

Shell Exploration & Production

Preparatory Work for Oil/Gas Development Scenarios

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MMS Arctic Technologies Workshop

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Shared Concerns

Drive data acquisition, technology development and design

Reduce Environmental Risk Through Technology

- Spill prevention
 - Structure Containment & Stability
 - Pipeline Integrity
 - Development Wells
- Minimize and mitigate impacts to subsistence hunting lifestyle, and culture
 - Sound
 - Discharge
 - Societal Issues (drugs, alcohol, etc.)

Maximize Benefits

- Employment Opportunities
- OCS Value Proposition (taxes, royalty sharing, TAPS life)



Typical Offshore Development Timeline

Stop / go

3 to 7 years

3 to 5 years

2 to 4 years

4 to 8 years

Acquire

Exploration

Appraisal / Feasibility / Options

System Selection &

Detailed Engineering

Leases

Seismic

Drill

Seismic

Drill

Studies

Preliminary Design

Construction & Installation

Chukchi



Sivulliq



pre-NEPA Regulatory & Stakeholder Discussions

NEPA / EIS Process & Permitting

Shallow Hazards & Site Clearance

Onshore / Offshore data gathering :
Soil samples, marine surveys,
environmental baselines surveys

First Production

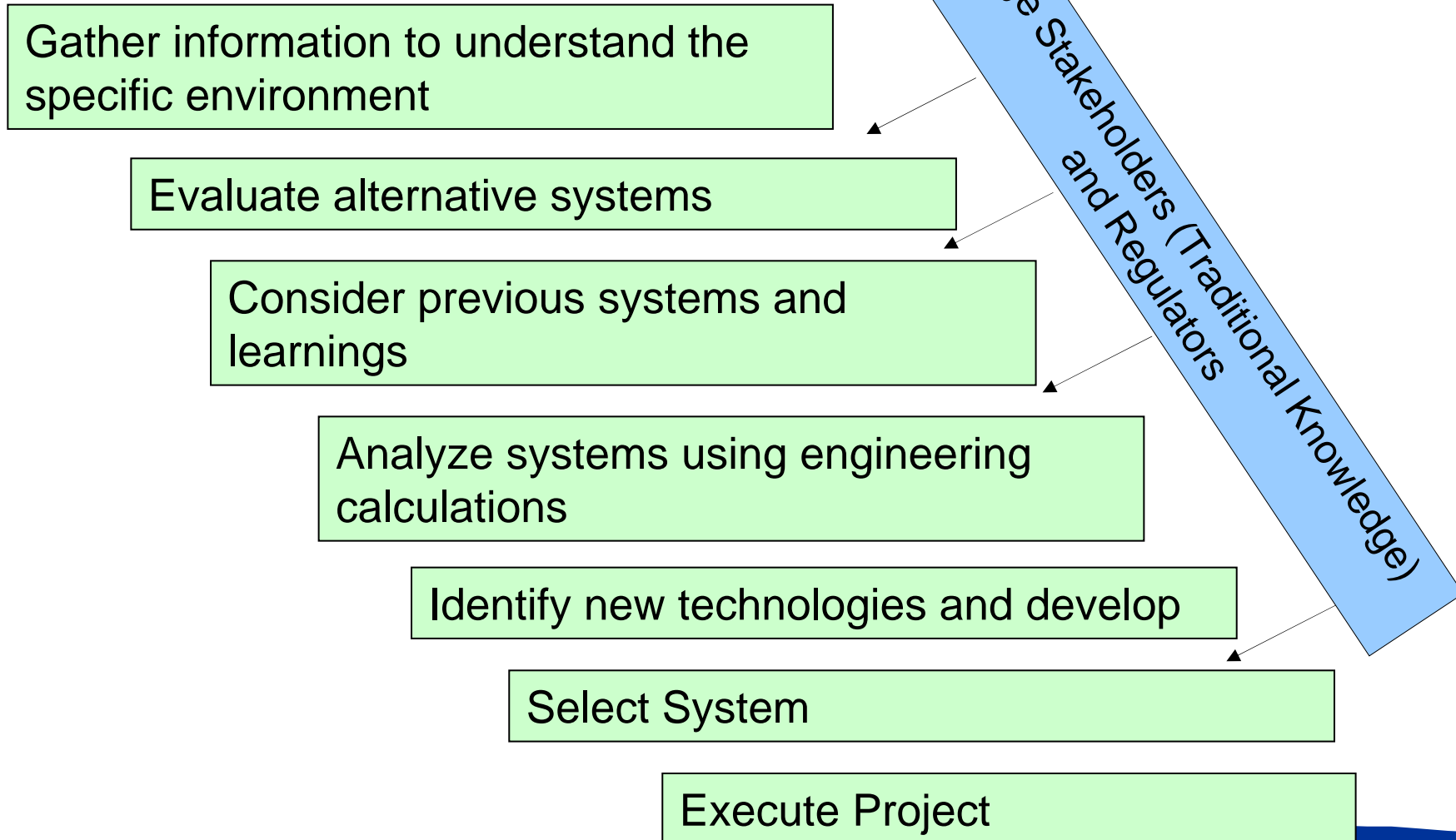


Research and Development

Stakeholder and Regulatory Engagement



Selecting Appropriate Systems



Systems Designed by Shell to Meet Specific Environmental Conditions



Cook Inlet

Strong Tides & Mild Ice



Beaufort Sea Exploration



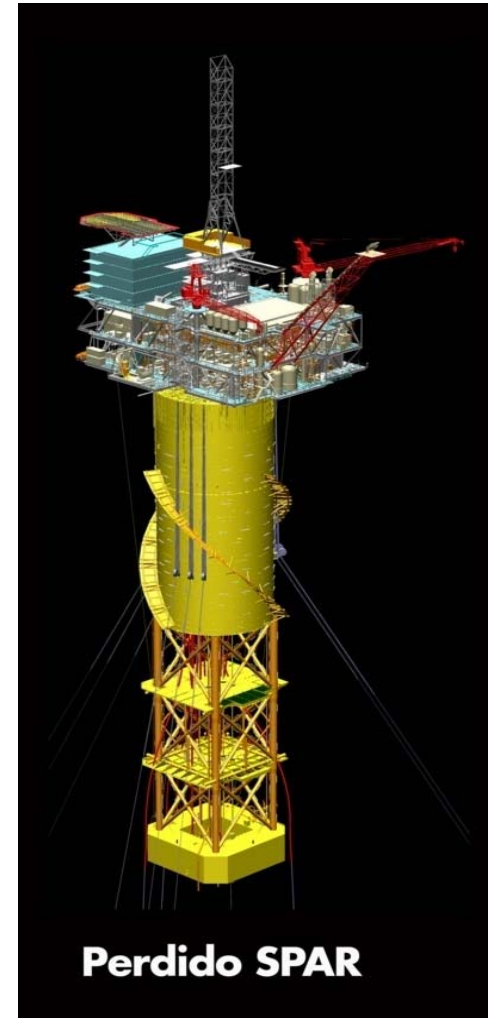
Sakhalin Russia

Moderate Ice & Seismic



North Sea

100' Waves



Gulf of Mexico

8000' depth & Hurricanes



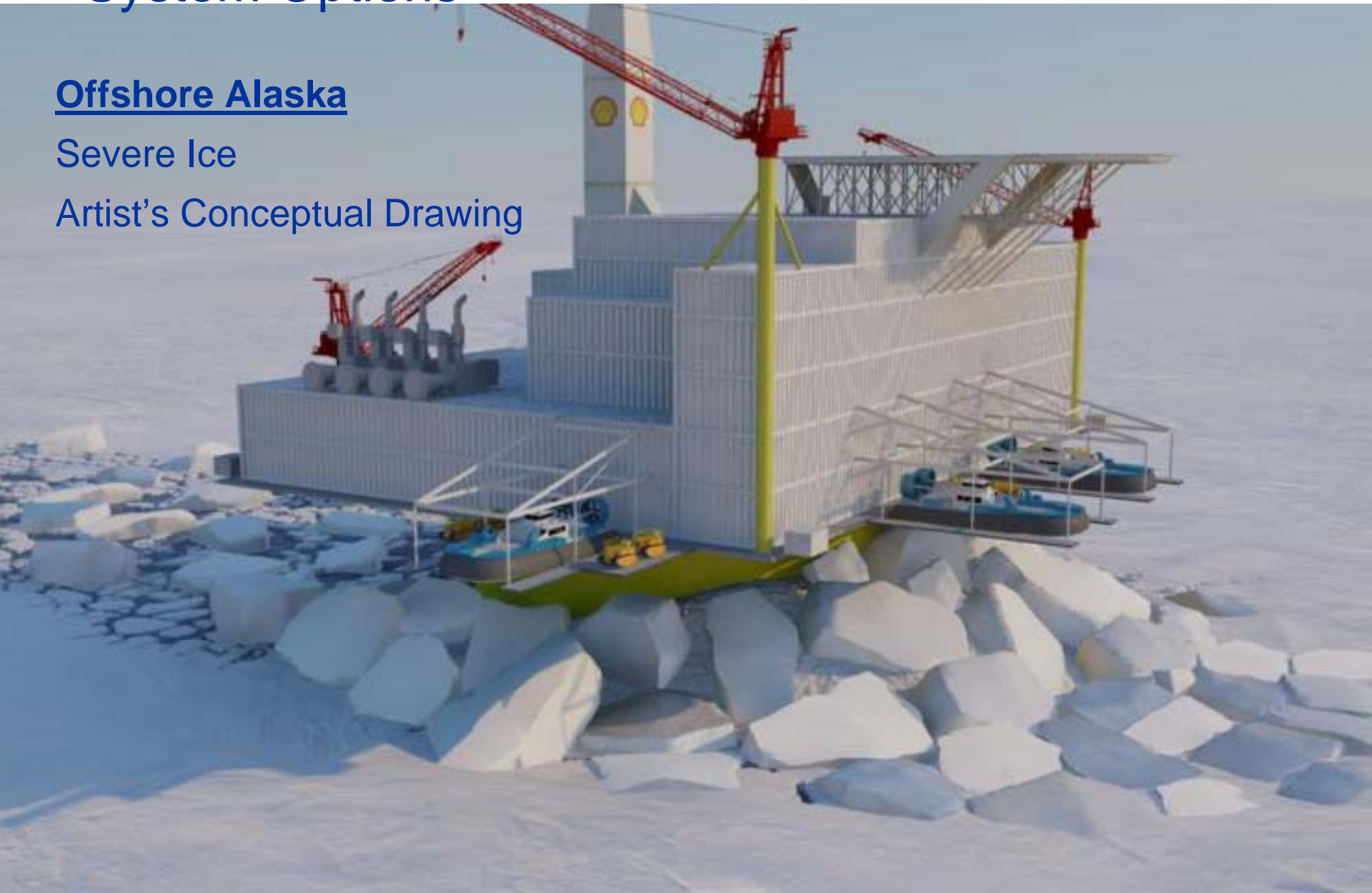
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System Options

