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ECOLOGICAL ASSESSMENT & REPORTING SERVICES

TECHNICAL MEMORANDUM

TO	Rebecca Clarkson, Aquaculture Direct	PROJECT	REL174582 – Coastal (Benthic) Habitat Characterisation – Pig Bay Marine Farm
FROM	Dr Ben Robertson Robertson Environmental Ltd (REL)	DATE	30 June 2026
CC	Mike Mandeno, Marine Farming Association		
SUBJECT	Coastal (Benthic) Habitat Characterisation - Pig Bay Proposed Marine Farm, Te Anamāhanga / Port Gore, Marlborough Sounds		

Coastal (Benthic) Habitat Characterisation — Pig Bay Proposed Marine Farm, Te Anamāhanga / Port Gore, Marlborough Sounds

1 Purpose and Scope

This memorandum[1] outlines the findings of a benthic habitat assessment commissioned by Aquaculture Direct on behalf of the Marine Farming Association to characterise the seabed within the proposed marine farm in Pig Bay, Te Anamāhanga / Port Gore ('**the Site**') at the northern end of the Marlborough Sounds. The objective of this assessment is to characterise the seabed habitat present within the proposed consent area (90.2 ha). The assessment updates and extends previous benthic assessments undertaken for salmon farming proposals at the Pig Bay Site[2], which characterised the benthic receiving environment as mud-dominated soft sediment with low structural complexity and infaunal assemblages typical of sheltered mud habitats in the Marlborough Sounds. This memorandum reports the

[1] This report is subject to the Report Limitations provided in **Attachment A**.

[2] Cawthron 2011. Assessment of effects of farming salmon at Papatua Bay, Port Gore: deposition and benthic effects. Cawthron Report No. 1990. Prepared for The New Zealand King Salmon Company Limited. 58 p.

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benthic habitat characterisation only; further description of ecological value and the effects of the proposed activity are assessed in the Project Ecological Impact Assessment (EcIA) Report. **Figure B-1**[3] shows the location of the proposed consent area within the Site in its coastal context.

2 Methods

The seabed was surveyed on 28 and 29 May 2026[4], undertaken consistent with the *Recommended Protocols for Conducting Benthic Ecological Surveys for Shellfish Farming in Marlborough, New Zealand* (Davidson et al. 2024), using advanced multibeam echosounder (MBES) sonar with ground-truthing by AUV-based Remote Visual Assessment techniques.

Full method detail, including the bathymetry and backscatter mosaics, are provided in **Attachment C**.

2.1 Seabed Habitat Characterisation

The seabed habitat characterisation approach involved the following:

- **Multibeam survey** – Full-coverage MBES bathymetry and backscatter were acquired with a survey-grade WASSP S3 PR multibeam echo-sounder (approximately 300 kHz), with dual GNSS inertial navigation system (INS) positioning and real-time kinematic (RTK) corrections (**Figures B-2a, C-3 and C-3**). Real-time navigation, data-logging, quality control, including patch testing, and display were provided by BeamworX software. Sound velocity profiles were collected to correct the acoustic data for water-column sound speed variations. Multibeam data were processed in BeamworX and gridded at 0.5 m resolution to produce bathymetric and backscatter mosaics for the survey area. Bathymetry and its derivatives (for example, slope and local relief) describe seabed geomorphic context and are used to identify three dimensional seabed features that may support reef or other structurally complex habitats, while backscatter provides information on seabed hardness and surficial sediment characteristics that distinguish harder biogenic or rocky substrata from surrounding soft sediment habitats. The bathymetric setting under the proposed consent area (30–40 m depths, gently sloping basin) is consistent with that reported by Cawthron (2011).

- **Ground-truthing** – The multibeam mosaics were validated against georeferenced video and still imagery collected along three representative transects using an Advanced Navigation Hydrus autonomous underwater vehicle (AUV)[5] (**Figure B-2b**). The AUV was positioned by a surface-deployed Subsonus ultra-short baseline (USBL) acoustic system, aided by RTK GNSS at the surface and an integrated INS. This configuration provides

[3] All referenced figures are presented in **Attachment B**.

[4] Sea conditions remained calm during this period with wave heights <0.1 m and wind <5 knot. Tidal range: 0.44-1.73 m.

[5] https://www.advancednavigation.com/robotics/micro-auv/hydrus/.

a nominal horizontal positional accuracy of approximately 0.5% of acoustic slant range, equivalent to approximately ±0.1–0.25 m across the 20–50 m ranges surveyed, referenced to the RTK GNSS position of the surface transceiver. Each transect was approximately 820 m in length, spanning the survey area and its depth range. Fifty-seven (57) georeferenced still images and continuous video were recorded. Each still-image station was assessed qualitatively for substrate type, epibenthic cover, and the presence of reef or biogenic habitat, based on visual interpretation of the AUV imagery. Imagery was captured at an altitude of approximately 0.5 m above the seabed, giving a field of view of approximately 0.5 m² per frame. Transect locations were selected from sonar interpretation to capture variation in seabed features.

- **Data processing and interpretation** – Dominant benthic habitat was classified primarily from the multibeam backscatter mosaic, supported by bathymetry and qualitative interpretation of AUV still imagery and video, using acoustic habitat mapping approaches consistent with the substrata framework of Lamarche et al. (2011)[6]. Substrata classes represent qualitative ecological interpretation of the processed acoustic and imagery datasets; no quantitative grain size analysis or angular backscatter response modelling was undertaken. Reef and biogenic habitats were classified in accordance with the NES MA definitions. The cover of conspicuous epibenthic fauna, natural shell material, and any marine farm derived shell material was assessed qualitatively from the imagery.

2.2 Desktop Review

A desktop review was undertaken to supplement field findings. This included an evaluation of existing ecological datasets, publicly available marine habitat layers, previous ecological assessments, and relevant scientific literature. Particular attention was given to identifying any mapped sensitive habitats, regionally significant habitats or species, and any records of Threatened or At Risk (TAR) species as defined under the New Zealand Threat Classification System (NZTCS).

Previous benthic assessments for proposed salmon farming at Pig Bay (Cawthron 2011 and associated DEPOMOD deposition modelling) were included in the desktop review. Those studies described mud-dominated soft sediments beneath the proposed consent footprint, with infaunal assemblages of relatively low taxa richness (61 taxa across nine cores) and communities dominated by brittle stars, small bivalves, polychaetes, ostracods and cumaceans, and mapped more diverse cobble, sand-shell hash and reef habitats with horse mussels, scallops, dog cockles, encrusting coralline algae, ascidians, tubeworms and reef fish inshore of the Site.

[6] Lamarche, G., Lurton, X., Verdier, A.-L., & Augustin, J.-M. (2011). Quantitative characterisation of seafloor substrate and bedforms using advanced processing of multibeam backscatter — Application to Cook Strait, New Zealand. Continental Shelf Research, 31(2), S93–S109.

3 Results Summary

The interpreted benthic habitat is shown in **Figure B-3** (with substrata type at the AUV stills shown in an inset); AUV stills symbolised by seabed biota in **Figure B-4**; and representative AUV imagery in **Plate B-1**. The full set of AUV stills is provided in **Attachment D**.

3.1 Mapped Benthic Habitat

The survey identified one broad benthic habitat type across the Site (**Figure B-3**):

- **Soft (mud-muddy sand) sediments** – The seabed was a continuous, homogeneous soft sediment of low structural complexity, comprising mud to muddy sand, covering 90.2 ha (100% of the proposed consent area).

