

Pipeline Engineering Introduction

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What is Pipeline Engineering ?

- **Pipeline Engineering is an activity not a discipline**
- **It can consist of mechanical design, civil design, control and instrumentation, process design and piping, layout and routing.**
- **There are specialisations, but pipeline engineering needs to be seen as a multi- discipline activity.**

Pipeline definition

- **Not well defined between pipeline and piping**
- **Outside of sites normally defined as pipeline**
- **A pipeline:**
 - **Has a dedicated set of regulations**
 - **Has dedicated design codes and standards**
 - **Is the most efficient means of transporting fluids long distance**
- **Also called flowline, export line, distribution line and injection lines**

Pipeline project management

- **This lecture is divided into these three main areas.**
- **Project Stages (Design through to Construction and commissioning)**
- **Authority Approvals and Permits (Planning, Safety & Environmental)**
- **Land agreements**

Oil and Gas typical project phases

- **History**
- **In early 1990's companies started to use defined stages to establish a projects value and cost.**
- **Initially these were:**
- **Appraise (Feasibility and concept)**
- **Select (FEED)**
- **Define (Detail design and procurement)**
- **Execute (Construction)**
- **Operate**

Oil and Gas typical project phases

- History**

- Many Oil companies adopted this system, but runaway project were still occurring.

- Stage gates were then developed and input into procedures to challenge a projects commercial value and schedule. Decision Support Packs needing to be compiled. Global process developed.

- As EPC contracts began to predominate, the Select Phase or FEED has become a level of detail design and used more to “lock in” designs, vendors, installation techniques and reduce the ability of EPC contractors to furnish technically correct designs, but which had potential long term consequences for operation.

- Significant overruns and claims on EPC contracts led to greater definition in this phase.

Oil and Gas typical project phases

- History**

- To then fill in the gap between Concept and FEED “Pre FEED” appeared in mid 2000’s.

- Similarly pre-feasibility has appeared. Now can have 6 or 7 stages

- Pre-feasibility

- Feasibility

- Concept

- Pre-FEED

- FEED (Select or Basic Engineering)