Offshore Alaska

Severe Ice

Artist's Conceptual Drawing



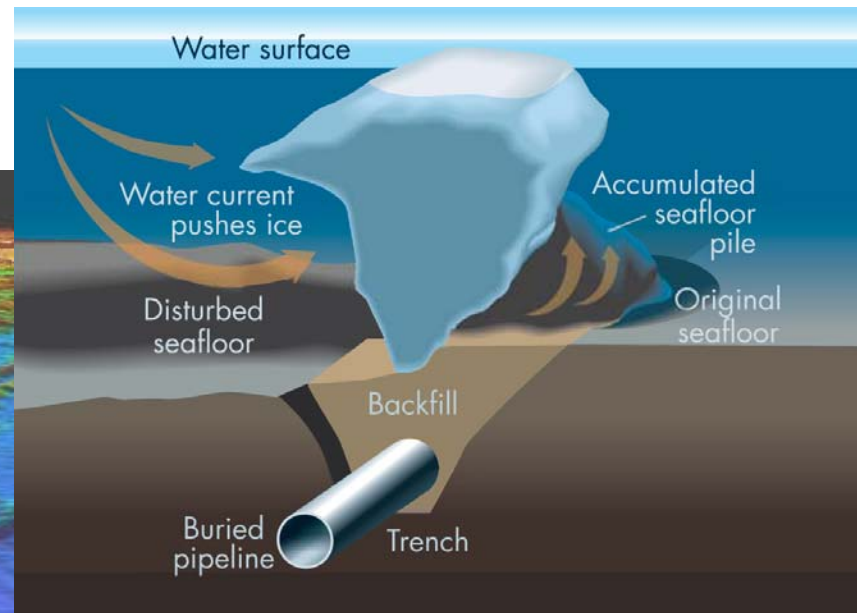
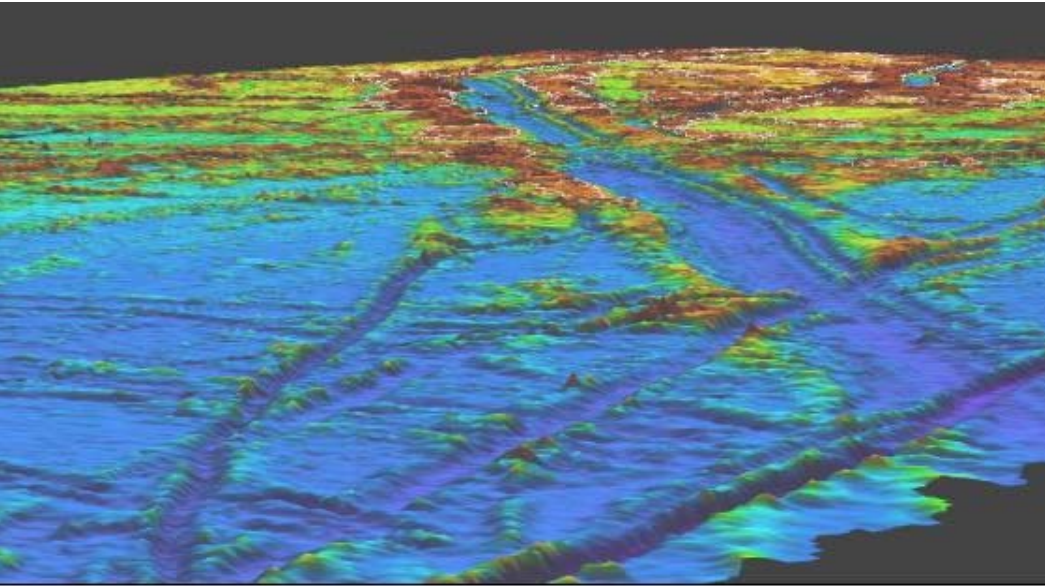
Environmental Data Collection

To reduce the risk of spills

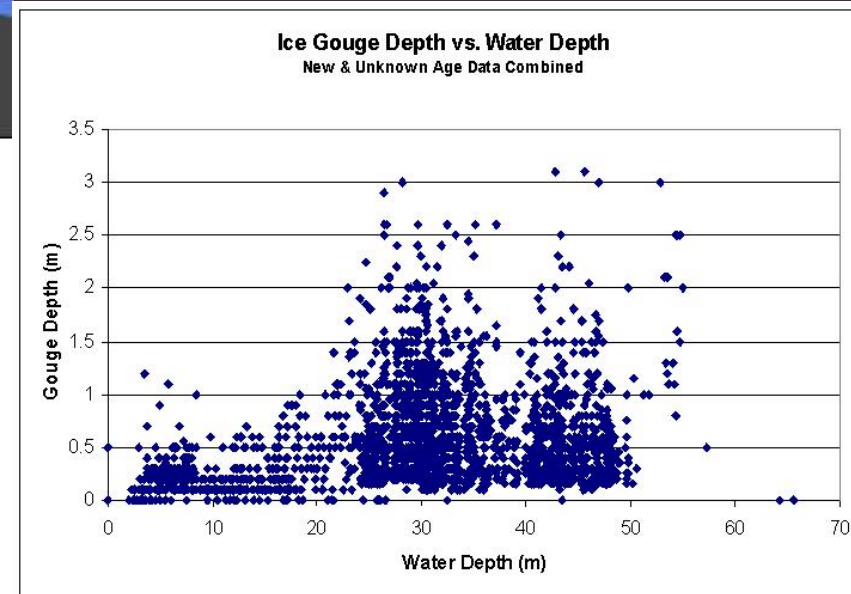
- Ice Gouge
 - Strudel Scour
 - Coastal Stability
 - Geotechnical (Soil Samples)
 - Ice Movement
 - Understanding the Ice Surface
 - Biological / Ecological
-
- Consider the changing environment
 - Some data collection requires regulatory permits to ensure minimal impact



