# Practical Pipeline Routing

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# Pipeline routing principles

- **Pipeline routing lecture**
- **Pipeline routing issues**
- **Routing sequence**
- **Routing in mountains**
- **Routing in side slopes**
- **Re-instatement and erosion control**
- **Fault lines and seismic areas**

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# Pipeline Routing issues

- **Shortest distance is a straight line**
- **Key Issues for creating route options and corridors to assess.**
- **Population / built up areas**
- **Natural and man made features**
- **Construction**
- **Environmentally sensitive areas**
- **Utility / transport corridors**

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# Pipeline routing sequence

- **Sequence of routing**
- **Identify constraints – Desk & Field survey**
- **Avoid / re-route**
- **Investigate**
- **Mitigate**
- **Assess alternatives**
- **Locate existing transportation corridors**

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# Pipeline Routing – People Issues

- **Population issues**
- **Safety**
- **Land ownership**
- **Other services**
- **Space**
- **Cost (street works)**
- **Population growth**

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# Pipeline routing - Features

- **Natural features**
- **Rivers / lakes**
- **Mountains**
- **Swamps / sabkha**
- **Mountains**
- **Fault lines**
- **Sand dunes**
- **Permafrost**

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# Pipeline Routing – Features

- **Man-Made features**
- **Roads / Motorways**
- **Railways**
- **Canals**
- **Environmentally sensitive areas**
- **Protected areas / species**
- **Peat and moorland**

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# Pipeline Routing - Construction

- **Construction considerations**
- **“Turn arounds”**
- **Multiple crossing**
- **Logistics / camps**
- **Matrix of costs for optimisation**
- **Options for long crossings required (Directional Drills versus alternatives)**
- **Side slopes / Front slopes**
- **Access to ROW**

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# Pipeline routing sequence

- **Identify corridors and establish key issues / areas**
- **Quantify costs and identify other issues.**
- **Site routing visit – critical activity**
- **Review options for slopes, side slopes, geotech risk, profile, length, CAPEX, construction.**

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# Pipeline routing - Drawing

- **Pipelines are drawn onto drawings with key specific requirements. These include:**
- **Cut lines**
- **Chainage marks (normally direction of flow)**
- **Engineering Data**
- **Plan and profile information**
- **Known as alignment sheets, strip maps, route maps,**