Across the 57 AUV stations, substrata composition, based on qualitative interpretation of still imagery and video, comprised sandy mud (33 stations, 58%), mud (18 stations, 32%), and muddy sand (6 stations, 11%). Sediments appeared coarser (muddy sand) at the shallowest stations (approximately 32 to 34 m) along transect T2, while mud and sandy mud predominated in deeper basin areas. Transect T1 was largely mud-dominated (16 of 21 stations), transect T3 was characterised primarily by sandy mud (16 of 18 stations), and transect T2 comprised a mixture of sandy mud and muddy sand. Shell material was sparse, with occasional fragments and minor, localised shell hash observed at three muddy-sand stations. No shell beds were identified.

In terms of bathymetry, the seabed forms a relatively smooth, gently sloping soft-sediment basin, deepening from approximately 26 m in the north to 43 m in the south-west. Local bathymetric relief is low, with only sub-metre-scale micro-relief evident. No discrete bathymetric or acoustic boundaries were detected, and the survey area is therefore interpreted as a single, continuous fine-sediment habitat (**Figure B-3**). This is consistent with Cawthron (2011), which described a mud-dominated, low-relief soft-sediment seabed, with limited conspicuous epibiota other than brittle stars and burrows.

Seabed substrata classification derived from multibeam backscatter, interpreted within the Lamarche et al. (2011) substrata framework, was validated against qualitative interpretation of AUV imagery, with concordance achieved at 56 of 57 stations (98%). A small area (approximately 0.8 ha) of acoustically heterogeneous backscatter at the survey margins was reclassified as fine sediment following imagery review. Imagery interpretation confidence was assessed as high or moderate at 51 of 57 stations. Classification confidence is high within AUV transect corridors and remains robust across intervening areas, supported by the consistent acoustic signature of fine sediments throughout the basin. Independent verification using continuous video (**Attachment C.6**) further corroborates the still-image-based classification.

3.2 Ecological Observations

- The benthic environment was typical of moderately exposed soft-bottom habitats.

- No sensitive, rare, or complex benthic habitats (e.g. horse mussel or rhodolith beds, tubeworm mounds, bryozoan thickets) were recorded.
- No hard substratum, characterised by reef or biogenic habitats, was found within 20 m of the proposed consent area.
- No TAR marine invertebrate taxa[7] or macroalga taxa[8] were observed.
- The desktop review confirmed that no mapped sensitive habitats or Ecologically Significant Marine Sites (as designated by the MEP) overlap with the proposed consent area (see **Figure B-5**), and this is consistent with the conclusions of Cawthron (2011) that no notable ecological habitats occur within the Site.

4 Conclusions

The seabed within the proposed marine farm in Pig Bay, Te Anamāhanga / Port Gore is a homogeneous soft-sediment basin of low structural complexity, comprising mud to muddy sand across the 90.2 ha consent area.

The present multibeam- and AUV-led survey confirms and refines previous findings reported by Cawthron (2011), indicating that the Site remains a mud-dominated habitat with epifaunal assemblages typical of sheltered soft bottom environments in the Marlborough Sounds. No sensitive, rare, or structurally complex benthic habitats, and no TAR species, were identified; reef, cobble and other complex habitats remain confined to the shallower inshore margin outside the Site. On this basis, the benthic receiving environment within the proposed consent footprint is considered ecologically typical for its setting and suitable for the proposed marine farming activity.

This memorandum addresses seabed habitat characterisation only; ecological values and the anticipated effects of the proposed activity are evaluated separately in the Project EcIA Report.

5 Closure

Robertson Environmental's professional opinions are based on its professional judgement, the information available at the time, and the scope of work agreed with the Client. This memorandum has been prepared for the exclusive use of Client, with respect to the particu-

[7] Funnel, G.; Gordon, D.; Leduc, D.; Makan, T.; Marshall, B.A.; Mills, S.; Michel, P.; Read, G.; Schnabel, K.; Tracey, D.; Wing, S. 2023: Conservation status of indigenous marine invertebrates in Aotearoa New Zealand, 2021. New Zealand Threat Classification Series 40. Department of Conservation, Wellington. 42 p

[8] Nelson, W.A.; Neill, K.; D'Archino, R.; Rolfe, J.R. 2019: Conservation status of New Zealand macroalgae, 2019. New Zealand Threat Classification Series 30. Department of Conservation, Wellington. 33 p.

lar brief given to us. No liability is accepted for the use of any part of the report for any other purpose, or by any other person or organisation.

If you have any further queries or wish to discuss any aspect of the above, please do not hesitate to contact the undersigned.

Robertson Environmental Limited

Report Prepared by:



Dr Ben Robertson

Principal Consultant Ecologist, Director

This assessment has been prepared in accordance with the EIANZ Code of Ethics and Professional Conduct and represents my independent professional opinion based on the available evidence.

Attachment A:

Report Limitations

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i) This Report/Document has been prepared for the particular purpose outlined in REL's proposal and no responsibility is accepted for the use of this Report/Document, in whole or in part, in other contexts or for any other purpose.

ii) The scope and the period of REL's services are as described in REL's proposal and are subject to restrictions and limitations. REL did not perform a complete assessment of all possible conditions or circumstances that may exist at the site referenced in the Report/Document. If a service is not expressly indicated, do not assume it has been provided. If a matter is not addressed, do not assume that any determination has been made by REL in regard to it.

iii) Conditions may exist which were undetectable given the limited nature of the enquiry REL was retained to undertake with respect to the site. Variations in conditions may occur between investigatory locations, and there may be special conditions pertaining to the site which have not been revealed by the investigation and which have not therefore been taken into account in the Report/Document. Accordingly, if information in addition to that contained in this report is sought, additional studies and actions may be required.

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v) Any assessments, designs and advice made in this Report/Document are based on the conditions indicated from published sources and the investigation described. No warranty is included, either express or implied, that the actual conditions will conform exactly to the assessments contained in this Report/Document.

vi) Where data supplied by the client or other external sources, including previous site investigation data, have been used, it has been assumed that the information is correct unless otherwise stated. No responsibility is accepted by REL for incomplete or inaccurate data supplied by others.

vii) The Client acknowledges that REL may have retained sub-consultants affiliated with REL to provide Services for the benefit of REL. REL will be fully responsible to the Client for the Services and work done by all of its sub-consultants and subcontractors. The Client agrees that it will only assert claims against and seek to recover losses, damages or other liabilities from REL and not REL's affiliated companies. To the maximum extent allowed by law, the Client acknowledges and agrees it will not have any legal recourse, and waives any expense, loss, claim, demand, or cause of action, against REL's affiliated companies, and their employees, officers and directors.

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Attachment B:

Supporting Figures

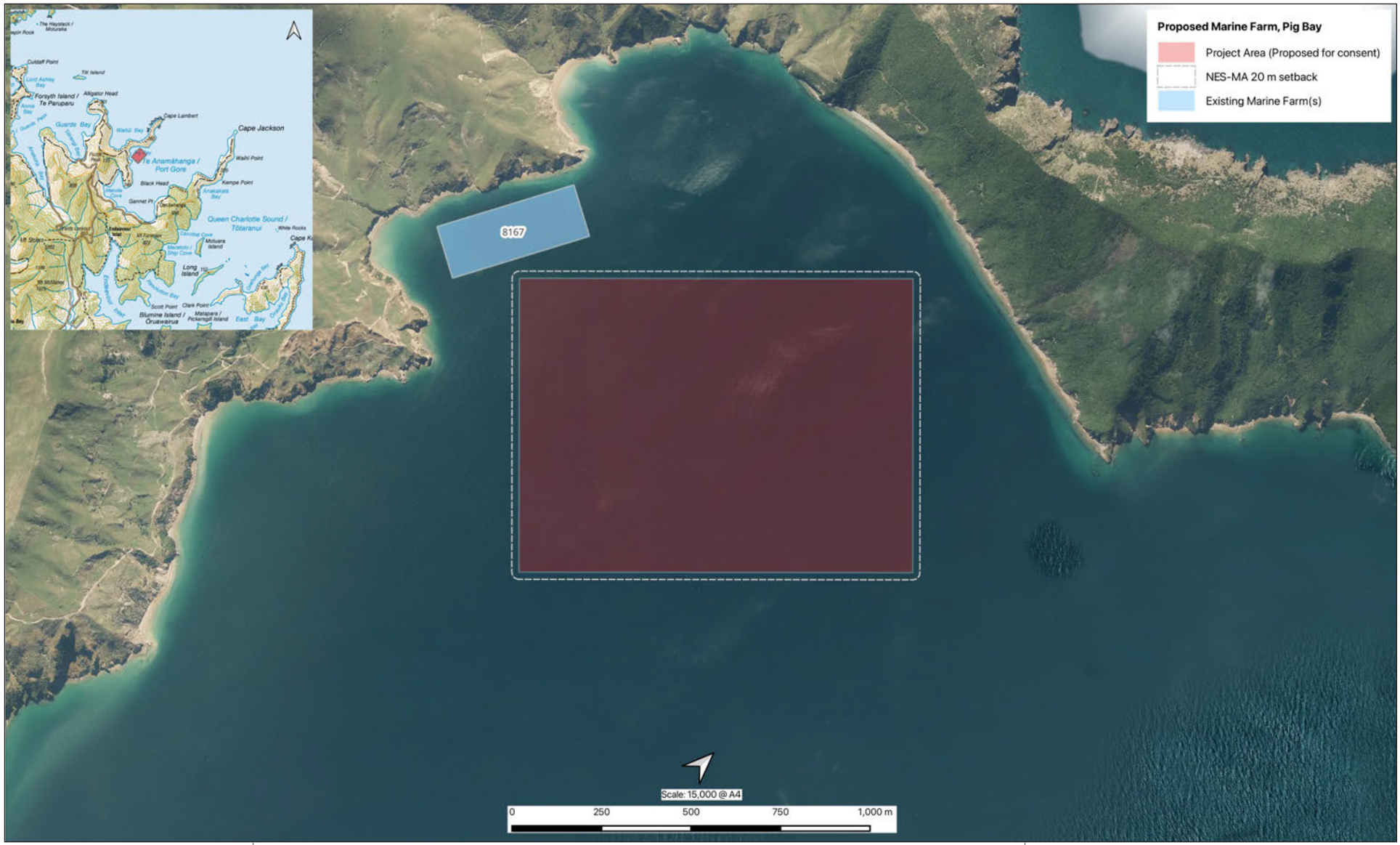


Figure B-1 Location of proposed Pig Bay marine farm targeted in this assessment. Note the surveyed area provides for an area of 20 m distance around the target proposed consent area in line with NES-MA requirements.

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PROJECT: PROPOSED PIG BAY MARINE FARM

Proposed Marine Farm Survey Extent

| Date: 25 June 2026 | Revision: A | Chart: LINZ 23/24
Plan map prepared for MFA by Robertson Environmental Limited

Project Manager: [redacted]

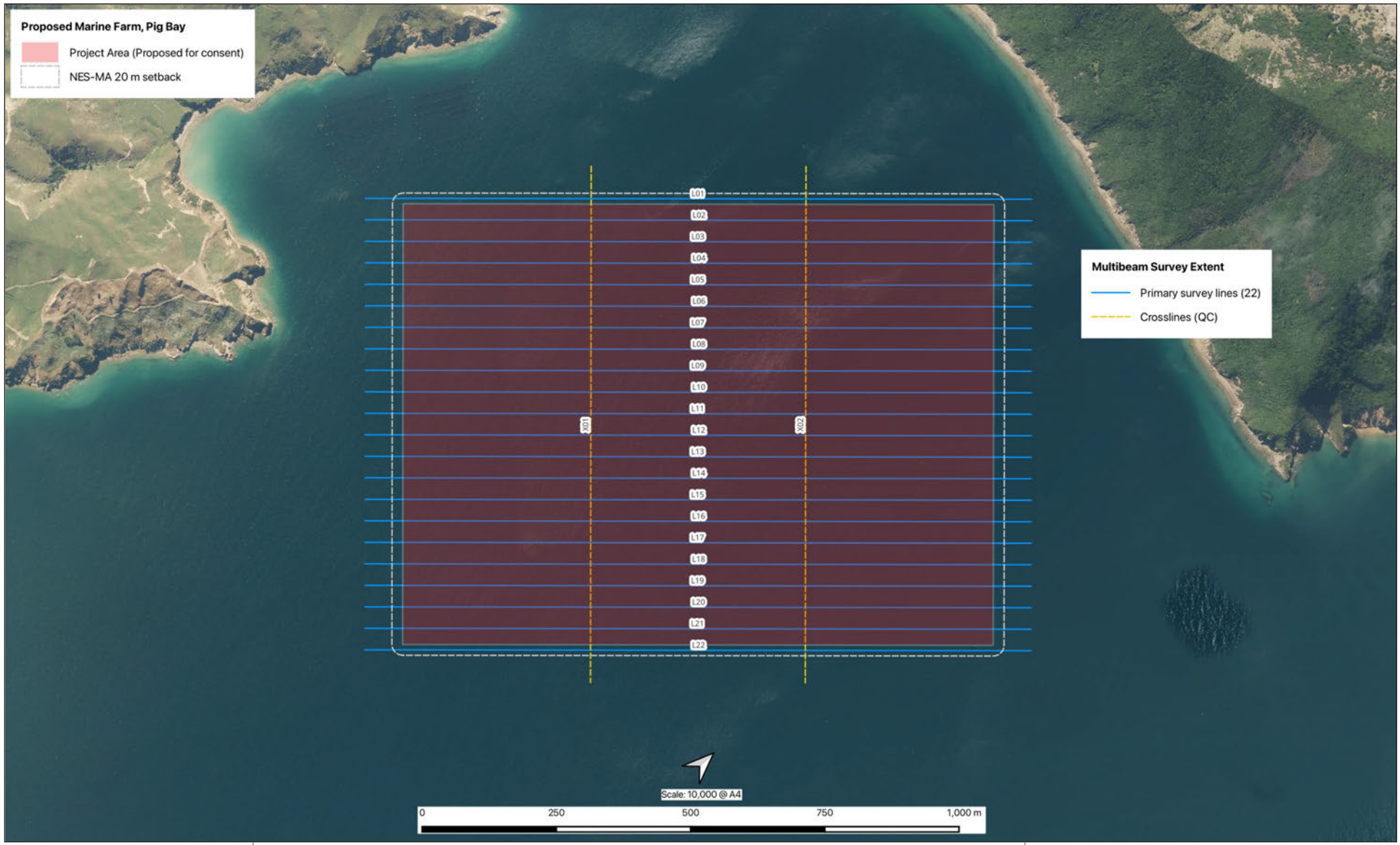


Figure B-2a Multibeam echosounder (MBES) survey coverage and line lay-out, proposed Pig Bay marine farm.