Ice Gouge

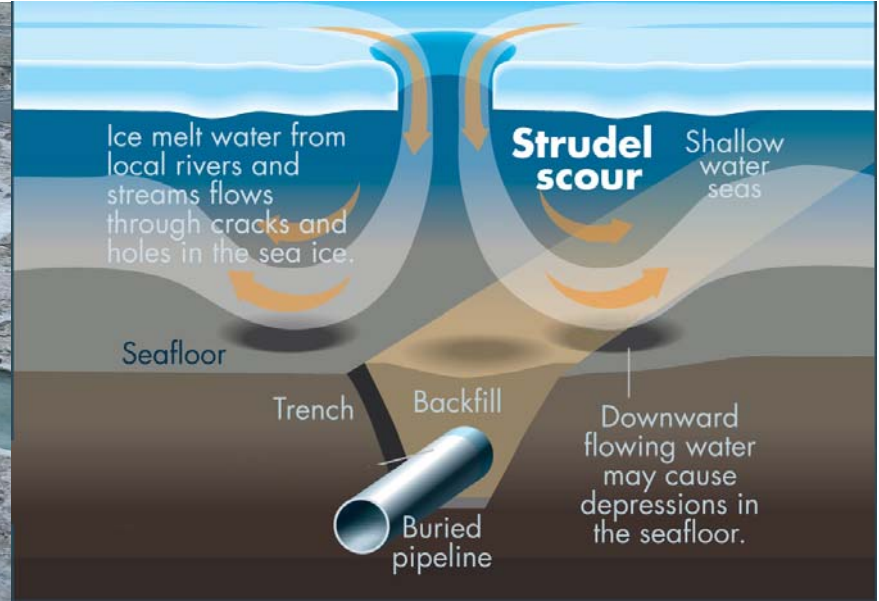


- Measure gouge depths on seafloor
- Gouges may be thousands of years old
- Track and name gouges to identify new ones
- **Gather repetitive data to estimate likelihood of modern gouges and identify safe pipeline burial depths**



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Strudel Scour



- Nearshore, where spring melt flows over frozen river and into ice holes/cracks
- **Understand locations and depths of scours to safely bury pipelines**
- Spring helicopter flight to locate drains
- Openwater survey of bottom to measure scours
- Must be done quickly



Coastal Stability



- Coastline survey identifies changes over time.
- **Required to locate safe location for transition of buried offshore pipeline to onshore line on vertical support members.**