- Detail design / EPC

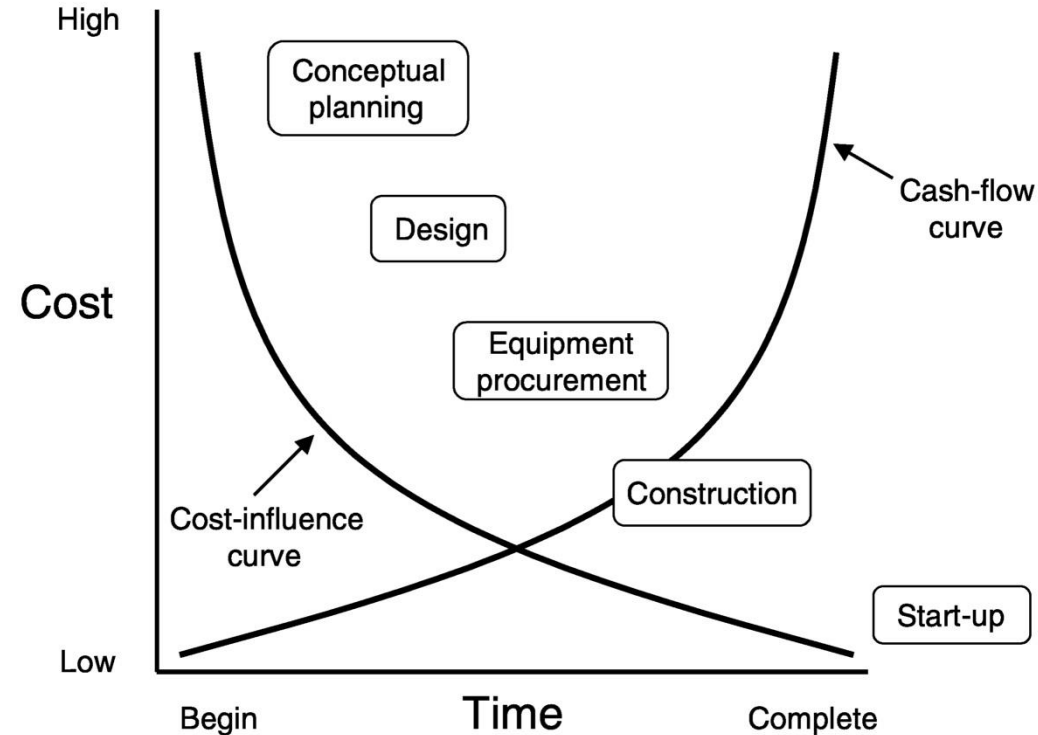
- Construction and commissioning

- Operation

- De-commissioning

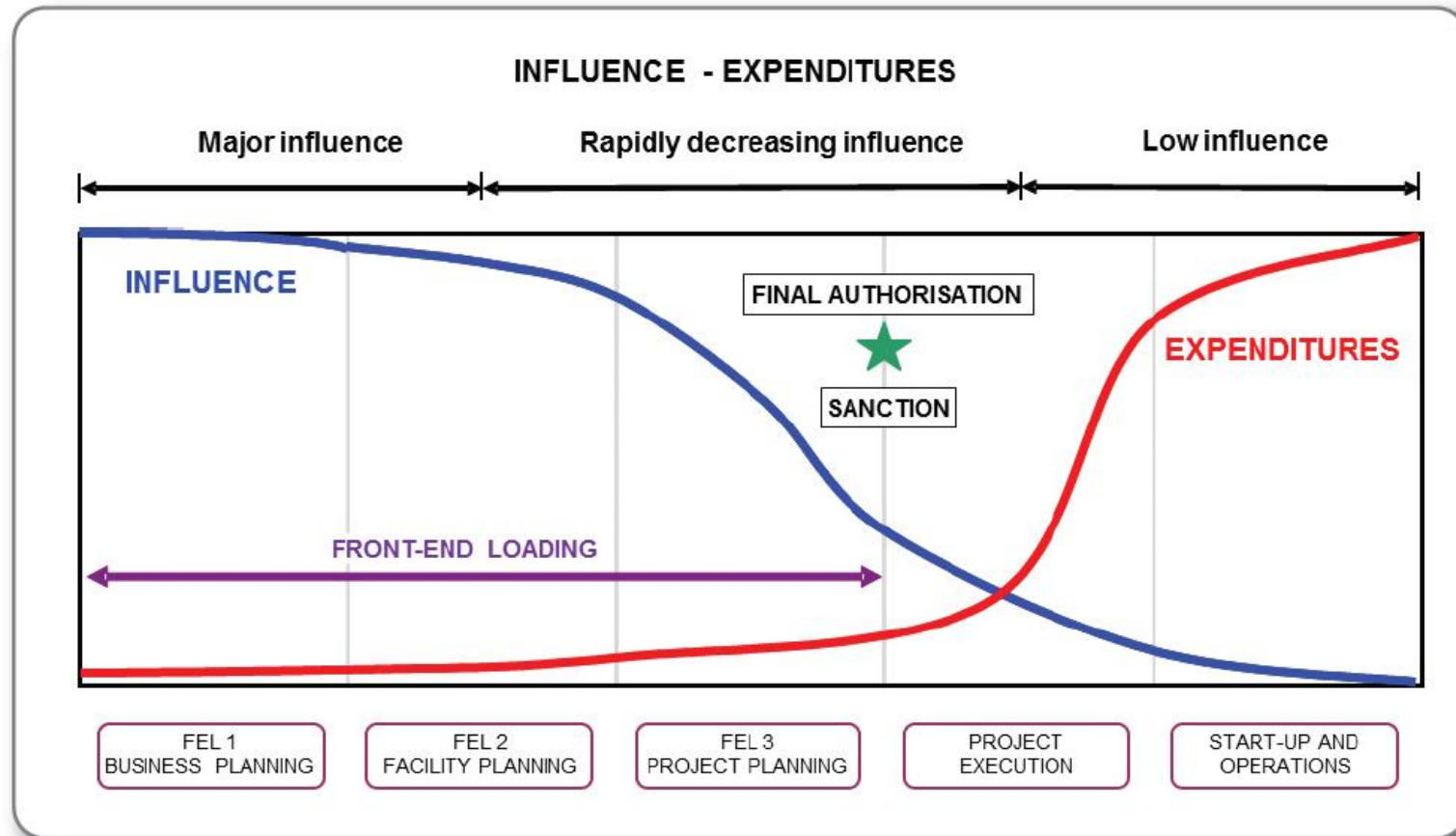
Oil and Gas typical project phases

•Front end loading – typical curve



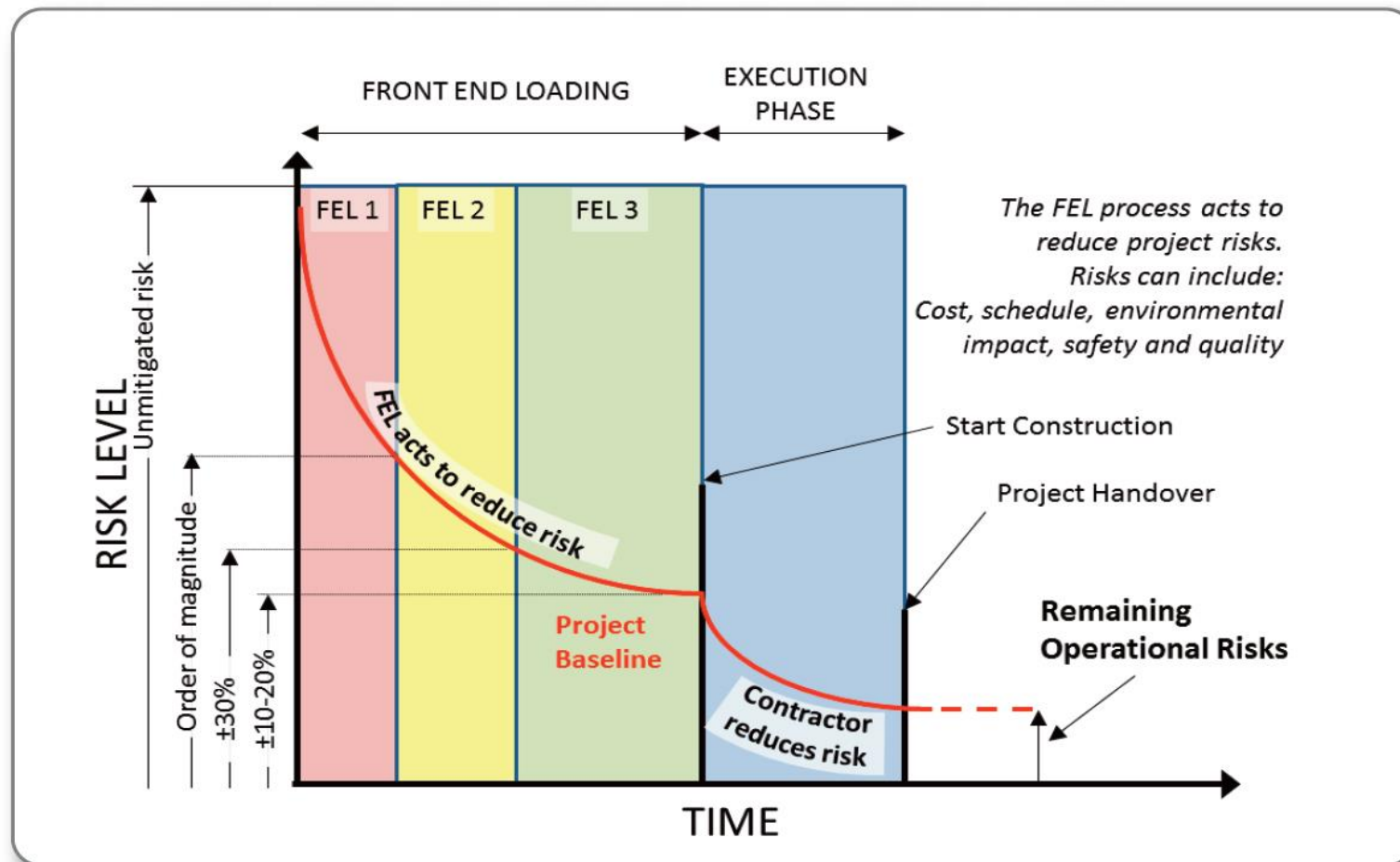
Oil and Gas typical project phases

- **Front end loading – more realistic**



Oil and Gas typical project phases

- Front end loading – reducing overall project risk



Pipeline project stages - Concept

• **Concept is the initial stage to determine the viability and establish outline areas of design. Often performed with low amounts of data.**

- **Approximate details**
- **Initial hydraulic analysis**
- **Route corridor 5 to 10km in width**
- **Multiple options investigated**
- **Cost estimate +/- 50%**
- **Outline schedule**
- **Used to determine if project still meets cost / schedule constraints**
- **Time allocated – 2 to 5 months**

Pipeline Project Stages – pre-FEED

- **Pre-FEED is intended to fill the gap between concept and FEED and allow review of initial approved concepts before major expenditure or time. It allows:**
 - **Examination of options from concept (2-3) in more depth**
 - **More time to develop concepts, especially novel areas with vendors**
 - **Examination of options can be assessed qualitatively, but options need to be examined robustly and in sufficient depth and not dismissed too early.**
