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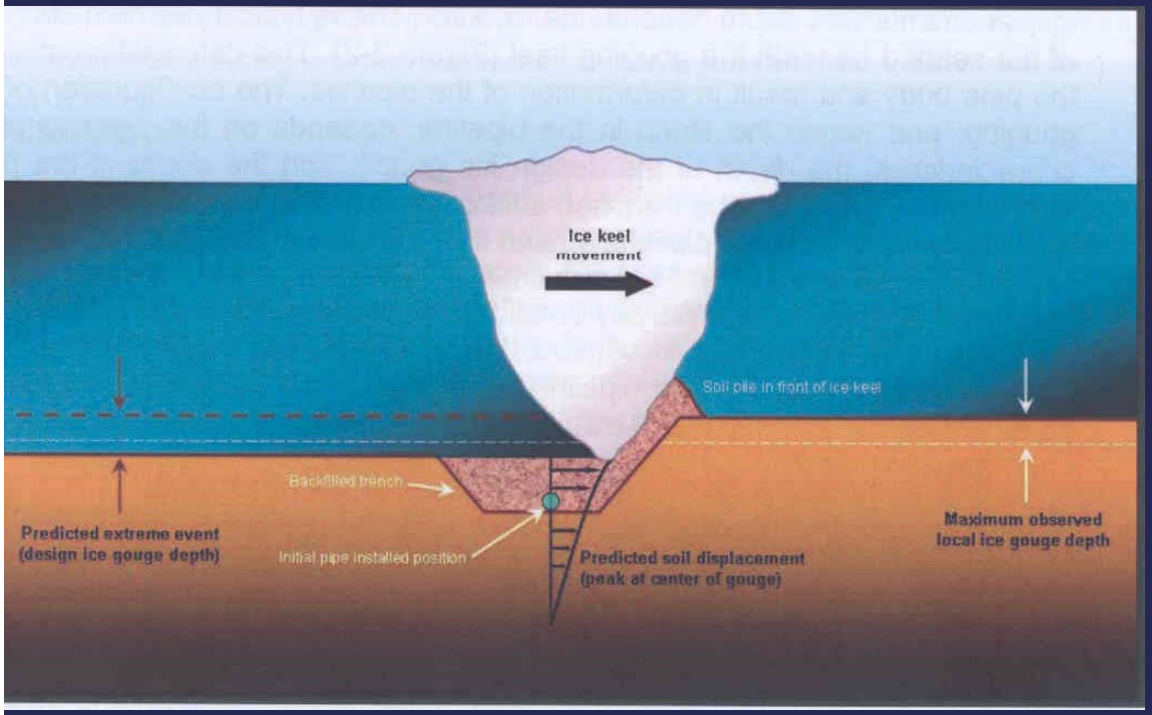
# DREDGING FOR OFFSHORE INDUSTRY

# OVERVIEW

- Glory (Caisson) holes for subsea installations
- Pipeline trenches
- Deep ocean mining
- LNG ports & ship channels
- Summary

