Rapid & Cost-Effective In-Situ Slurry Dewatering

RESIDUE SOLUTIONS

WODCON XXI – MIAMI
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Overview

- An review of some dredge impoundment management practices;
- Summation of key risks and issues commonly encountered;
- Provision of alternative process and practices commonly undertaken in other similar materials
  - Mud Farming – What is it? How does it work?
- Discussion around advantages, required controls and limitations;
- Three case studies provided covering:
  - Dredge (high clay, unflocculated);
  - Oil Sands (high clay, flocculated) and;
  - Alumina (high fines, no clay, unflocculated).
- Discussion and conclusions

Dredge Impoundment Management

Purpose – to cost-effectively contain all required sediment loads within environmental guidelines and facilitate construction and/or access as required.

- Dredged material is usually emplaced in large impoundments at variable depth;
- Material is left fallow for several years to desiccate and self-weight consolidate;
- Some peripheral drainage works are implemented, and material is left fallow until access or further works are possible e.g:
  - (Sand) pre-loading, wick draining, other ground conditioning process.

Common Issues

- Material derived from maintenance dredging activities is variable in composition and density;
- Each campaign also has different tonnage and available storage volume/area is therefore highly dynamic;
- Commonly encountered scenario of large loads and limited space, or poor consolidation leading to access or construction delays.
- This issue is also commonly faced by mining companies managing mineral tailings.
- They identified that they need to actively manage this process to achieve a safe, cost effective outcome under all scenarios.

Active vs Passive Management

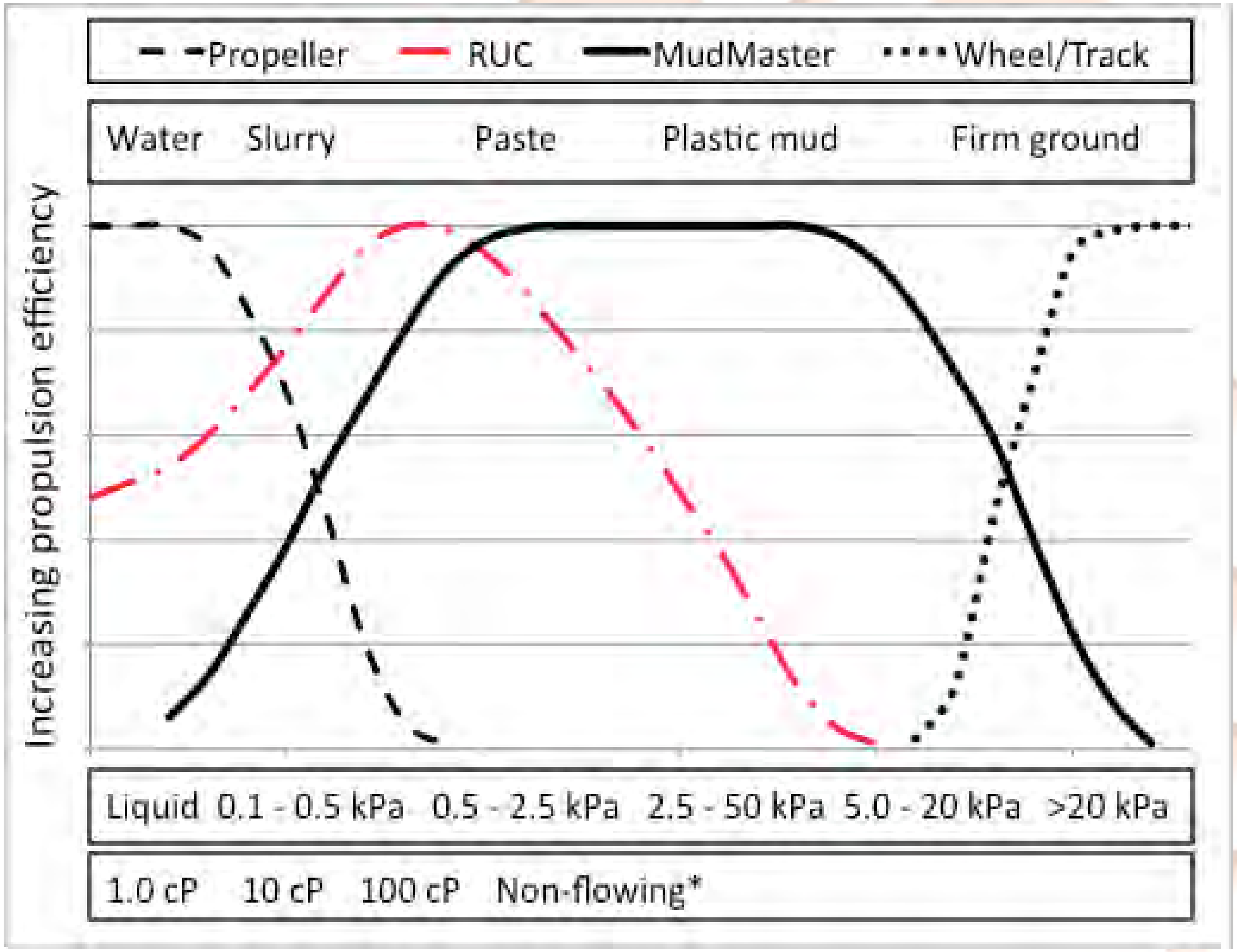
- Active in-situ slurry dewatering puts you in charge of timeline and outcome;
- Delivered through resource application intensity (controls time) and campaign duration (final density/strength);
- Requires fit-for-purpose equipment with an understanding of material properties and required end-point.
- Referred to as “Mud Farming” in the mining industry
  - Developed for management of mineral tailings
  - Established for 30+ years.
- Cheapest and most efficient method for large-scale, emplaced slurry consolidation.

