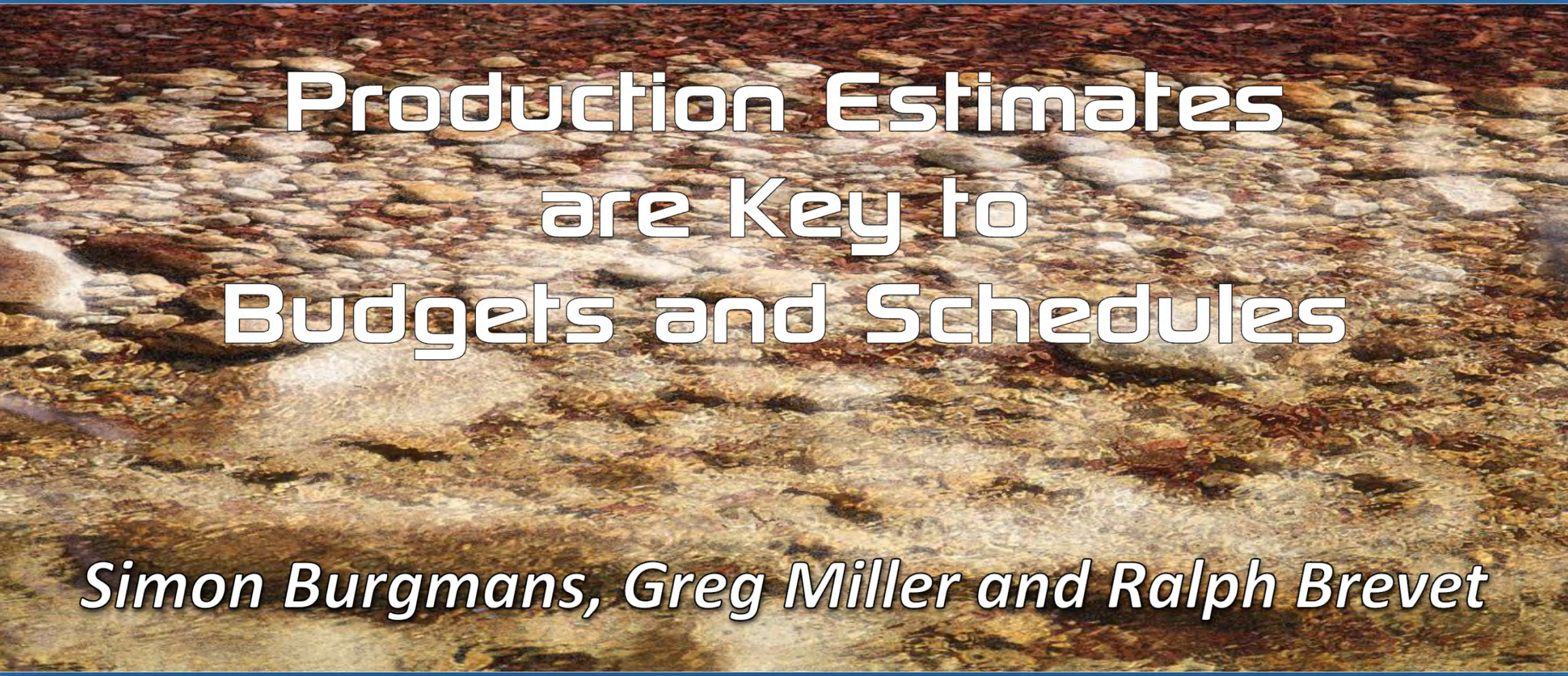
in 2D redging
Solutions adding value



Production Estimates are Key to Budgets and Schedules

Simon Burgmans, Greg Miller and Ralph Brevet

Overview

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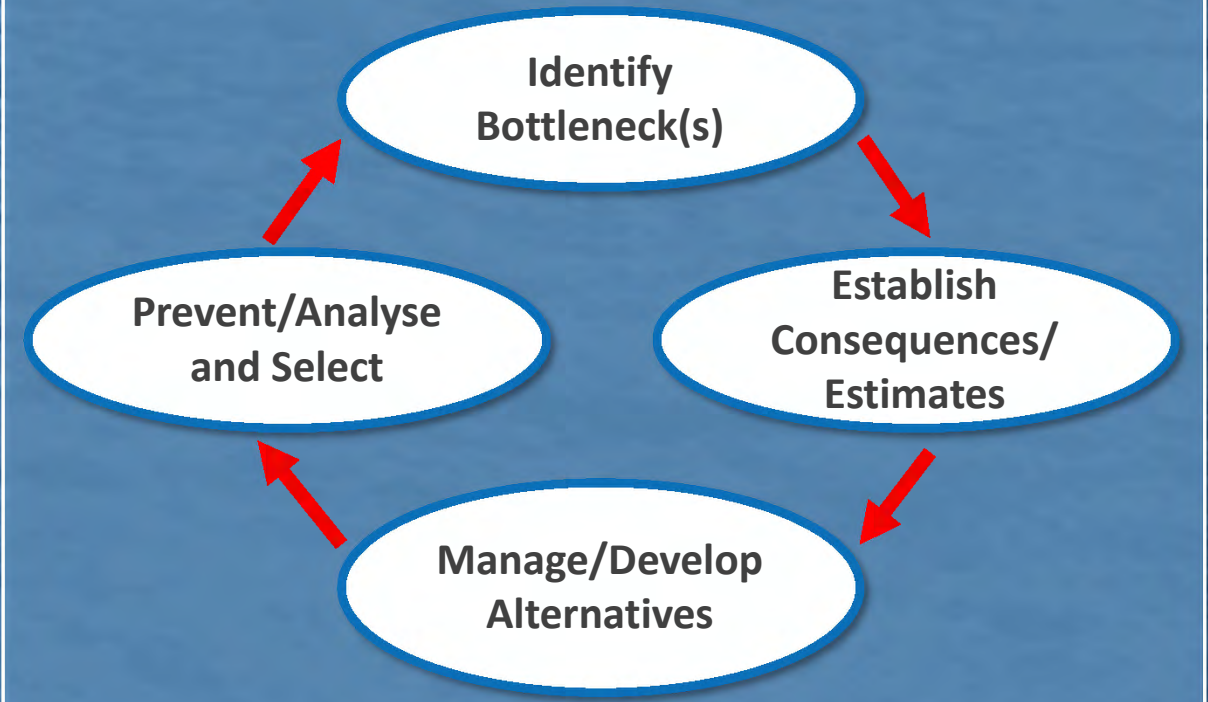
- No contract type can protect you from a Contractor's underperformance that results in claims and delays
- Contractor's issues with underperformance become a Client's headache
- Robust production estimates provide the best insurance against slipping budgets and schedules

