Part 2
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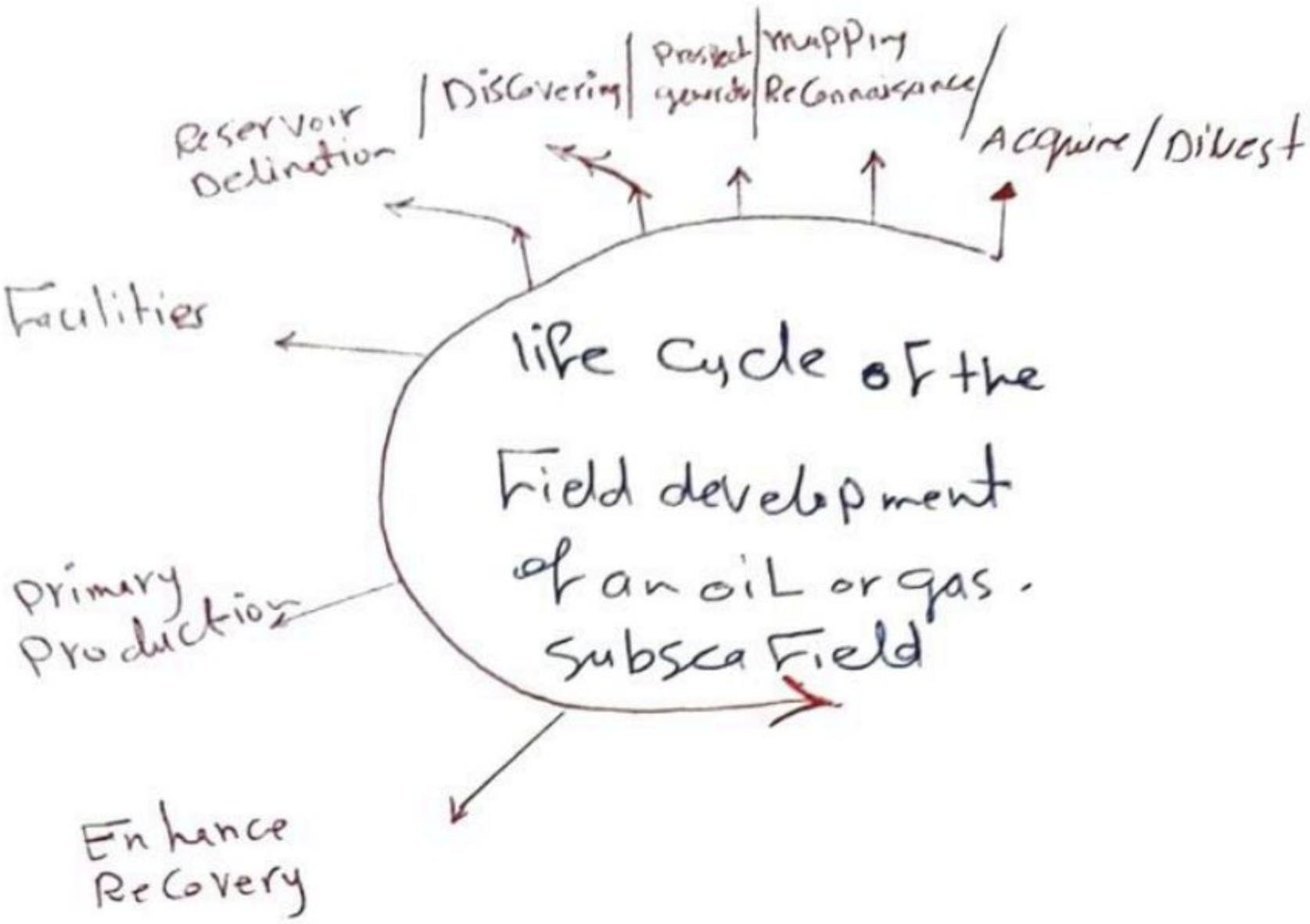
Subsea Field development



* when defining a field architecture, the following issues should be Considered.

