Managing dredged Acid Sulfate Soils

A case study
GLADSTONE PORT EXPANSION
WESTERN BASIN MAIN WORKS DREDGING
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- Dredging and Reclamation Works by Joint Venture:
  - Van Oord Australia Pty Ltd
  - Dredging International Australia Pty Ltd
- Funding parties LNG project Gladstone:
  - GLNG Operations Pty Ltd
  - Australia Pacific LNG Pty Ltd
  - QCLNG Operating Company Pty Ltd
  - Arrow CSG Australia Pty Ltd
WESTERN BASIN MAIN WORKS DREDGING

- Dredge Equipment
  - Back Hoe Dredges
  - Trailing Suction Hopper Dredges
  - Cutter Suction Dredges
- 26 Mm³
- Destination
  - Offshore Placement
  - Western Basin Reclamation Area
- Acid Sulfate Soils (ASS)
  - 1.5 Mm³
ACID SULFATE SOILS

- Coastal wetlands
- Past 10,000 years (Holocene epoch)

- POTENTIAL ASS (PASS)
  - Iron sulfides (pyrite)
  - waterlogged
  - no oxygen: stable

- (P)ASS in USA
ACID SULFATE SOILS

• ACTUAL ASS (AASS)
• Drainage / upland placement
  • Oxidation
  • Sulfates $\rightarrow$ sulfuric acid
  • pH < 4
  • Leachate (heavy metals)

• Danger
  • Inhibit aquatic life
  • Habitat degradation
  • Degradation of engineered structures
PASS Definition

- Potential Sulfidic Acidity (PSA)
- Self-neutralizing PASS
  - Natural carbonate content
  - Acid Neutralizing Capacity (ANC)
- Safety Factor (SF) = 300%
  - Mixing
  - Solubility
  - Fineness
- Net Acidity (NA)
  - NA = PSA – ANC / SF
  - PASS: NA > 0.03 %S
PASS MODEL

- Outlining the problem
  - Management strategy
- In situ PASS data
  - 561 boreholes, 2246 samples
  - Geochemical data
  - Stratigraphy
- Modeling
  - Net Acidity
  - 3D domain
  - Blocks of 80m³
  - IDW algorithm
PASS MODEL

PASS - Distribution of MAXIMUM NA in Holocene sequence dredge volume

Net Acidity (300%)

-20.0 - -2.0
-2.0 - -1.0
-1.0 - -0.5
-0.5 - 0.0
0.0 - 0.03
0.03 - 0.5
0.5 - 1.0
1.0 - 10.0
PASS MODEL

Cross-Section A-A'

Cross-Section B-B'

Cross-Section C-C'
PASS MANAGEMENT OPTIONS

• STRATEGIC REBURIAL
  • Offshore
  • Onshore

• NEUTRALIZATION
  • By Dredge Process
    • Vertical Mixing
    • Dual Dredge Blending
  • Active Treatment
    • Lime mixing
    • Contingency
STRATEGIC REBURIAL

- Underneath permanent water level
  - Anoxic conditions
  - High grade PASS
- Reclamation area
  - Groundwater modeling
- Safe PASS Reinterment Level ~ MSL
- Limited storage capacity
STRATEGIC REBURYAL

- Offshore placement
  - Minimize bulking
  - Selective dredging
  - Back Hoe Dredges + Barges

- Keep saturated during transport
- 24h limit
- pH test every 2 hours
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NEUTRALIZATION BY DREDGE

- Vertical Mixing
- Combined NA
  - Excess ANC
  - CSD
  - Onshore
  - Above SPRL
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(P)ASS TRACKING

- Offshore site
  - 300m x 300m grid
  - Split hopper barges
  - Appointed disposal-cells

- Reclamation site
  - 1hectare cells
  - Below SPRL
    - Adaptive placement
  - Above SPRL?
    - Testing program
PASS Sampling Strategy

- Above SPRL
- 3m layers
- Continuous coring

- Field tests
  - 0.25m intervals
  - Early indication
    - $\text{pH}_F$
    - $\text{pH}_{\text{Fox}}$

- Validation tests
  - Lab
PASS Sampling Strategy

- Composite sample
  - 0.5m intervals
  - every 5,000m³
- PASS?
  - adjacent samples
  - 1 ha
  - overall NA
- Fail?
  - secondary sampling
  - 3 sites
  - vertical delineation
PASS Strategic Reinterment

- Relocation
  - Below SPRL
  - Swamp excavator
    - GPS/position sensors
    - vertical control
  - 2m water on top
  - >30 cm capping
    - Stiff clay layer
(P)ASS Treatment

- Safe storage capacity?
- In situ treatment
  - deep rotary mixing
  - aglime injection
  - binder agent
(P)ASS Treatment

- Actual ASS
  - no reinterment
  - quick response
  - aglime
  - ripper/spreader/rotary hoe
ONLINE PASS TRACKING

• **SOILVIEWER**
  • Real time cutter position
  • PASS 4D-model integration
ONLINE PASS TRACKING

- SOILVIEWER
  - Bridge
  - Relay to shore
  - Client
Managing dredged Acid Sulfate Soils

Thank you for your attention

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24 October 2012