High-Level Introduction to Production Limiting Factors

- Cutting or jetting
- Pick-up
- Pumping
- Operator or control system

Conducting Bottleneck Assessments



Identifying bottlenecks is critical to improving and monitoring productivity

Introduction to Dredge Performance Monitoring

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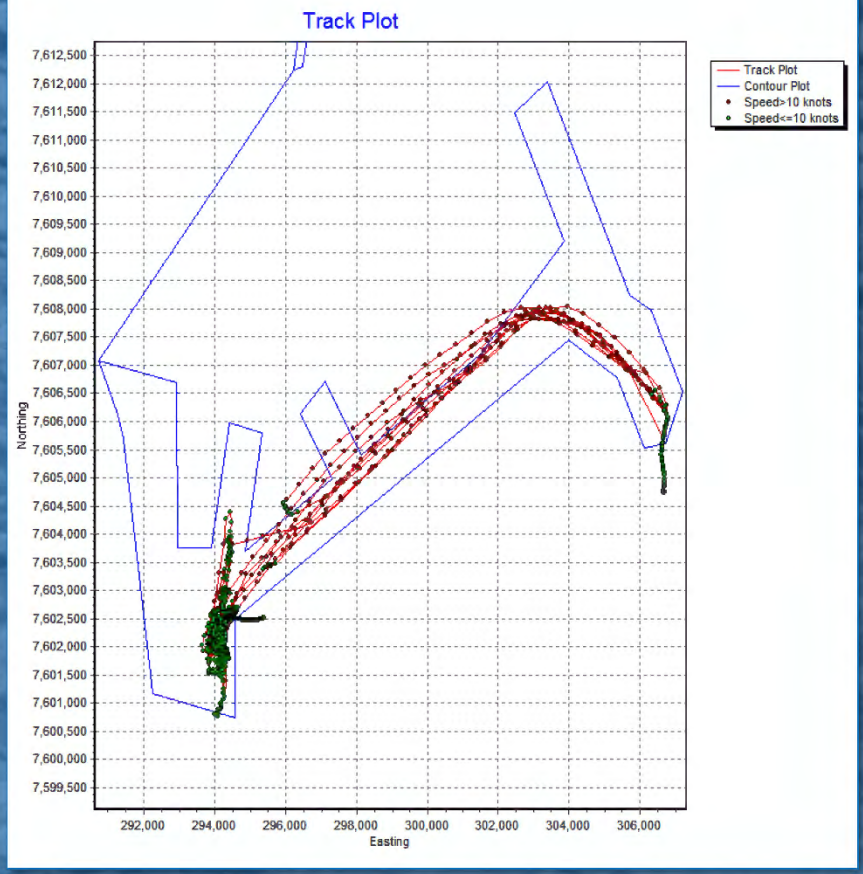
- Why use performance monitoring?
  - ◊ Optimise production
  - ◊ Review permit compliancy
  - ◊ Administer contract
  - ◊ Conduct engineering or scientific analyses
- Monitoring system in a nutshell:
  - ◊ Calibrated sensors
  - ◊ Manipulate data, if required
  - ◊ Verify data integrity
  - ◊ Visualise data

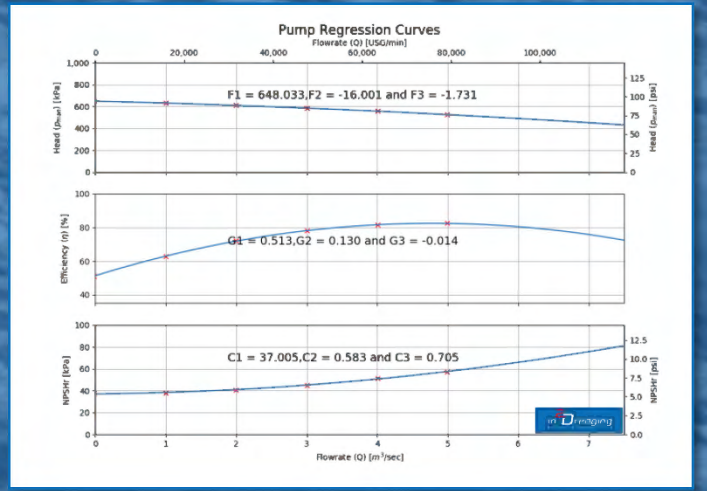
Vessel Speed Monitoring

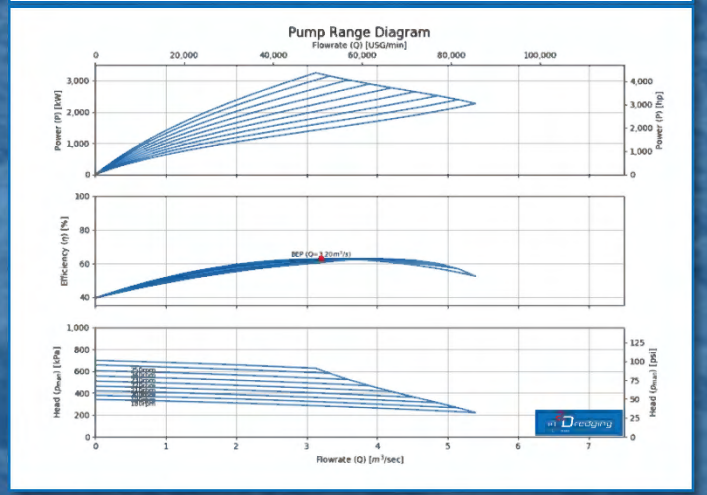


Evidence based decision making rationalises relationship between Client and Contractor

