Water storage, Pumps, and Recycling

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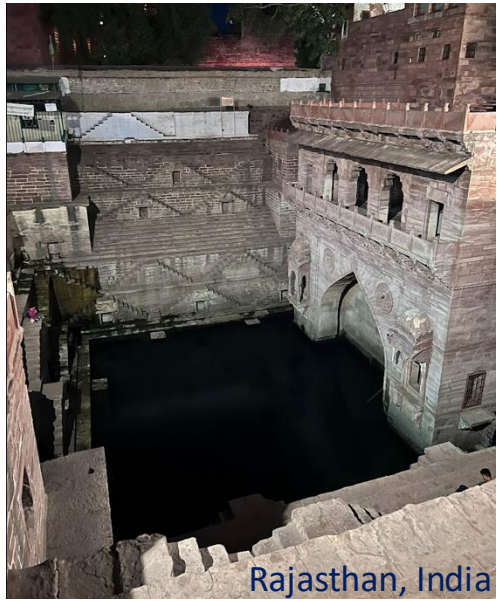
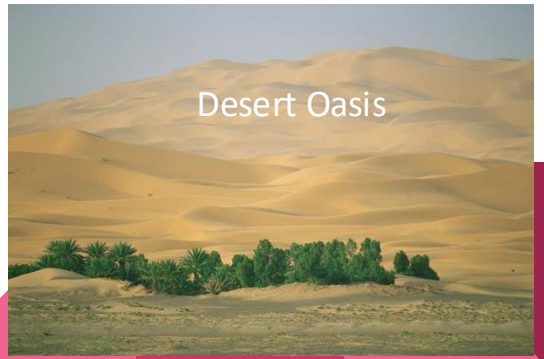
Obtaining Water in the early days…

Windmills and Water Wells …

Underground source, pumped or “brought-up” to the surface



Bringing water into a city has always posed challenges…



Obtaining Water in the modern days

Dams provide water capture and upon overflow (dam levels too high), water is released.

The water can drive turbines to generate power and can raise water levels in a downstream river.

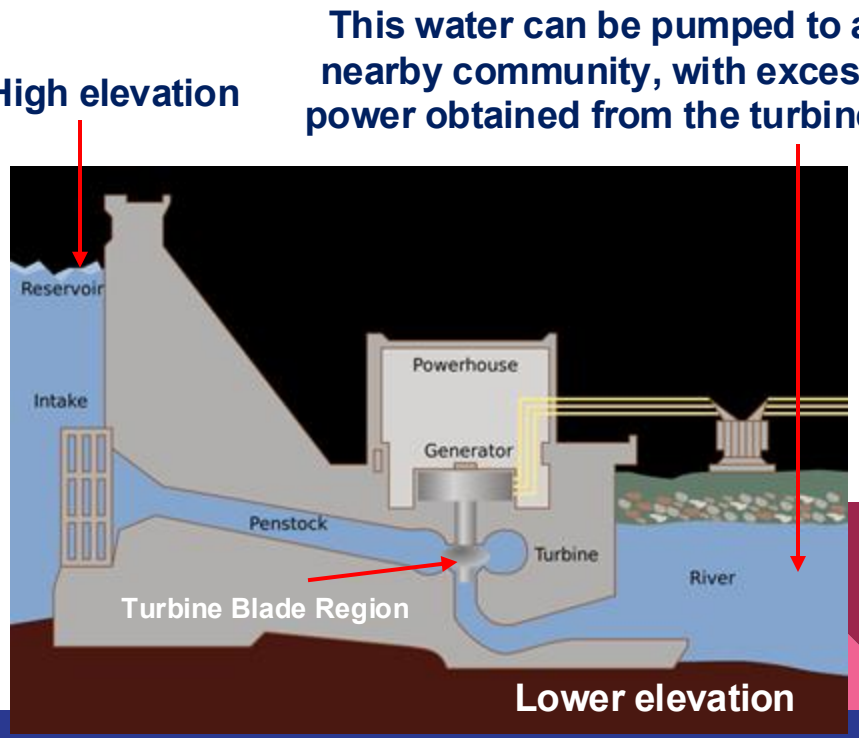
Too much generated power can improve an economy, and possibly affect nearby countries and political tension (See recent Grand Ethiopian Renaissance Dam project)

Obtaining Water - long distances

The turbines can generate electricity (for different uses) and can also power pumps to push water to a community further away,

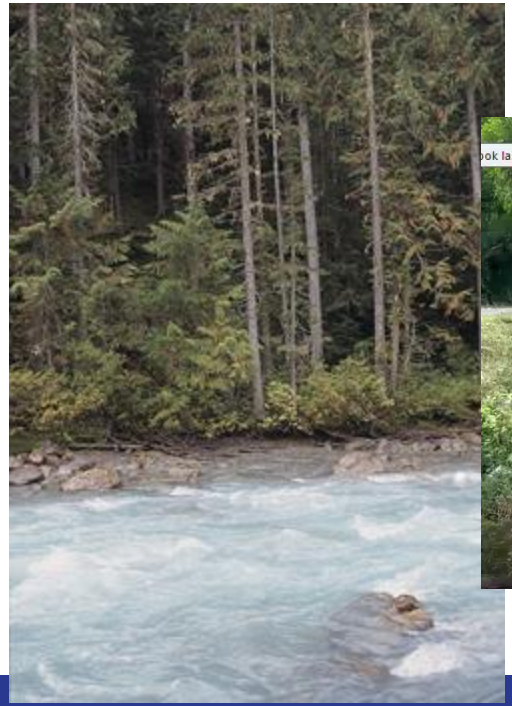
Water is pumped in pipe-lines over various distances.