 - **Intention to move forward into FEED with confirmed route and design**

Pipeline project stages – Pre-FEED

Pre-FEED would normally result in:

Single recommended option (line size, route etc)

Transient and SS hydraulic analysis

Route corridor width of 2 km or better

Cost Estimate / contingency of +30%

Authority permits identified

Initial Safety and environmental studies undertaken

Schedule for remaining phases undertaken

Key design documents issued (Design basis, Route drawings)

Pipeline project stages – FEED

- **FEED (Front End Engineering Design) is intended to take a concept or pre-FEED report and detail the selected option to provide more information for the detail design contractor or EPC contractor to bid**
- **Level of detail at the end of FEED is variable and dependant on the overall project concept of when to purchase long lead materials and type of construction contract.**
- **Leads to FID and final sanction**

Pipeline project stages – FEED

Single recommended option (line size, route etc)
Transient and SS hydraulic analysis complete
Route corridor of 1 km or better
Cost Estimate to +15% with firm prices
Long lead materials identified and orders prepared or placed
Authority permits identified
Safety and environmental studies undertaken
Schedule for remaining phases undertaken
Key design documents issued (Design basis, P & IDs, Data sheets, specifications, Route drawings)
Often includes preparation of EPC ITT packages

Pipeline project stages – Detail design

- **Detail design takes the chosen FEED option and produces final design documents and drawings to allow construction contractors to build the pipeline and for purchase of all required items.**
- **There are a variety of contract types applicable including EPC, separate design and construction contracts and mixtures of the two.**
- **It is common for long lead items, especially pipe, bends and valves to be purchased by the client and then “free-issued” to the construction contractor to reduce overall timescales or to gain advantage of global agreements**

Pipeline project stages – Detail design

- **Alignment sheets, (1:5,000) and defined route and corners or IP's,**
- **Detail crossing drawings and surveyed profiles**
- **Specifications and data sheets for work and materials**
- **SCADA (Supervisory, Control and Data Acquisition) system design, inc communication cables**
- **Cathodic Protection Design**
- **Stress Analysis**
- **HSE design**
- **Duration 6 to 12 months**

Pipeline project construction contract types

- **EPC (Engineer, Procure & Construct)**
- **Separate Detail Design, Construction and Procurement contracts**
- **BOT (Build, Operate, Transfer)**
- **Turnkey**