Disappointing Discharge Production

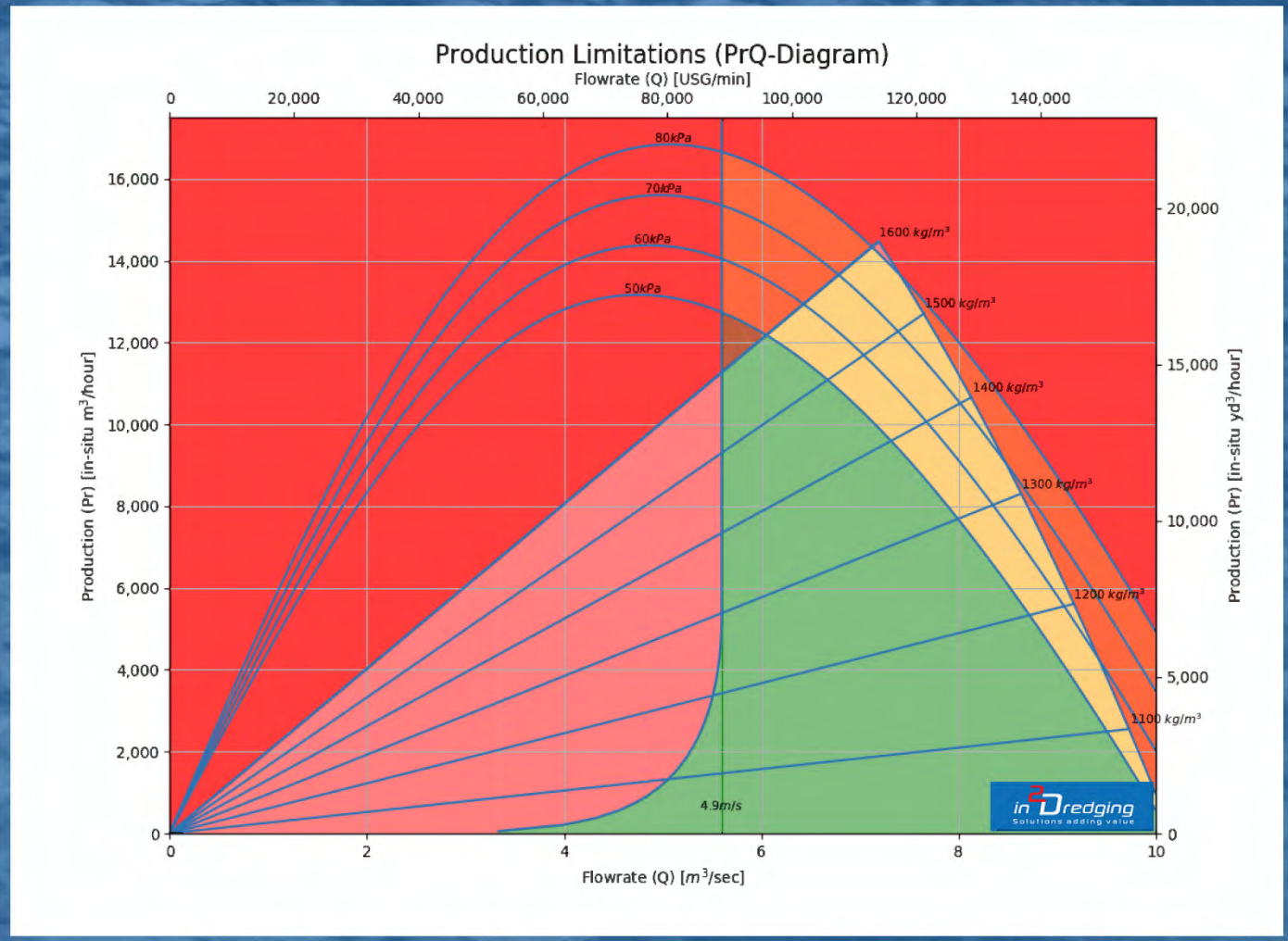
- Dredging professionals can accurately estimate suction and discharge production with specialised tools such as Pumps 'n Pipeline (PnP)
- Define pumps and pipelines before committing or mobilising. Required data includes:
  - ◊ Pump engine characteristics
  - ◊ Pump characteristics
  - ◊ Pipeline configuration
- Provide enough definition on mixture properties from geotechnical data. Required data includes:
  - ◊ Particle size distribution
  - ◊ Shell content
  - ◊ In-situ, lump and solid density
  - ◊ Yield stress