Gravity-fed options are preferred (no pump required)

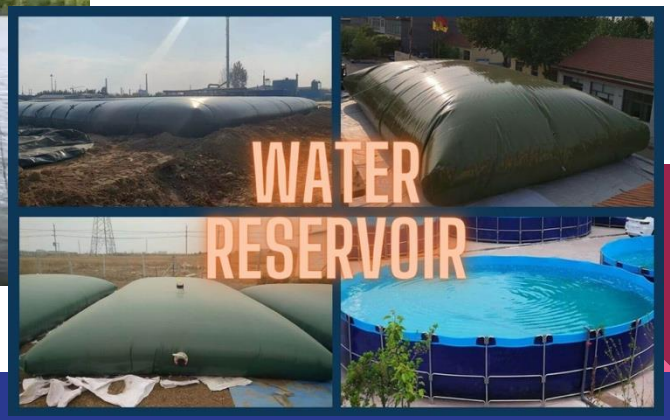


Obtaining Water

Another type is to channel flowing water from a river, and to capture this water and transfer into a tank.



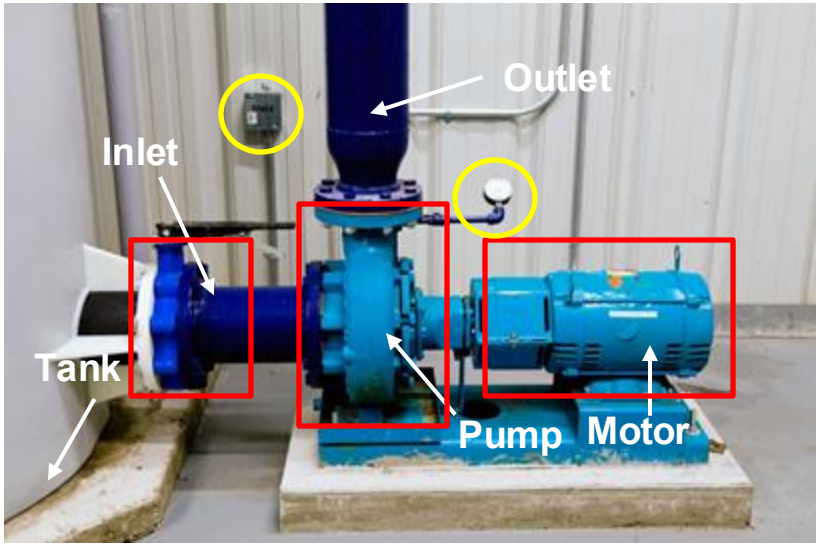
Scales of reservoirs -> (to reserve) -> to store water.



If the Water-Source is too far away…

Need to transport water from the source (Dam or River),

How do we transport the water?

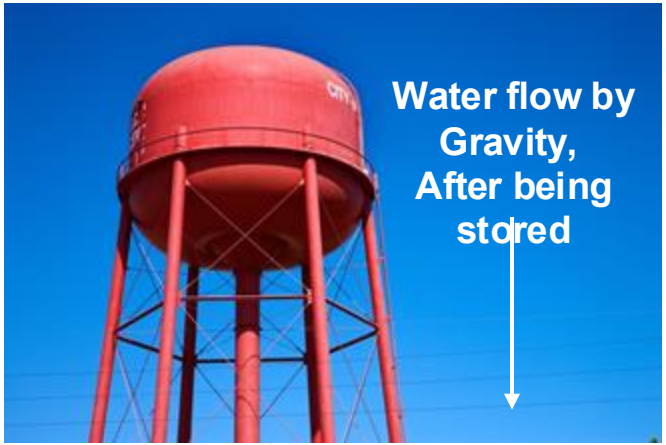


Water carried in carts or containers…

If the Water-Source is too far away…

What happens after the water is transported/Pumped?

We going to have store the water?, but where?



Take advantage of gravity feed systems. Water flows under the action of gravity.

