Gravity pipeline

1. Specific flow
2. Partial flow
3. Boundary cases
4. Air blockage
5. Practical exercise

1. Solving the Bernoulli equation

In gravity system, each system has its specific flow but:

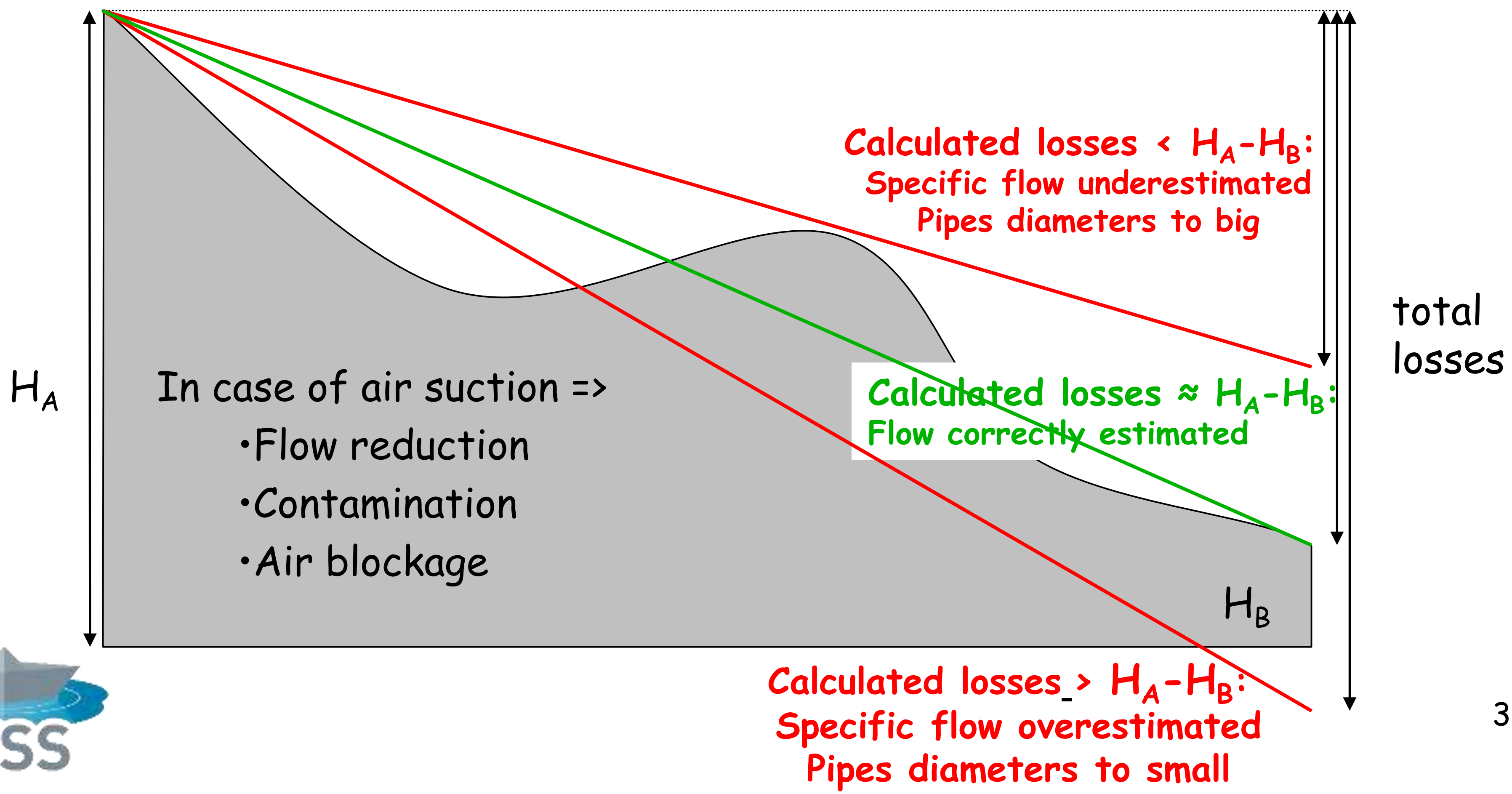
- To calculate the flow, we need to know the losses
- To calculate the losses we need to know the flow

1. Calculate losses with an estimated flow
2. Take a lower Q if $\Sigma H_{LP} > \Delta H$, and a bigger Q in the contrary
3. Iteration till having the same result (± 2%)