# White Rose Glory Hole Excavated with Vasco de Gamma (Jen de Nul)

# Ice Gouge

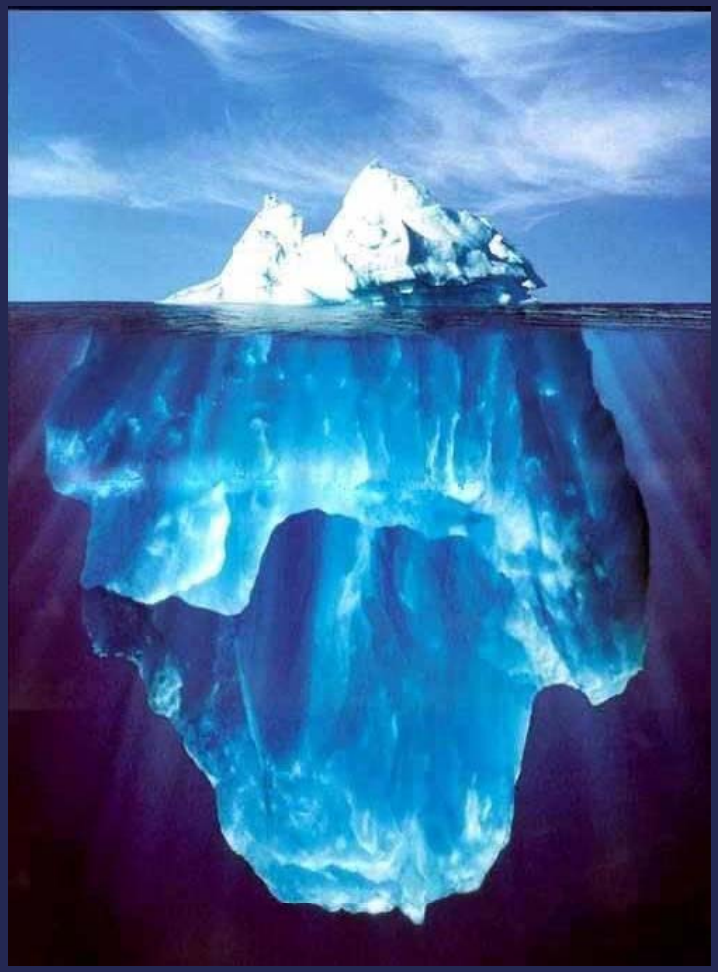



- Ice Gouge
  - 0 – 20 m water depth
    - 100 yr gouge depth – 1.3 m
  - 20 m to platform
    - 100 yr gouge depth – 3.65 m
  - Water depth > 20 m
    - 100 yr gouge depth - 4.35 m