If the Water-Source is too far away

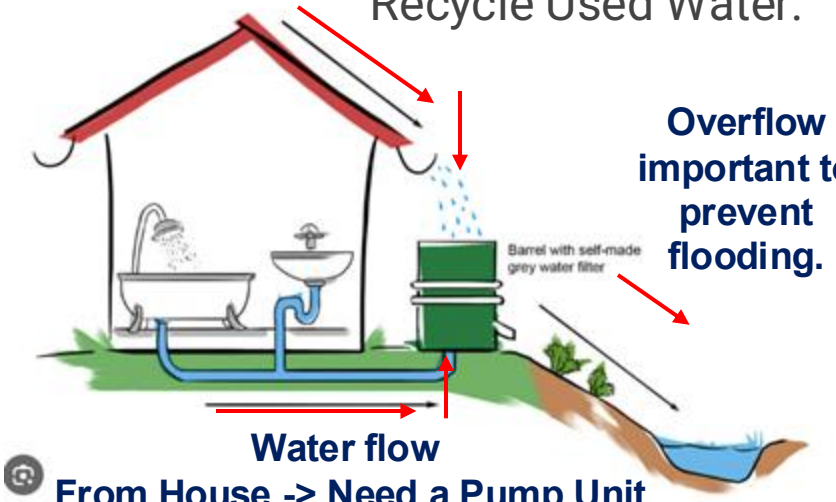
Different types of water:
Grey : Irrigation but not for drinking/consumption
Blue : Safe for consumption by People and Animals
Black : Sewerage and not safe unless treated further

What else can we do?

Harvest Water

Water flow From Roof

Recycle Used Water.



Overflow important to prevent flooding.

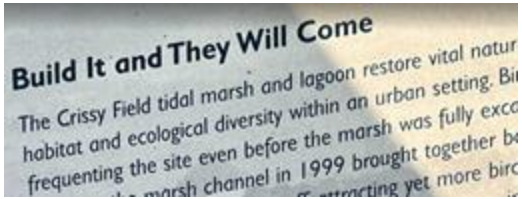
Water flow From House -> Need a Pump Unit

If the Water-Source is too far away

What else can we do?

Wetlands: capture water for biodiversity->reduce irrigation requirement for plantations

Crissy Field Tidal Marsh San Francisco



Build It and They Will Come

The Crissy Field tidal marsh and lagoon restore vital natur
habitat and ecological diversity within an urban setting. Bi
frequenting the site even before the marsh was fully exca
marsh channel in 1999 brought together b
attracting yet more birc

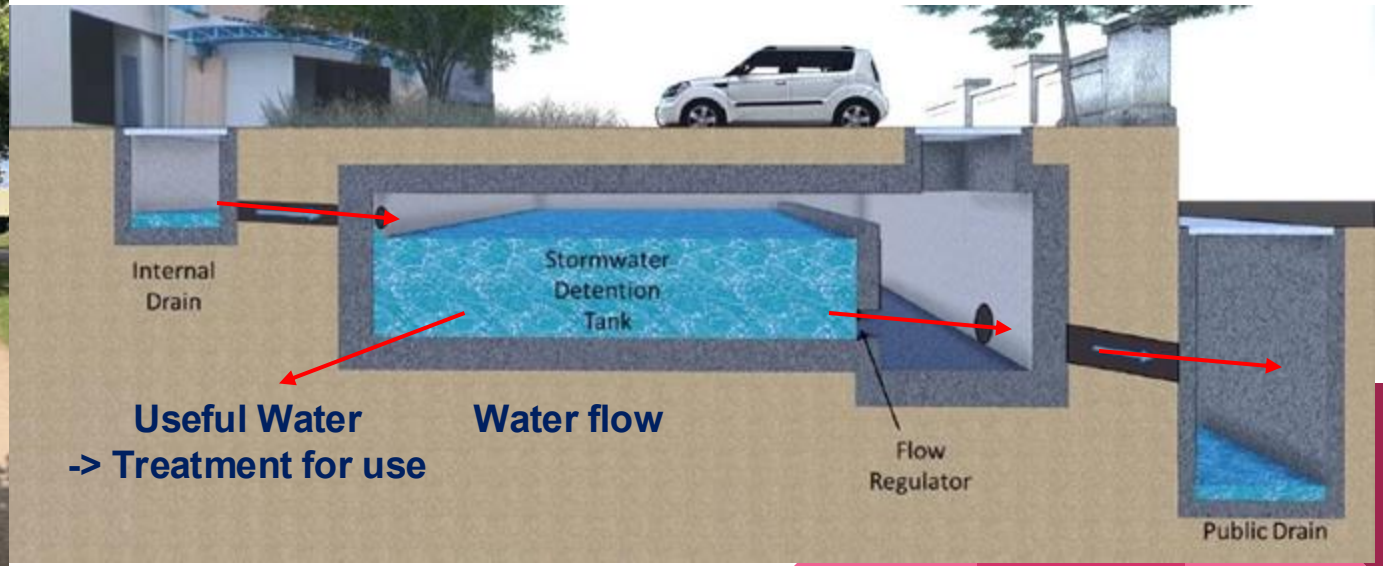
Enhance natural water storage biodiversity:

River plantation along the banks of Charles River Boston

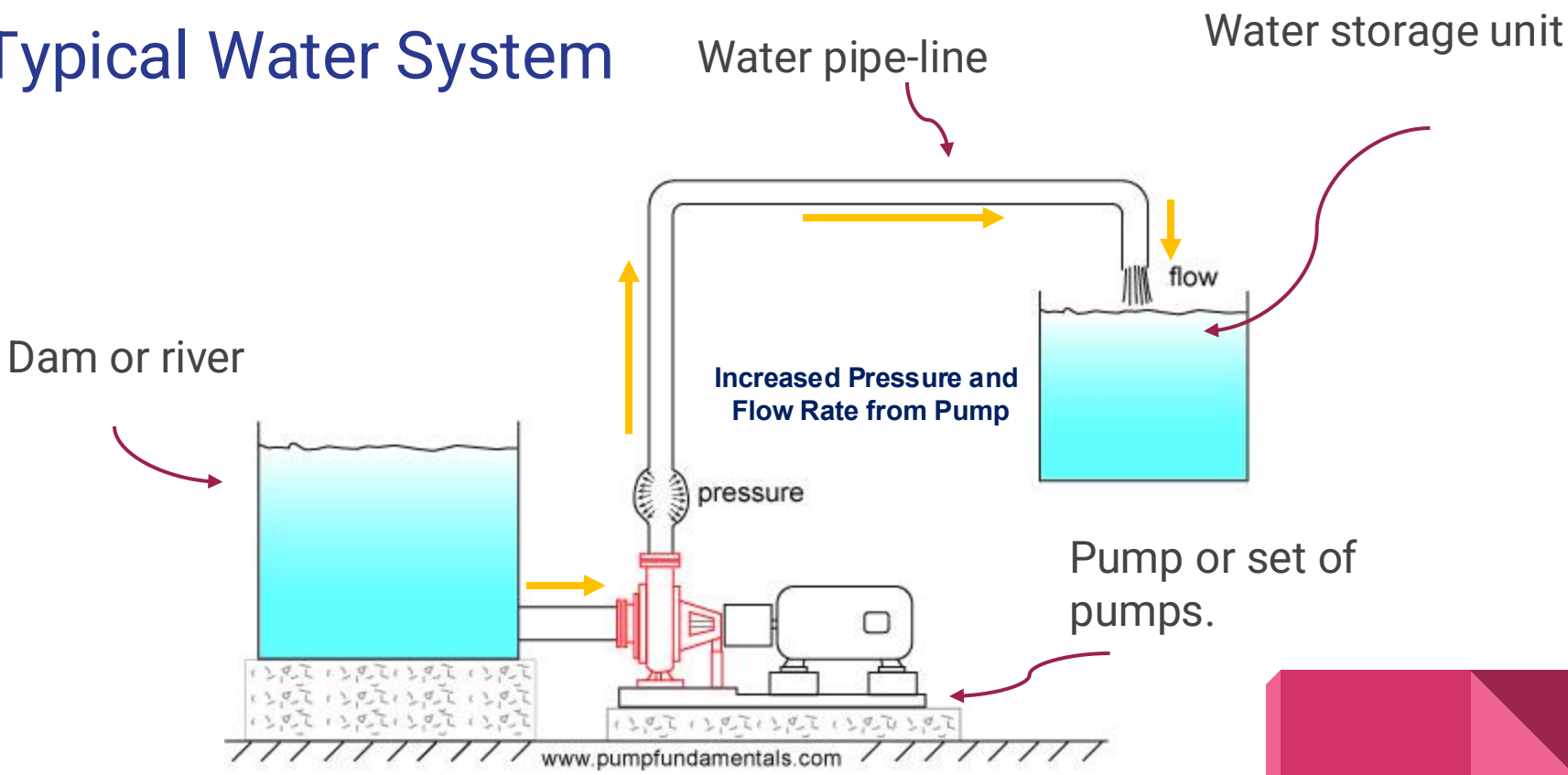
What about other techniques?

Canals (Delft):

Underground Water Storage:

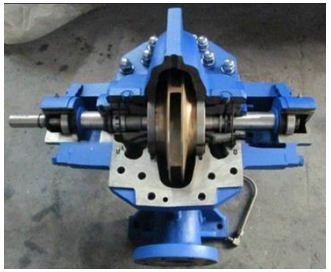


Typical Water System



About a pump for Water:

- The motor drives the impellor disc.
- The impellor disc increases water pressure and rate of water flow a the Outlet.



Double Inlet Centrifugal Pump

This power required by the pump can be simplified way be given as:

Pump power = $\rho g(\frac{V}{A})H$ OR Pump power= $\rho g Q H$

- ρ- water density (about 1000 kg/m3)
- V- is how fast the water exits the Outlet (m/s)
- A-is the cross-sectional area of the Outlet Pipe (m2)
- Q- is the flow rate (m3/s), $Q = \frac{V}{A}$

Water Outlet

Single Inlet Centrifugal Pump (Common)