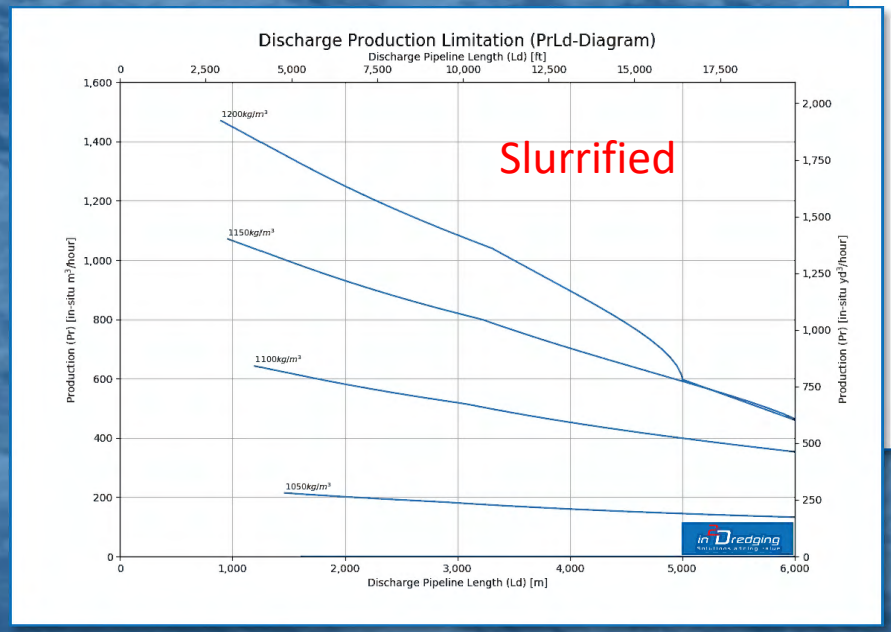
Pumping Production Limitations in One Graph

