

# **NORI-D Collector Test Update**

Dr. Michael Clarke, Environmental Program Manager

Presented at the side event at the ISA Council 27<sup>th</sup> session Part III  
on 2<sup>nd</sup> November 2022 in Kingston, Jamaica



# Distance to NORI Contract Areas from Nauru




## Nauru

Distance to CCZ: 6,437 km  
Distance to NORI-D Contract Area: 8,505 km

## Clarion Clipperton Zone (CCZ)



## Exploration Areas (1.28 million km<sup>2</sup>)

 Exploration contract areas granted by the International Seabed Authority

## Protected Areas (1.97 million km<sup>2</sup>)

 Areas of Particular Environmental Interest (APEIs)

## Exploration Areas

 NORI (Sponsored by Nauru)

 NORI D

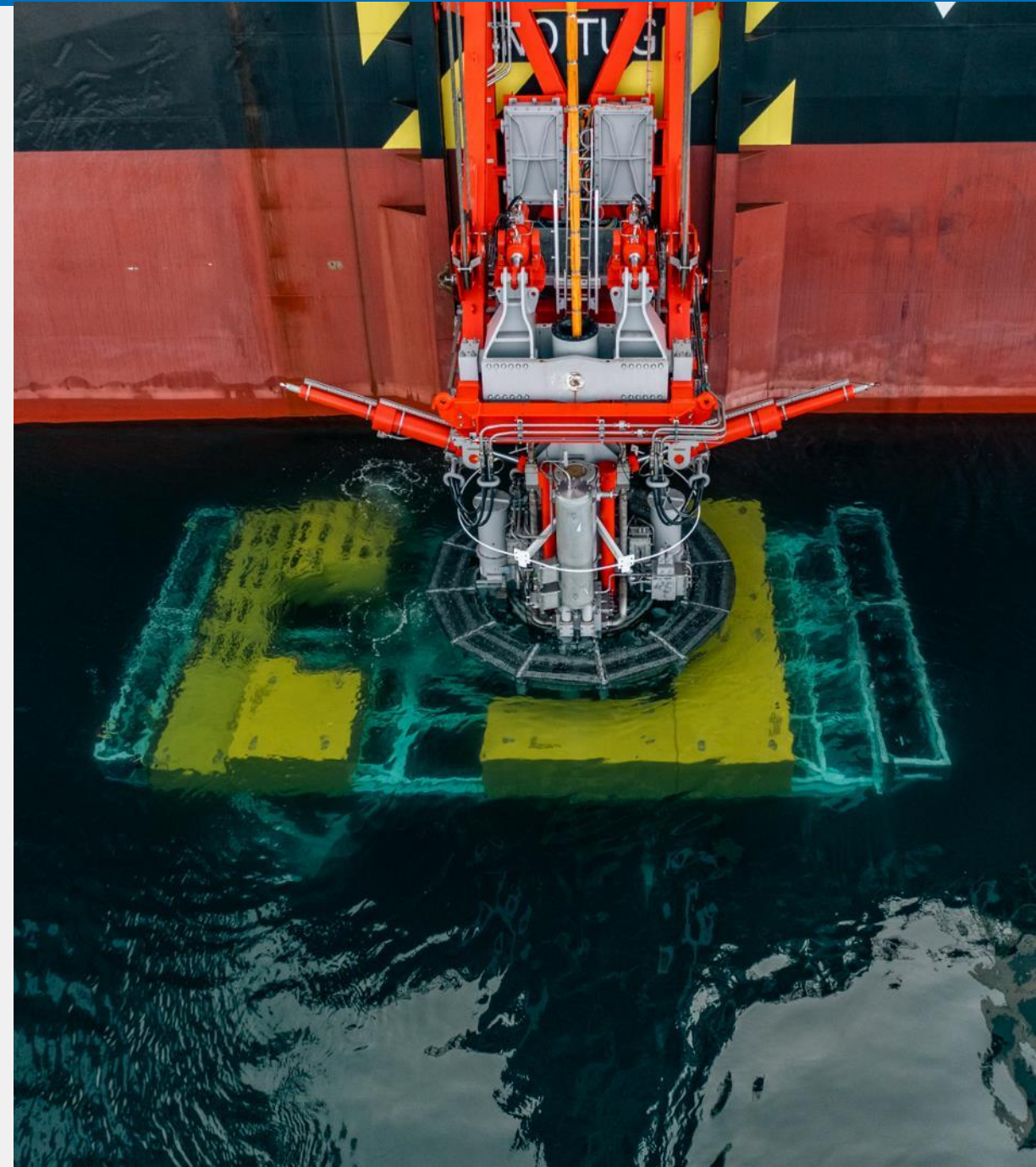


## Key test mining project objectives.

Main objectives of full system test mining project:

- 1** Demonstrate technical feasibility of polymetallic nodule collector system
- 2** Assess technical performance of prototype collection system, incorporate learnings into full-scale commercial system
- 3** Assist in predicting potential environmental impacts of full-scale operations

- Contract let by NORI to Allseas Group S.A. in 2019
- Multiple technology concepts evaluated
- For significant and representative results, a prototype with scale of approx. 1/5th of full production equipment was selected by Allseas



## Offshore collector system: General arrangement.

Platform for equipment handling  
and nodule processing  
(surface vessel)

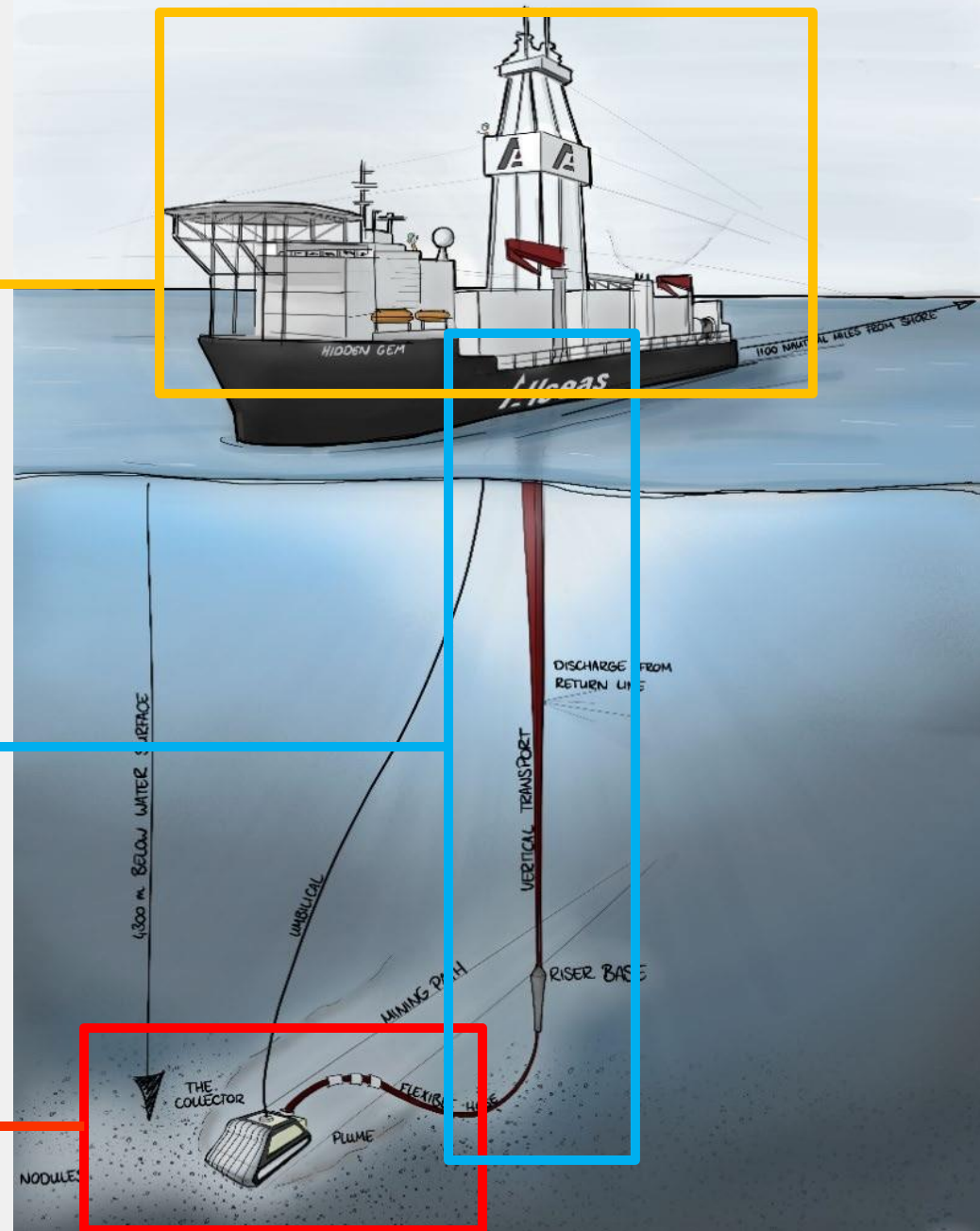
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Vertical transport system  
(riser pipe)