➢ Similar process can be used with the diameters

Flow Estimation

- Work as closely as possible from reality, no margin can be taken



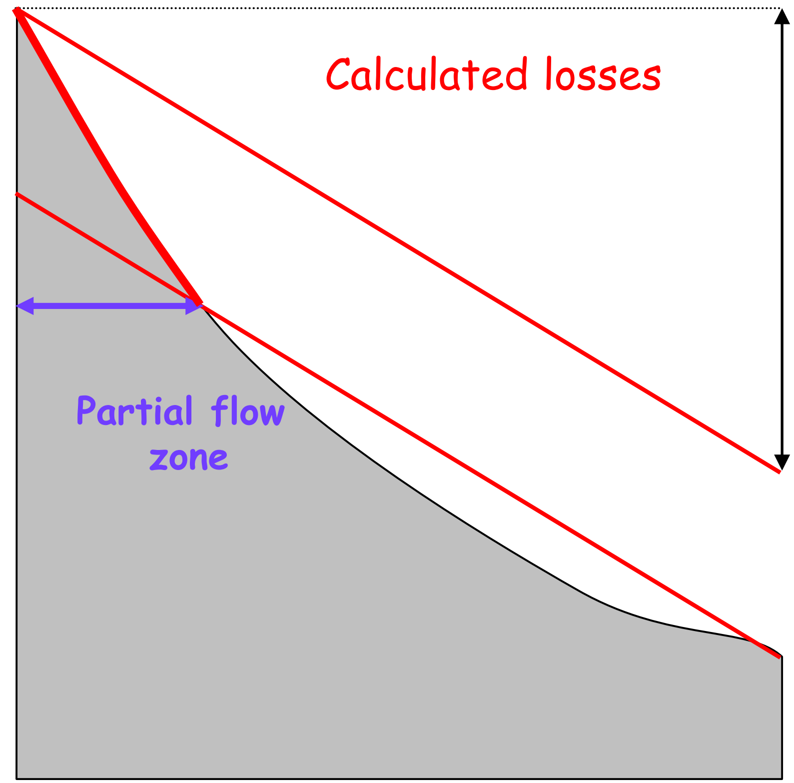
Specific flow

- The specific flow is the maximum flow that can pass in the system without adding energy (pump, extra height)
- **If the actual flow is lower, partial flow will occur on a part or the totality of the line**
- In this case, it should be checked that speed is still acceptable (<3m/s)!

➢ Check also that there is no depression zones on high points.

2 Partial flow

- Q < Qn => Pipe not full
- Atmospheric pressure
- Energy directly dissipated



Concave case

Convex case

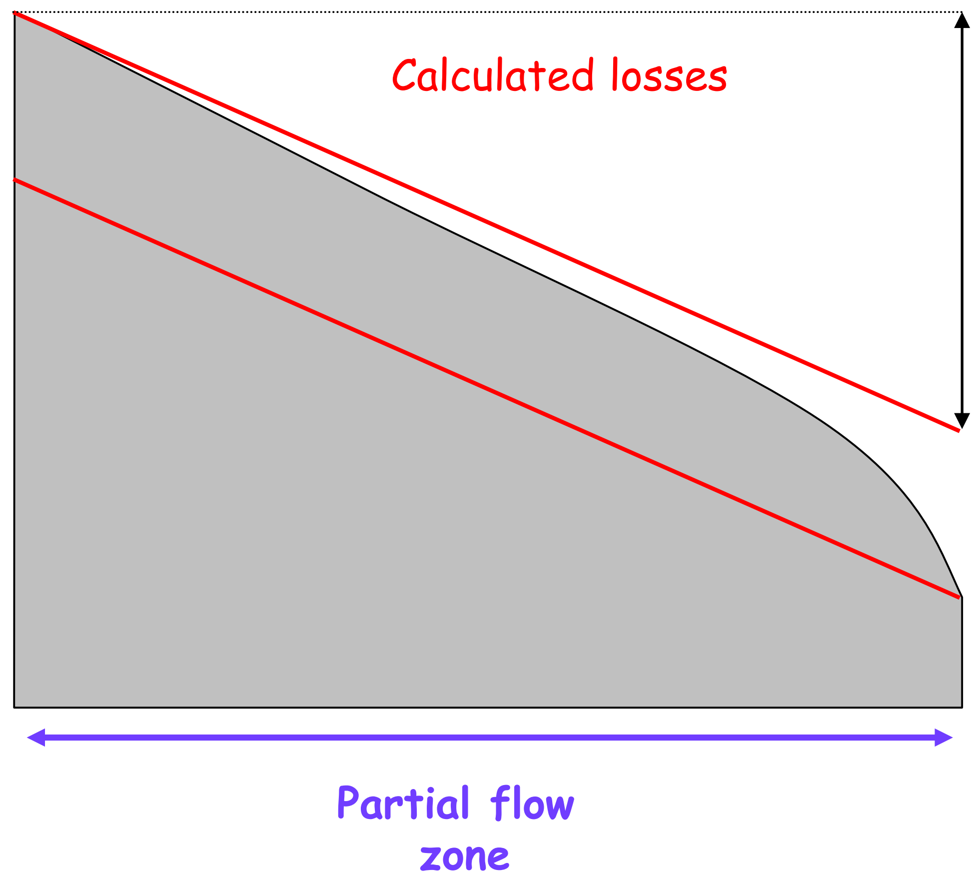
Watch out for connection

In the partial flow zones :