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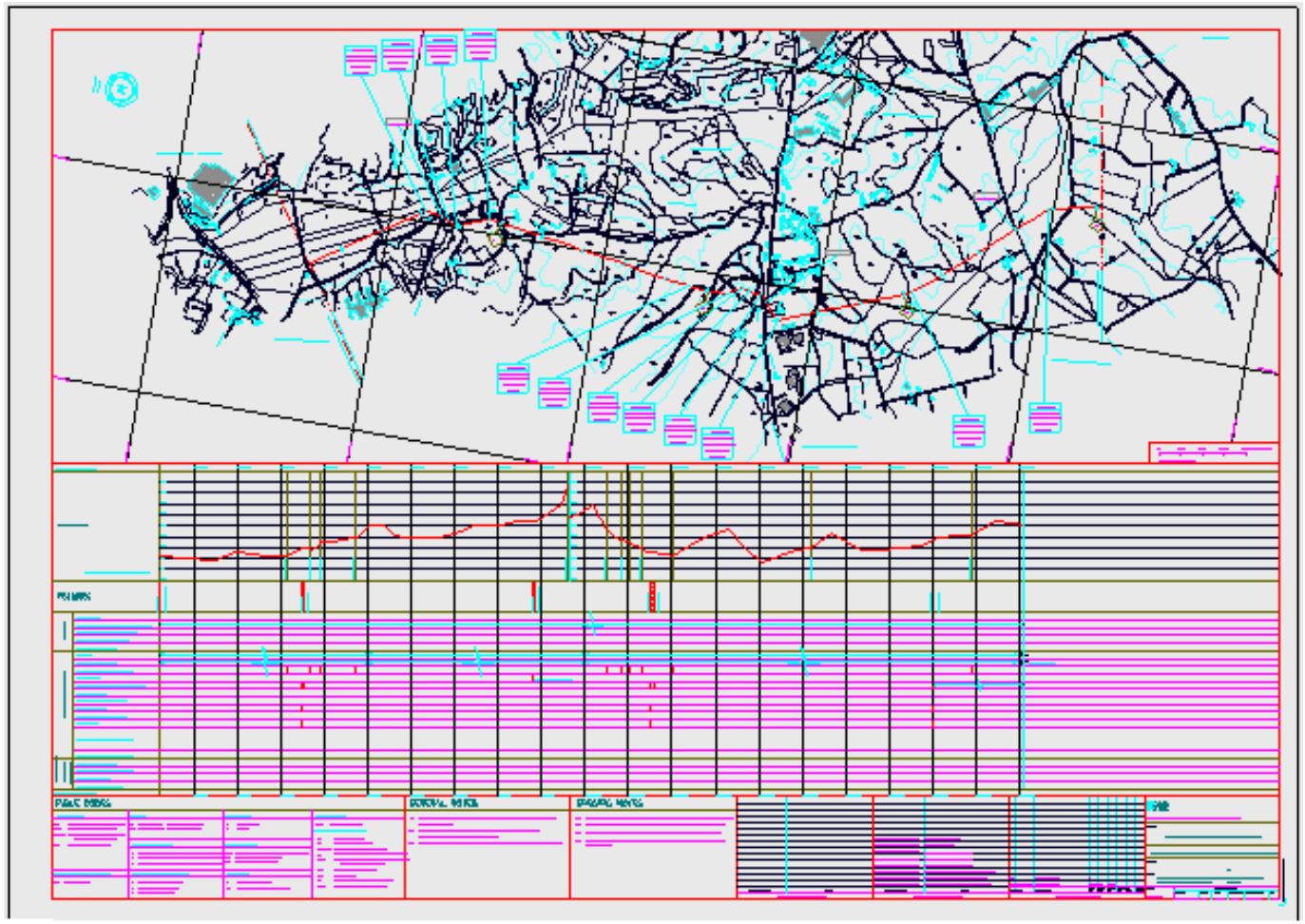
# Pipeline routing – Alignment sheet



Plan data – map, photo

Profile

Engineering data

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# Pipeline routing Terminology

- **Pipeline routing uses certain terminology:**
- **Chainage – length from a given zero mark (normally with flow). Can be negative.**
- **Bends – Angles are given away from the straight ahead position. Often called IP's (intersection point) between the straight lines.**
- **SBL, SBR, Sag and over bend**

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# Pipeline routing – mountains and slopes

- **At times routing through mountains and significant slopes either in line (front slope) or side slope cannot be avoided or are advantageous in terms of length or other issue.**
- **To route in these areas an understanding of feasible options are required, such as:**
- **Steep slopes, Ridge running,**
- **Side slopes & Gullies**

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# Pipeline Routing – steep slopes

- **Steep Slopes**
- **Best way is perpendicular to slope**
- **Top of ridge is an option**
- **Side slopes > 15% are problematic and should be avoided if possible**
- **Slopes can be susceptible to land slide / slip and seismic activity**
- **Trenches can be subject to washout**