2

Seabed collector vehicle

1



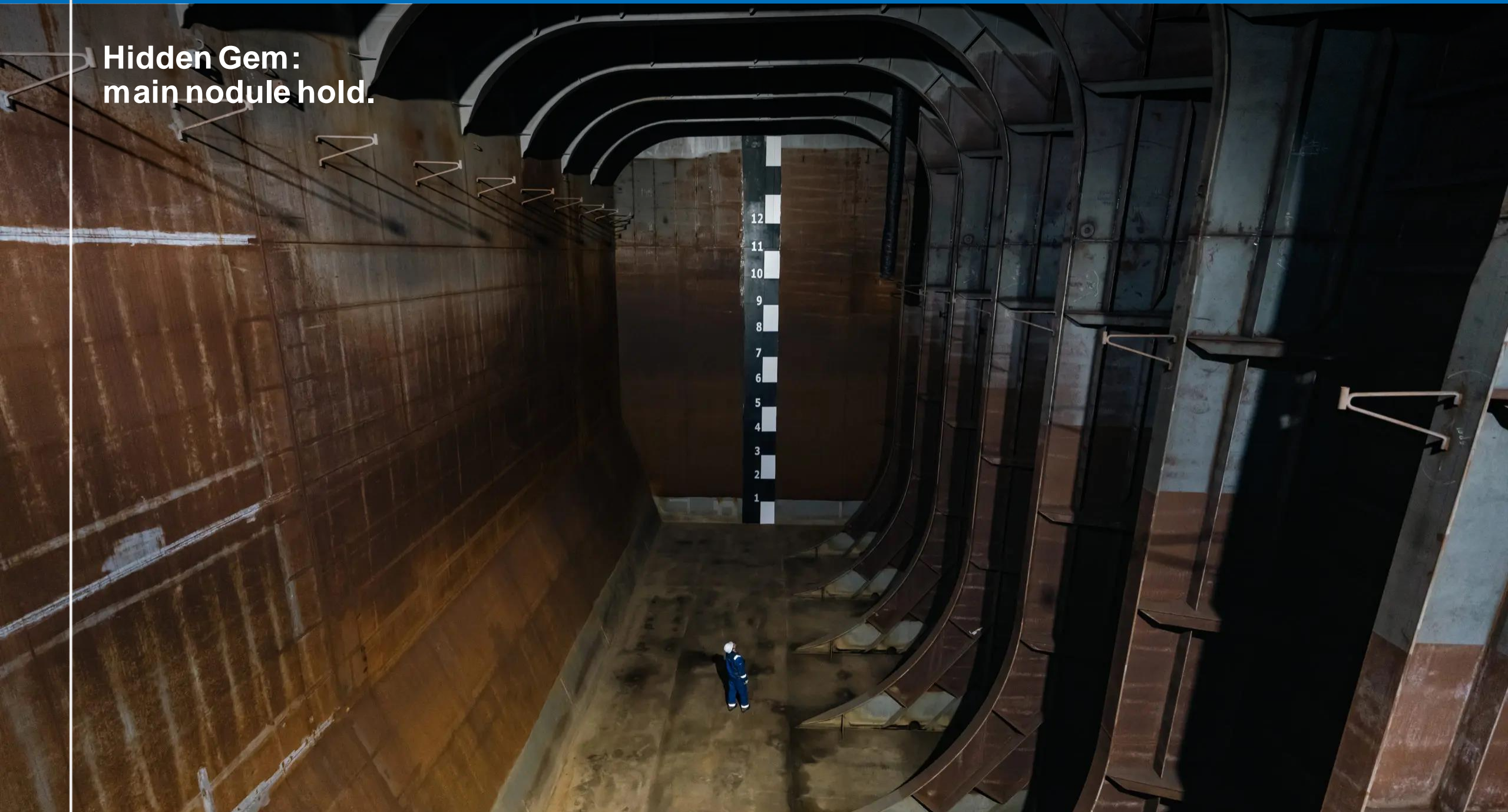


# Surface support vessel: Hidden Gem.





**Hidden Gem:  
main nodule hold.**





# Hidden Gem: Launch & Recovery System (LARS).





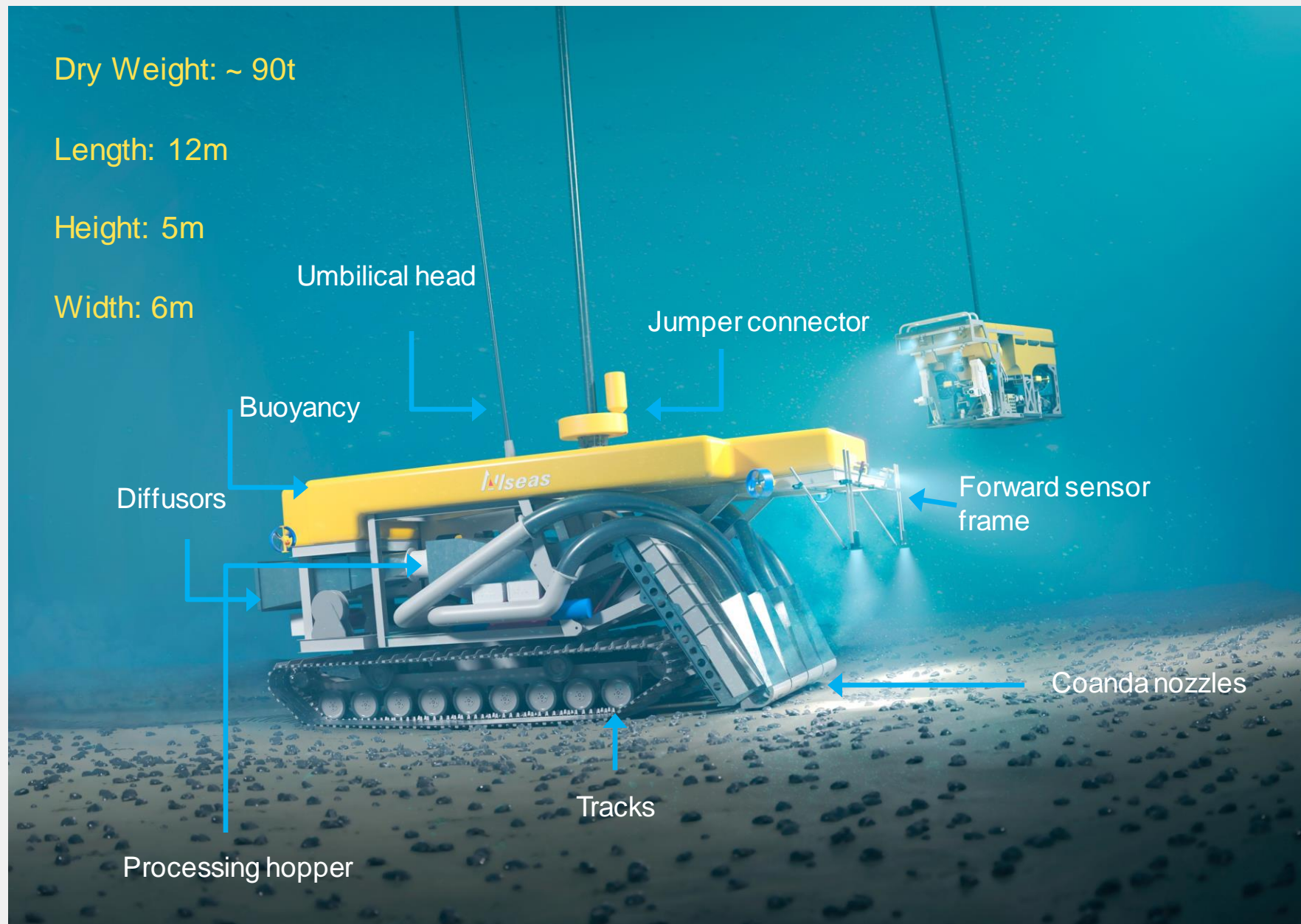
## Collector design.