Water Outlet

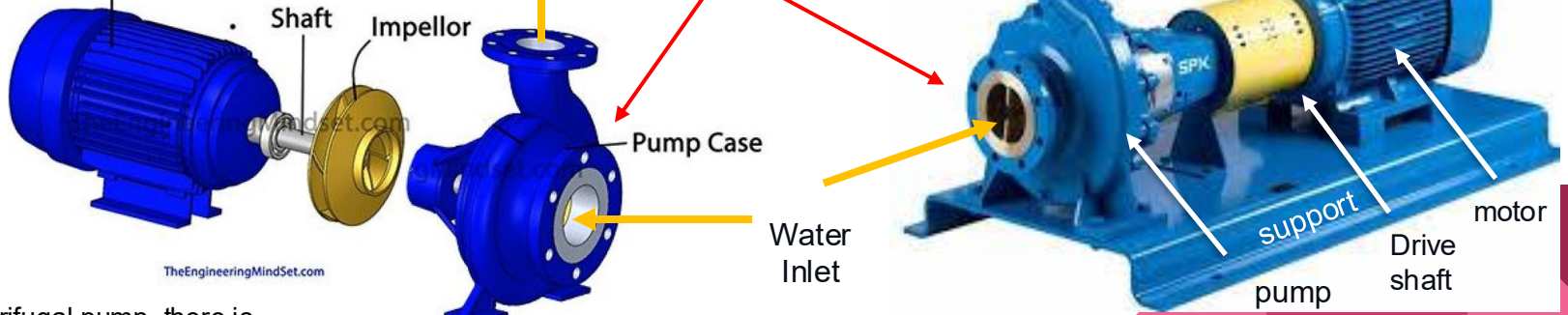
Generally an Induction Motor

Shaft

Impellor

Pump Case

Water Inlet



This is a centrifugal pump, there is also mixed and axial flow pumps

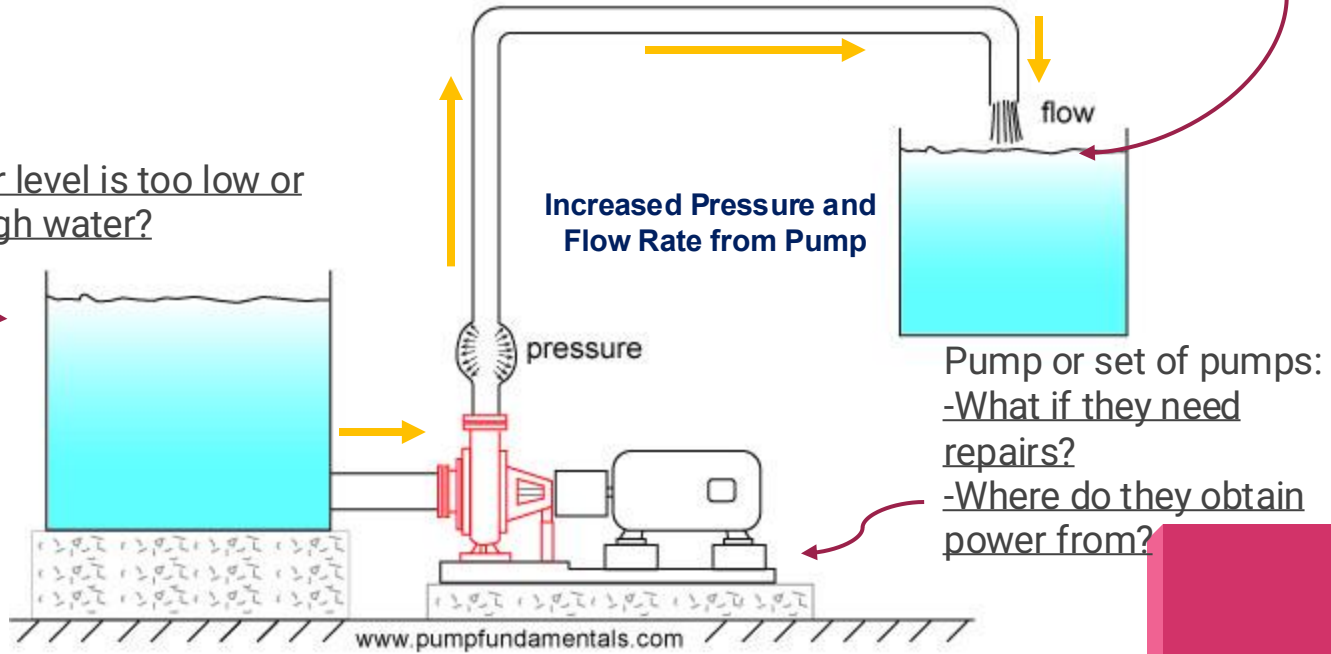
Typical Water System
Solution Spaces

Water pipeline:
-What if there are leaks in the pipeline?

Water storage unit:
-What if the water storage is too high,
-or too small?