1. Deep water or shallow water development.
2. Dry tree or wet tree
3. stand alone or tie-back development.
4. subsea processing.
5. Artificial Lift methods.
6. Facility Configuration (template, well cluster, satellite wells, manifolds,

① Deep water or shallow water development.

Items	Shallow-water	Deep water
Hardware Designs	• Because a diver-assists with all interventions, an ROV-Related structure is not needed	• Because an ROV assists with all interventions, an ROV Related structure is needed.
installation requirement	• limited by the size of vessel	• more difficult than in shallow water

Shallow water → Less than 200m / Deep water range between 200 - 1500m / Ultra-deep

⇒ wet TREE & DRY TREE systems

Dry ~~wet~~ Tree	wet ~~Dry~~ Tree
• Located on or close to the platform.	• the Christmas Tree and it's associated Components setting in the seabed.
• have a central well bay for the surface trees, providing direct access to the wells for workover and recovery.	• have a central moon-pool
• Tension Leg platform (TLPs) and Spars utilized.	• wet tree systems are suitable For widespread reservoir structures
•	• more than 70% of the wells in deepwater developments. ~~that are either~~

Look at Pages 31 to 34

→ system selection.

→ The best tree system (wet or Dry tree system) matchup with the reservoir characteristic can be selected by experience and Technical analysis,

① • Economic Factors :- Estimated Net Present value (NPV), internal rate of Return (IRR), Project Cash Flow, Project schedule, enhanced Proliferation Control ~~initiation~~ initiative (EPCI)

② • Technical Factors :- Field worldwide Location, operating philosophy Concept reliability, Feasibility, and industry readiness.

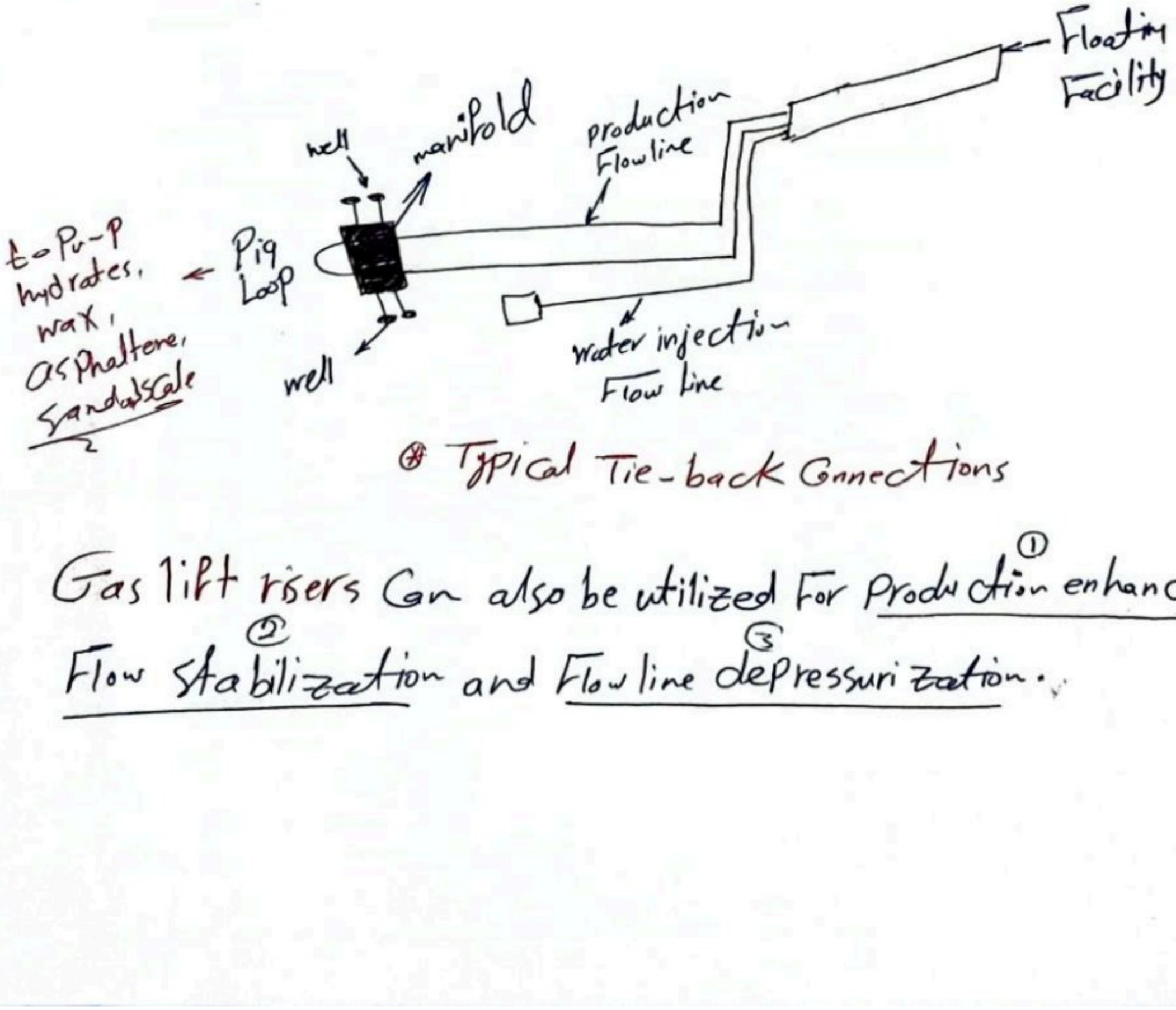
⇒ Subsea Tie-back development.