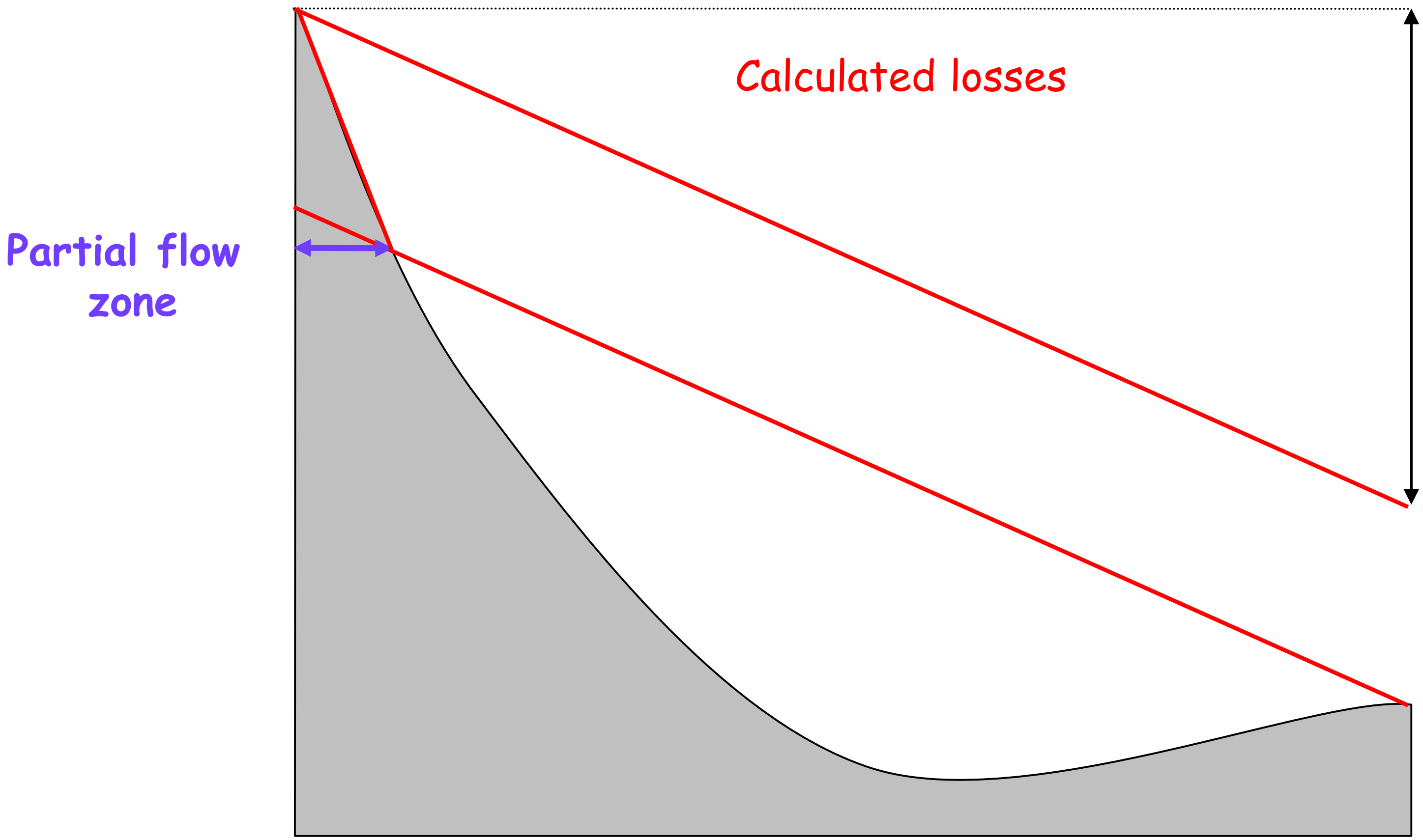
the actual losses > calculated losses

Bernoulli is not valid !!