What is Mud Farming ?

- Mechanically assisted, post-deposition slurry dewatering and consolidation
  - Rapid Water Recovery = Reduced Volume + Densification/Consolidation
  - Reduced Volume = Extended impoundment availability/capacity
  - Consolidation = Increased bearing capacity, rapid, easy, safe access
  - Lower overall Capex and Opex due to increased capacity / reduced filling rates.
- First trialled in dredge (1970's), then adopted in mining.
- Key learnings and governing principles can now be applied to any over-saturated material.
- However, success is dependent on development of fit-for-purpose equipment

Fit-for-Purpose equipment

- Must bridge the capability gap between wheel/track access and propeller/boat;
- Equipment must be able to traverse low-density slurry through to firm ground;
- Therefore must be water buoyant, strong and powerful – leaves only one option.



Fit-for-purpose equipment

- MudMaster® - an Archimedes Screw Tractor technology (AKA Amphirol);
- Standard configuration tailored to suit any size/application;
- Patented technology with real time monitoring anywhere in the world.

MudMaster® - How does it work?

- Slurry is usually (but not necessarily) placed at a known depth on a firm substrate.
- MudMaster® is applied to establish and sustain drainage channels (scroll lines) parallel to the angle of repose.
- As the profile releases its water this flows into scroll lines and drains away and/or evaporates.
- When free drainage is complete, further scrolling allows for evaporation of adsorbed water and/or compaction.
- Consolidates deep into the profile until the target density and/or strength is achieved.
- Process is then repeated or area handed over to conventional earthmoving equipment for further works.

Mud Farming Case Study 1: Alumina

Synopsis:

- 7.6 MTPY (dry basis), 175 ha (440 acre) available (point-in-time), impending production expansion.

Problem:

- Passive placement could take up to 3 years to consolidate;
- Final outcome variable and unpredictable;
- No more area available within lease boundary;
- Insufficient time and no capital for new facility construction.

