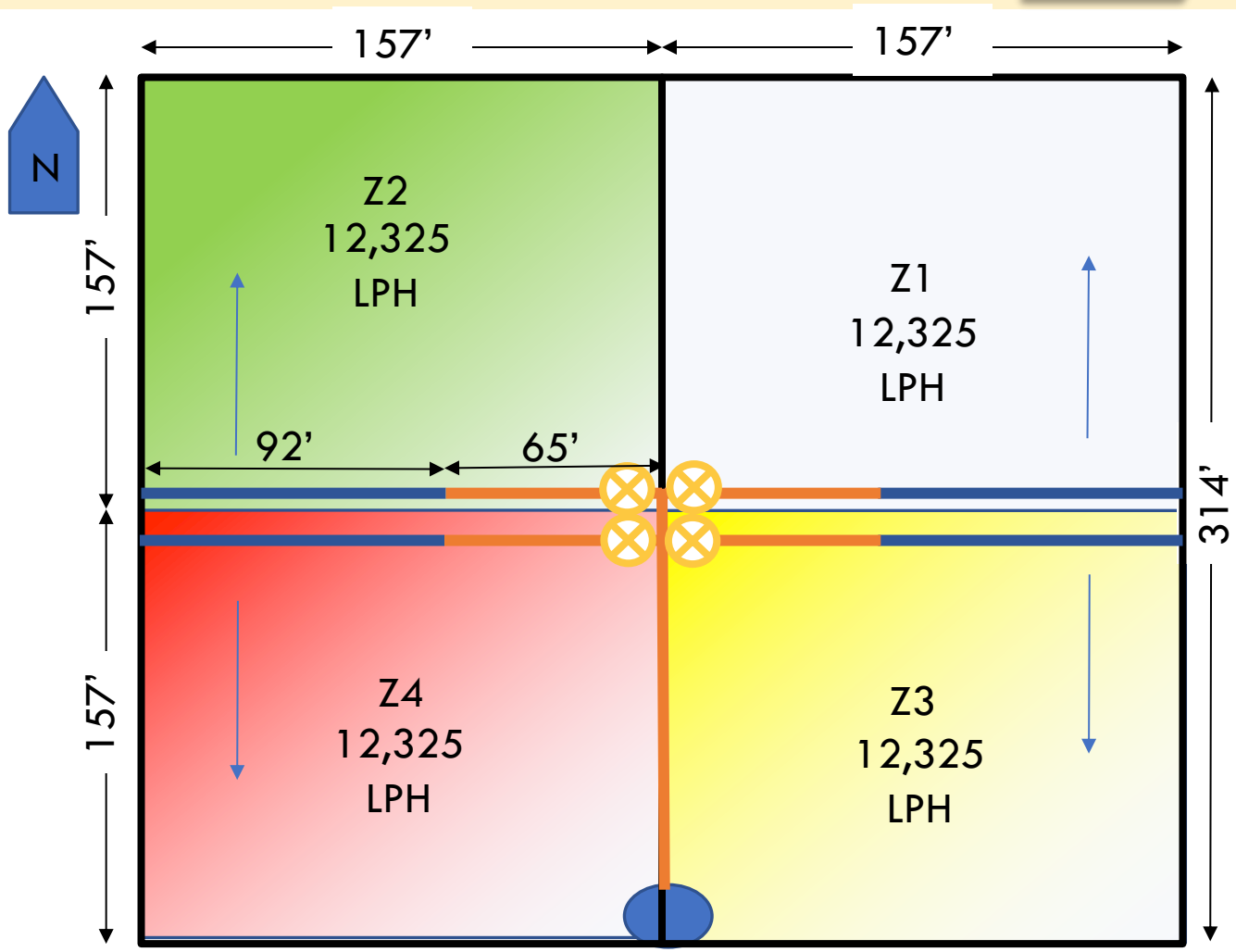

Bore Hole
Pump
Setting
263’
200’
100’
12”


L2L
4’
9”
P2P

PRODUCT TO BE USED

- Drip line (16mm OD, 0.9mm WT, 30cm, 2.2 LPH)
- uPVC Pipe, 2 inch Class C, 1.5 inch Class D (all pipes as per BS3505)
- Submersible Pump, with 10 HP Motor, 3 Phase