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PROJECT: PROPOSED PIG BAY MARINE FARM

MBES Survey Layout

| Date: 25 June 2026 | Revision: A | Chart: LINZ 23/24
Plan map prepared for MFA by Robertson Environmental Limited

Project Manager: [redacted]

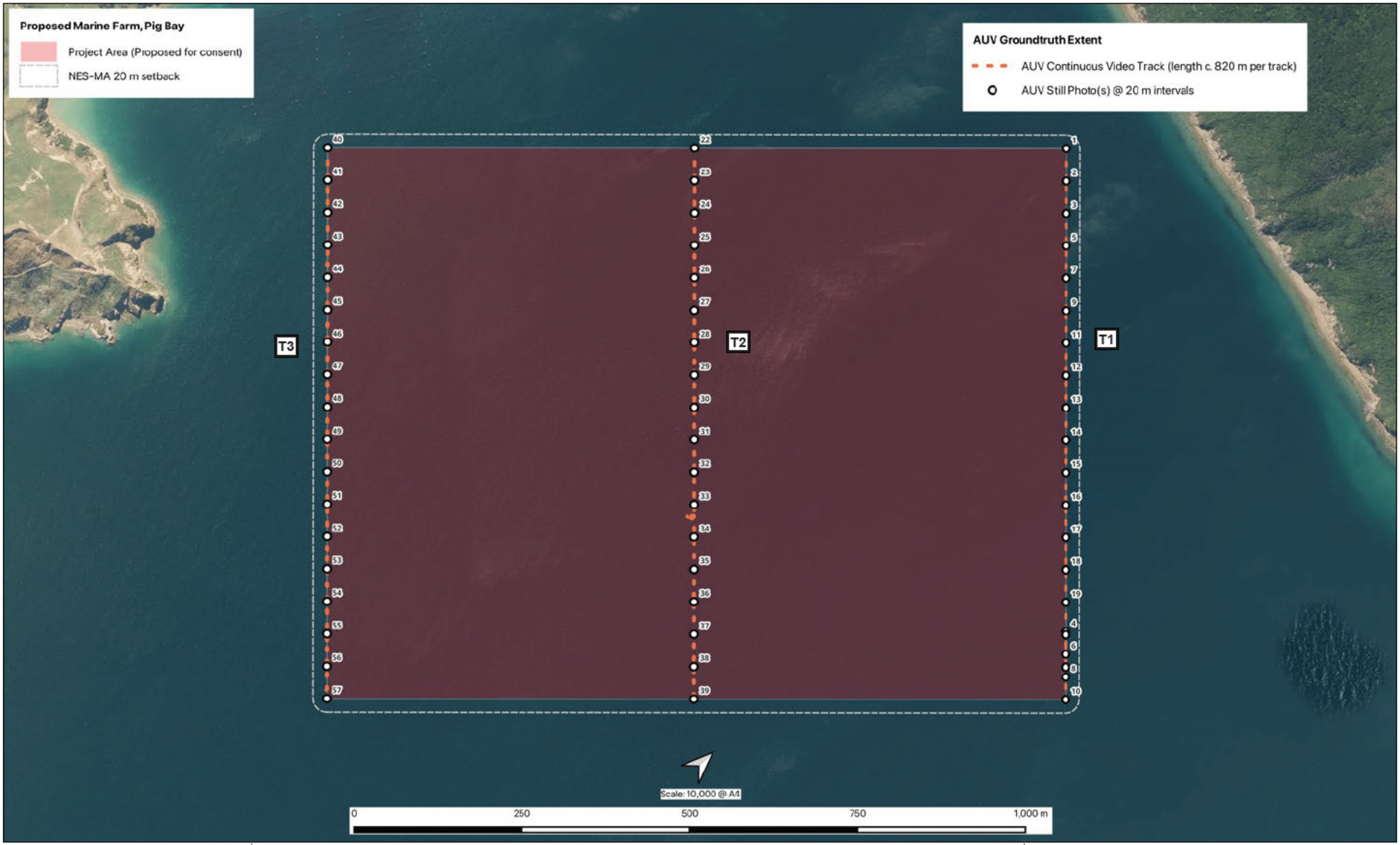


Figure B-2b AUV ground-truthing coverage, showing the three imagery transects (T1–T3) and 57 georeferenced still positions across the proposed consent area. Note transects were positioned to span the survey area and its full depth range (≈26–43 m) to verify the acoustic substrata classification. See detailed results in **Table C.2** and still photos in **Attachment D**.

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PROJECT: PROPOSED PIG BAY MARINE FARM

AUV Ground-truth Extent

| Date: 25 June 2026 | Revision: A | Chart: LINZ 23/24
Plan map prepared for MFA by Robertson Environmental Limited

Project Manager: [redacted]



Figure B-3 Dominant benthic habitat overlaid with hill shaded bathtymetry of the proposed Pig Bay marine farm. Substrata type recorded at each AUV still is shown inset. See detailed results in **Table C.2** and still photos in **Attachment D**.

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PROJECT: PROPOSED PIG BAY MARINE FARM

Dominant Benthic Habitat

| Date: 25 June 2026 | Revision: A | Chart: LINZ 23/24
Plan map prepared for MFA by Robertson Environmental Limited

Project Manager: [redacted]

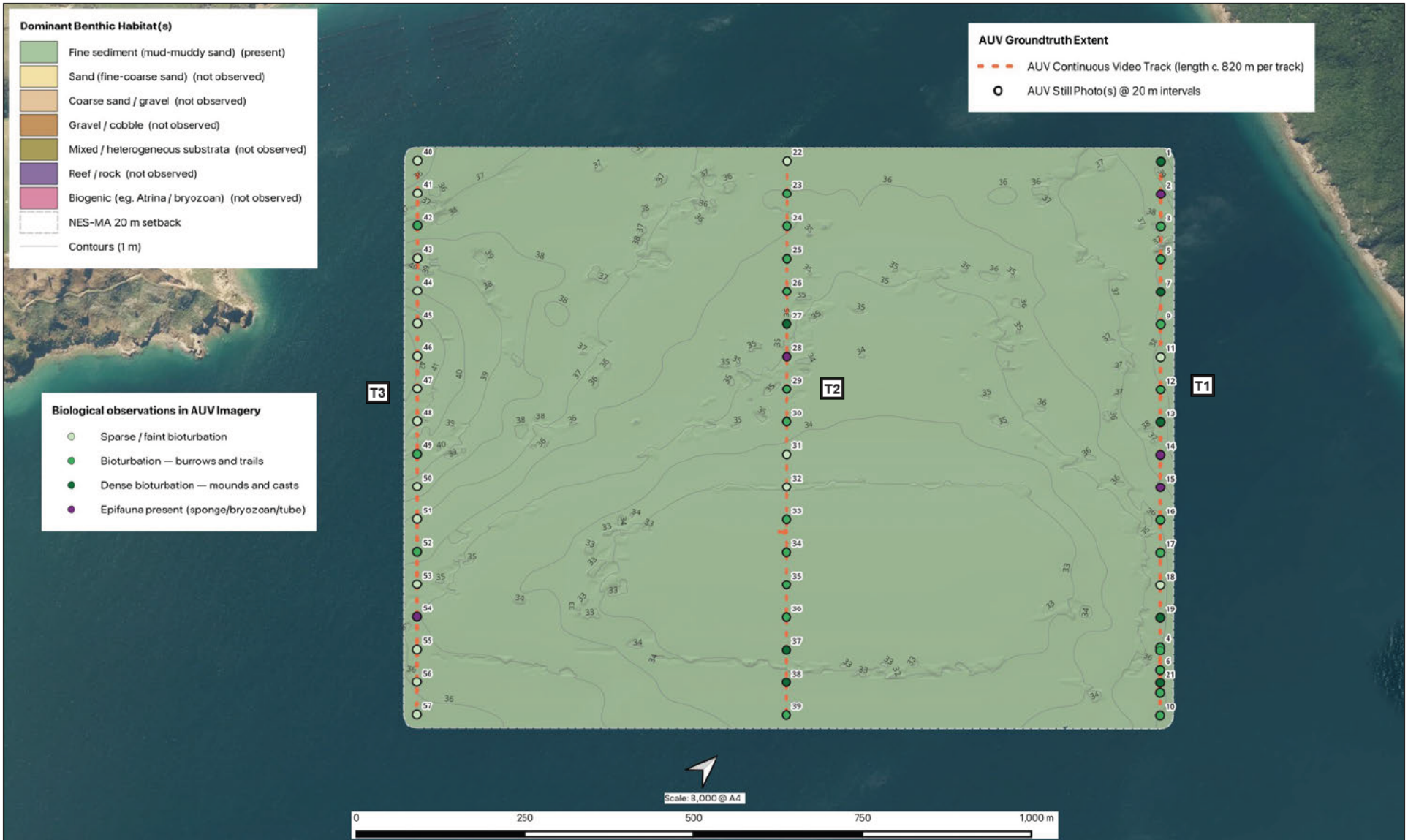


Figure B-4 AUV still photos (1–57) symbolised by seabed biota over mapped hill shaded habitat. Note the seabed is bioturbation-dominated (burrows, mounds and casts) with sparse emergent epifauna, and no reef, biogenic habitat features were observed on any transect. See detailed results in **Table C.2** and still photos in **Attachment D**.