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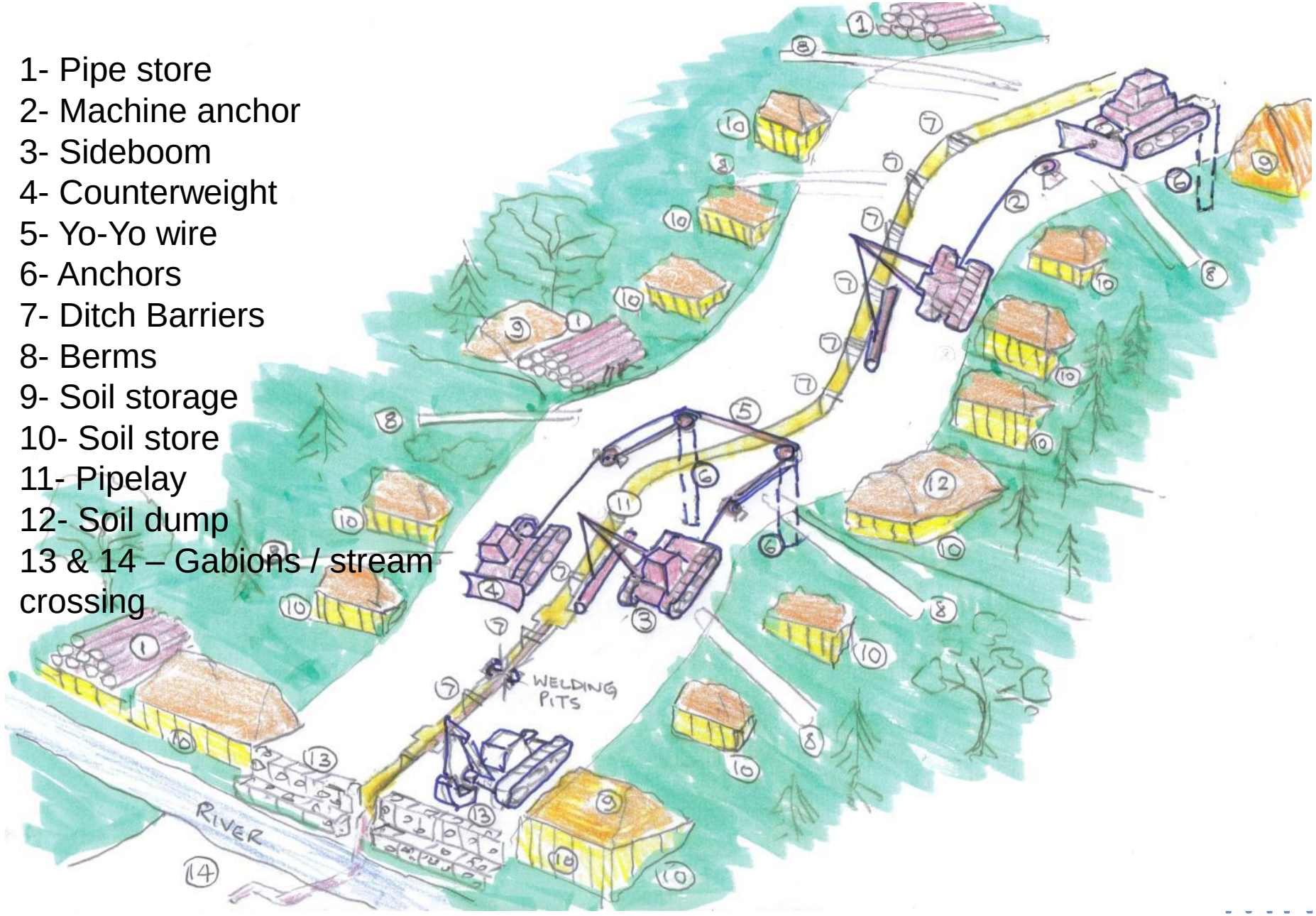
1- Pipe store
2- Machine anchor
3- Sideboom
4- Counterweight
5- Yo-Yo wire
6- Anchors
7- Ditch Barriers
8- Berms
9- Soil storage
10- Soil store
11- Pipelay
12- Soil dump
13 & 14 – Gabions / stream crossing



# Pipeline routing steep slope

# Pipeline routing aerial slinging

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# Pipeline routing - cutting

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# Pipeline routing – ridge running

- **Ridge running**
- **There are some famous examples**

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# Pipeline routing – ridge running

Narrow **ridges**

**Earth movement and side slope strategy**

**Piling may be required**

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# Pipeline routing – ridge running

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# Pipeline routing – side slopes