number of factors specific to That field :-

- Distance from existing installation
- water Depth
- reservoir size
-

⇒ Tie Back Design.

- Arrive at the Process facility above critical Temperatures (such as The wax appearance Temp. or the hydrate creation Temp.)
- Can be made to flow again after a planned or unplanned shutdown.
- Can be made to flow at a range of driving Pressure, flow rates.
- Avoid hydrates, wax, asphaltene and sand, scale.



⊛ Typical Tie-back Connections

Gas lift risers Can also be utilized For Production ① enhancement, Flow Stabilization ② and Flow line depressurization ③.

→ select Long tie-backs or a new stand alone Facility [4]

Can be based on various Factors.

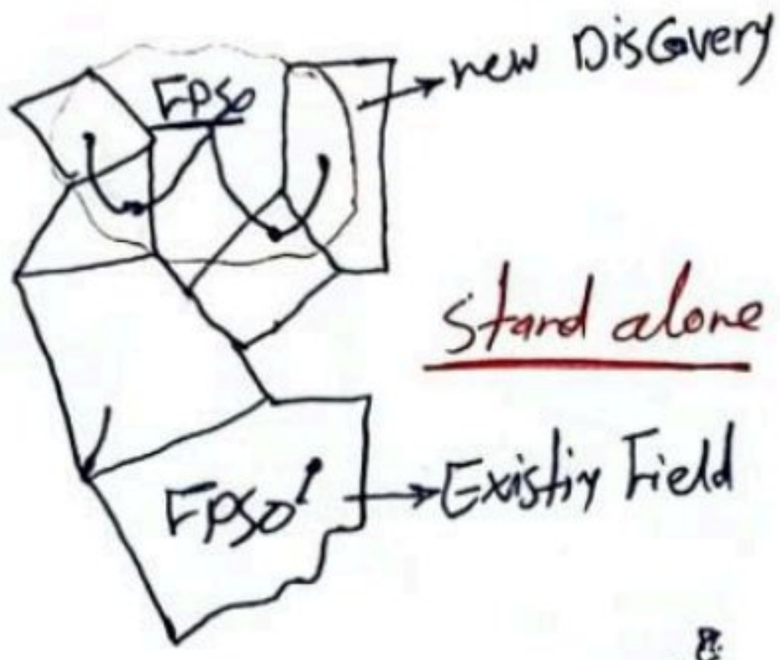
① Lowest life Cycle Cost (Lower CAPEX and OPEX).