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PROJECT: PROPOSED PIG BAY MARINE FARM

AUV Imagery - Biota Observed

| Date: 25 June 2026 | Revision: A | Chart: LINZ 23/24
Plan map prepared for MFA by Robertson Environmental Limited

Project Manager: [redacted]

Attachment C:

Detailed Methods

C.1 Survey and data processing

Full-coverage multibeam bathymetry and backscatter were acquired over the survey area on 28 May 2026 from the vessel *Christina A*, using a pole-mounted WASSP S3 PR multibeam echo-sounder (approximately 300 kHz). Vessel motion and position were resolved by the WASSP's own GNSS/INS with real-time kinematic (RTK) corrections, and a sound-velocity profile was applied during acquisition. Calibration patch tests were run before and after the main survey lines. Soundings were processed in BeamworX and gridded to a 0.5 m surface in NZTM2000, with depths reduced to NZVD2016. Residual acquisition artefacts were suppressed in the gridded-surface domain, with genuine discrete seabed relief preserved, and terrain descriptors (slope, aspect, fine- and broad-scale bathymetric position index, and vector ruggedness) were derived. The backscatter mosaic was confirmed co-registered with the bathymetry on the common 0.5 m grid.

C.2 Substratum and habitat classification

Substrata were classified following the substrata framework of Lamarche et al. (2011), at the qualitative imagery-facies level appropriate to the data acquired. Three acoustic imagery facies (homogeneous low-to-moderate reflectivity; homogeneous highly reflective; and heterogeneous variable reflectivity) were derived by unsupervised clustering of a feature stack combining backscatter level and texture with terrain descriptors, then reconciled to the six-class substratum legend set out in **Table C-1**. Reef and biogenic habitats were classified in accordance with the National Environmental Standards for Marine Aquaculture (NES-MA) definitions. Backscatter values are expressed in decibels (dB), and no fixed backscatter thresholds were applied in the classification. The classification workflow is summarised in **Figure C-1**, the bathymetry in **Figure C-2**, and the backscatter mosaic in **Figure C-3**.

C.3 Ground-truthing and reconciliation

Seabed imagery was collected with a Hydrus autonomous underwater vehicle (AUV) flown at approximately 0.5 m altitude along three transects (T1, T2 and T3; T1 in two segments). Fifty-seven downward-looking stills were georeferenced from the vehicle's onboard positioning, and continuous video with per-second position, depth and altitude telemetry was logged. Each station was assessed for substratum type, epibenthic cover, the cover of natural and any marine farm-derived shell material, and the presence of biogenic or sensitive habitat. Imagery observations were intersected with the acoustic facies; classes were retained where imagery and acoustics agreed, and re-attributed where they did not. A single station of acoustically variable texture at the survey margin (Photo_No 28 on T2), lacking corresponding seabed relief, was re-attributed to fine sediment on imagery review. Imagery agreed with the acoustic classification at 56 of 57 stations (98%); agreement is summarised in **Figure C-4**, transect and station locations in **Figure B-2B**, and per-station observations and coordinates in **Table C-2**.

C.4 Geodesy and datums

All spatial data are referenced to the New Zealand Geodetic Datum 2000, projected in NZTM2000 (EPSG:2193); station coordinates are tabulated in **Table C-2**. Depths are expressed as positive metres below NZVD2016. Bathymetry and backscatter were gridded at 0.5 m resolution. The survey area depth range is approximately 26 to 43 m; the mapped extent is approximately 120 ha, within which the proposed consent area is 90.2 ha.

C.5 Field operations

The survey was undertaken from the vessel *Christina A* (skipper Julian Goulding), with the AUV operated by Robertson Environmental Limited. Multibeam acquisition was completed on 28 May 2026 and comprised calibration patch tests before and after a set of 22 survey lines covering the survey area. AUV ground-truthing was undertaken across three transects (T1, T2 and T3; T1 in two segments) on 28 and 29 May 2026, totalling 57 georeferenced stills and continuous video. Sea conditions remained calm throughout this period, with wave heights under 0.1 m and wind under 5 knots, and the tidal range over the survey was 0.44 to 1.73 m. Underwater visibility was good, and no downtime affecting data quality was recorded.

C.6 Ground-truthing validation: continuous-video cross-check

As a completeness check on the discrete stills, the continuous AUV video along the three transects was independently re-classified. Frames were sampled at one every 90 seconds (112 frames, of which 110 had the seabed visible; two off-bottom transit frames were excluded) and georeferenced against the 57 known still positions, returning a median positional error of 0.0 m (maximum 0.2 m). Each frame was classified blind to the still-based result, using the same scheme as the still pipeline (substratum, acoustic-facies analogue, biota and fauna density).

At the habitat level the video and stills agree across all three transects: 100% soft fine sediment (mud, sandy mud or muddy sand), with no reef, rock, gravel or coarse substratum detected by either method, low fauna density throughout, and bioturbation the dominant biological signal. The per-transect comparison is set out in **Table C-3**.

The two methods differ only in detail, and none of the differences changes the habitat call. On T1 the video read one substratum notch coarser than the stills (dominant sandy mud versus mud), within the subtle mud-to-muddy-sand range that is inherently low-confidence from single motion-grabbed frames. The denser video sampling flagged more local textural heterogeneity between still points (approximately 16 to 44% of video frames versus 0 to 6% of stills), reflecting fine-scale ripple and mound patches within a broadly homogeneous plain rather than a different habitat. The continuous review confirms that the sparse stills did not miss any reef, biogenic habitat or coarse-substratum patches between sample points.

Caveats:

- The stills were extracted from the same footage, so this is a sparse-vs-continuous consistency check, not a comparison of two independent instruments. The genuine independent cross-check is the existing stills-vs-multibeam-acoustic agreement (the imagery-acoustic agreement field; 56 of 57 stations, **Figure C-4**).
- The mud / sandy-mud / muddy-sand distinction is inherently low-confidence from single video frames and is best confirmed by physical sediment sampling where available.

Table C-1. Substratum classification legend with the corresponding acoustic imagery-facies (after Lamarche et al. 2011).

Substratum class	Description	Acoustic imagery facies (Lamarche et al. 2011)	Mapped within survey area
Mud	Fine mud	Homogeneous, low-to-moderate reflectivity	Yes (soft-sediment habitat)
Sandy mud	Mud with a minor sand component	Homogeneous, low-to-moderate reflectivity	Yes (soft-sediment habitat)
Muddy sand	Sand with a notable mud component	Homogeneous, low-to-moderate reflectivity	Yes (soft-sediment habitat)
Sand	Clean to rippled sand	Homogeneous, moderate-to-high reflectivity	Not observed
Gravel, shell or coarse substratum	Gravel or coarse shell debris	Homogeneous, highly reflective	Not observed
Reef or hard substratum	Bedrock, boulder or biogenic reef (NES-MA)	Heterogeneous, variable reflectivity	Not observed

The three fine-sediment classes (mud, sandy mud and muddy sand) together form the single soft fine sediment habitat mapped across the survey area. The heterogeneous acoustic facies flagged at the survey margin was re-attributed to fine sediment following imagery review. Substratum classes are textural impressions interpreted from AUV imagery; no physical sediment sampling or grain-size analysis was undertaken.

