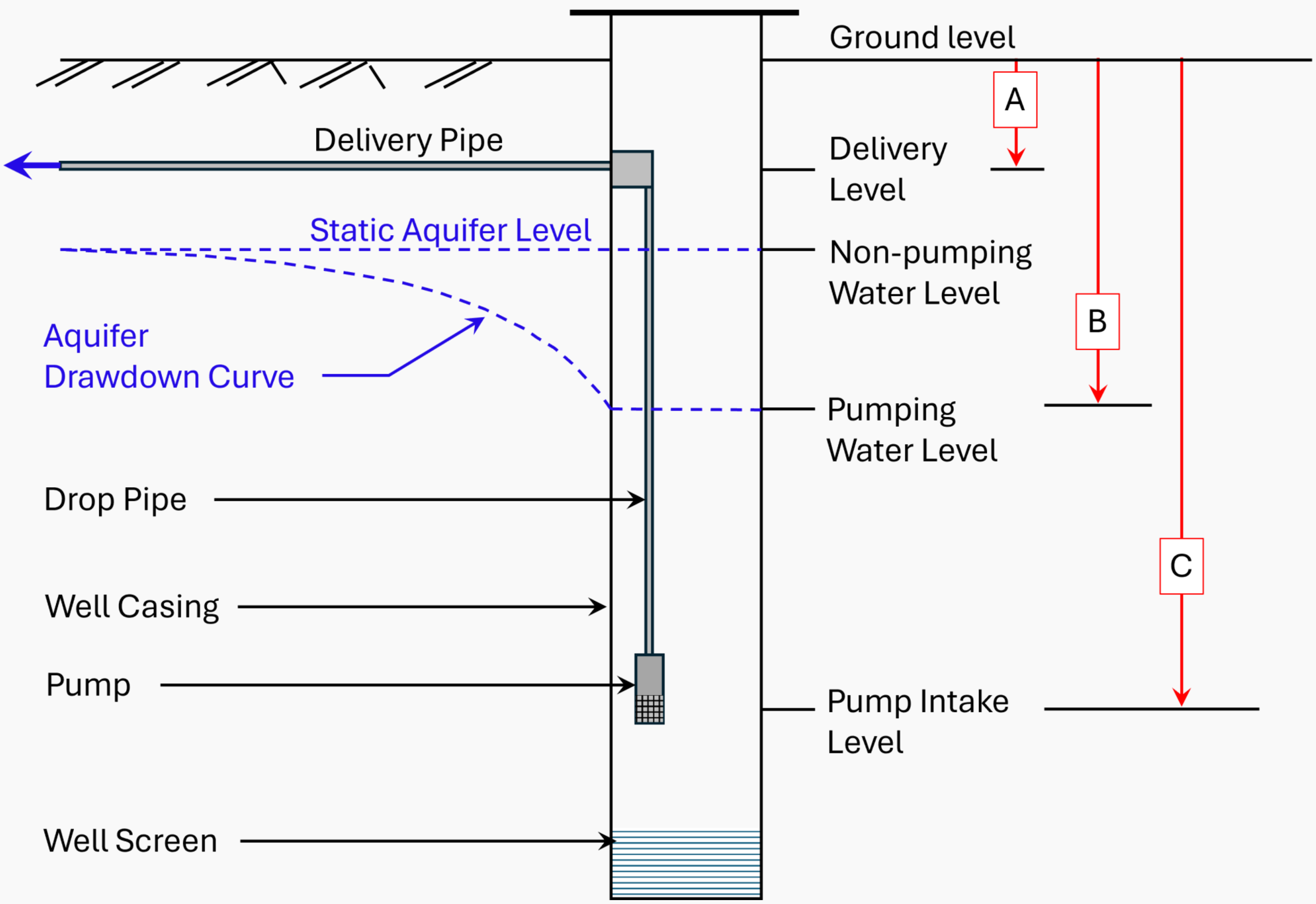
How to Size a Groundwater Pump



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Equations & Variables

Total Dynamic Head = $H_d - H_s + H_f + V_h$

Symbol	Units	Description	Details
TDH	L	Total dynamic head	$TDH = H_d - H_s + H_f + V_h$
H_d	L	Static discharge head	$H_d = A - C + D_p$
H_s	L	Submergence Head	$H_s = C - B$
H_f	L	Head loss in Drop Pipe + head loss in Delivery Pipe (Darcy -Weisbach Equation)	$H_f = f\left(\frac{L}{d}\right)\left(\frac{v^2}{2g}\right)$
V_h	L	Velocity head of water migrating through the aquifer to well	Negligible for aquifers
A	L	Depth to the Delivery Pipe	See drawing
B	L	Depth to the Pumping Water Level	See drawing
C	L	Depth to the Pump Intake Level	See drawing
L	L	Length of pipe work	Drop pipe & Delivery pipe
d	L	Inner diameter of pipe work	Drop pipe & Delivery pipe
v	L/T	Delivery velocity of the supply water	Calculated from Q
g	L/T2	Acceleration due to gravity	Universal constant
f	-	Friction Factor	Empirical value - see table
Q	L3/T	Delivery flow rate	Design criteria
D_p	L	Delivery pressure expressed in terms of head	Design criteria

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When to use this

Use this to estimate the **total dynamic head (TDH)** your pump must deliver at your **design flow**, then choose a pump that meets that duty point on the manufacturer's pump curve./

Know your system

1. Water levels and elevations (water level, discharge elevation)
2. Pipe run details (pipe size, length, fittings and valves)

Know your design targets

1. Required **flow** at the discharge point
2. Required **pressure** at the discharge point (if any)

Quick units check

Keep everything in one head unit (ft or m of water). Pump specs often mix units, so convert before you add terms.

- Convert pressure (psi or kPa) to head (ft or m).