Dry Weight: ~ 90t

Length: 12m

Height: 5m

Width: 6m





## Prototype Collector Vehicle (PCV) on LARS.





# PCV umbilical.



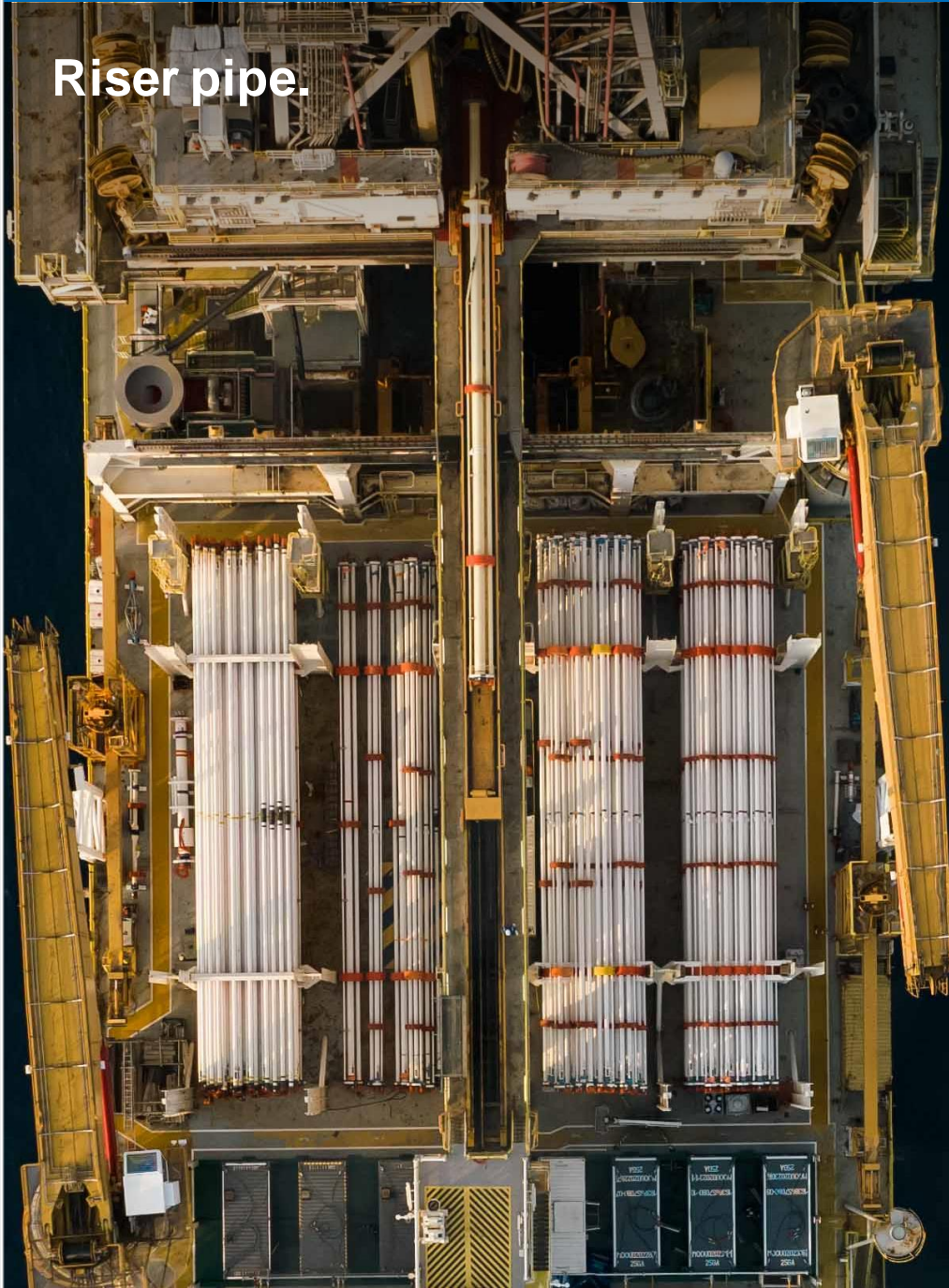


## Riser pipe.





## Riser pipe.

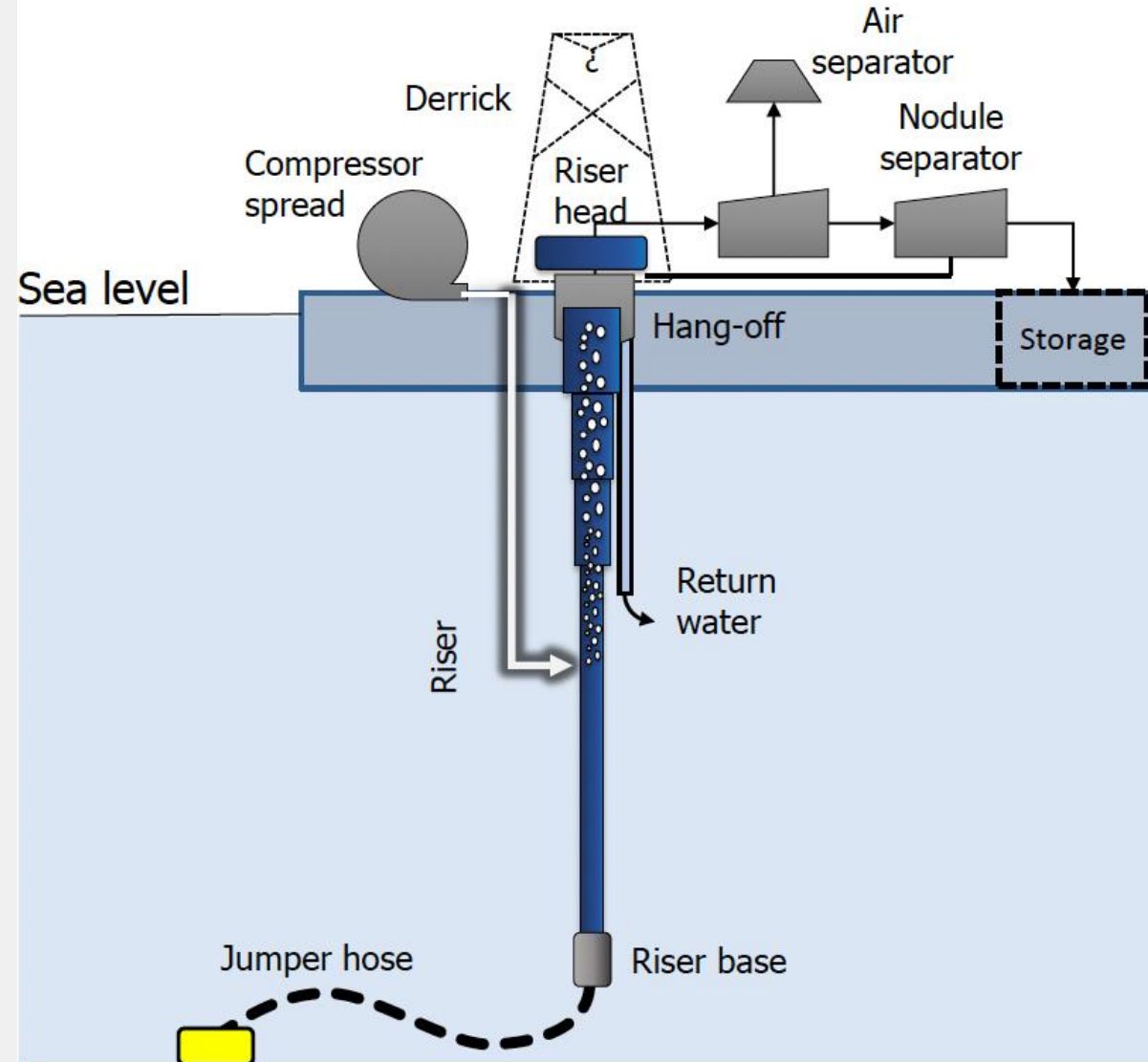




## Offshore pilot system general arrangement.

The prototype collector system will be put through the following trials:

- Deployment of riser pipe from the surface vessel to the seabed
- Coupling of the riser pipe and umbilical with the seabed collector vehicle
- Propulsion and manoeuvring of the vehicle on the seabed.
- Collection of nodules
- Transfer of nodules up the riser pipe to the surface vessel
- Separation and retention of nodules from entrained water and sediment on the surface vessel
- Release of entrained seawater and sediment through a return pipe at a depth of approximately 1,200m