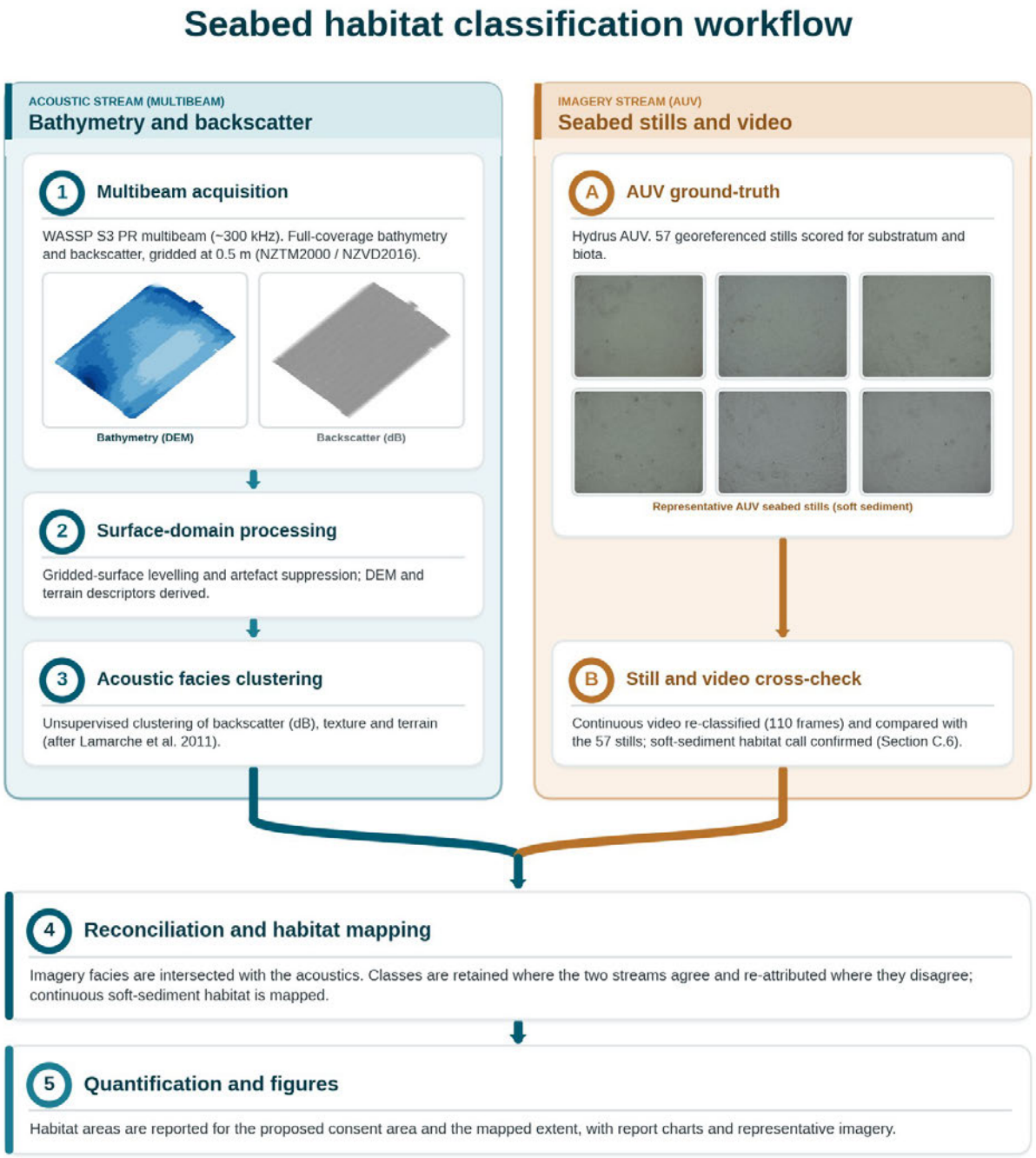


Figure C-1. Classification workflow, from multibeam acquisition through acoustic facies clustering and AUV ground-truthing (including the still-versus-video cross-check, Section C.6) to the reconciled soft-sediment habitat classification. Note acoustic classes were retained where imagery and acoustics agreed and re-attributed where they did not (Section C.3).

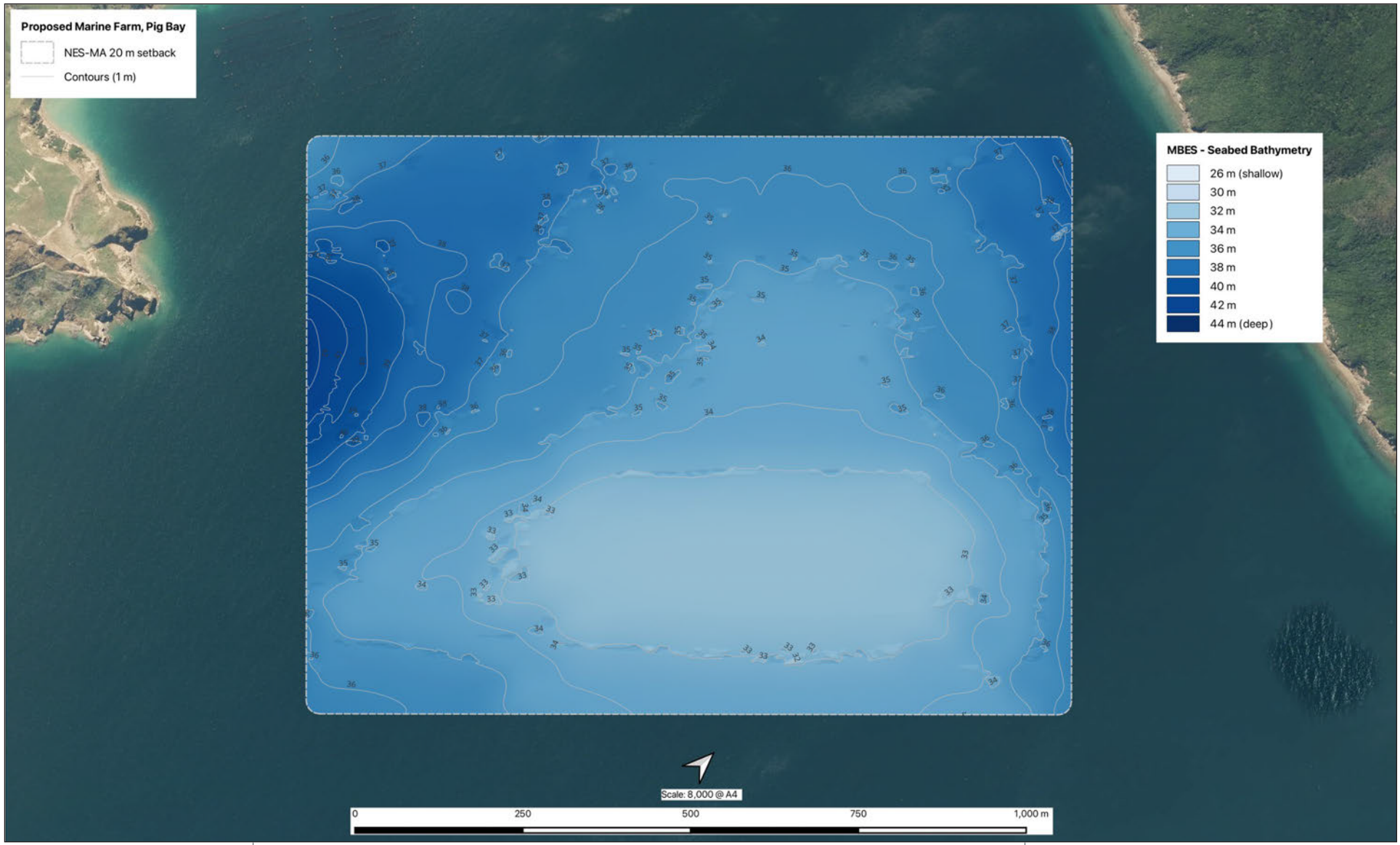


Figure C-2 Bathymetry of the survey area at 0.5 m resolution, deepening from ≈26 m in the north to ≈43 m in the south-west. Note depths are expressed as metres below the New Zealand Vertical Datum 2016 (NZVD2016) and are shown with shaded relief and 1 m contours.