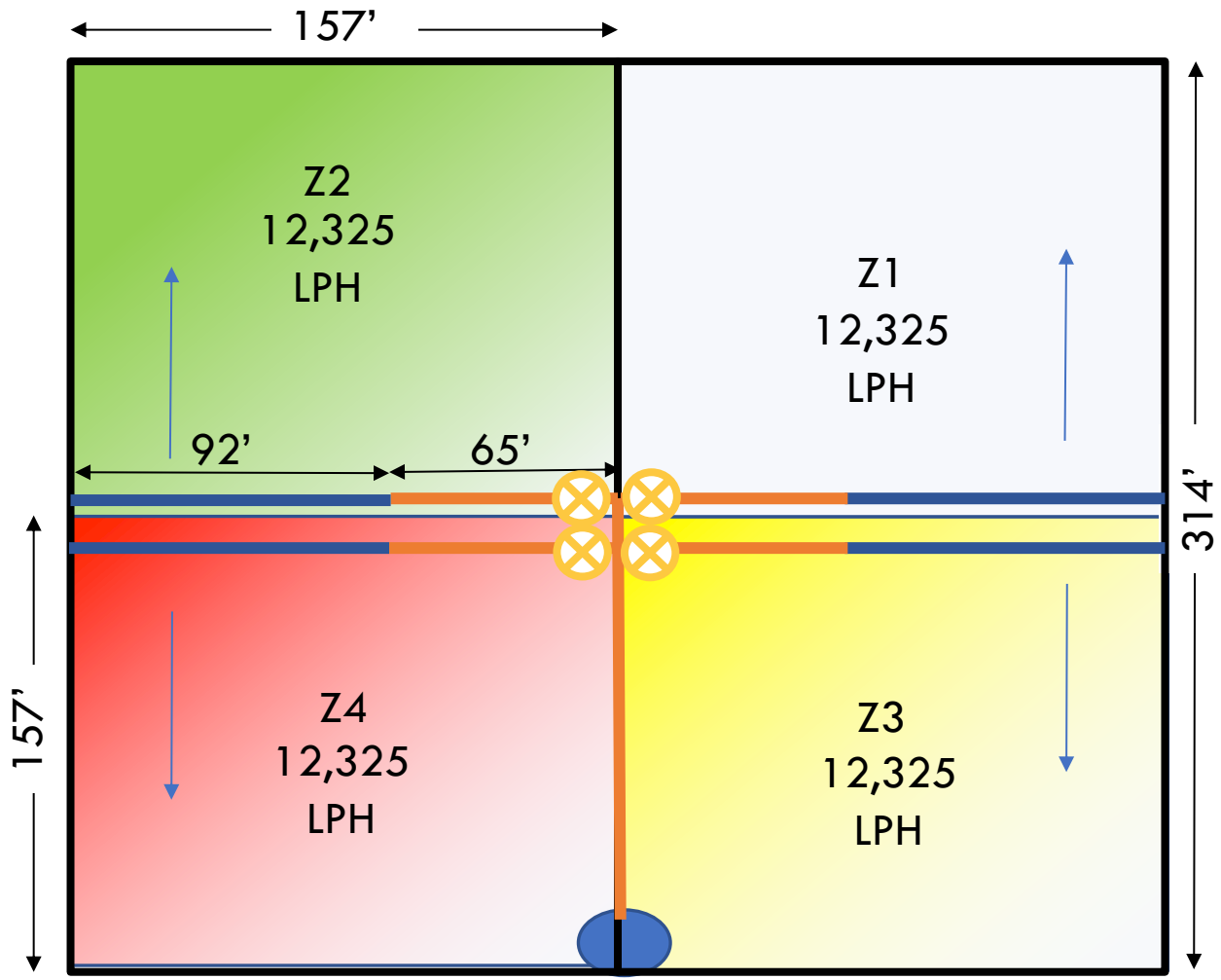
- Area Divided in 4 Zones (Z1, Z2, Z3, Z4)
- Flow Rate Per Zone, 12,325 LPH
- Main line, uPVC 2inch
- Submain Line, uPVC 2, and 1.5inch
- Lateral (Drip Line) Direction: North South
- Lateral Spacing, 4ft
- Lateral Per Crop Row, Single
- Nozzle Pressure Required: 1 bar, (10mtr)