Mud Farming Case Study 1: Alumina

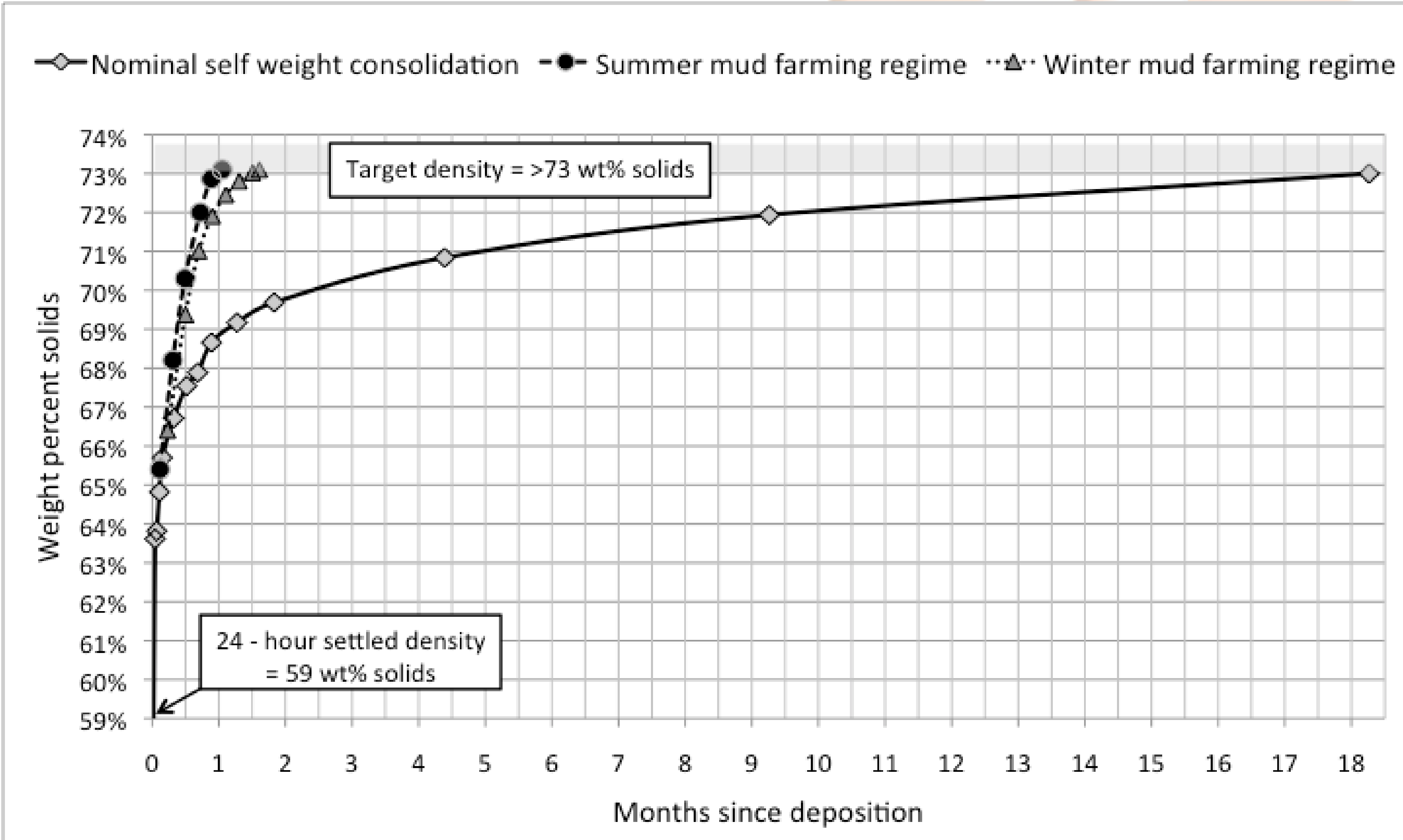
Solution:

- Strictly controlled placement depth implemented;
- Mud Farming transitioned from construction-only to full-scale application (from complimentary to primary management tool).

Outcome:

- Consolidation in 35-50 days instead of up to 3 years!
- Full-scale operation sustained within existing footprint;
- Upstream embankment construction sustained;
- Slight increase in opex and no required capex.
- Remains world's largest and best run Mud Farming operation.

Mud Farming Case Study 1: Alumina



Mud Farming Case Study 2: Oil Sands

Synopsis:

- 14.5 MTPY, high-smectite clay, heavily flocculated; 650 ha (1,550 acre) available footprint

Problem:

- Variable beach angle and therefore placement depth;
- Inappropriate equipment to traverse deep areas;
- Variable outcomes, low plant availability (<35%);
- Many handling and storage issues;
- Extraordinarily high flocculation dose rates.