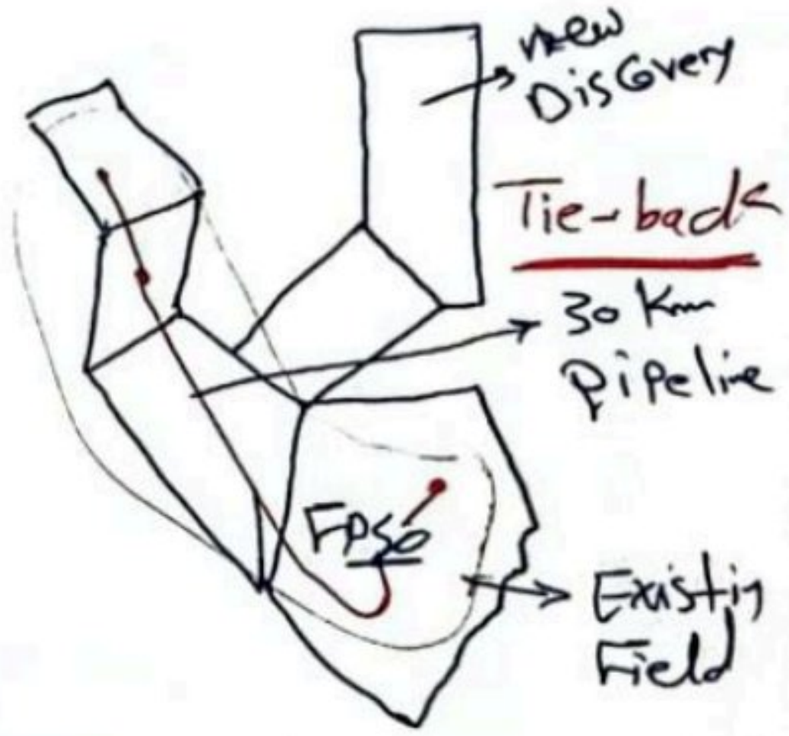
② Safety of Personnel and other stakeholders.

③ Impact of the Particular Facility on the environment

④ Use of Existing infrastructure

→ Comparison between the stand-alone and Tie-Back developments.





items	Stand-alone develop.	Tie-Back DeveloP.
advantages	• more than one Field Can be Connected.	Lower Costs - smaller Projects.
Disadvantag	• Earlier startUP time • Higher Cost • Larger Project.	• Later start-UP time • only two Field Can be Connected. • From operations perspective, Control of remote x-tree, manifold, Can Cause problem another operational issues revolves around associated Flow assurance Problem For Long-distance tie-backs

→ Classification of stand alone Facilities

Can be divided into Four typical hust facilities :-

① FPSO ② TLP ③ Jacket structure ④ semi-sub-

→ Fixed platforms :- Various Types of structure are used, steel jacket, Concrete Caisson, Floating steel, and even Floating Concrete.
Fixed platforms are economically feasible for installation in waterdepths up to 520 m.

→ Compliant towers :- These platforms consist of slender flexible towers and a pile foundation supporting a conventional deck For drilling and production operations. Compliant towers are designed to sustain significant Lateral deflections and forces and are used indepth ranging from 450 to 900 m

→ Jackup platforms :- Jackup platforms (or jackups), are platforms that can be jacked up above the sea using Legs that can be Lowered are used in depths up to (120)m, some designs to (170) m

→ Floating Production systems (FPS) :- FPSs consist of Large monohull structures, generally (but no always) in the shape of ships, equipped with Processing Facilities, Called FSO, FSU, FPSO (no ↗

→ Tension Leg platforms (TLPs) :- TLPs are Floating platfors tethered to the seabed in amanner that eliminates most vertical movment.
used in water depths 2000 m.
mini TLPs can also be used as utility, satellite.