FRICTION LOSSES CALCULATION

- Worst Case Scenario
  - Remote Point
  - High Flow
- In case one zone is Remote but Highest flow is for any other zone (not Remote)
  - Calculate for both (All Zones) with their respective flow and Distance and selected the Highest TDH (Re Call Total Dynamic Head from Previous Training)

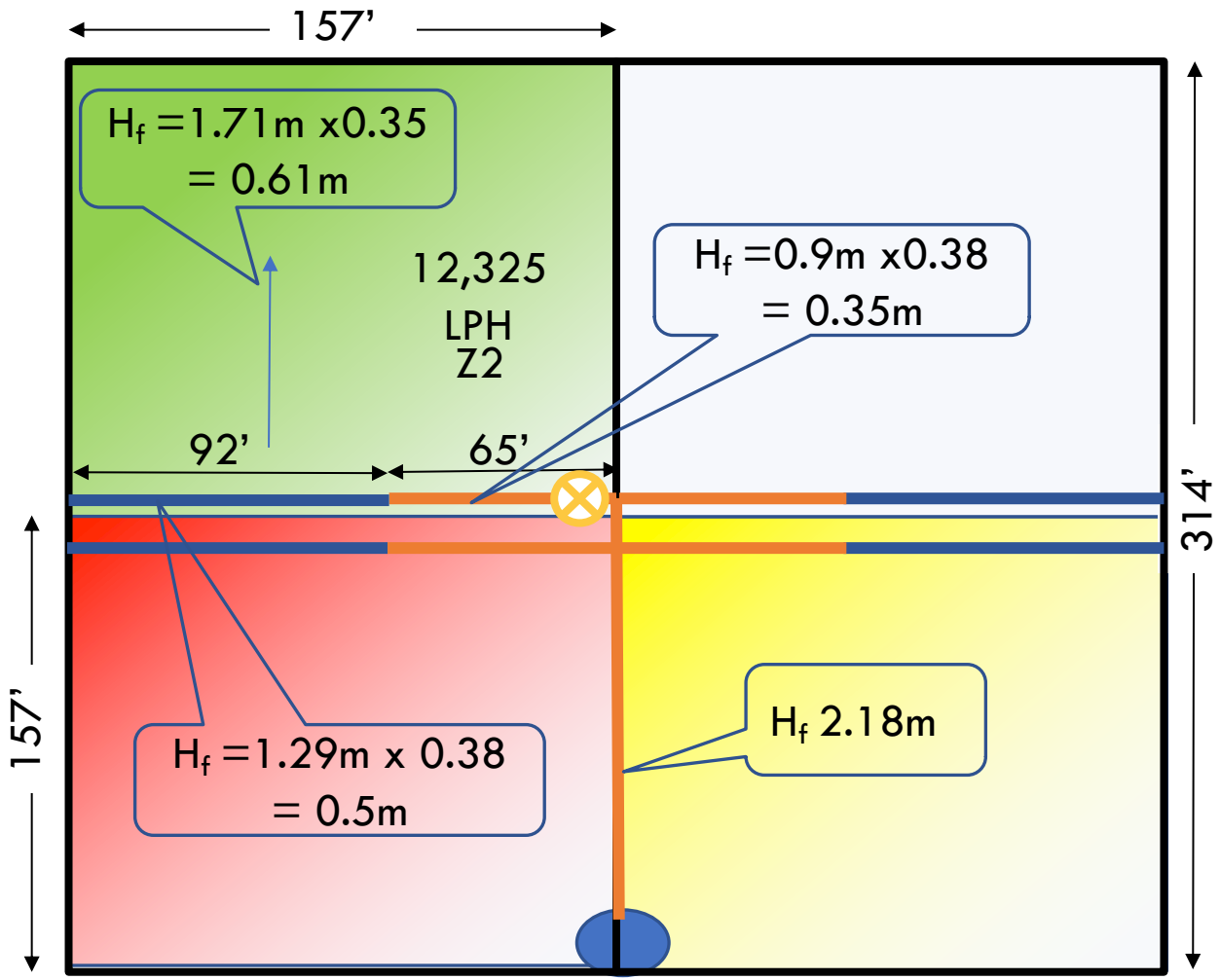
- All Zones are equally remote with equal flow
  - We can select any zone for TDH calculations
- Main line, 2inch, Class C, 157ft (48mtr), Flow 12,325 LPH
- Submain Line, 2inch, Class C, 65ft (20mtr), Flow 12,325 LPH
- Submain line, 1.5 inch, Class D, 92ft (28mtr), Flow 7,500 LPH
- Lateral, 16mm OD, 1.2mm WT, inner Dia, 13.6mm
- Nozzle Pressure : 10mtr