- Recovery of riser pipe and vehicle to the surface vessel.







NO SMOKING

Hidde

NO 845320



## Baseline studies & impact assessment.

**18** offshore campaigns

**710** days at sea

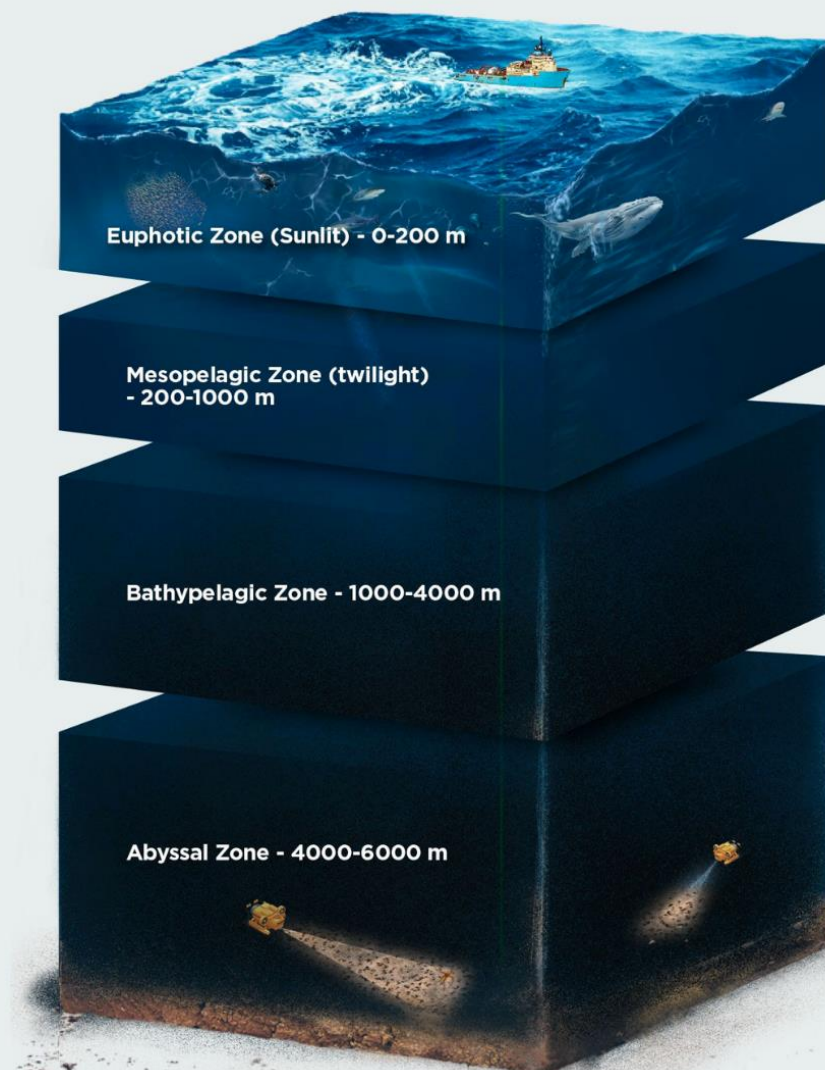
**100+** studies

### Benthic biology

- Megafauna Characterization (Photo transects)
- Megafauna Characterization (Time Lapse)
- Macro Fauna Characterization
- Micro Fauna Characterization
- Meso Fauna Characterization
- Macro Fauna Characterization

### Sediment analysis

- Baited camera and traps
- Benthic respiration and nutrient cycling
- Seafloor metabolic activities
- Bioturbation, sediment characteristics
- Porewater sampling
- Exposure toxicology studies
- Metals determination by ICP analysis
- Induction of gene transcripts (metals)