The speed will depend on the slope

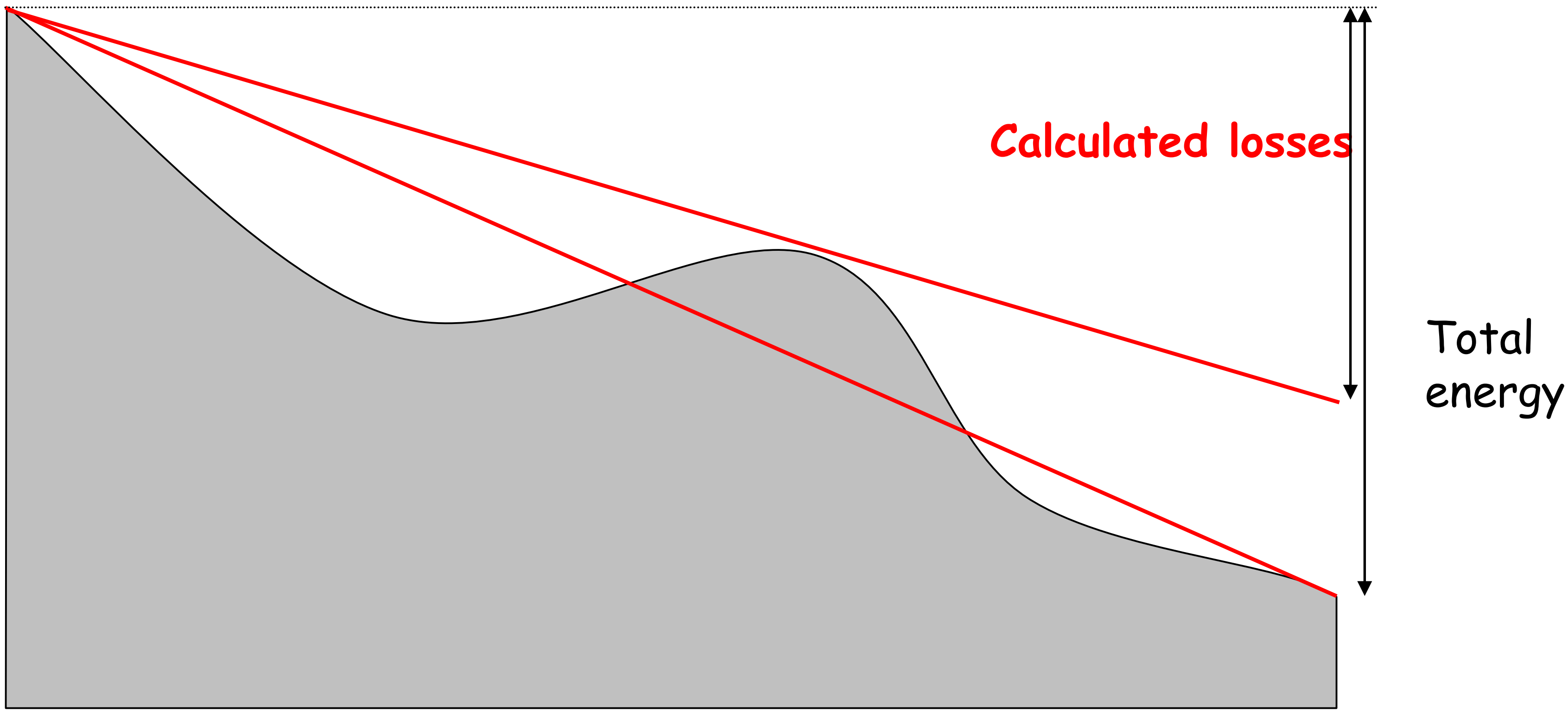


U shape case



Case with a high point

- Where are we going to have partial flow ?