# ICEBERGS & ICE KEELS

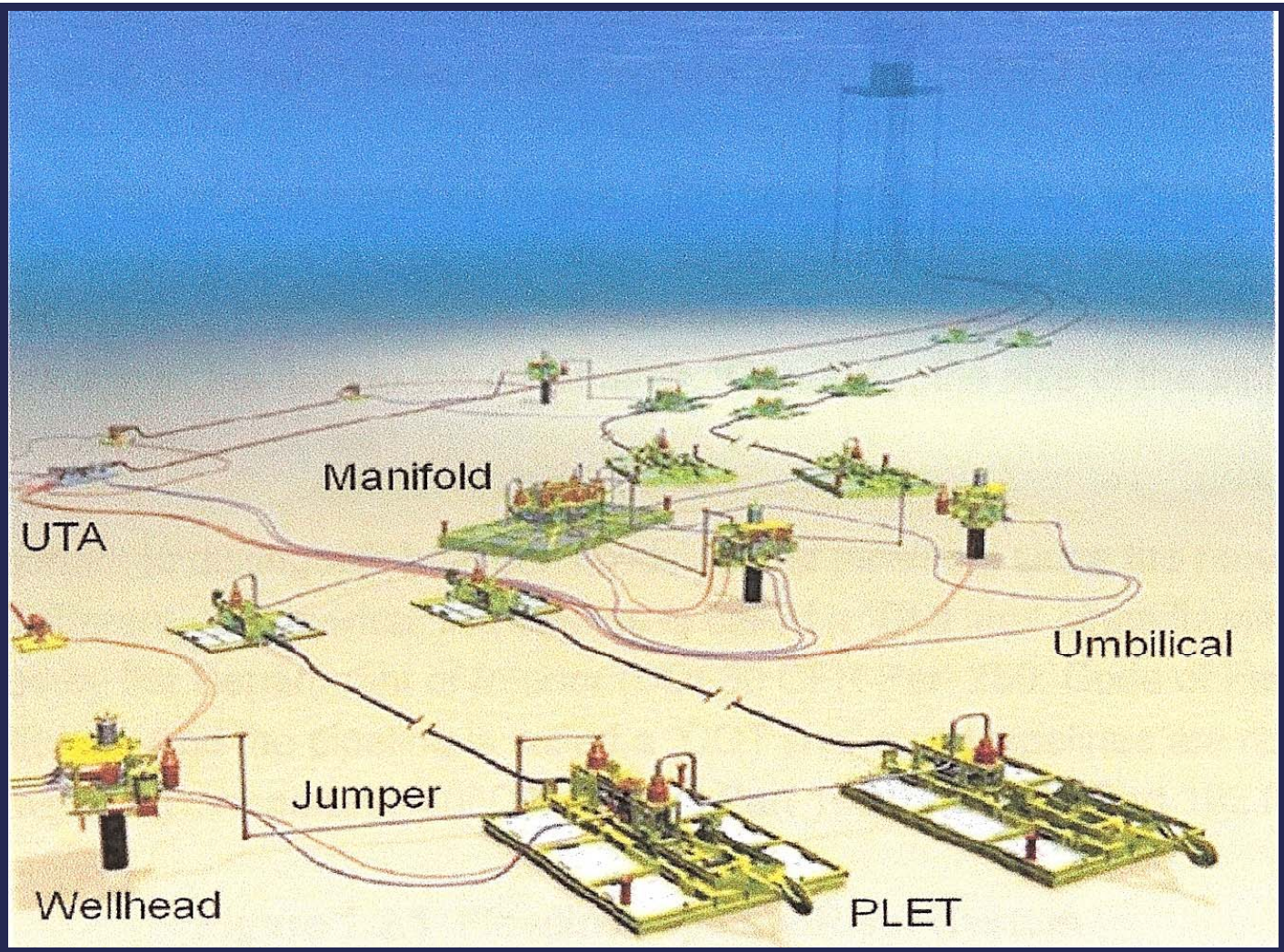


- Icebergs are a floating mass of freshwater ice (http://www.solcomhouse.com/iceberg.htm)
- Typical Arctic icebergs:
  - 45 m (147.6 ft) tall
  - 180 m (590.4 ft) long.
- About 87.5 % of the iceberg is below the water and is called an ice keel.
- Icebergs the size of a small house are called bergy bits
  - 1-4 m (3.3 – 13.1 ft) in height
  - 5-14 m (16.4 – 45.9 ft) in length.
- Smaller icebergs are called growlers:
  - less than 1 m in height and less than 5 m in length.
- Larger icebergs are found in the North Atlantic.



# Example Subsea Layout

# Subsea Layout (manifold, umbilical, Pipeline End Termination (PLET), Jumper, Umbilical Termination Assembly (UTA)



# REMOTELY OPERATED DREDGE FOR DIGGING TRENCHES (ALLSEAS' DIGGING DONALD WWW.ALLSEAS.COM )

*Digging Donald*

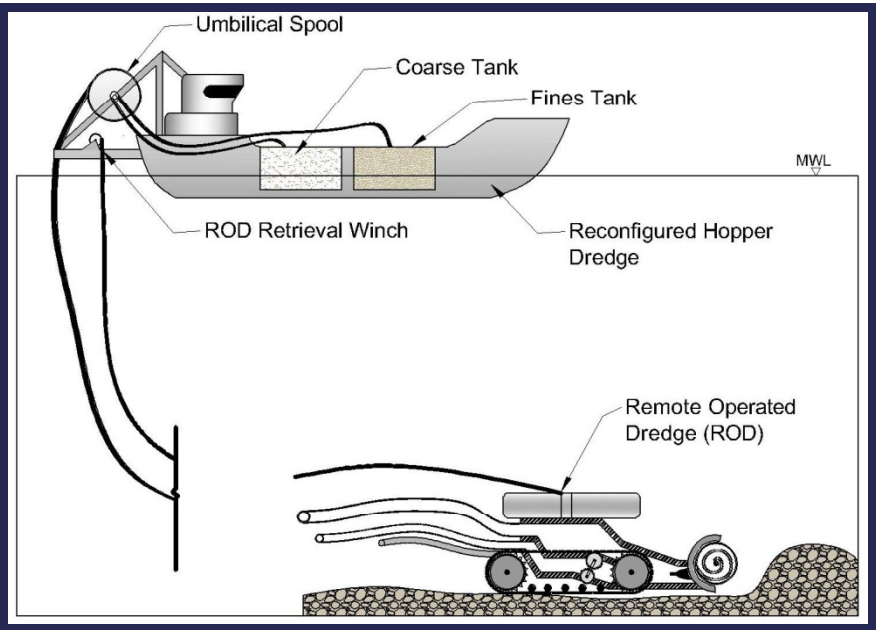
**Length**
17.7 m (58 ft)
**Width**
9.6 m (32 ft)
**Height**
6.7 m (22 ft)
**Maximum water depth**
400m (1,312 ft)
**Maximum speed**
500 m/hr
**Installed power**
1,000 kW (1,341 hp)
**Maximum pipeline diameter**
Trenching 42" OD
Jetting 48" OD