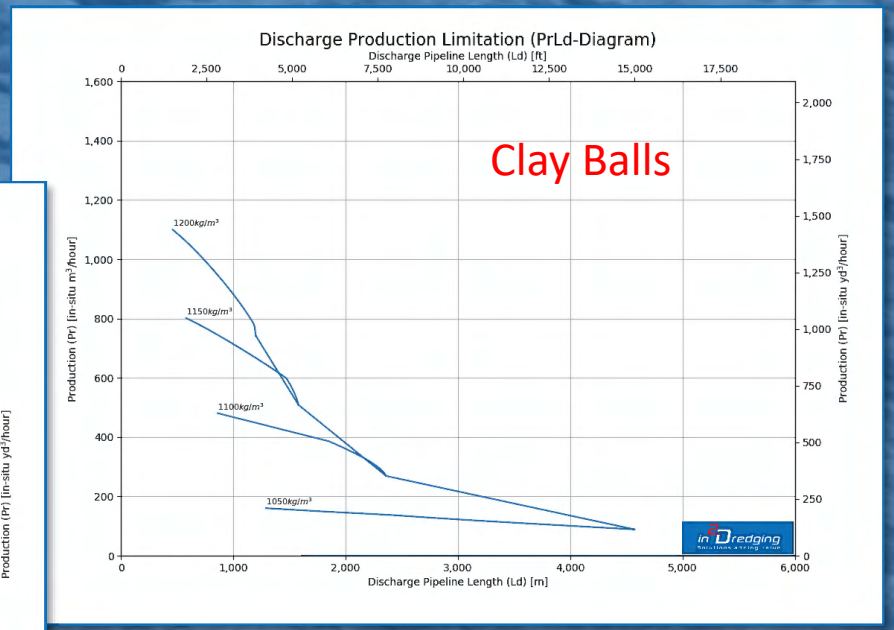
- Operating areas:
  - ◊ Green is “possible”
  - ◊ Orange is “challenging”
  - ◊ Red is “impossible”
- Pump Production Limitations:
  - ◊ Pickup mixture density
  - ◊ Pump’s limiting vacuum
  - ◊ Engine’s characteristics
  - ◊ Mixture’s critical velocity



Risks of No Clay Ball Degradation

- Hydraulically transporting clay balls is a major risk as its potential impact on discharge production is disastrous, if not expected
- Clay balls are likely to remain intact when:
  - ◊ Clay content > 50%
  - ◊ Undrained shear strength > 25 kPa
  - ◊ Situ density > 1,500 kg/m³
  - ◊ Liquid limit > 25% < 125%
  - ◊ Plasticity Index > 25%





More physical modelling and detailed field observations are required

Underestimating Cutting Production in Hard Rock

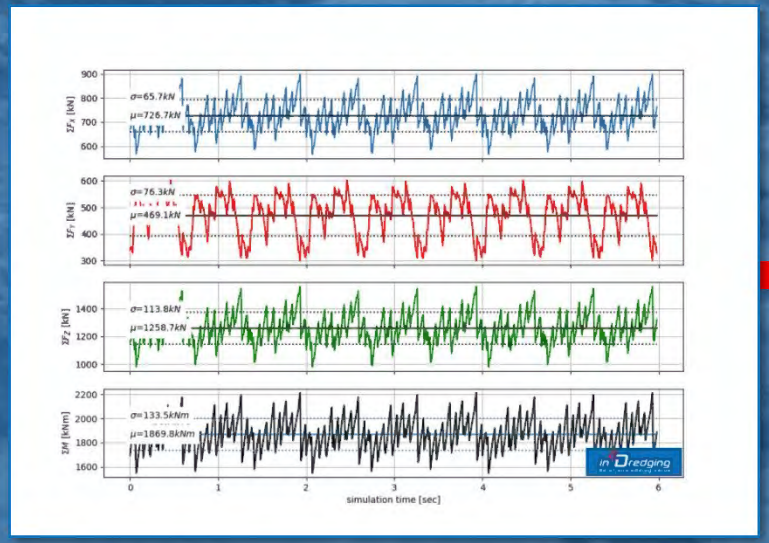
- Large Contractors have gained invaluable expertise on cutting hard rock
- Cutting hard rock is less known by remainder of dredging industry
- The risk from the potential presence of rock is often underestimated or even ignored
- The cutting of hard rock can be limited by:
  - ◊ Cutter Power
  - ◊ Side Winches
  - ◊ Spud Hold Force
  - ◊ Ladder Weight