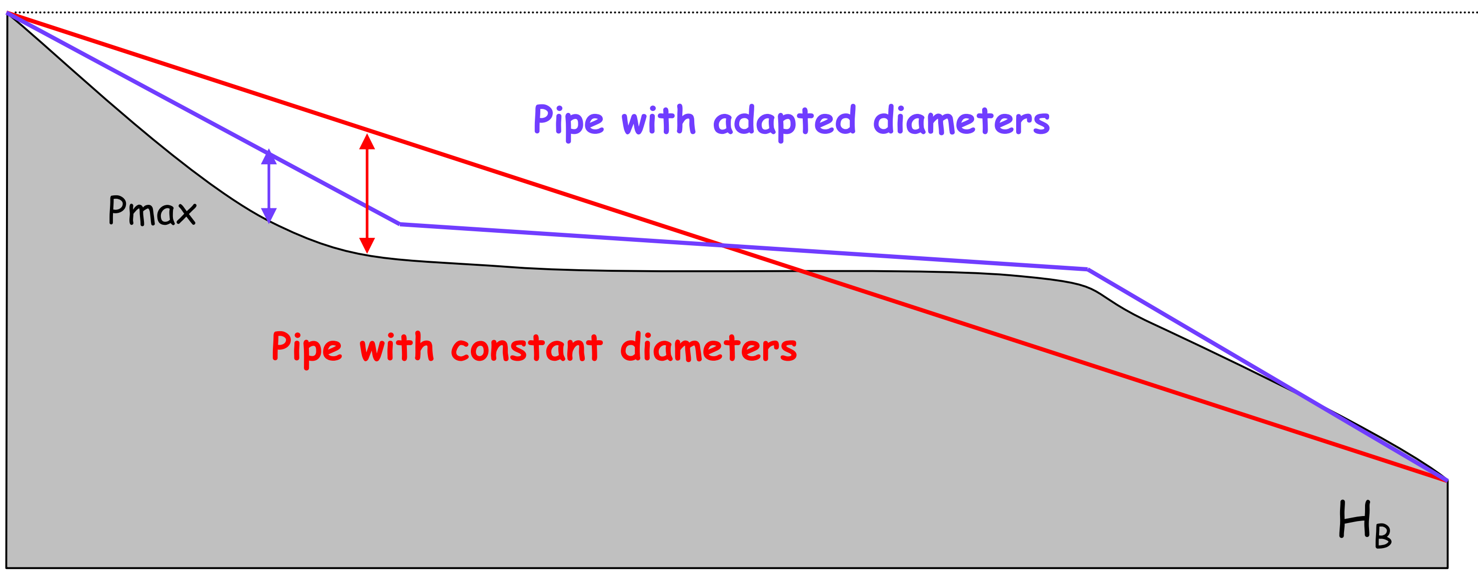


Adjust diameters to profile

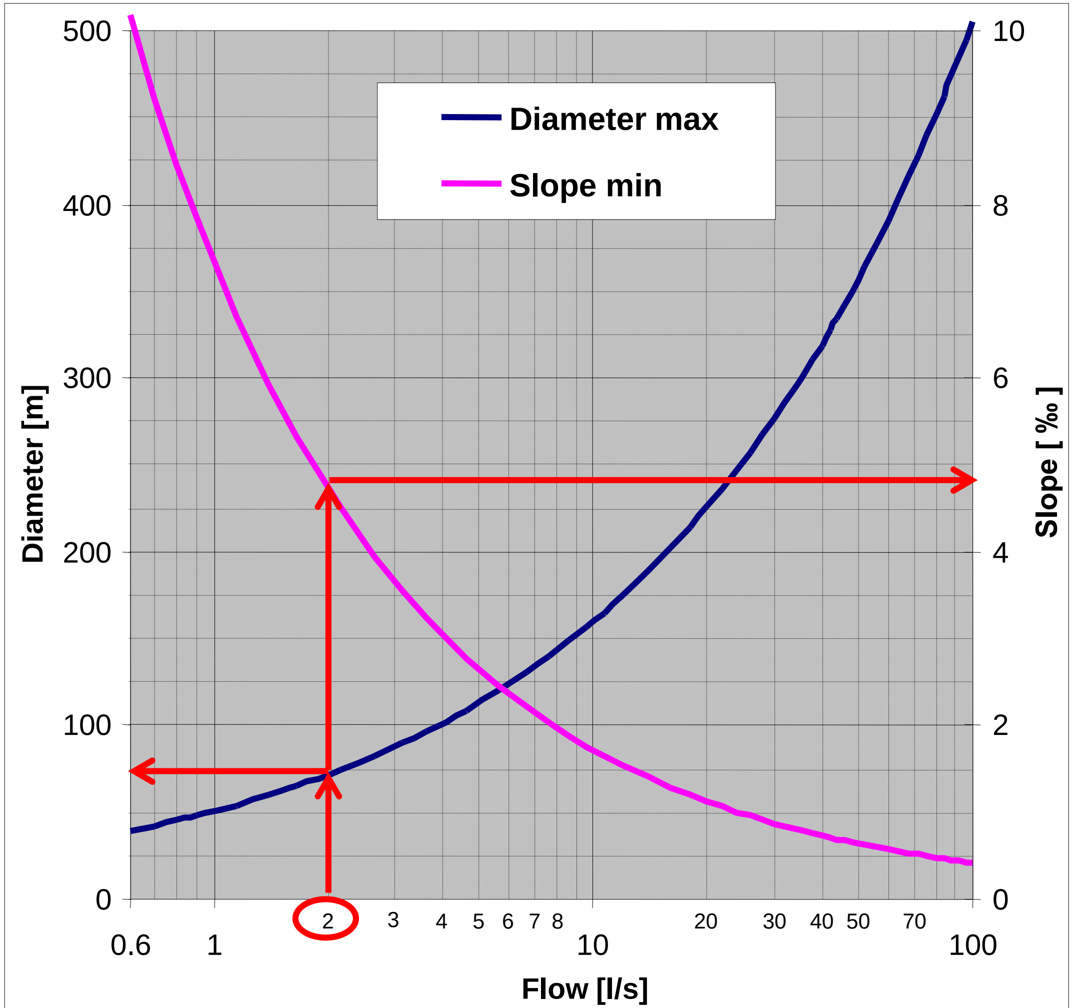
To avoid depression :

- Small diameters downhill
- Big diameters uphill

=> Limit internal pressure



3 Boundary situations



When the slope is small

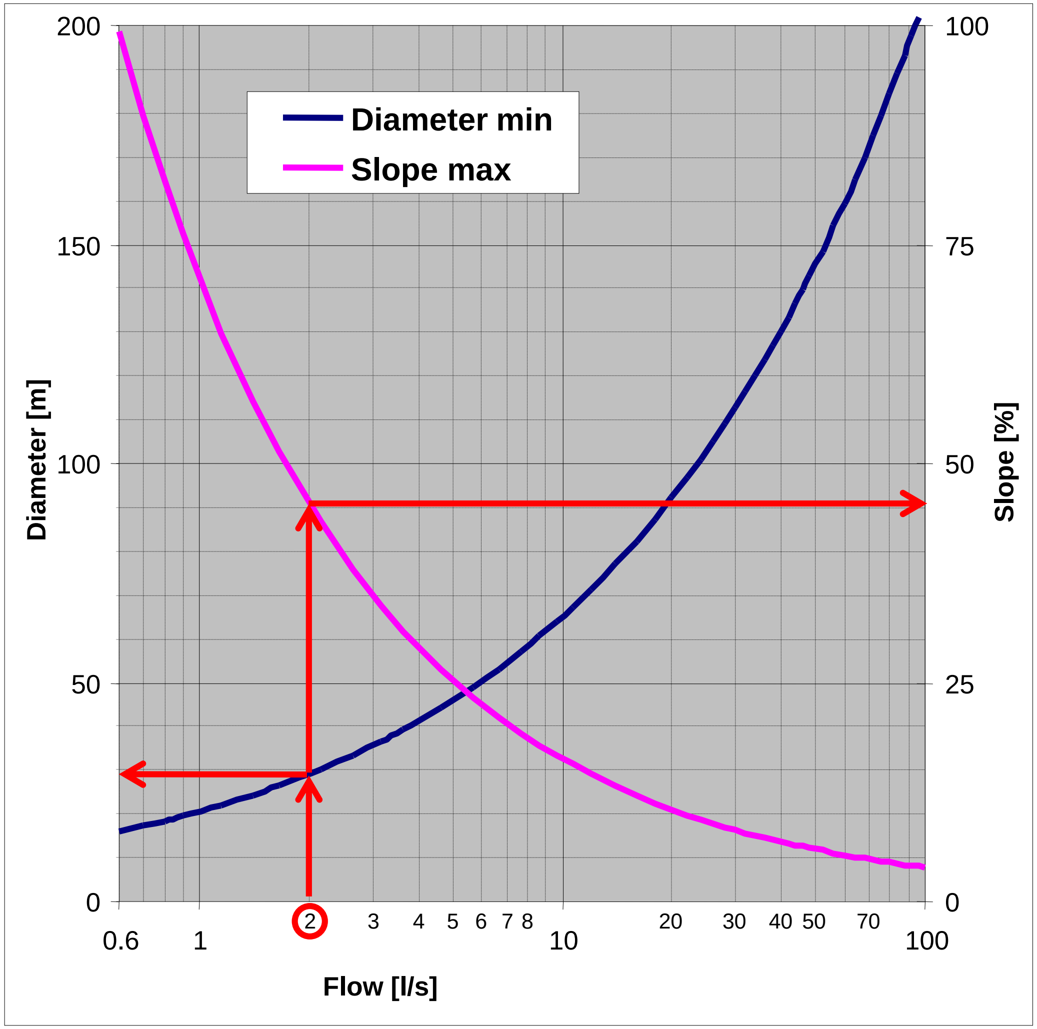
Example :

- For a flow of 2 l/s
- Maximum diameter is 75 mm if the speed is > 0,5 m/s
- If the average slope is < 0,5 %, we don't have enough elevation to pass the desired flow

=> Pumping station will be needed

Speed min : 0,5 m/s

Boundary situations



When it is steep

Example :

- For a flow of 2 l/s
- The minimum diameter is 30mm if we want to have a velocity < 3 m/s
- If the average slope is > 45 %, the height will be too much to be dissipated with linear friction losses from pipes.