Pipeline Construction - EPC

- **Perceived advantages**
- **Provides fixed price when scope is clear and FEED information sufficient**
- **Places risk on Construction Contractor to manage**
- **Reduces interfaces between contractors for client to manage**
- **Potential negatives**
- **Changes to scope expensive**
- **Innovative design approaches reduced**
- **Creates adversarial approach**
- **Claims frequent**
- **Loss of control of materials by client**

Pipeline Construction - Design & construct

- **Perceived advantages:**
- **Allows scope to be finely tuned / adjusted**
- **Provides high level of definition for construction contract – lower risk of overrun**
- **Control of materials remains with client**
- **Potential negatives:**
- **Schedule can be extended compared to other types**
- **Initial cost estimate can be higher**
- **Requires client to manage interfaces and be technically aware.**

Pipeline Construction – BOT / Turnkey

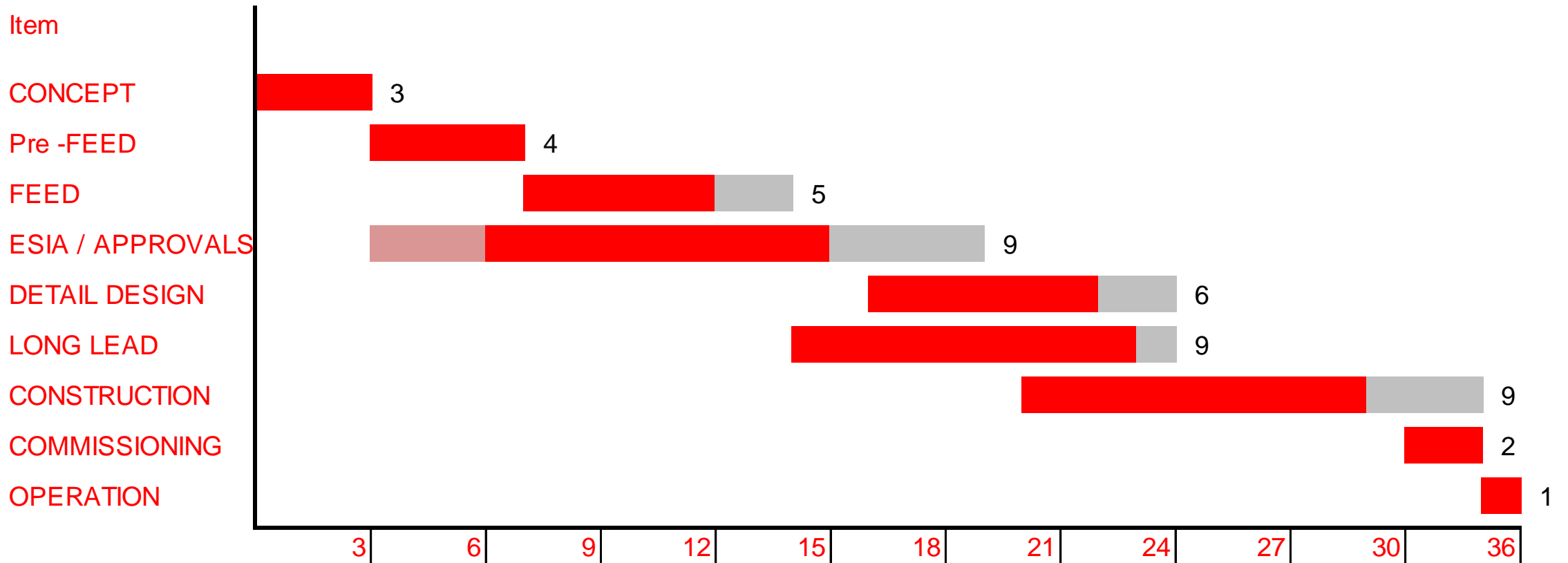
- **Perceived advantages**
- **Removes all requirement for client to have skilled team**
- **Reduced schedule**
- **Contractor responsible for commissioning and initial operation reduces risk (penalties)**

Potential negatives

- **Requires contractor to have multiple skill areas which is not common**
- **No opportunity for client to review or modify design**