Dam or river:

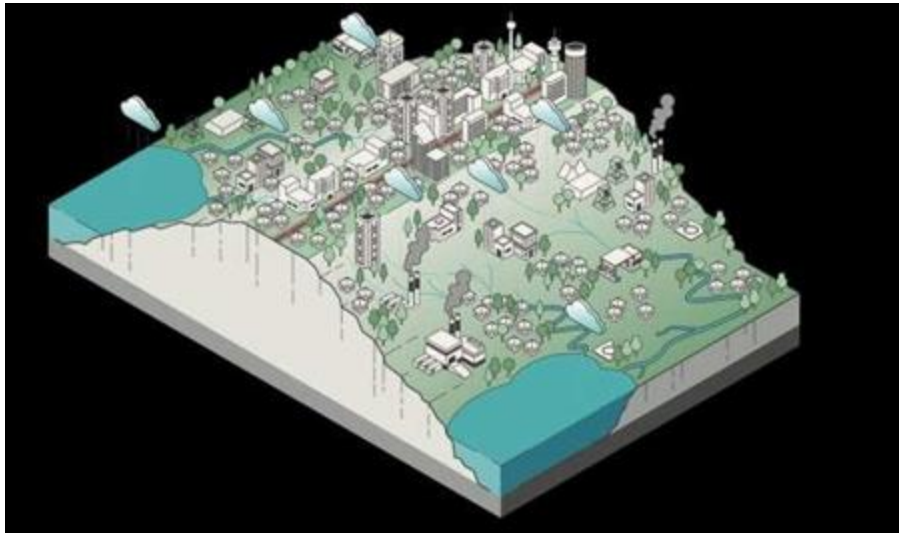
-What if the water level is too low or there is not enough water?



Pump or set of pumps:
-What if they need repairs?
-Where do they obtain power from?

Typical Water System
Solution Spaces

This can represent the dam or river:
-What if this is too low or too little water?



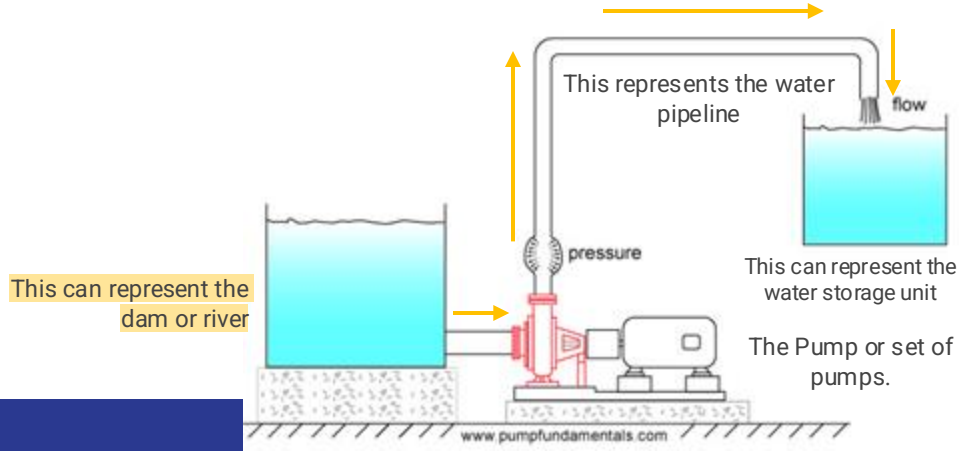
Create water spaces:

- Unused mines but must be checked for storage quality
- Build micro-dams or micro-lakes.

Then we have a new problem:

How to fill these water spaces:

- Pump water from the lower water bodies to higher elevations.
- Use wetlands
- Rain-water harvesting



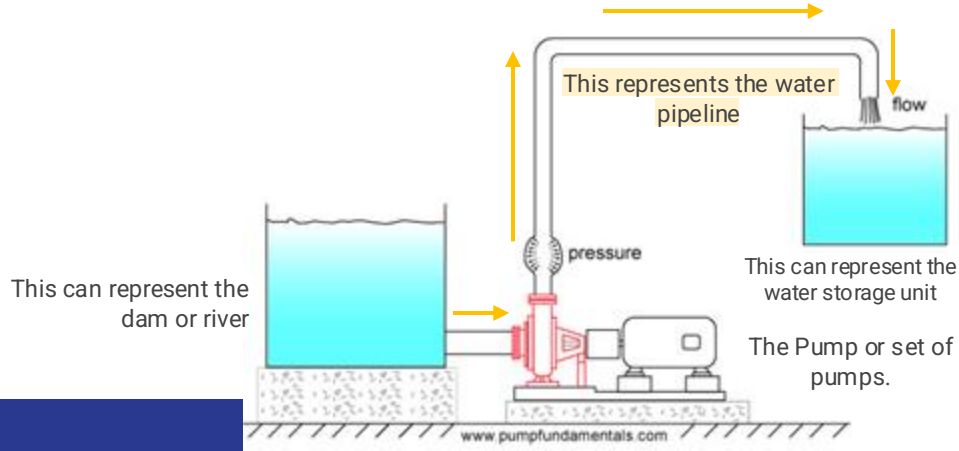
Typical Water System
Solution Spaces

This is the water pipeline:
-What if there are leaks in the pipeline?

What if this happens underground?