→ Spar platforms :- installed at an almost 2438 m water depth.

→ Basic Artifical lift methods.

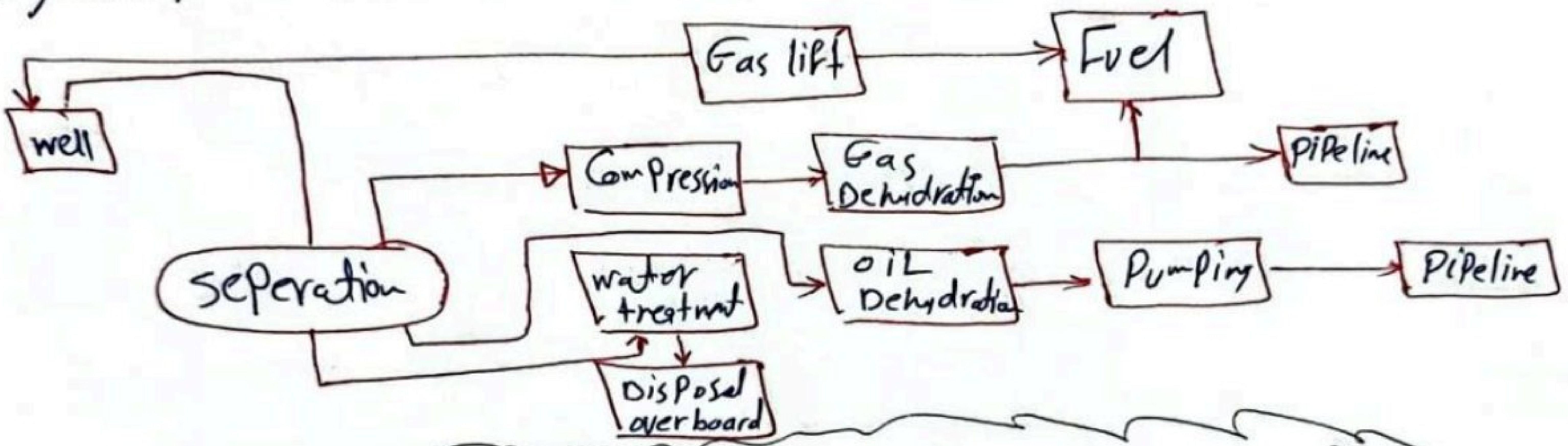
① Gas lift ② subsea boosting ③ electric sumbmersible Pumps

① → Gas lift

used to Produce Fluids from wells that are already dead or need to increase the Production rate.