- Use Provided Excel Sheet for Friction loss Calculations

- Main line, 2 inch, Losses = 2.18m
- Submain line, 2 inch, Losses = 0.92m
  - Out let factor 0.38
  - Final Hf= 0.35m
- Submain line, 1.5inch, Losses = 1.31m
  - Outlet factor = 0.38
  - Final Hf = 0.5m
- Lateral, 16mm, 0.9mm WT, Losses = 1.71m
  - Outlet factor = 0.35
  - Final Hf = 0.61m

Total Hf = 2.18+0.35+0.5+0.61 = 3.64m



- Minor Losses = 20% of Major Losses = 0.2*3.64 = 0.73m
- Major + Minor Losses = 3.64+0.73 = 4.37m Say 4.4m
- NOW:
  - Nozzle Pressure = 10m
  - Losses in Disc Filter = 2m
  - Elevation from Water Table up to Ground Surface = 263ft = 80.16m
- SO TDH = Major Losses + Minor Losses + Nozzle Pressure + Disc Filter Losses + Elevation Differences
  - 3.64+0.73+10+2+80.16 = 96.53 m say 97m

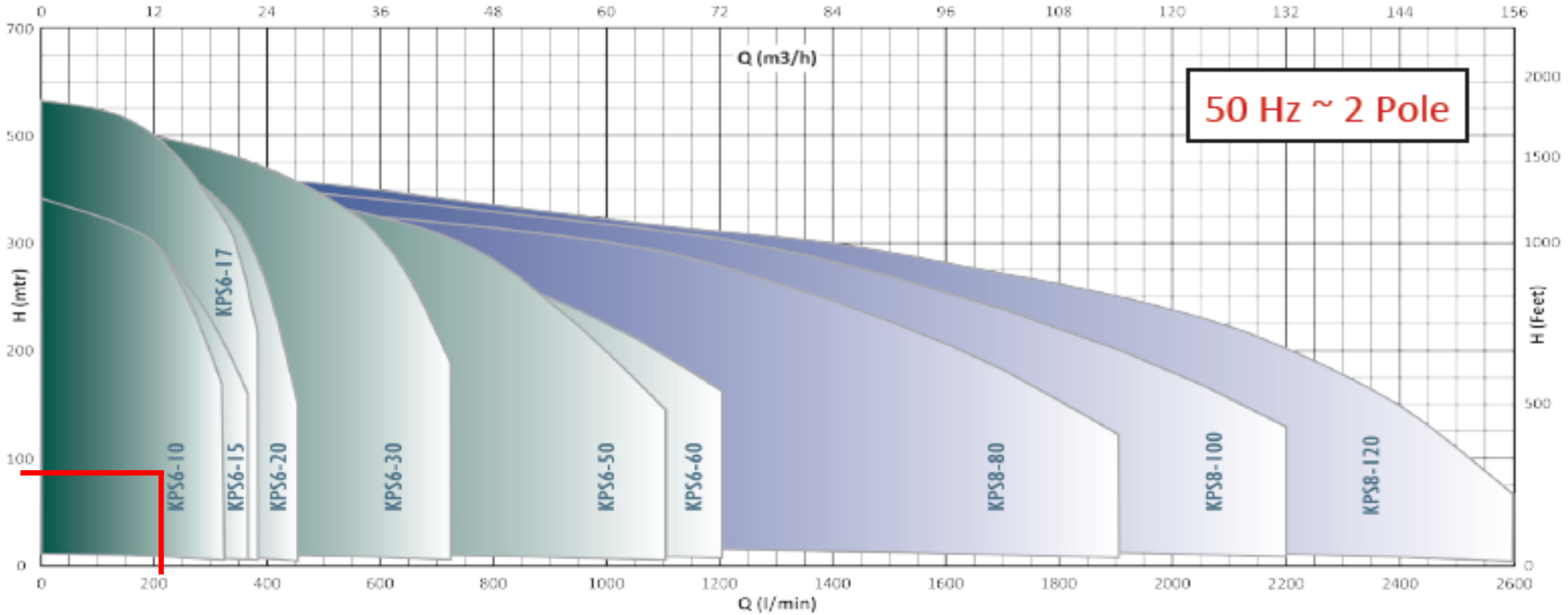
Duty Point

Flow Rate (Q) = 12,325 LPH (205.5 LPM, 12.3m3/hr)