- Convert flow (gpm or L/s) to velocity using your pipe diameter. Velocity is what drives friction losses.

Procedure for Submersible Pumps:

1. Calculate Static Discharge Head

This is the total height to lift + Delivery pressure needs

$$H_d = A - C + D_p$$

2. Calculate Submergence Head

This is the “free” head or discount on the total height to lift

$$H_s = C - B$$

3. Calculate Friction Head in pipework:

$$H_f = f\left(\frac{L}{d}\right)\left(\frac{v^2}{2g}\right)$$

- Calculate H_f for the drop pipe and the delivery pipe, then add them.
- Use f=0.02 for most smooth-pipe water systems. Refine f with a Moody chart or pipe friction loss calculator if needed.
- Optional: add losses from fittings and valves (usually minor)

4. Calculate the TDH:

$$TDH = H_d - H_s + H_f + V_h$$

Note: V_h is ignored for groundwater wells

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Worked example – Given Mixed Units

- Target flow: 24 US gpm (converts to v = 1.9 m/s in 1.25" pipe)
- Required pressure at delivery: 50 psi (converts to 35.2m of H_2O)
- Delivery point [A]: 2.5 m below ground
- Pumping water level [B]: 79 m below ground
- Pump intake level [C]: 95 m below ground
- Drop pipe: 1.25 in PVC, length ≈ 95 − 2.5 = 92.5 m
- Delivery pipe: length = 50 m
- Ignore minor losses for first-pass TDH (pitless adapter, elbows, valves)

1) Static Discharge Head

$$H_d = 95m - 2.5m + 35.2m = 128m$$

2) Submergence Head

$$H_s = 95m - 79m = 16m$$

3) Friction Head

$$\text{Drop Pipe: } H_f = 0.02\ (92.5m / 0.032m)\ (1.9m/s^2 / 2(9.81m/s^2) \approx 11m$$

$$\text{Delivery Pipe: } H_f = 0.02\ (50m / 0.032m)\ (1.9m/s^2 / 2(9.81m/s^2) \approx 6m$$

$$\text{Total } H_f = 17m$$

4) Total Dynamic Head

$$TDH \approx 128m - 16m + 17m = 129m$$

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