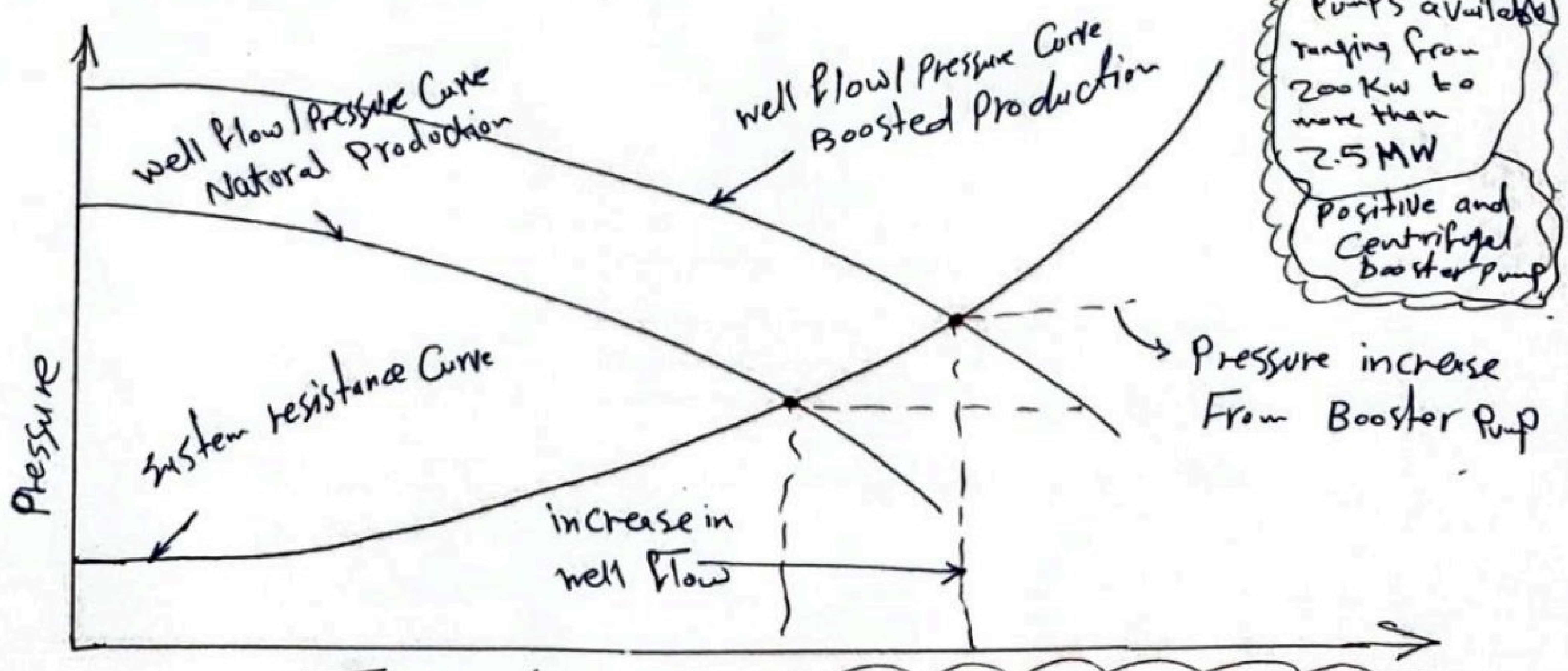
gas lifting is assessed based on the following information:-

① Fluid Properties, gas-oil Ratio, oil viscosity and gas compressibility
② max. water content.
③ multiphase flow correlations. (تعمل على خلق فرق ضغط في البئر مما يؤدي إلى خروج الانتاج)



Traditional gas lift Field Configuration

⇒ Subsea Pressure Boosting



system resist. Curve → charactrized by the specific sys. Configuration and water depths

⇒ Electric submersible Pump [ESP] [7]

⇒ Subsea processing (SSP)

Subsea Processing (SSP) can be defined as any handling and treatment of the produced Fluids.

- Boosting
- Heat Exchanging
- separation
- Gas treatment
- Solids managment
- chemical injection.

The benefits :-

- Reduce total CAPEX.
- accelerated or increased production.
- Two-phase seperators are used For seperation of any gas-liquid sys. such as gas-oil, gas, water and gas condensate system.
- Three-phase seperators are used For the gas From liquid phase and water From oil.