### Surface biology

- Surface fauna (Pelagos)
- Remote Sensing, Hydrophone Acoustics

### Pelagic biology

- Microbial Community Characterization
- Phytoplankton Community Characterization
- Zooplankton Community Characterization
- Gelatinous Zooplankton Characterization
- Micronekton Characterization
- Trophic Analysis (Stable Isotopes)
- Temporal Variability of Pelagic Communities
- Trace Element Profiles In Water Column
- Particulate Profiles in Water Column
- Discharge Plume Characterization
- Midwater Discharge (food webs particle composition)

### Collector impact studies

- Met ocean studies
- Bathymetry (seabed mapping)
- Habitat mapping
- Database development
- Digital twin development
- Collector test studies
- Plume modeling
- Existing Resource Utilization Study
- Noise & Light Study
- Meteorology & Air Quality Study
- Hazard & Risk Assessment
- Emergency Response Planning
- Cultural & Historical Resources
- Waste Management
- Cumulative Impacts

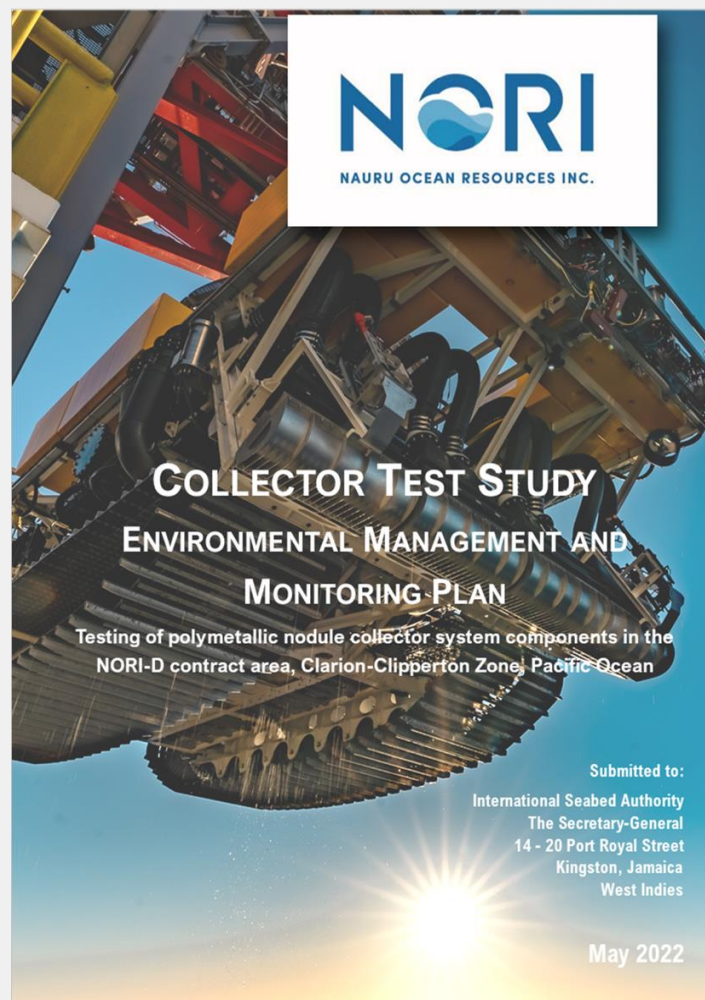
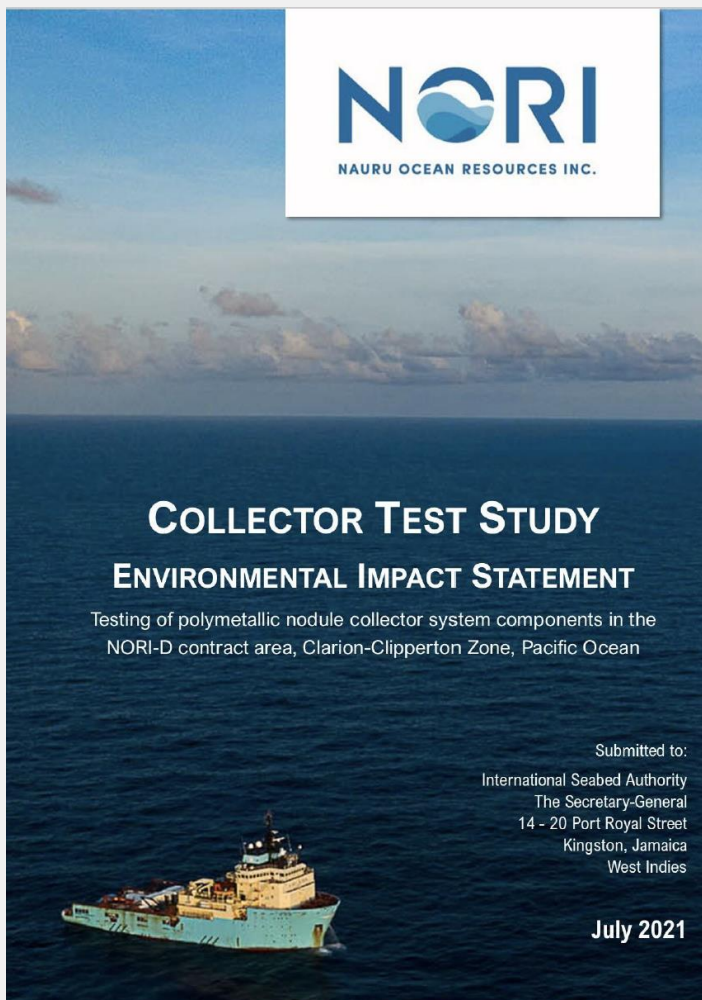


## Collaborating with leading research institutions for our NORI-D Collector Test.





## Environmental Impact Statement (EIS) was submitted to the ISA in July 2021 and approved in September 2022.



### NORI-D Collector Test EIS review process

- EIS submitted to the ISA in July 2021
- Two stakeholder information sessions conducted
- Responses were provided to over 600 stakeholder comments
- Revisions made to the EIS in response to stakeholder comments and initial ISA review
- EMMP submitted in May 2022
- Additional information supplied in response to LTC request in August 2022
- Recommended inclusion of the collector test in the work program provided in September 2022