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PROJECT: PROPOSED PIG BAY MARINE FARM

MBES Hill Shaded Bathymetry

| Date: 25 June 2026 | Revision: A | Chart: LINZ 23/24
Plan map prepared for MFA by Robertson Environmental Limited

Project Manager: [redacted]

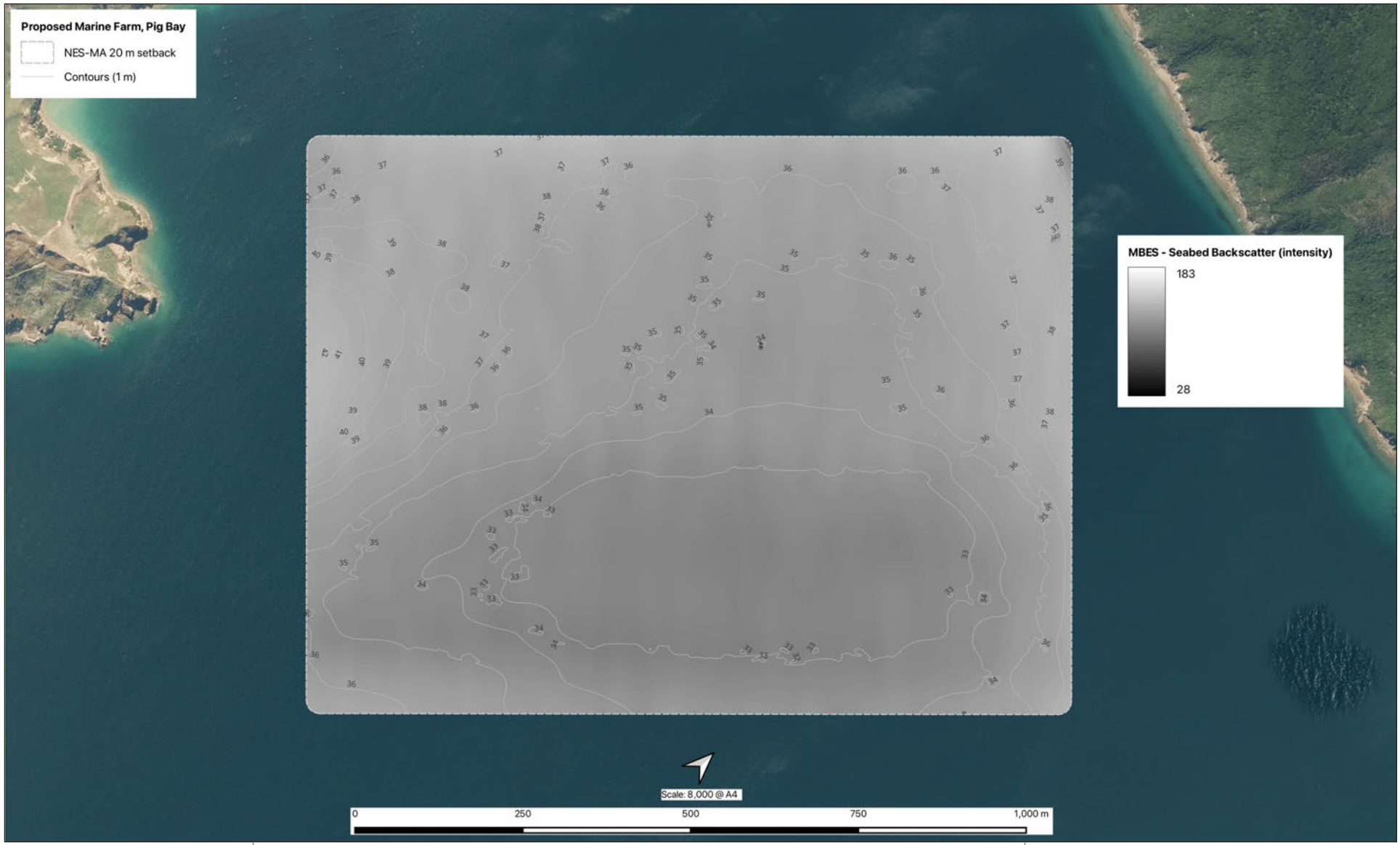


Figure C-3 Backscatter mosaic over the proposed consent boundary.

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PROJECT: PROPOSED PIG BAY MARINE FARM

MBES Backscatter

| Date: 25 June 2026 | Revision: A | Chart: LINZ 23/24
Plan map prepared for MFA by Robertson Environmental Limited

Project Manager: [redacted]

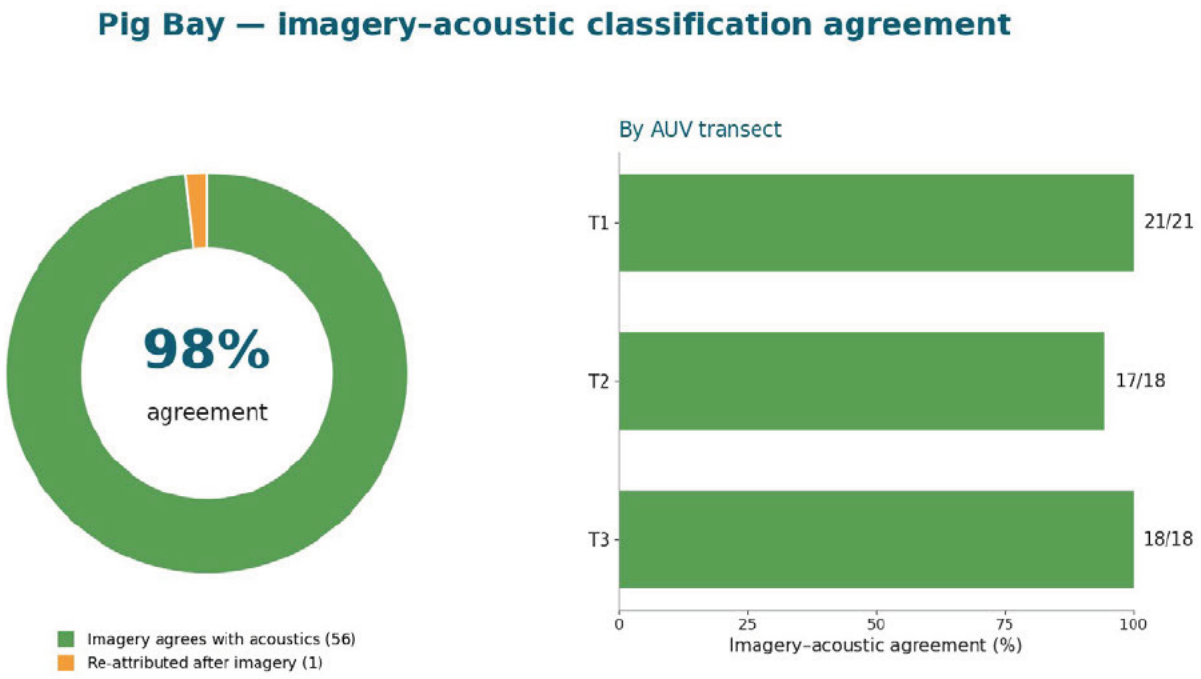


Figure C-4. Imagery-acoustic classification agreement: 56 of 57 AUV stations (98%) confirm the acoustic soft-sediment classification, shown overall and by transect (T1-T3). Note the single re-attributed station (Photo_No 28, Transect T2) was acoustically flagged as variable-texture but was reclassified to fine sediment on review of its AUV still and the adjacent continuous-video frames.