Pipeline project stages – Ideal Schedule

EXAMPLE SCHEDULE FOR 50+KM PIPELINE



Authority approvals and permits

- **All countries have approval and permit procedures which need to be obtained prior to construction.**
- **This varies widely and can be a single application or over one hundred depending on country and authority requirements.**
- **Common requirements are route plans, generally at 1:10,000 or better showing the route or corridor of 1km or less.**
- **Permits and approvals take 6 to 12 months to obtain and often contain conditions, some of which need to be completed prior to start of construction. Public hearings are sometimes required.**
- **Compulsory purchase / rights might be required (last option)**

Authority approvals and permits

Public consultations and hearings

- **Tell people the pipeline is buried**
- **Alyaska line pictures often used**
- **Avoid “Town Hall” meetings**
- **Risk without reward is not accepted**
- **Objectors concentrate on when, not if**
- **General level of understanding is very low**
- **Internet sites now abound**



Safety Authority approvals and permits

- **Many countries have safety legislation and authorities (UK is HSE), which require specific studies or reports.**
- **For gas, chemical or hazardous substances, you often require a risk assessment (QRA) and safety studies to demonstrate that the new pipeline will not cause harm to the public.**
- **Other safety related studies are required to demonstrate consideration for demolition, construction, operation and maintenance and final removal. This is required in UK under CDM regulations, but should be undertaken to provide a safety review of the design.**

Environment Authority approvals and permits

- **Many countries have environmental legislation and there are numerous EU directives which apply all over the EU, which require specific studies or reports. Also required by financial bodies such as World Bank, EBRD, African Bank etc.**
- **The most common is a requirement to produce an Environmental and Social Impact Assessment report (ESIA).**
- **Can have significant impacts on routing issues or impacts on schedule whilst studies are completed and the impact assessed and can lead to onerous conditions or time windows being imposed.**

Environment Authority approvals and permits

- **Needs to start as part of Concept / early FEED as an input into routing work.**
- **Add environmental designation areas onto maps and plans (e.g. SSSI, SAC, “red book creatures”),**
- **Avoid “easy” remedial options e.g. HDD until these options are confirmed. Have alternative routes.**
- **Usually need to show no realistic alternative is available before approval is given to enter designated areas**

Land agreements and permits

- **Nearly all of the land part of the earth is “owned” by someone.**
- **Governments / royal families**
- **Tribes / villages (common land)**
- **Individuals**
- **Companies / utility companies**

Varies world-wide and needs local knowledge to find data

Seabed and rivers are commonly government owned / controlled but often others have licenses / historic legislation which require their permission to cross.

Land agreements and permits

- **Placing pipelines in land requires agreements to do so. These can be termed “wayleaves”, “easements” and Right of Way (RoW) and can be leases or purchased outright. There is often confusion over these terms.**
- **Common issues:**
- **Width of permanent easement is commonly 3 to 5 m either side of pipeline (can vary up to 15m) or from outside of the outer pipeline if multiple pipes are being laid.**
- **They grant certain rights and requirements on land owners, e.g. no trees, construction or excavation inside the easement without consent**
- **Construction ROW can be 25 to 40m wide (open countryside)**

Land agreements and permits

- **Number varies, but in agricultural areas and around villages etc, can average between 0.5 to 1 per km.**
- **Historical “splitting” of land over generations can lead to multiple small owners and increase in land approval time and costs.**

Abandonment

- **Growing issue as pipelines age and become uneconomic to repair / not required.**
- **Requirements to remove or abandon “in-situ” unclear in many cases / not defined – BPEO used.**
- **Clear contents**
- **Seal in sections (300-500m)**
- **Avoid transmission of water from one area to another**
- **Grouting – limited sections**
- **Collapse needs to be considered**
- **Cathodic protection continued (sacrificial)**

Summary

Common project Phases

Contract types

Pipelines of reasonable size from start to finish take minimum 24 to 36 months

Authority Approvals required

Safety studies required

Environmental studies and approvals

Land ownership and issues

Abandonment

The background of the slide is an abstract, swirling pattern in shades of blue and black, resembling a vortex or a stylized eye. The text is positioned on the left side of the image.

Thank You

Any questions?