# Collector Test Environmental Monitoring Studies.

## Impact Zone 1 - Surface

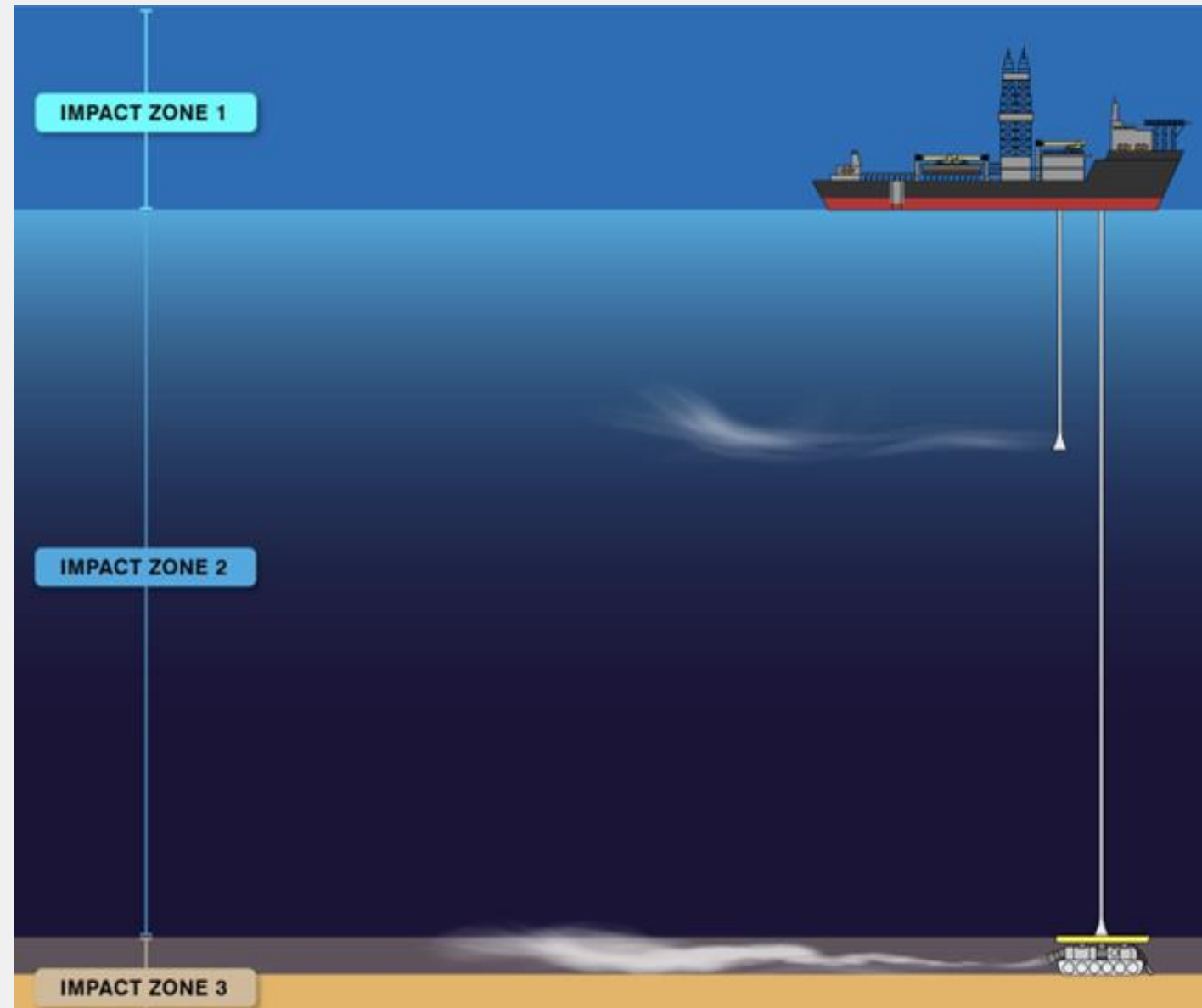
- Vessel emissions
  - Noise
- 

## Impact Zone 2 - Pelagic

- Mid-water plume dispersal and characterization
  - Trace metals / Ecotoxicology
  - Acoustic modeling
  - Phytoplankton community characterization
  - Food web linkages (stable isotope analysis)
- 

## Impact Zone 3 - Benthic

- Physical and chemical disturbance of sediment
- Seafloor mapping (pre and post-disturbance)
- Fauna (mega, macro, meio, forams, micro)
- Sediment ecotoxicology
- Ecosystem function (benthic landers)
- Acoustics / Light





Date: 30/05/2020

Time: 18:20:36 UTC

Dive No: 144

Easting : 482149.97m

Northing: 1147003.90m

HDG: 56.92

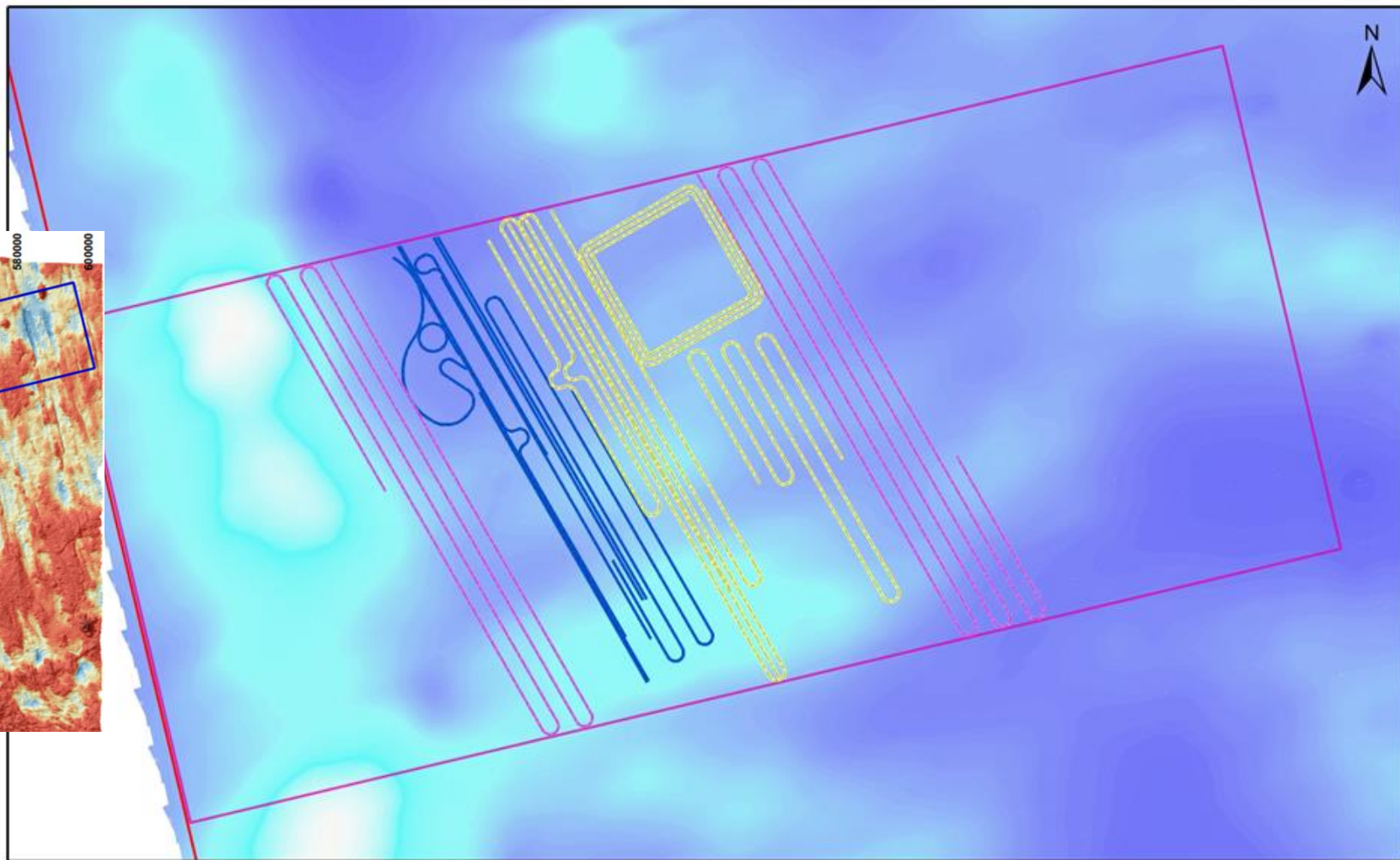
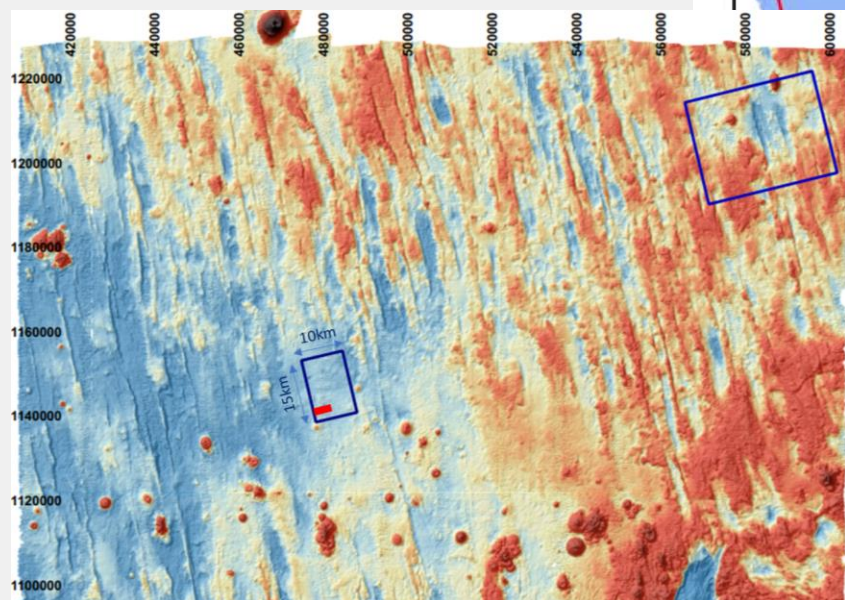
Depth: 4294.20m