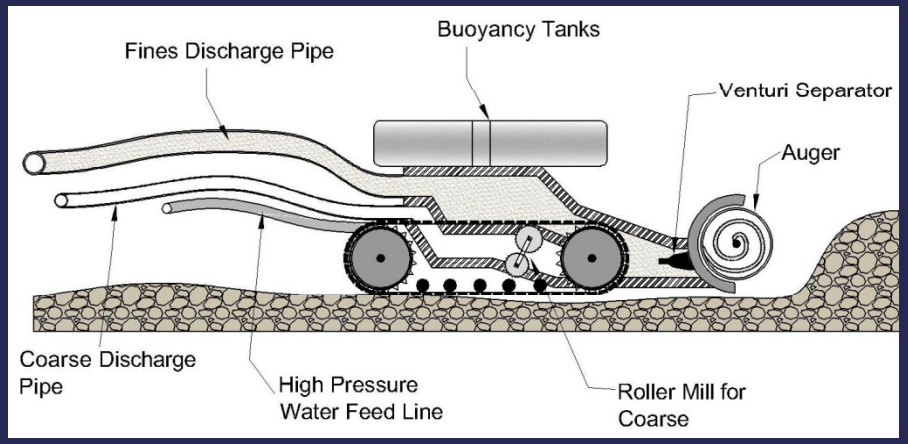
# SELF PROPELLED CUTTER SUCTION PIPELINE DREDGES NEEDED FOR ARCTIC SHORT DREDGING PERIODS