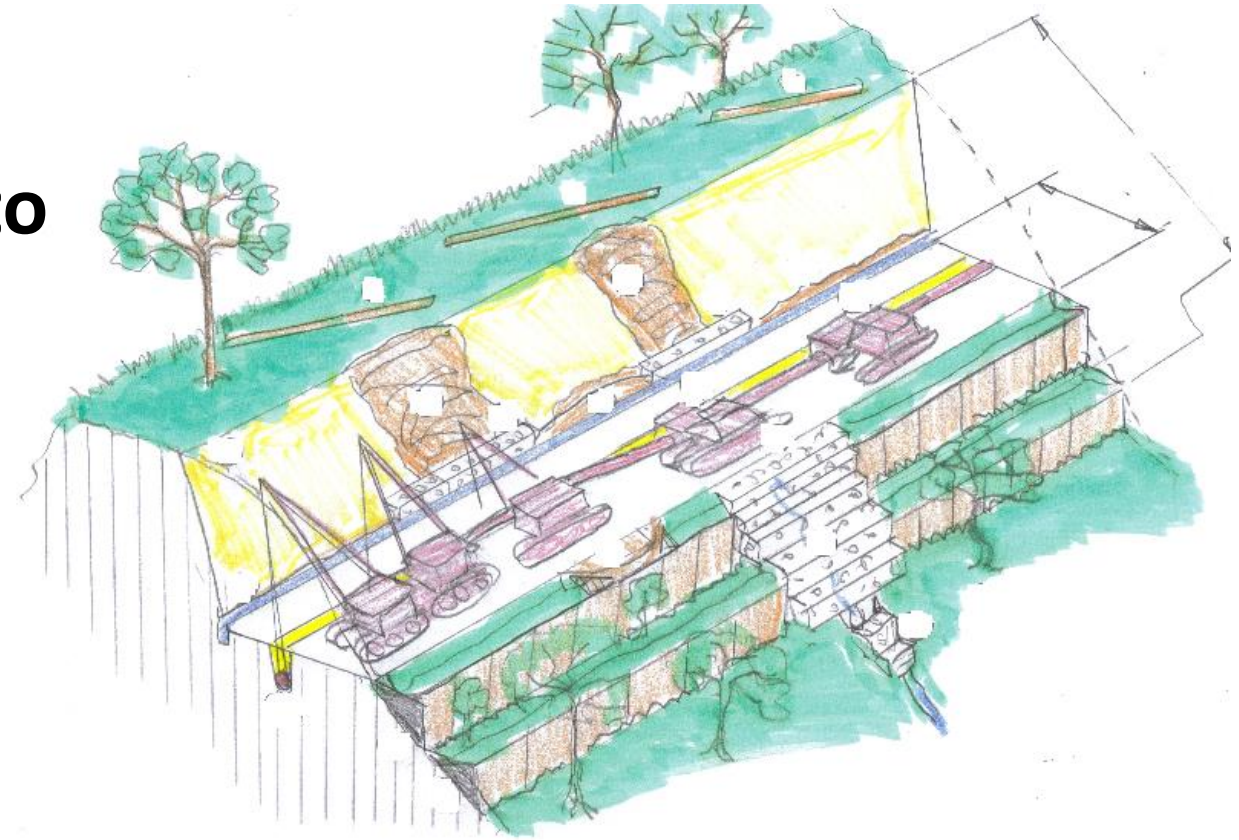
**Side slopes**

**Pipe inserted into hill**

**Terrace of fill**

**Minimum width**

**Risk of landslip**



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# Pipeline routing – side slopes

# Pipeline routing – gullies and wadis

- **Gullies, rivers & wadis**
- **Flowrates can vary by factor of 100 or dry to flood**
- **Historical river movement data needs to be used**
- **Poor soil and re-instatement leading to wash-out**
- **Restore banks using gabions and concrete mats**
- **Bury pipe below surface by min 1.5m**
- **Consider concrete coating**
- **Long term support might be required to fragile soils**

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# Pipeline Routing - gullies

**Gulley re-instatement using gabions**


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# Reducing erosion steep slopes

**Using multiple trenches and jute matting**

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# Reducing erosion steep slopes

**Using multiple trenches and jute matting**

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# Pipeline routing – seismic faults

- **Seismic faults**
- **Identify location of surface fault lines**
- **Crossing at angle where slip line is known**
- **Allow for slip movement using special back fill**
- **Monitor regularly using strain gauges / GPS**
- **May require re-lay / re-position**

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# Pipeline routing – seismic faults

- **Seismic issues mainly related to ground effects**
- **Land slide**
- **Liquefaction**
- **Shear movement**

- **Detailed Geo-hazard assessment required.**

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# Pipeline routing - Summary