⇒ In this case, singular losses should be added to limit the water velocity

Velocity max : 3 m/s

Installation of a break pressure tank

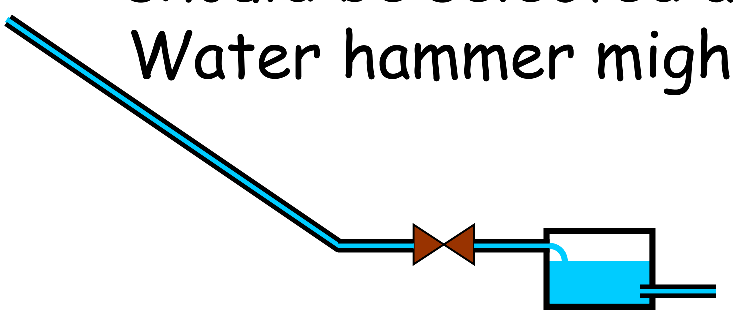
In case it is too steep to dissipate energy in small diameters' pipes, it should be dissipated with singular losses (valve)

The break pressure consist of :

1. A throttling system and a regulating valve to dissipate energy
2. A tank to control the flow and the that pressure = Pa

In case regulation valve can be closed, the system upstream will be under static pressure and the PN should be selected accordingly.

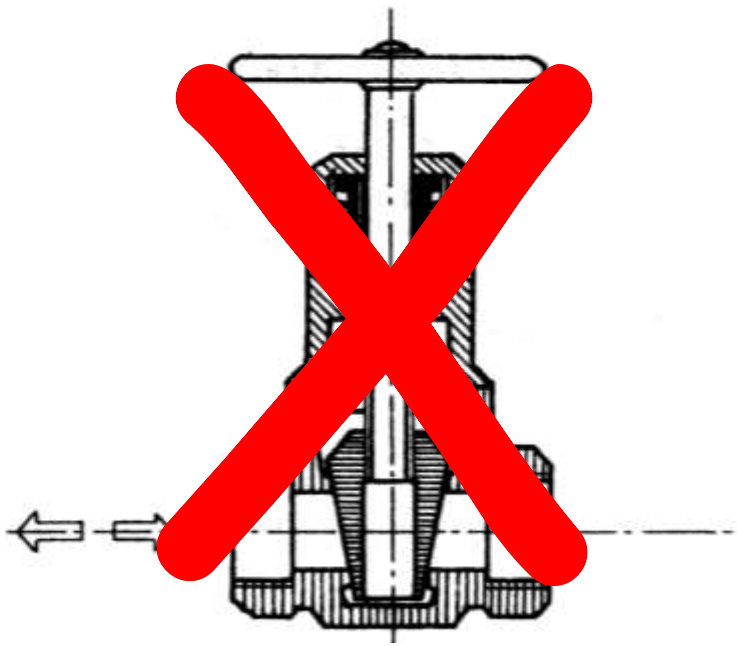
Water hammer might also occur.



What happen it the valve is not well adjusted ?

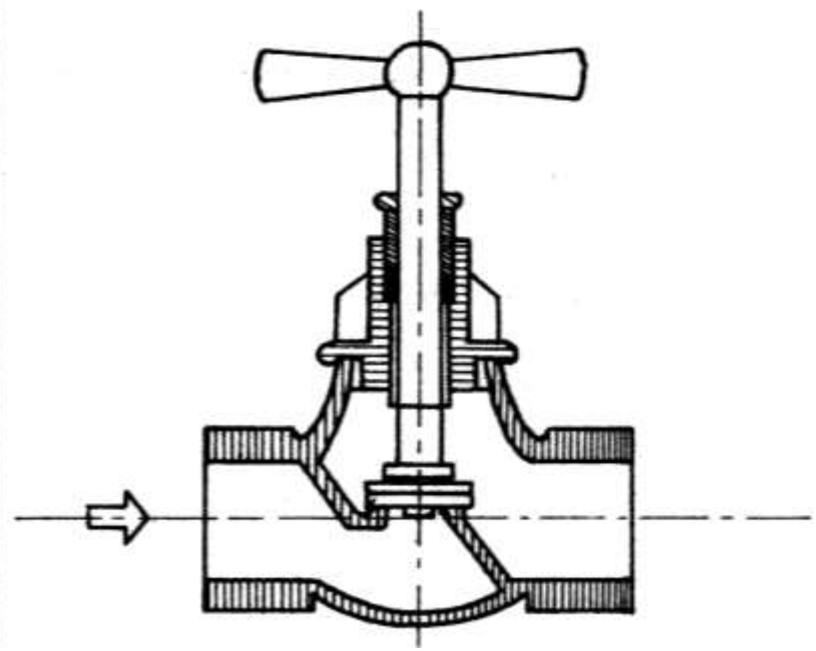
Adjust the flow

Gate valve



Not to be used !