TDH (H) = 97m

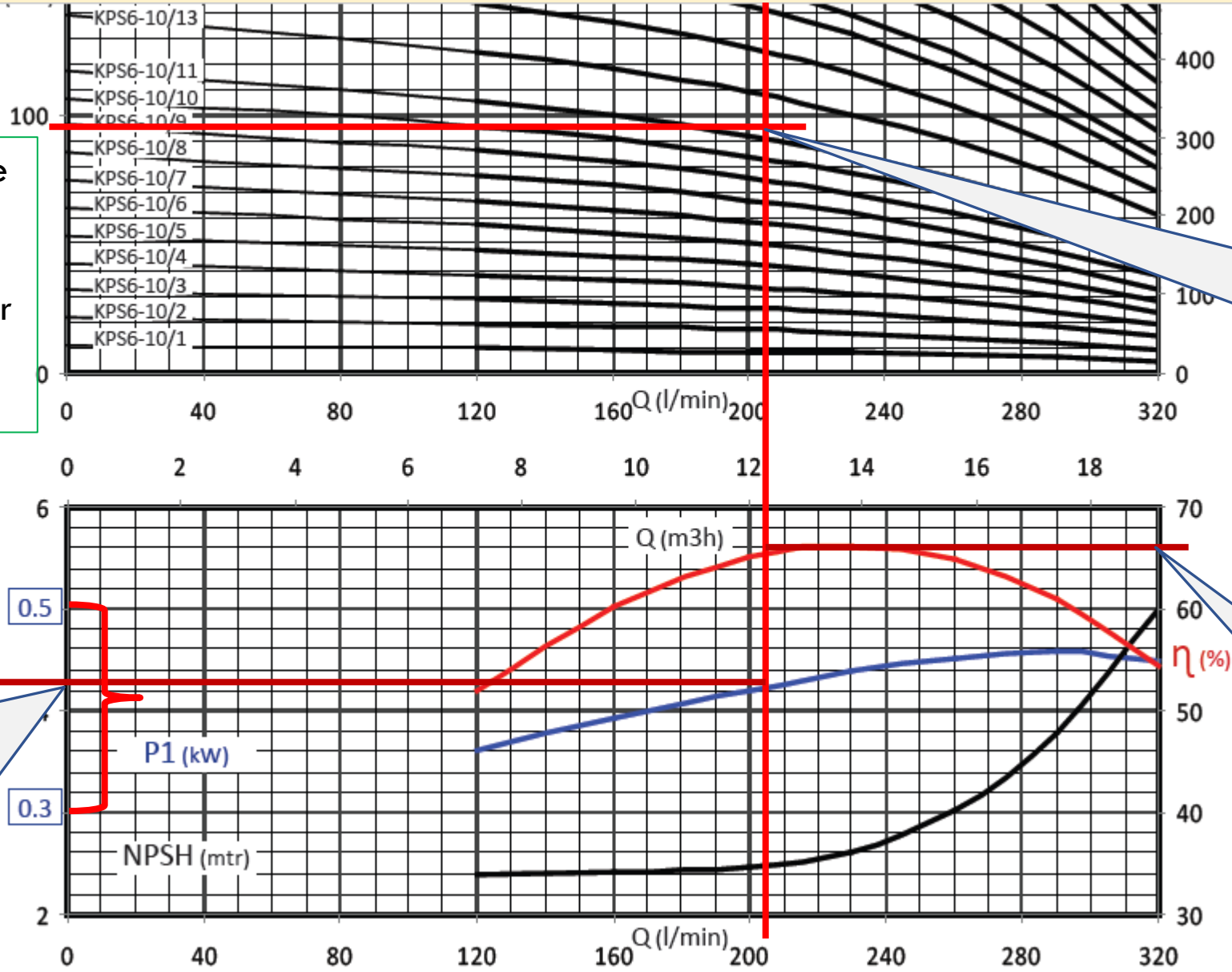
We need a Pump Set which can deliver 12,325 LPH @ 97 mtr Head

Group Performance Curve



KPS 6-10
Performance Cures

All Information available on pump curves are for pump only.
No motor or prime mover info is given on pump curve