⇒ Classification of subsea processing Systems

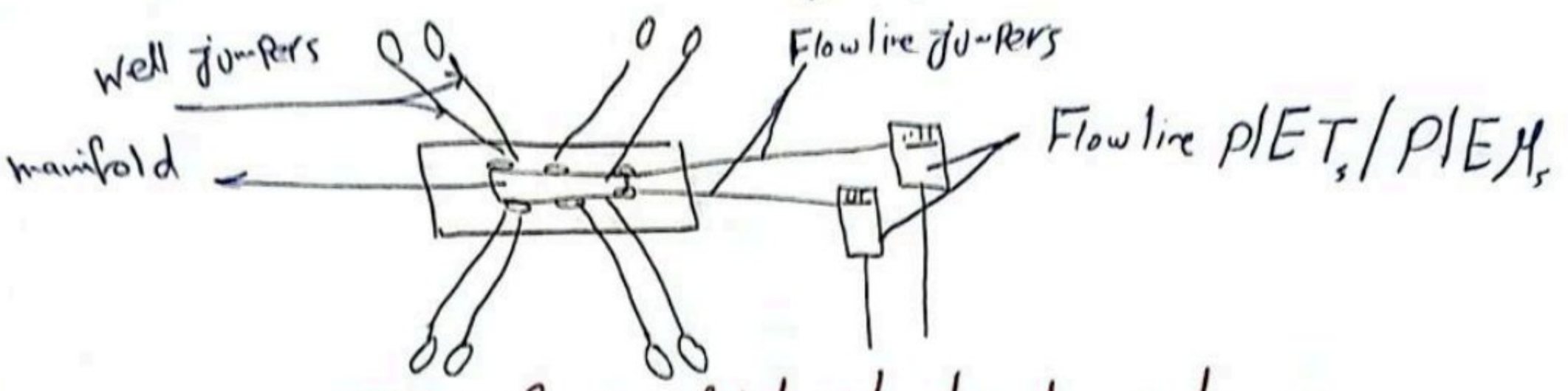
Classificatin	Characteristic	Equipment	water Disposal	Sand Disposal
Type 1	Multiphase mixture is handled directly	Multiphase Pump	None; Pumped with other produced Fluids.	None; Pumped with other produced Fluids.
Type 2	Partial seperat of The Production Stream.	seperator and Multi Phase Pump; use wet-gas Compressor		

⇒ Satellite well system

- A satellite well is an individual subsea well. The evaluation must involve hydraulic calculations and cost analysis, and Flowline cost, umbilical cost, and installation cost.

⇒ Template and clustered well system.

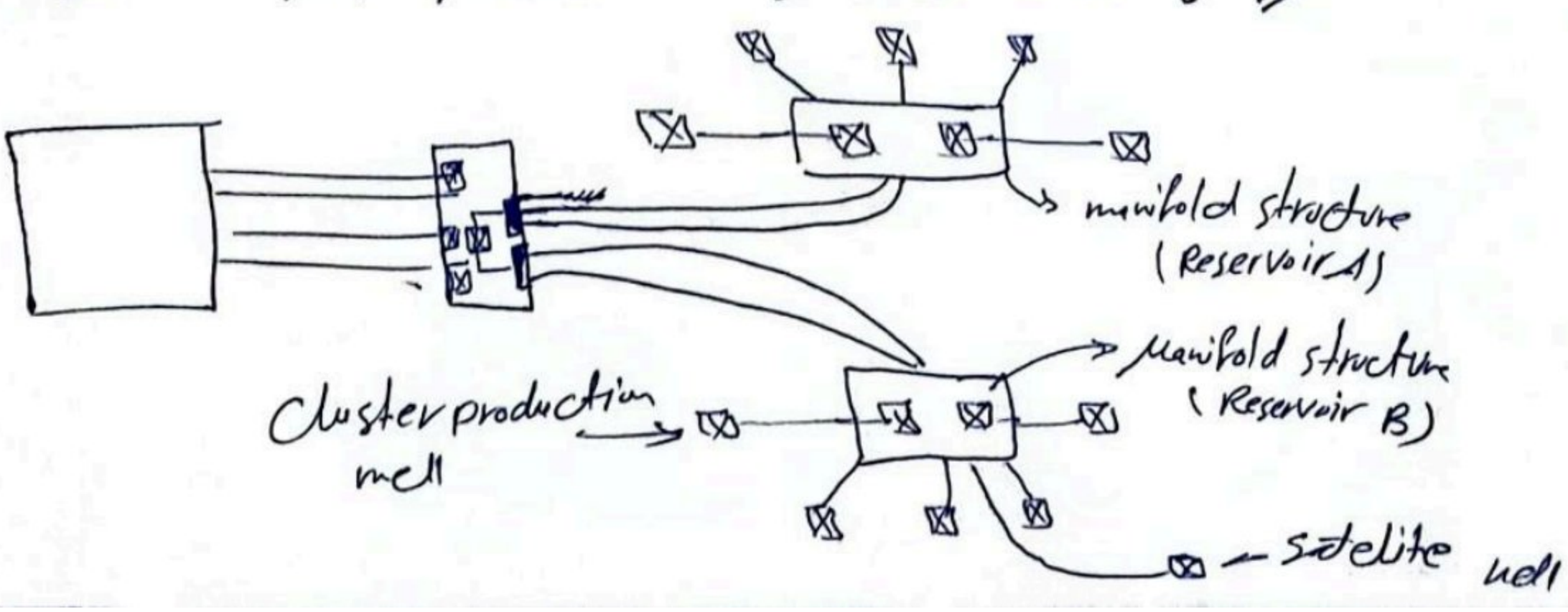
if subsea can be grouped closely together