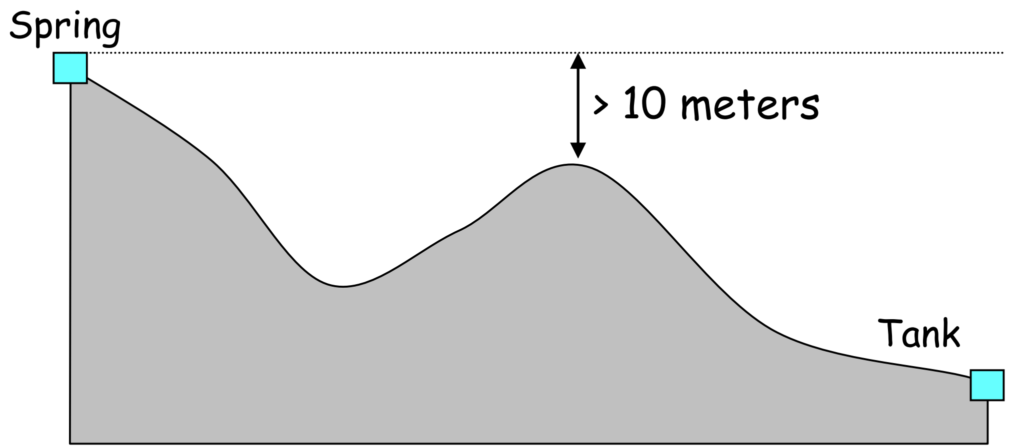
Globe valve



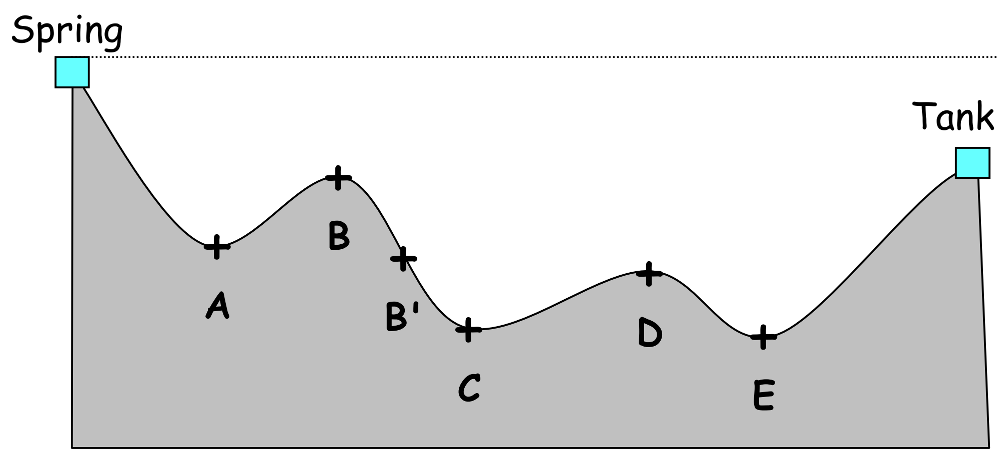
Correct

4 Air blockage

- Problem during commissioning
- If flow happen, air will be absorbed
- Identified the critical sections (BC & DE)
- Solution :
  - Air valve, tap, Tee,
  - Fill in with water slowly
  - Pumping at the spring