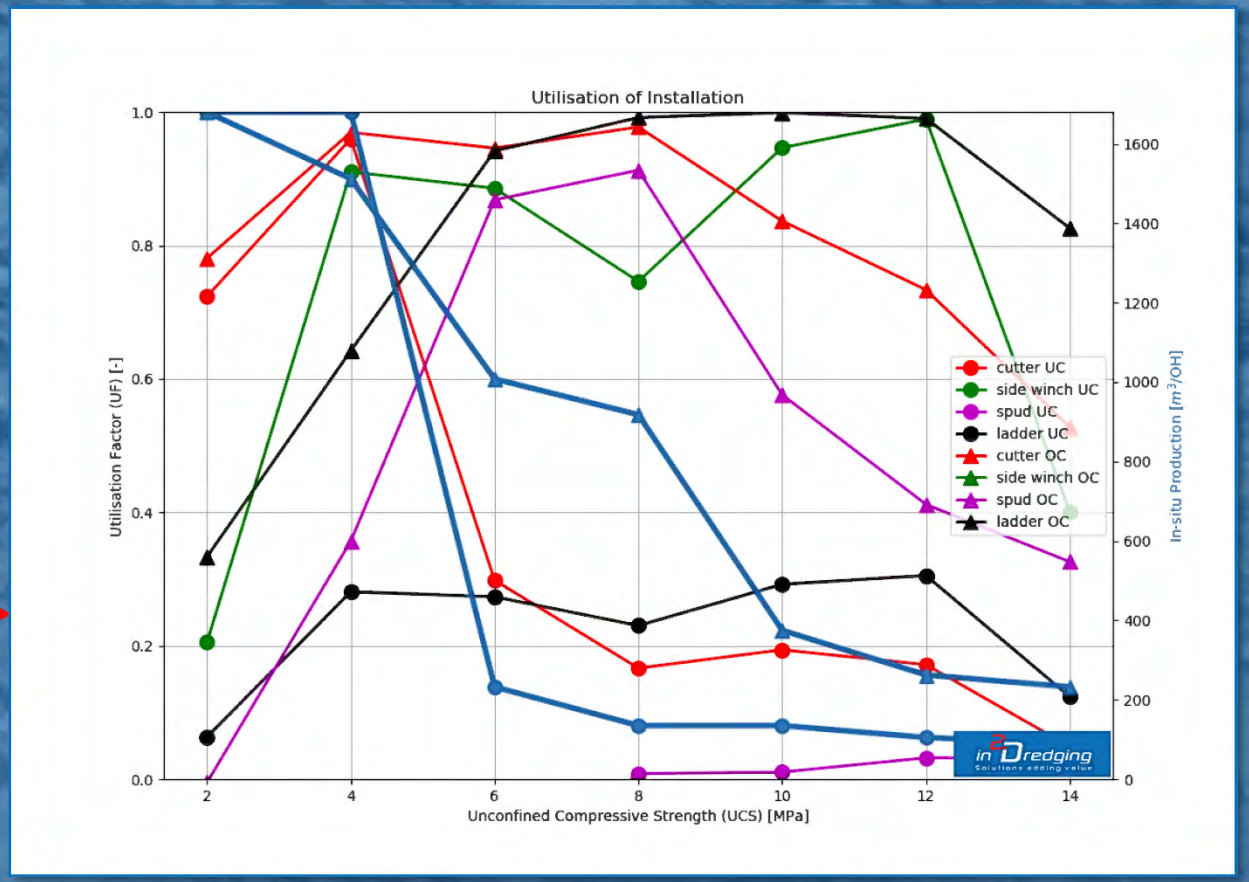
Cutter head over-cutting 5MPa rock.

Arrows show teeth and resultant forces.

Underestimating Cutting Production in Hard Rock (2)