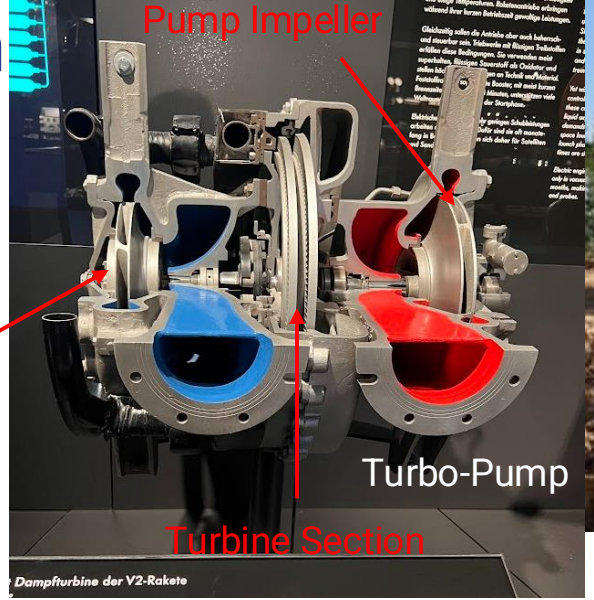
Monitor the pipeline for leaks

- Use sensors to measure water leakage (moisture levels, conductivity, acoustics, decrease in pressure or volume flow rate),
- Identify underground water leakage near the pipeline.
- Can also be caused with
  - -pipe erosion,
  - -increased water pressure,
  - -sudden valve closer



Typical Water System
Solution Spaces

The Pump or set of pumps:
-What if they need repairs?
-Where do they obtain power from?



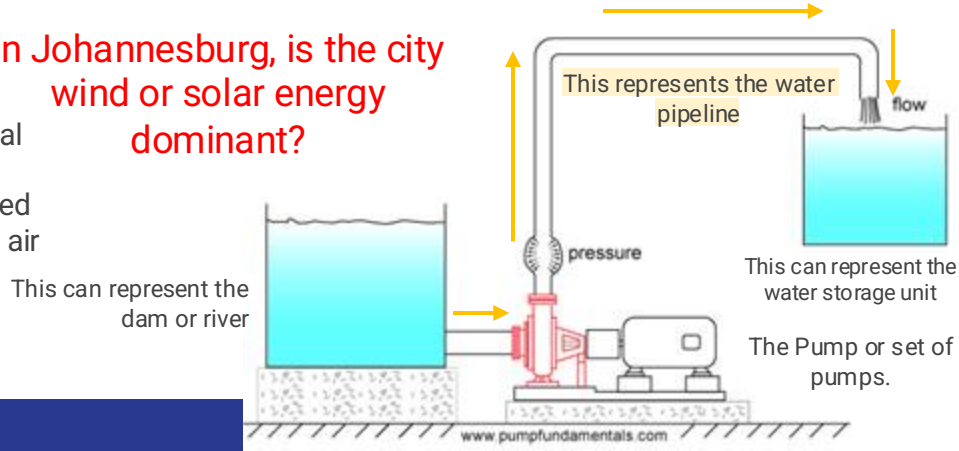
Pump Impeller

Flotation pump/power unit

How can we generate electricity?

- Solar pumps
- Turbine powered pumps (special applications)
- Can the Turbo-Pump be designed using excess steam or exhaust air from another device?

In Johannesburg, is the city wind or solar energy dominant?



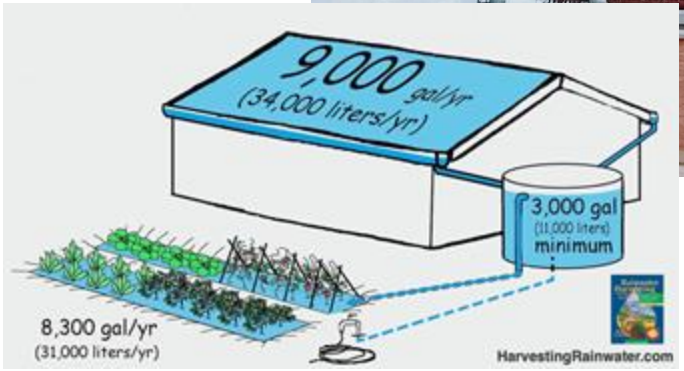
New Brixton water reservoir

Typical Water System
Solution Spaces

This can represent the water storage unit:

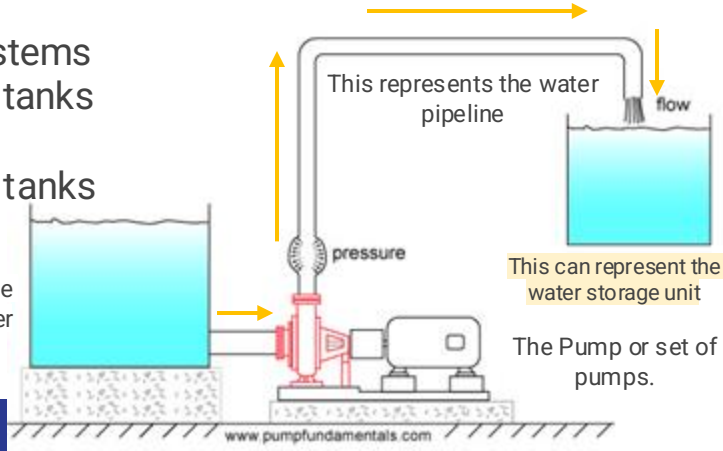
- What if the water storage is too high?
  - Pump water into the water storage unit