No risk of air blockage



Risk of air blockage

WSS

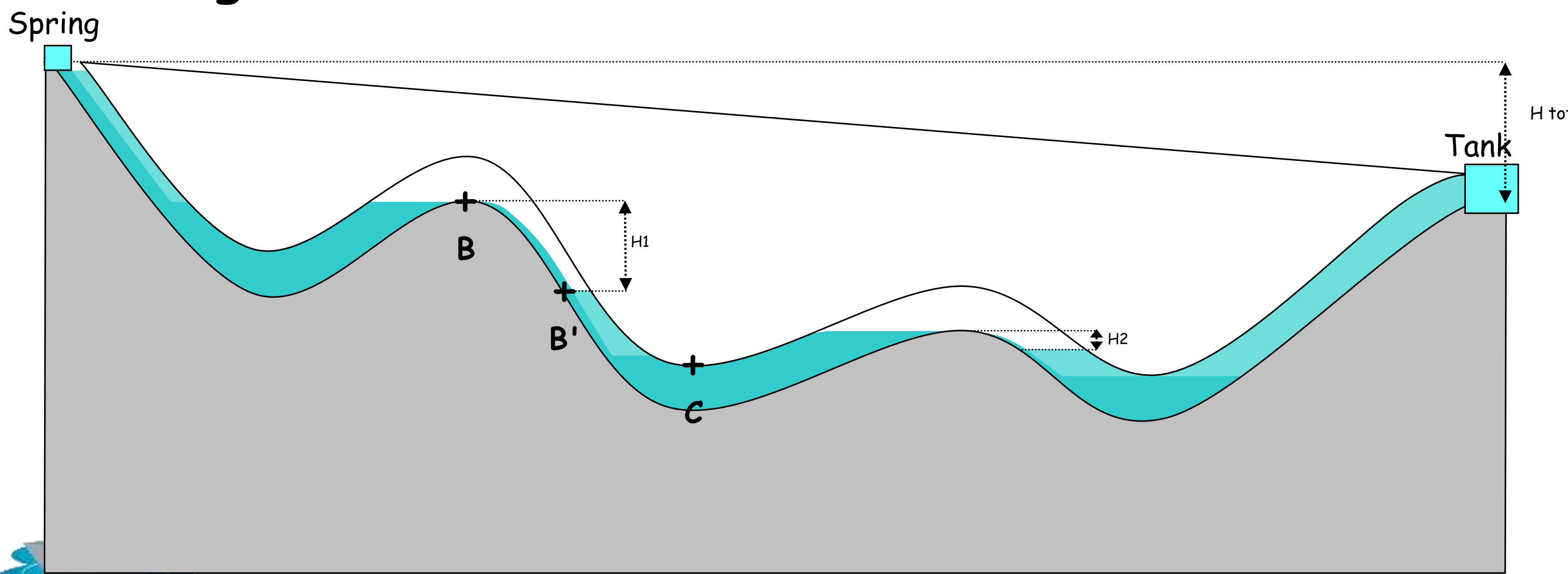
Air blockage

Critical section : BC

⇒small pipes B'C

⇒large pipes BB'

Blockage if H1+H2 > H tot

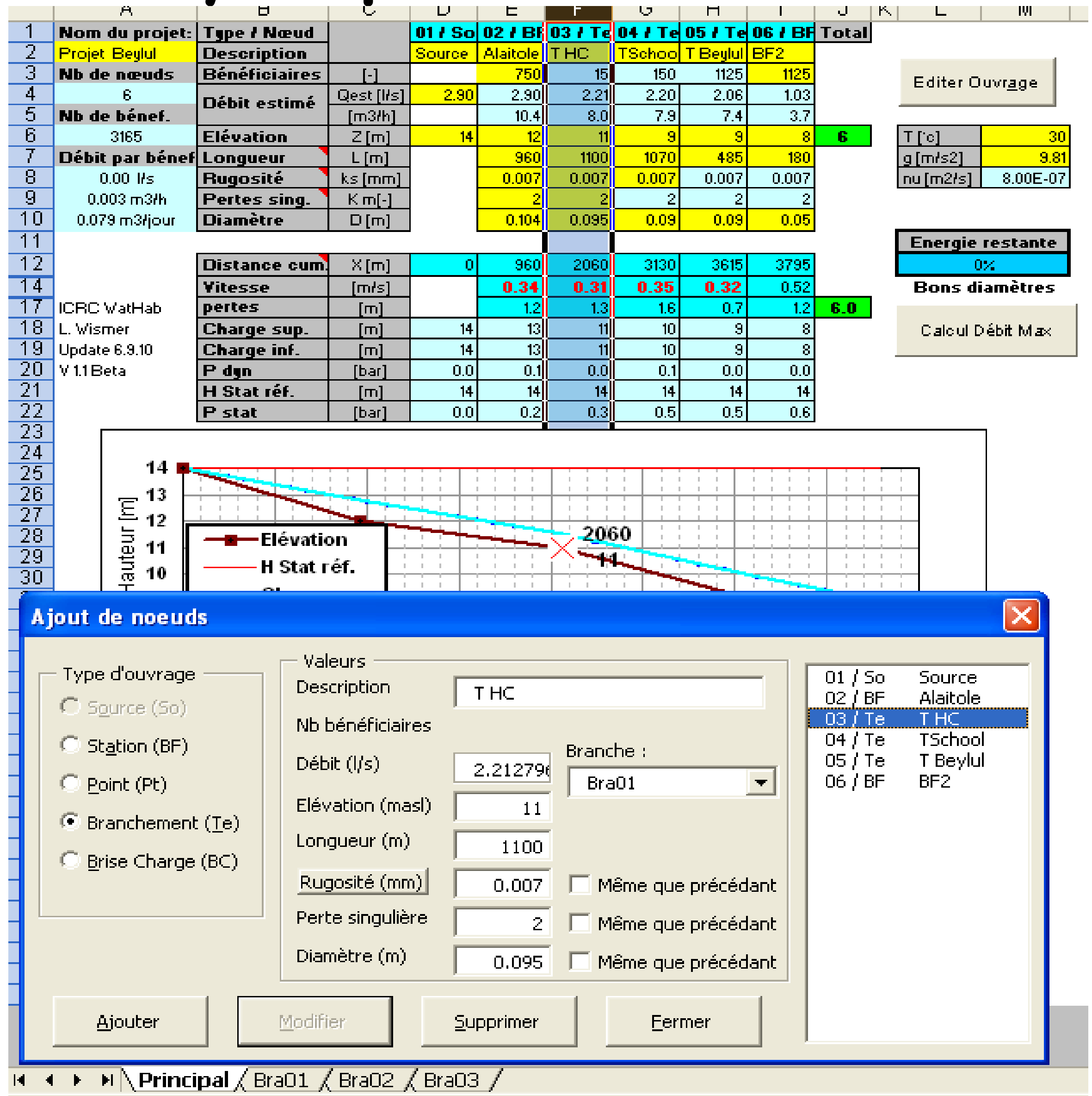


Always target optimum, no "safe side"

- Over design
  - Cost
  - Sedimentation
  - Water quality
  - Air blockage
  - Risk of depressure
- Under design
  - Insufficient flow
  - Erosion
  - Water hammer

Tool Gravity Pipe

- With function "Editer Ouvrage", enter all points
- Update with the window or directly in the spread sheet
- Adjust diameters to have a good pressure profile
- Possibility to have branches
- Version in English is planned



WSS