Mud Farming Case Study 2: Oil Sands

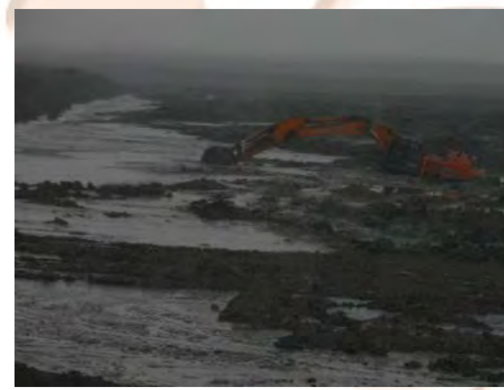
Solution:

- Ideal placement depth defined;
- Reduced flocculation trial undertaken;
- MudMasters applied into freshly poured areas.

Outcome:

- Beach angle criticality removed – not of primary importance!
- Flocculation dose rates greatly reduced and strictly controlled.
- MudMaster® availability >90%, no major outages;
- Consistent outcomes in controlled placement areas;
- Handling and compaction issues largely addressed.

Mud Farming Case Study 2: Oil Sands



Mud Farming Case Study 3: Dredge

Synopsis:

- 0.35 – 0.9 MTPY, high-smectite clay, un-flocculated; 45 ha (110 acre) available footprint.

Problem:

- Extended/unpredictable consolidation periods;
- Variable outcomes, construction schedule and access risk;
- No/limited surge flow storage capacity.

Mud Farming Case Study 3: Dredge

Solution:

- Controlled placement implemented;
- MudMaster applied into freshly poured area.

Outcome:

- Rapid volume recovery, no MC reversion from rainfall;
- Trafficable surface established within 6 months;
- Sand preload executed within 12 months of placement (2 years ahead of nominal schedule).

Mud Farming Case Study 3: Dredge

Depth (mm)	Final peak shear strength (kPa)	
	Passive, fallow for 48 mths	Farmed for 6 mths, tested at 12 mths
150	13.5	16.5
300	5.0	3.3
600	3.7	3.3
900	4.8	2.8
1200	5.3	4.0
1500	3.8	4.4

Benefits to On-Shore Disposal

- **Normal operations**
  - Rapid volume recovery, increased impoundment capacity.
  - Paradigm shift from cost management to asset construction.
  - Flexibility to manage surge volumes (flood) as required.
- **Surge loads**
  - Approach can be scaled to any volume required
  - Consolidation can be accelerated to keep pace with delivery rate or accelerate return to operations plan
- **Final layer/closure/capping**
  - Rapid, safe access for deep-profile engineering assessments;
  - Trafficable surface for larger equipment - quicker;
  - Timely capping/closure works execution.

Key learnings from Mining for Dredge

- **Controlled placement and Drainage**
  - Use the properties of the dredged material to work for you;
  - Install depth markers to track even residue placement;
    - Think of the dewatering cell as an asset requiring careful management;
    - More homogenous material at a consistent depth provides more predictable cycle times and final properties.

- **Know your material**
  - If there is a storage capacity issue and smectites are likely, then flocculate;
    - Enhances preliminary dewatering rate and clarity thereof;
    - Improves initial settling and mitigates surface free energy effects (stickiness) without impacting ultimate compaction behaviour.

Conclusions (1)

- **What is the benefit?**
  - Rapid dewatering/volume recovery/increased storage capacity;
  - Subsequent densification and strength development;
    - Increases bearing capacity, allows access or material recovery;
    - Reduces operational risk to conventional earthmoving equipment in subsequent works.
- **What is the cost?**
  - With controlled placement - <USD $2.50 / m^3
    - Rapid dewatering to recover volume
      - Minimum 20% per 1m (3 ft) deposition every 2 – 6 months
    - Deep-profile strength development (in 25% of the time)
    - Cost is predictable and easily controlled.

Conclusions (2)

- **Minimal change**
  - Mud Farming requires few, but very important changes to current management practices
  - Rules of operation need to be enforced – KPI’s tracked, clear roles and responsibilities.
- **Safe access to all areas all the time.**
  - MudMaster® design envelope matched to material properties.
- **Low risk, proven approach;**
  - Proven and published;
  - In full-scale application in many materials around the world;
  - Currently used to manage over 30 million tonnes material/year.

Thankyou

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