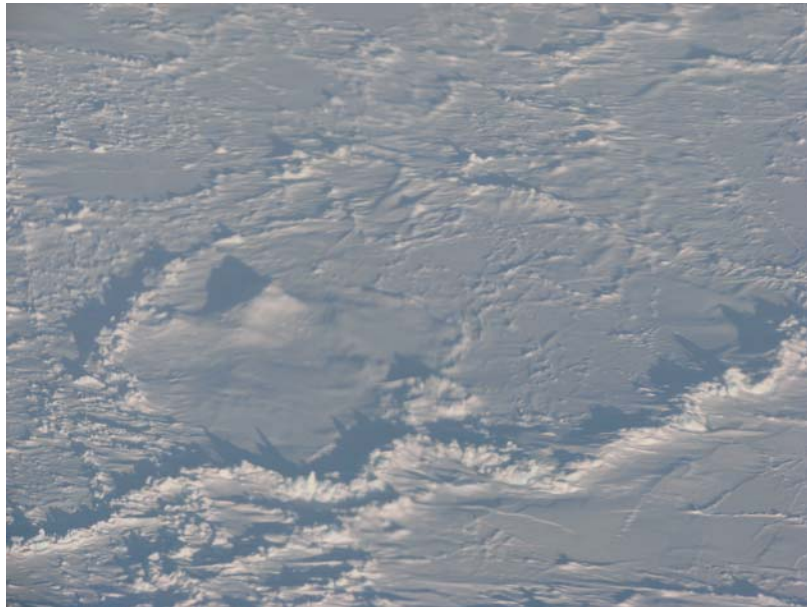
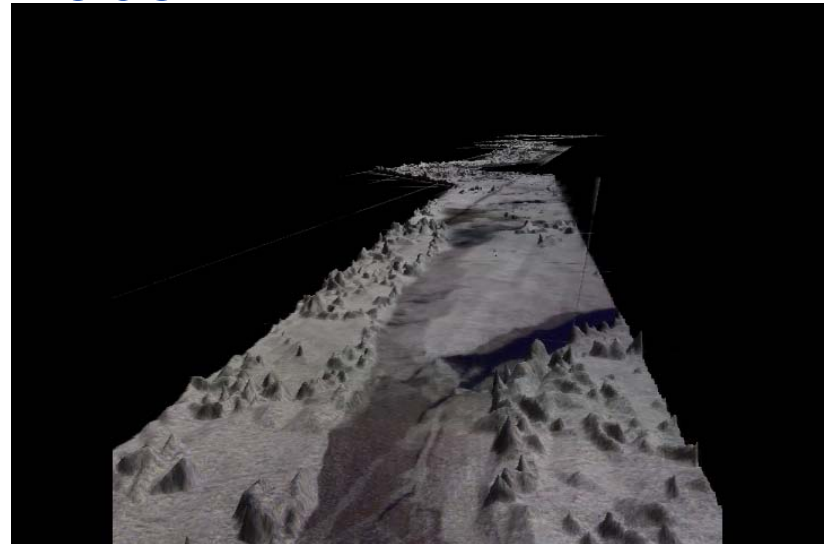
Geotechnical Survey



- Geotechnical data gathering shows the types and strengths of soils.
- **Required for safe designs**
 - platform connections to the seafloor
 - trenching equipment to bury pipelines
 - soil resistance to ice keels



Understanding the Ice Surface



- Aerial stereo photos are taken to create a 3D view of the ice surface
- Inspection and measurement build understanding
- **Evacuation and resupply methods must consider ridge sizes and ability to navigate around them**
- **The platform must resist the ridges**



Ecological / Biological

Ecological Characterization – (baseline)

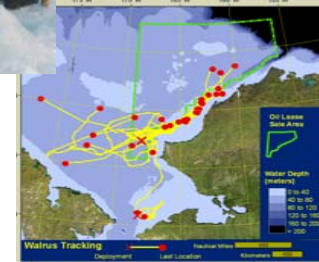
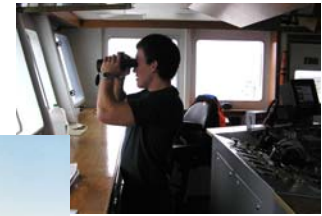
Developing an understanding of the ecological setting, inventorying biotic / abiotic resources and conditions, & understanding forcing factors

- Benthic biota
- Plankton
- Marine Mammals
- Birds
- Fisheries
- Sediment & water chemistry
- Ice conditions
- Acoustics

Key Resource Studies

Investigating key ecological resources, their status and response to potential activities and effectiveness of minimization/mitigation measures

- Bowhead Whale
- Walrus
- Eiders
- Beluga whale
- Ice Seals
- Polar Bear
- Coastal zones and processes
- Wetlands



Conclusion

- Selecting a system to minimize environmental risk takes time.
- Different environments lead to the selection of different systems.
- Early scientific data collection is required for selection of safe designs.
- Safe designs can help address the concerns shared by operators and stakeholders.

Please see us if you wish to discuss further.