# TRAILING SUCTION HOPPER DREDGES


Cristobal Colon
Capacity: 63,000 $yd^3$
Digging depth: 508 ft

# NEW CONCEPT REMOTELY OPERATED DREDGE SYSTEM

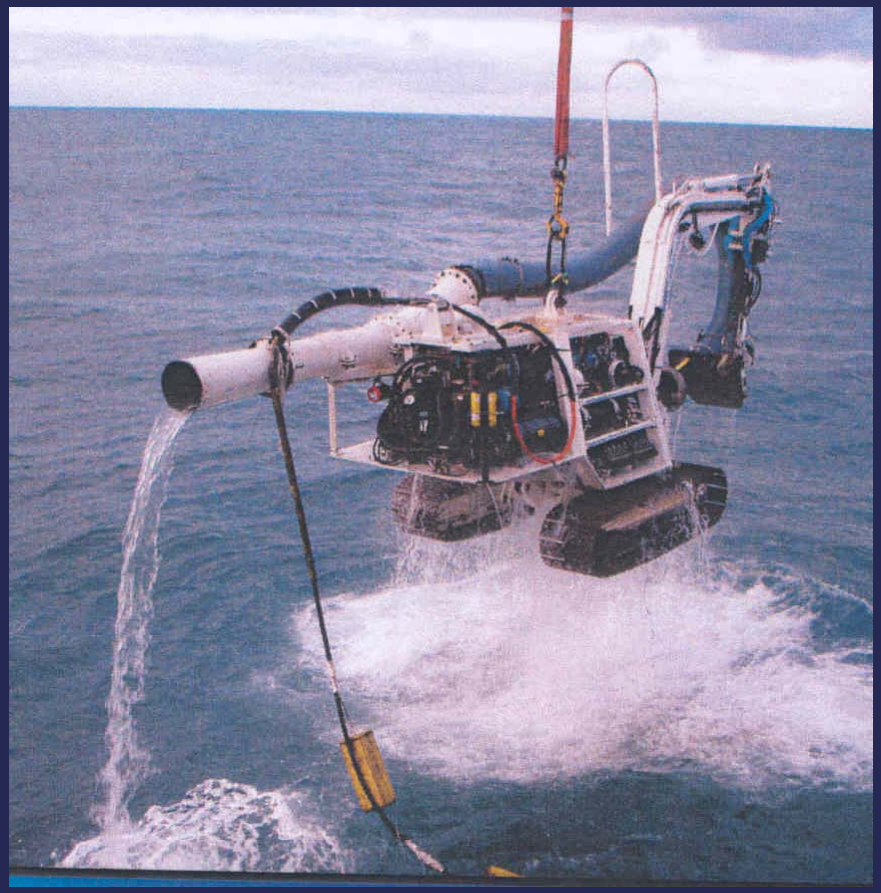



- Ability to work free from the constraints of trailing suction arms, winch lines, anchor handling equipment, and ladder pumps.
- Reduced mobilization costs and transit time, unhindered traffic flow, and discharge pipeline maintenance.