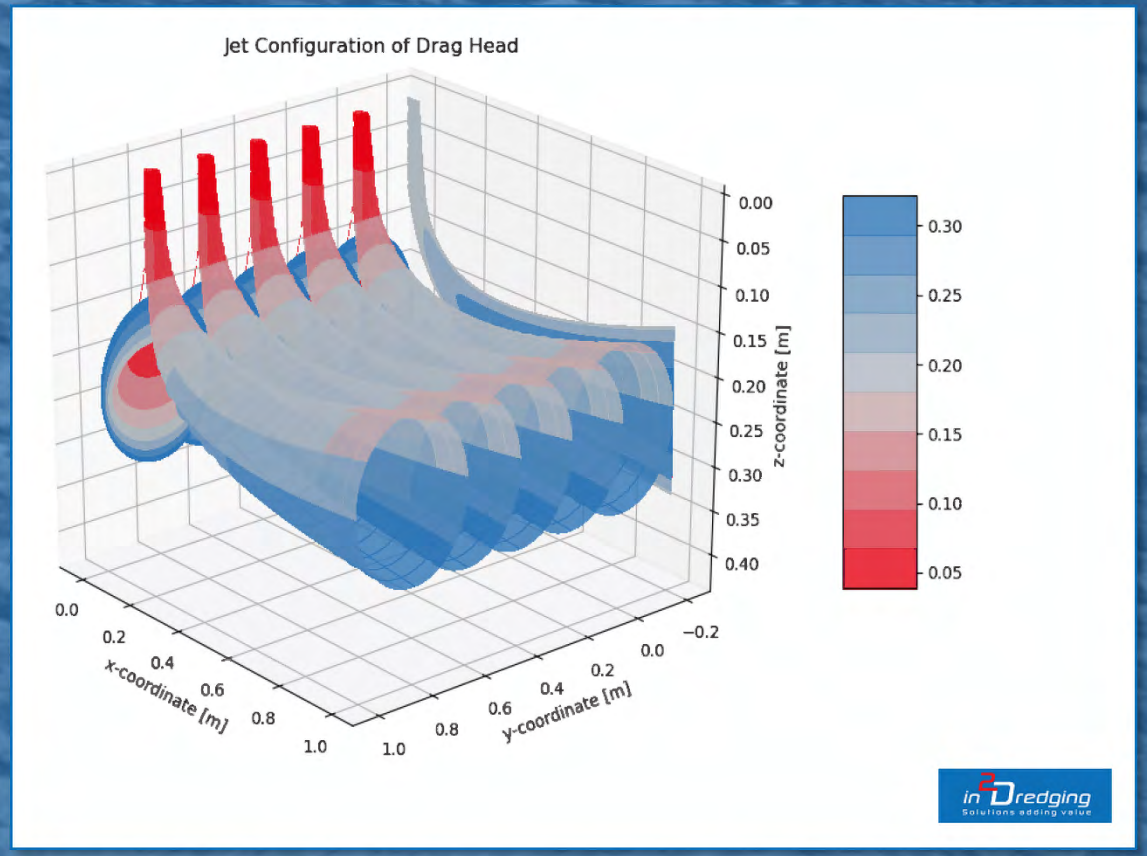
- The cutting forces on each tooth allow calculation of the resultant force, a principle on which the Subsea Rock Cutting (SRC) estimation tool is based
- The resultant force is counteracted by the cutting installation





Underestimating Jetting Production

- By resolving the jet trajectories one can accurately estimate jetting production in sandy and clayey soils
- Jetting production is low in less permeable sand (10^{-5} m/s)
- Jetting is energy inefficient in medium to hard clay and often a schedule risk



A small up front investment in jet modelling may result in a sizeable saving during execution

Underperformance

- Soil and weather are the biggest risk factors, but what are the true causes of delays and cost overruns?
- Detailed performance monitoring has shown that the following causes are just as relevant as unsuitable soil and weather conditions:
  - ◊ Lack of instructions on requirements
  - ◊ Wrong work methodology
  - ◊ Operator error
- Gather evidence on daily performance from:
  - ◊ Sensor reading log files (ASCII data file)
  - ◊ Progress surveys (xyz files)

Conclusions

- Production estimates are key to Budgets and Schedules
  - ◊ High-definition production estimates reduce risk of delays & cost overruns
  - ◊ Estimates should be produced by both Clients and Contractors
  - ◊ Advanced tools for pumping, cutting and jetting are available that produce robust and reliable estimates
- Performance Monitoring
  - ◊ Almost all dredges have onboard systems from which you can acquire data files
  - ◊ Performance monitoring is best carried out by both Clients and Contractors
  - ◊ Daily equipment performance monitoring safeguards reputations as well as budgets and schedules