Alt: 1.17m





## Benthic studies.



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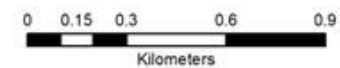
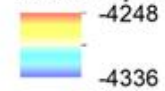
### Management Areas

- Test Field
- Collector Test Area

### Collector Component Testing

- Harvester Test Runs HTRs
- Production Runs PRs
- System Test Runs STRs

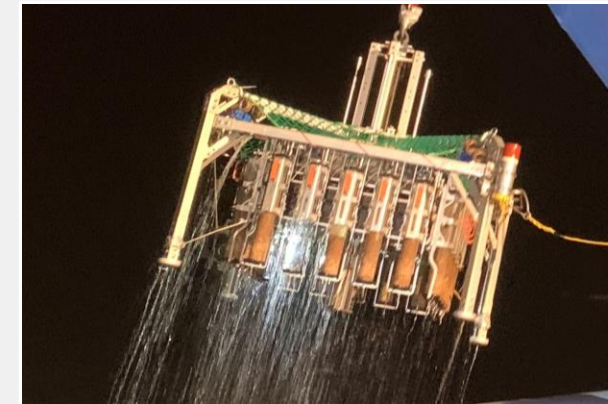
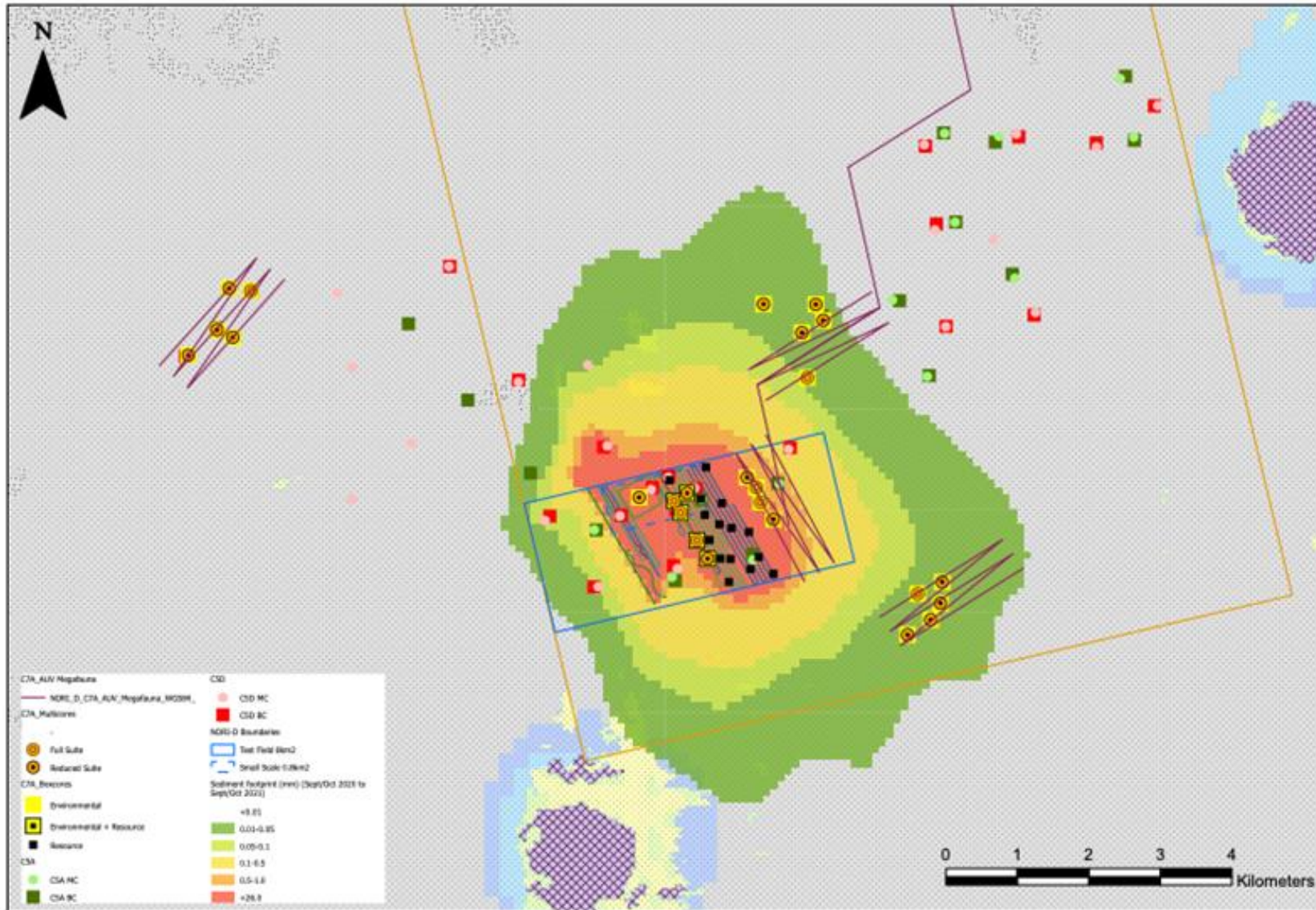
### Water Depth (m)