# Pro Dive Scanmudring: Scanmaskin Excavator

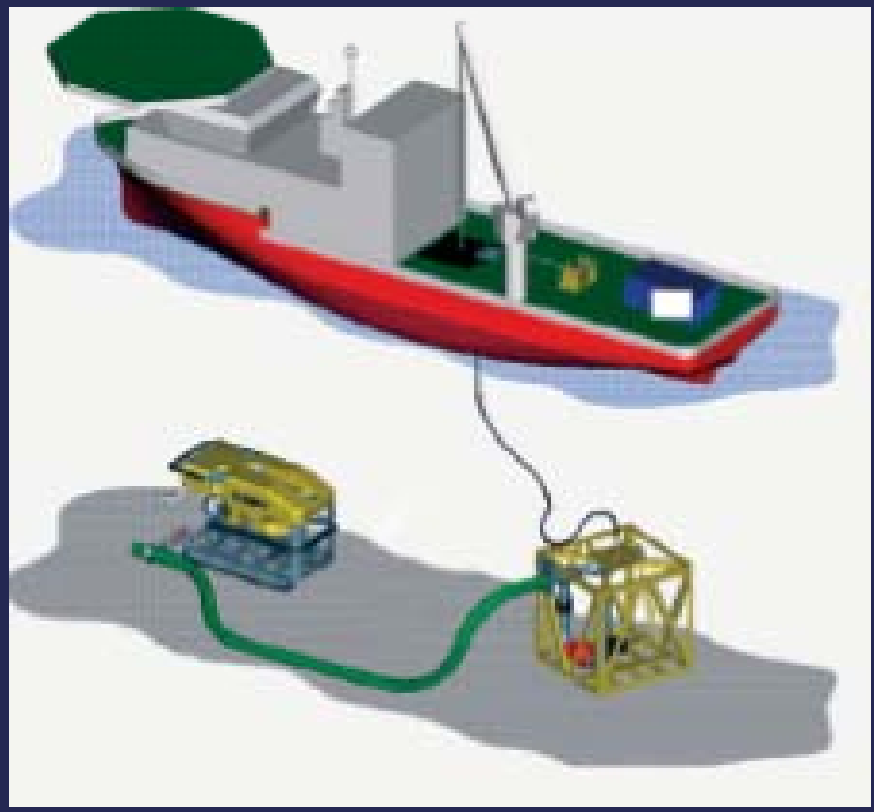




# Developing Technology
## (van Duursen and Winkelman, Damen Dredging Equipment)

# ROV Dredges (GTO Norsk)

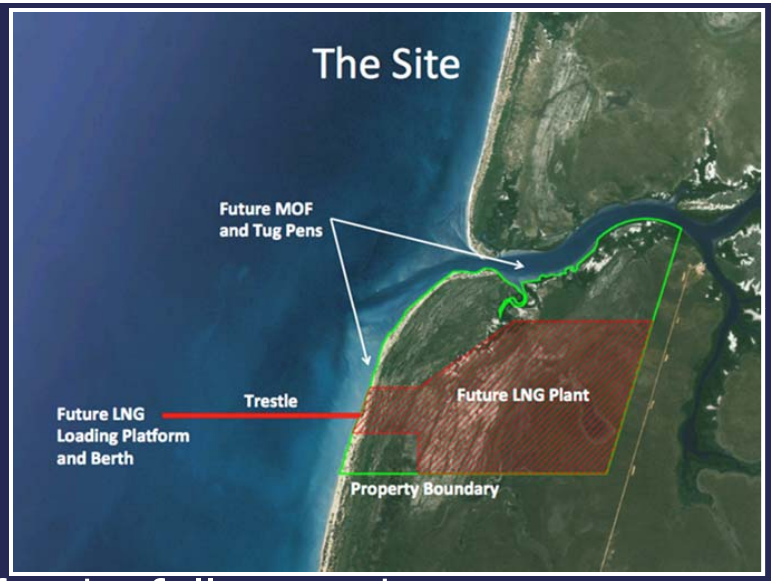
(Courtesy of Norsk Hydro)



Courtesy of GTO

# Materials Offload Facility (MOF) to Support Operation of LNG Plant

- Two options:
  - Open coast *(selected)
  - River Inlet



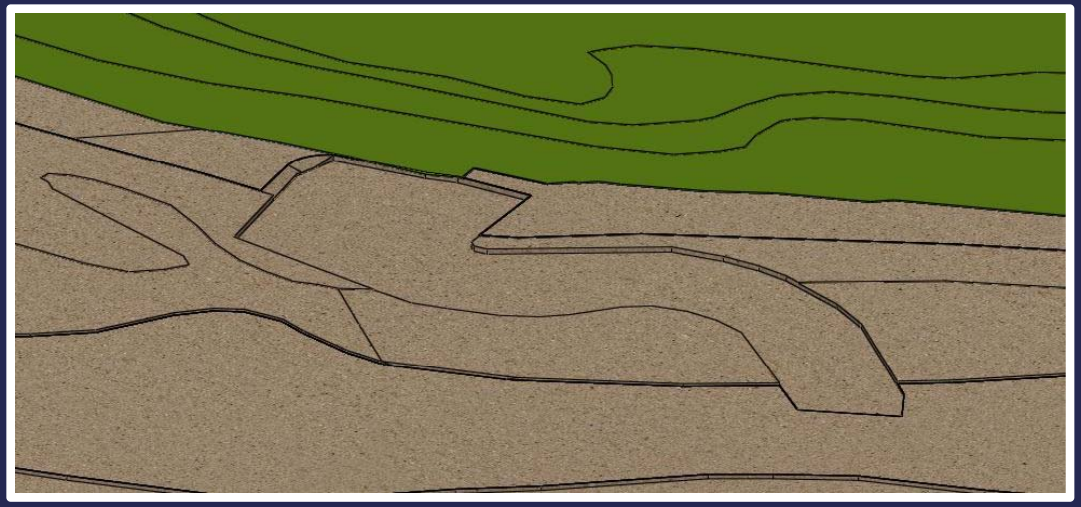

Courtesy of Chevron

- **Design Criteria**
- The MOF and tug pen are to be designed for the following design criteria:

1. Facility design life **50 year**
2. Shore protection works: **200 year**
3. Tug pen protection: **Hs < 1.0m at 200 year**
4. MOF quay serviceability: **1 year**
5. Geotechnical stability factor of safety: **FS > 1.5**