- **Summary**
- **Establish constraints**
- **Assess alternatives**
- **Avoid mountains / side slopes**
- **Prepare erosion control**
- **Design water course crossings to resist storms**
- **Seismic design**

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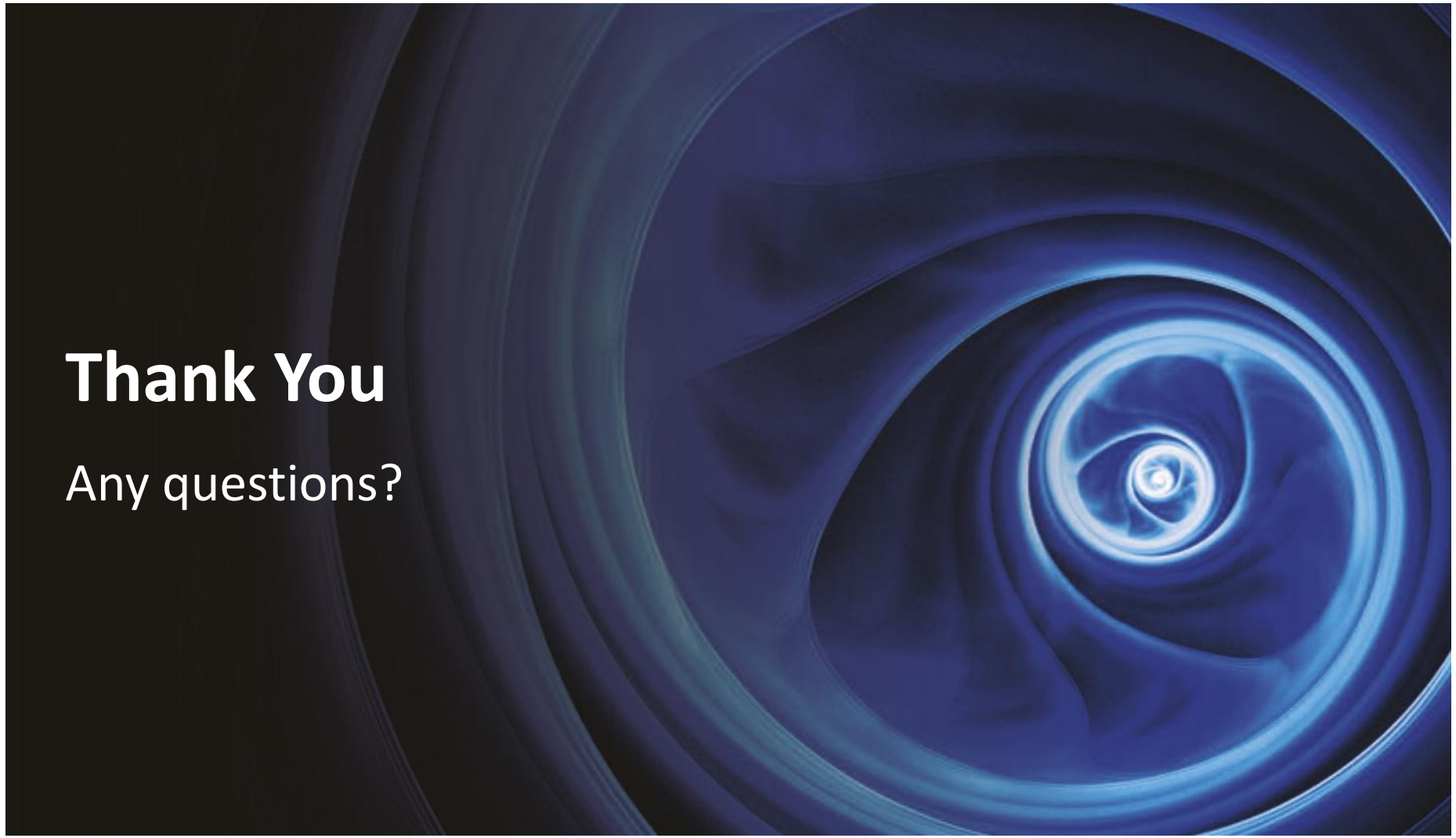


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