- or too small?
  - Water storage networks



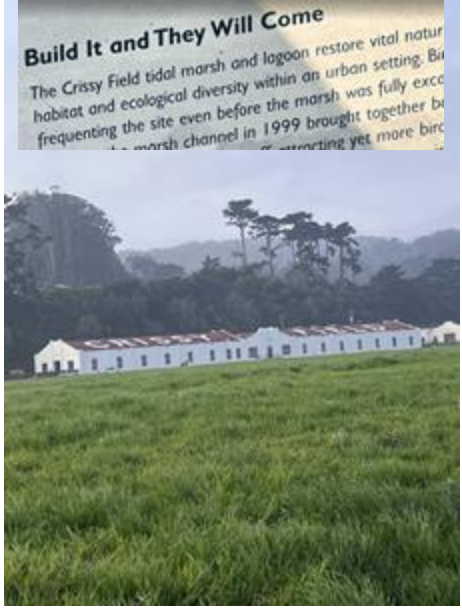
How can we store water?

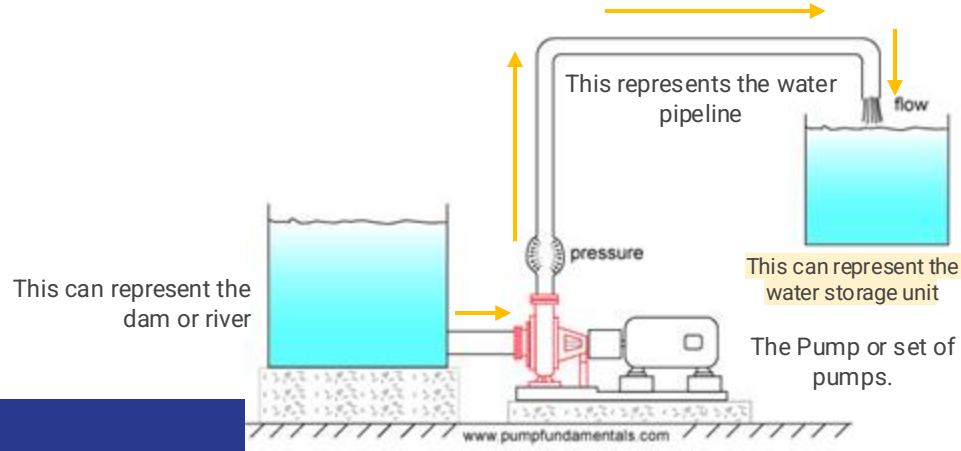
- Build water reservoirs
- Cultivate water-ecosystems
- Use special use water tanks for a community
- How large must these tanks be?



Summary
Solution Spaces

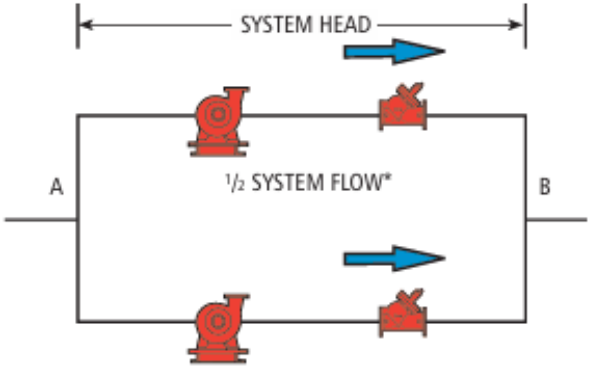
- Create water spaces
- Monitor the pipeline for leaks
- About Pumps:
  -What if they need repairs?
  -Where do they obtain power from?
- How can we store water?
- Cultivate water-ecosystems





More on Pumps

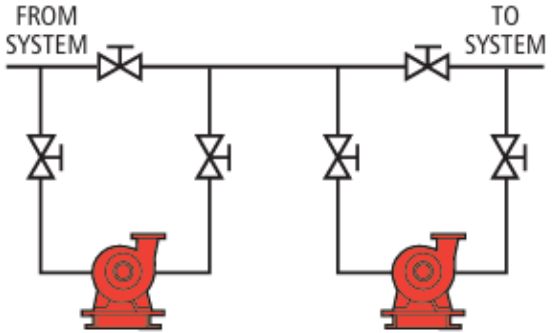
Series Pumping: Increased pump head (elevation)



Basic Parallel Pump Installation
Figure 1

Series Pumping: Increased pump Flow Rate

A common method of piping pumps for series operation is shown in Figure 28. The valves allow either one or both pumps to be in operation.



Practical Series Pump Installation
Figure 28

This type of piping arrangement allows either of the pumps to be valved off for routine maintenance without interrupting service to the system. Again note that for normal series operation, the total flow will pass through each pump.