# Dredging

- The total dredging will result in 940,000 cubic meters of total material removed
- Assumed cutter dredging rate is 833 cubic meters per hour (20,000 per day)
- Assuming a continuous operation approximately 1 month will be required on site to complete dredging operations
- Real competition time based on a 5 day dredging work, 2 day maintenance schedule it will take 1.5 months to complete the entire dredging process

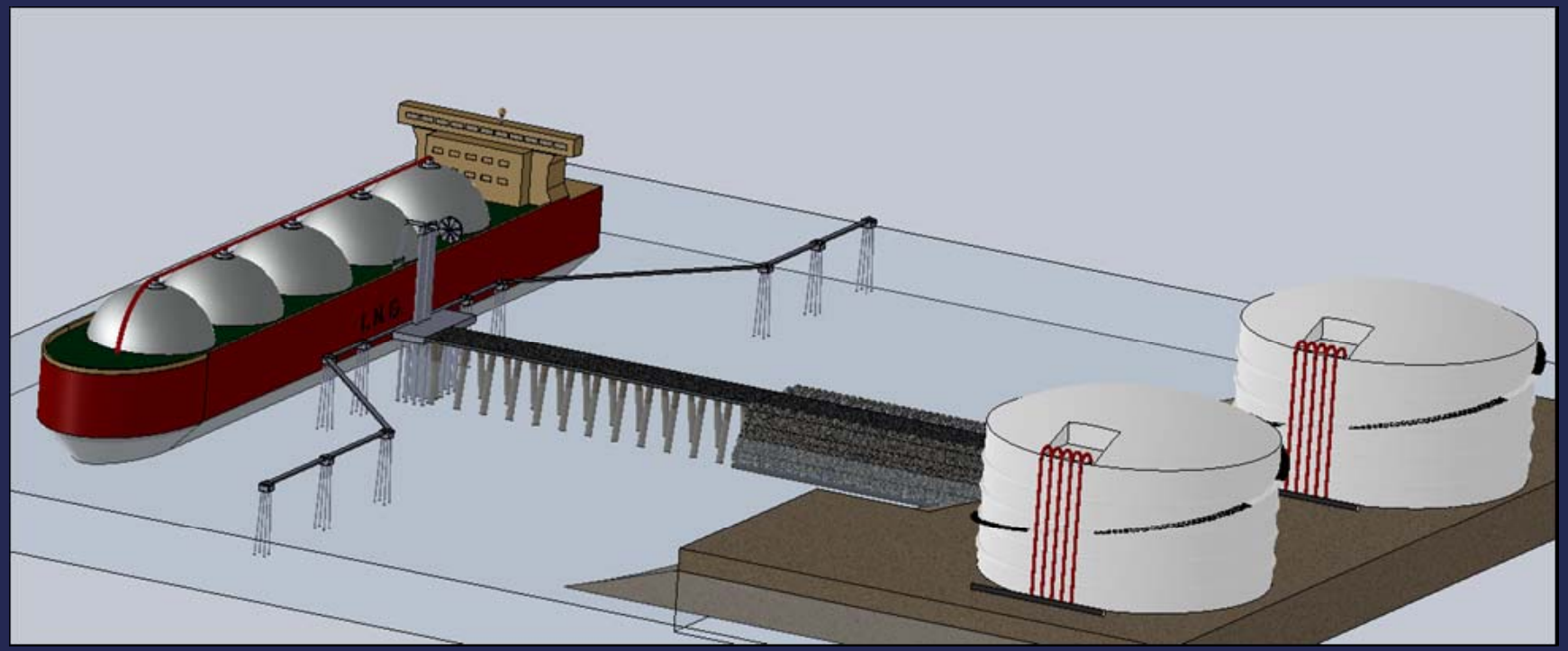



| Dredging Removal Rate Break Down | | |
|---|---|---|
| **Total soil removed** | 940,000 | **m3** |
| **Dredging rate** | 20000 | m3/ day |
| **Total Hours required** | 1128 | hours |
| **Total days Required** | 47.0 | days |
| **Total Months Required** | 1.7 | months |
| *** Above rates assume CONTINUOUS operation | | |
| **Total Weeks Required** | 9.4 | **weeks** |
| **Total Months Required** | 2.4 | **months** |