Duty Point

Pump BHP/Impeller = 0.3 + [{(0.5-0.3)/10}*6.5] =0.43 KW
Impeller =13
Total BHP = 13*0.43 = 5.6 KW
=7.5 HP

Pump Efficiency = 66%

Water HP<Pump HP< Motor Rated HP< Motor Actual HP

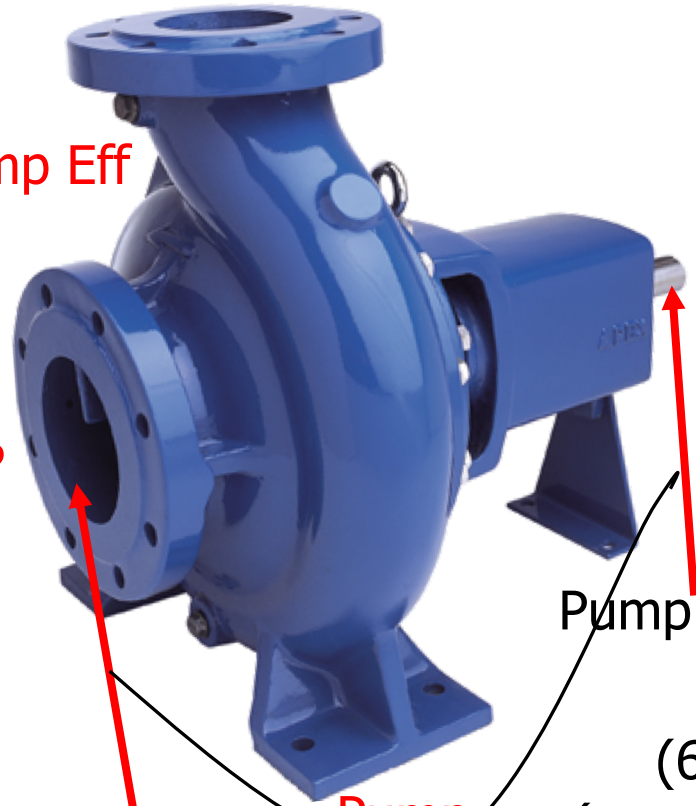
Design System for Motor Input HP

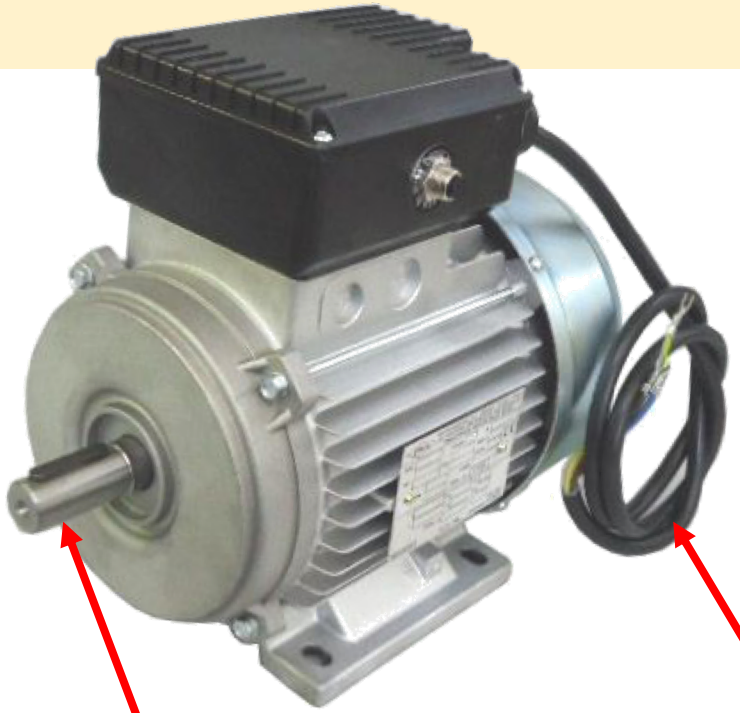
Water HP= Q*H

Pump HP (BHP), P2= WHP/Pump Eff

Motor Rated HP, P2 = Pump HP

Motor Input HP =P2/Motor Eff





Water HP

(4.43)

Pump Efficiency 66%

Pump HP

P2

(6.71)

(as per curve 7.5HP)

Motor Rated HP P2

Motor Efficiency

Motor Input HP