Baselayer Bathymetry EM2040D: 50cm grid resolution

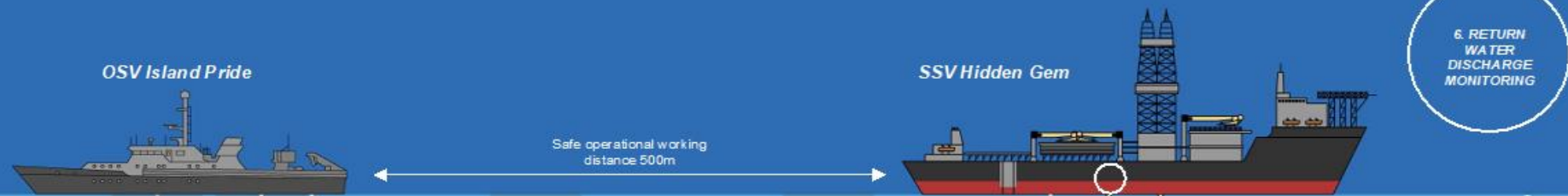


## Benthic studies.

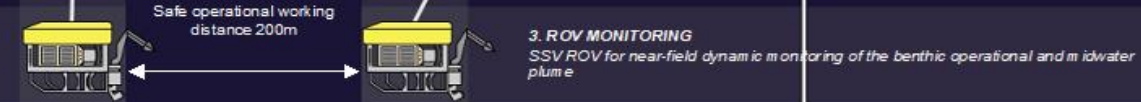




# Acoustic and plume monitoring.



6. RETURN WATER DISCHARGE MONITORING



Midwater passive plume

Benthic operational plume

surface

1,200m

4,300m



## Plume monitoring assets.

**50** monitoring stations distributed in and around the test field to monitor and map the far field plume *in situ*.

### BENTHIC PLUME ARRAY

- 7 x Fixed Landers with ADCPs, CTDs, OBS – optical backscatter
- 2 x Fixed bottom current and turbidity landers with acoustic modems that we interrogate in real time
- 3 x McLane sediment traps
- 20 x sediment plates measuring sedimentation
- 4 x Camera landers recording sedimentation
- 1 x acoustic mooring
- 1 X acoustic lander
- 1 x midwater mooring that we interrogate for midwater currents
- 7 x DGTs diffuse gel samplers
- 2 x AUVs mapping near and far field

### MID WATER PLUME ARRAY

- 3 x ROVs (1 x on Island Pride with 10 x Niskin array for water sampling + ADCP + CTD and
- 2 x ROVs on Hidden Gem
- 1 x Trace metals CTD rosette with 12 Go-Flos for water samples
- 1 x Hydrographic CTD rosette with 24 niskins for water samples
- 1 x McLane Pump rosette with 7 x pumps







## Full baseline data sets due December 2022.

### Meiofauna

Jeroen Ingles, Florida State University

All meiofauna and nematode data for 0-1, 1-3, 3-5 cm for 5A and 5D have been produced – there is still cleaning and QA/QC as well as assigning functional metrics, but this is a massive milestone given **>108,000 individuals** were identified across the two baseline campaigns. This will be the core data for meiofauna baseline analyses. **To my knowledge, this is the largest meiofauna study in any single license area...**

### Foraminifera

Bryan O'Malley, Eckerd College, University of Southern Florida

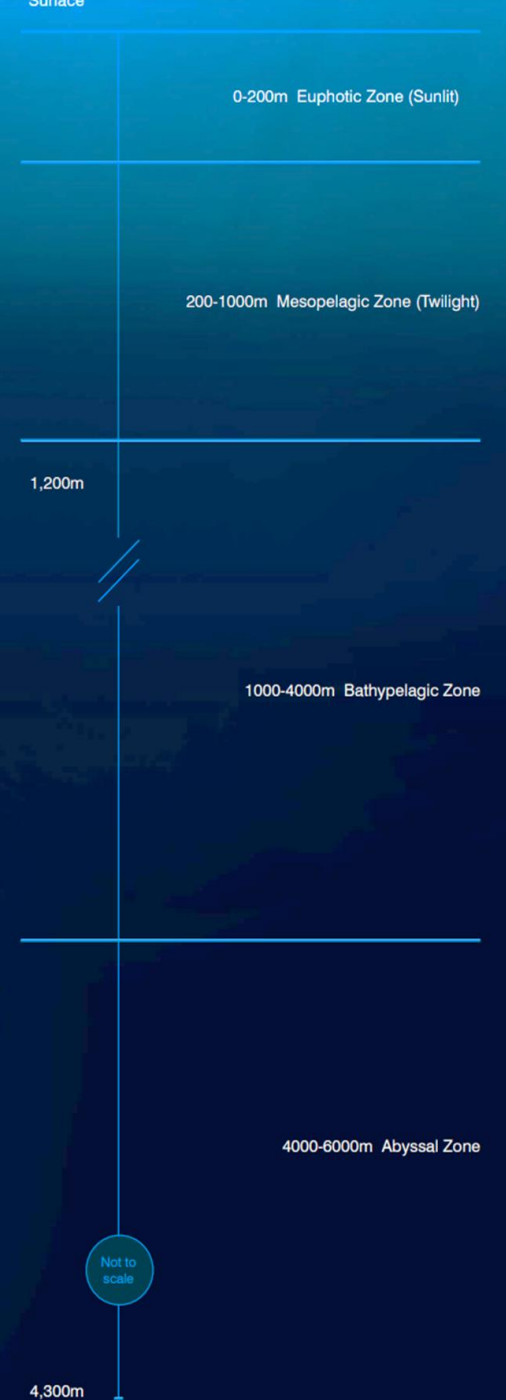
	NORI-D	
	NORI-D C5A	NORI-D C5D
# Sites	23	30
# Cores	23	30
# Foraminifera	25,965	>33,000
Reference	O'Malley et al., unpub	O'Malley et al., unpub
Sieve fraction	>63 um	>63 um



# Adaptive Management and Digital Twin.

Our eyes and ears on the deep-sea. The digital twin is a mix of sensors and cloud-based AI that optimize the environmental performance of operations by applying environmental constraints and limits to the mine planning process.

The iterative nature of an adaptive management approach also means that the predictive and protective capabilities of the AMS will gradually improve over time as more information enters the system.



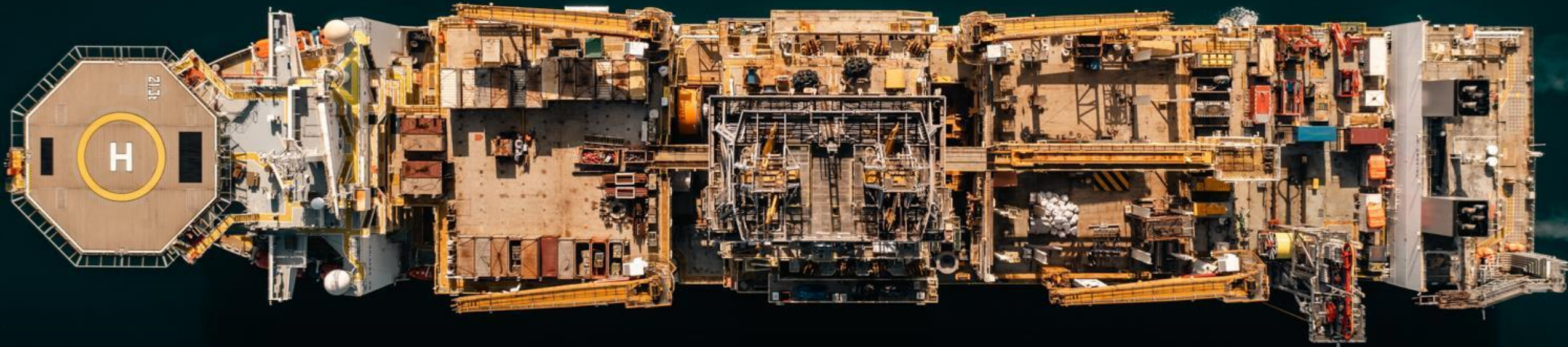






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## Ma Tubwa Kor!