3 & TAMU 44

# LNG Terminal



# Dredged Material Placement Area

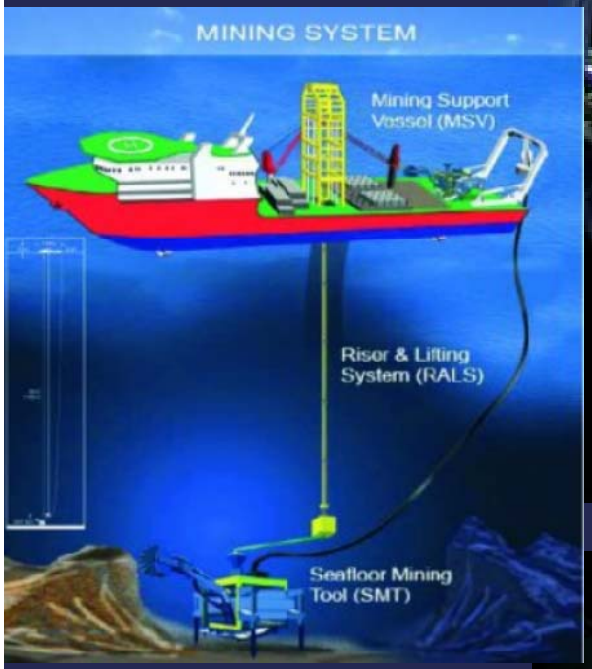
- Located NW of the Berth
  - South of recommended shipping track
- 2.25 Square Nautical Mile area
- Maximum Pumping Distance = 8.4 Nautical Mile
- Minimum Pumping Distance = 6.9 Nautical Miles
- 2.6 meter elevation if evenly distributed

# Dredging

http://www.jandenul.com/

- Cutter Suction Dredge
  - 20 Million Cubic Meters
    - 48% Calcareous Rock
    - 52% Compacted Sands
  - Typically used for newly excavated channels
  - 36 inch design dredge type
    - 13 month dredge time
  - Spud Carriage
  - Pumps sediment to disposal area via pipeline
  - 95% Floating Pipeline, 5% Submerged Pipeline
  - 1 Booster Pump required

# Deep Ocean Mining




# Technology Gaps and Limitations

- Trailing suction hopper dredges operated by Jan de Nul, Boskalis, Van Oord, and others can excavate in the 50 m (164 ft) water depth and have hopper capacities of 11,000 $m^3$ (14,378 $yd^3$) and greater.
- US trailing suction hopper dredges have to increase the dragarm length to reach the caisson hole depth, and the technology is available. Approximate cost $500K.
- A self-propelled cutter suction dredge is possible, but no current self-propelled cutter suction dredge can excavate below 35 m (115 ft) water depth. The technology exists to increase the length of the ladder, length of spuds, length of dredge hull, and the support structure for the ladder extension at a cost of approximately $500K.
- ROV dredges would require increased size/power and a long pipeline with booster pumps located along the pipeline to the placement areas. ROVs could be helpful in removing boulders or other debris.

# SUMMARY

- Caisson holes for subsea installations
  - Some hopper dredges can reach depths > 100 ft (30 m), but most have to make modifications
- Pipeline trenches
  - Trenches for pipelines needed for protection from ice scour in Arctic.
  - Short dredging season in Arctic
  - Boulders are issue in Arctic
  - Depth of trenches is ~4 m (13 ft) and ROVs are typically capable of 2 m (6 ft)
  - Cutter suction dredges typically need to be modified to excavate deeper than 30 m (100 ft)
- LNG ports & ship channels
  - Dredging ports and entrance channels for remote locations to accommodate LNG facilities
- Deep ocean mining
  - Pumping and separation facilities are being developed to mine minerals from deep ocean water

# THANK YOU & QUESTIONS