Typical manifold cluster Layout

⇒ Clustered satellite wells

Clustered satellite subsea well are less expensive than widely spaced satellite well because of flowline and control umbilical savings a single umbilical and umbilical Terminal assembly (UTA) and a single production flow line can be used between the well cluster and the production platform, a field with 8 clustered satellite wells, two subsea production manifolds, and a single production umbilical and UTA.



→ The following are some benefits of production well templates as compared to clustered satellite wells.

- wells are precisely spaced.
- manifold piping and valves can be incorporated.
- piping and umbilical jumpers between the tress and manifolds may be prefabricated and tested.
- piping and umbilical interfaces are less expensive than for clustered.
- installation time is reduced by modularizing much of the equipment.

→ The following are some disadvantages of production well ——

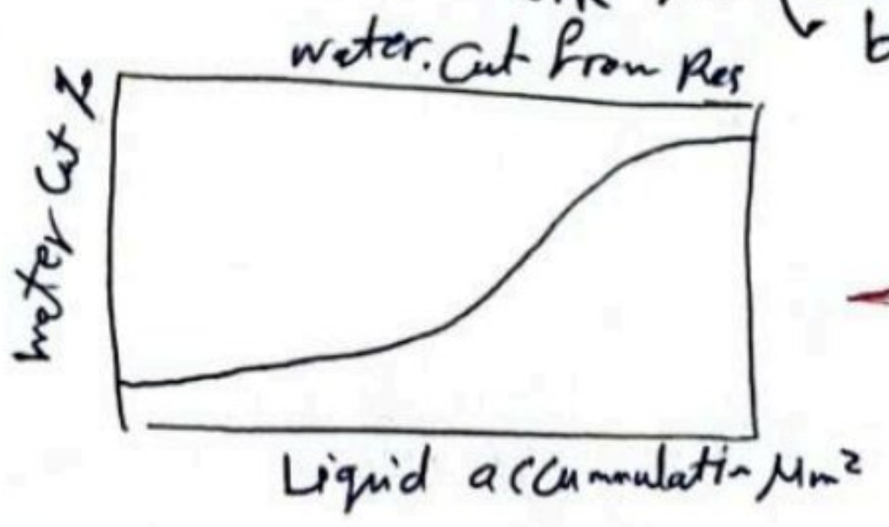
- Design and fabrication time may be longer.
- There is less flexibility in determining well location.
- ROV access may be limited due to space constraints

⟹ Daisy chain

⊛ A reservoir's inflow performance is achived by Fetkovick's equ

$$Q(P_{wf} \cdot P_R) = AOFP(P_R) \cdot \left[1 - \left(\frac{P_{wf}}{P_R}\right)^2\right]^n \rightarrow 0.82 \quad , C = 0.35$$

where $AOFP(P_R) = \left(\frac{P_R^2}{bar^2.cc}\right)^n \cdot \frac{5m^3}{day}$, where well bore = 325 bar / reservoir press = 350 bar



← water-cut profile