Table C-2. AUV still observations (57 stills), by Photo No (1-57): transect, station coordinates (NZTM2000), depth, substratum, epifauna and benthic features, and suitability against MEP Policy 13.21.3 and NES-MA (s4, 7-9). Depths are metres below NZVD2016.

Photo_No	Transect	NZTM E	NZTM N	Depth (m)	Substratum	Epifauna / benthic features	Suitability in terms of MEP (Policy 13.21.3) and NES-MA (S4, 7-9)
1	T1	1701610	5459487	38.8	mud	burrows/bioturbation; worm tubes	Suitable
2	T1	1701645	5459453	38.9	sandy mud	burrows/bioturbation; worm tubes	Suitable
3	T1	1701679	5459420	38.2	mud	burrows/bioturbation	Suitable
4	T1	1701714	5459386	37.9	sandy mud	burrows/bioturbation	Suitable
5	T1	1701749	5459353	38.0	mud	burrows/bioturbation; worm tubes	Suitable
6	T1	1701783	5459319	38.0	sandy mud	burrows/bioturbation	Suitable
7	T1	1701818	5459286	38.1	mud	burrows/bioturbation	Suitable
8	T1	1701853	5459252	38.0	mud	burrows/bioturbation	Suitable
9	T1	1701887	5459219	37.8	mud	burrows/bioturbation; worm tubes	Suitable
10	T1	1701922	5459185	37.6	mud	burrows/bioturbation; worm tubes	Suitable
11	T1	1701956	5459151	36.8	mud	burrows/bioturbation; worm tubes	Suitable
12	T1	1701991	5459118	36.1	mud	burrows/bioturbation	Suitable
13	T1	1702026	5459084	35.7	mud	burrows/bioturbation	Suitable
14	T1	1702060	5459051	35.7	sandy mud	burrows/bioturbation	Suitable
15	T1	1702095	5459017	35.8	mud	burrows/bioturbation	Suitable
16	T1	1702130	5458984	36.0	mud	burrows/bioturbation	Suitable
17	T1	1702164	5458950	35.9	sandy mud	burrows/bioturbation; worm tubes	Suitable
18	T1	1702126	5458987	36.0	mud	burrows/bioturbation	Suitable
19	T1	1702151	5458963	36.0	mud	burrows/bioturbation	Suitable
20	T1	1702175	5458940	35.8	mud	burrows/bioturbation	Suitable
21	T1	1702199	5458917	36.0	mud	burrows/bioturbation	Suitable
22	T2	1701225	5459090	36.2	sandy mud	scattered burrows; bioturbation	Suitable
23	T2	1701260	5459056	36.0	sandy mud	burrows; bioturbation	Suitable

Photo_No	Transect	NZTM E	NZTM N	Depth (m)	Substratum	Epifauna / benthic features	Suitability in terms of MEP (Policy 13.21.3) and NES-MA (S4, 7-9)
24	T2	1701295	5459023	36.0	sandy mud	burrows; bioturbation	Suitable
25	T2	1701329	5458989	35.9	sandy mud	burrows; bioturbation	Suitable
26	T2	1701364	5458955	35.8	sandy mud	burrows; bioturbation	Suitable
27	T2	1701399	5458922	35.4	sandy mud	burrows; bioturbation	Suitable
28	T2	1701433	5458888	34.9	sandy mud	burrows; bioturbation; possible sea cucumber; shell fragments	Suitable
29	T2	1701468	5458855	34.5	sandy mud	burrows; bioturbation	Suitable
30	T2	1701502	5458821	34.1	sandy mud	burrows; bioturbation	Suitable
31	T2	1701537	5458788	33.8	sandy mud	burrows; bioturbation	Suitable
32	T2	1701572	5458754	33.6	sandy mud	burrows; bioturbation	Suitable
33	T2	1701606	5458721	32.3	sandy mud	burrows; bioturbation	Suitable
34	T2	1701641	5458687	32.0	muddy sand	burrows; bioturbation; shell fragments	Suitable
35	T2	1701676	5458654	32.0	muddy sand	burrows; bioturbation; shell fragments	Suitable
36	T2	1701710	5458620	32.1	muddy sand	burrows; bioturbation	Suitable
37	T2	1701745	5458586	32.5	muddy sand	burrows; bioturbation	Suitable
38	T2	1701780	5458553	33.4	muddy sand	burrows; bioturbation	Suitable
39	T2	1701814	5458519	33.9	muddy sand	burrows; bioturbation	Suitable
40	T3	1700845	5458697	35.6	mud	none visible	Suitable
41	T3	1700880	5458663	36.2	mud	bioturbation	Suitable
42	T3	1700914	5458630	37.4	sandy mud	burrows/bioturbation	Suitable
43	T3	1700949	5458596	39.5	sandy mud	bioturbation	Suitable
44	T3	1700984	5458563	40.0	sandy mud	bioturbation	Suitable
45	T3	1701018	5458529	41.5	sandy mud	bioturbation	Suitable
46	T3	1701053	5458496	41.9	sandy mud	none visible	Suitable
47	T3	1701087	5458462	41.8	sandy mud	none visible	Suitable
48	T3	1701122	5458428	41.1	sandy mud	bioturbation	Suitable

Photo_No	Transect	NZTM E	NZTM N	Depth (m)	Substratum	Epifauna / benthic features	Suitability in terms of MEP (Policy 13.21.3) and NES-MA (S4, 7-9)
49	T3	1701157	5458395	39.9	sandy mud	burrows/bioturbation	Suitable
50	T3	1701192	5458361	38.5	sandy mud	bioturbation	Suitable
51	T3	1701226	5458328	36.8	sandy mud	bioturbation	Suitable
52	T3	1701261	5458294	36.1	sandy mud	burrows/bioturbation; possible small shell fragments	Suitable
53	T3	1701295	5458261	35.8	sandy mud	bioturbation	Suitable
54	T3	1701330	5458227	35.1	sandy mud	burrows/bioturbation; worm tubes	Suitable
55	T3	1701365	5458194	35.8	sandy mud	none visible	Suitable
56	T3	1701399	5458160	35.5	sandy mud	bioturbation	Suitable
57	T3	1701434	5458126	36.3	sandy mud	bioturbation	Suitable

Bioturbation denotes biogenic reworking of the sediment surface by burrowing and surface-active infauna (for example burrows and casts), interpreted qualitatively from the AUV stills; it was the dominant biological signal across the soft-sediment habitat. All 57 stills recorded soft fine sediment. Coordinates are NZTM2000 (EPSG:2193). Photo_No is the continuous still label (T1 = 1-21, T2 = 22-39, T3 = 40-57).

Table C-3. Continuous-video versus still-frame classification, by AUV transect (cells show video / stills).

Metric	T1 (video / stills)	T2 (video / stills)	T3 (video / stills)
Frames / stills assessed	37 / 21	36 / 18	37 / 18
Dominant substratum	sandy mud / mud	sandy mud / sandy mud	sandy mud / mud
Soft fine sediment	100% / 100%	100% / 100%	100% / 100%
Fine-homogeneous facies	65% / 100%	56% / 94%	84% / 100%
Low fauna density	97% / 100%	83% / 83%	100% / 100%
Bioturbation recorded	92% / 100%	100% / 100%	95% / 78%

Both methods agree on the habitat call (soft fine sediment, low fauna density, bioturbation-dominated). Substratum sub-class matches on T2 and T3; on T1 the video reads one notch coarser (within the mud-to-muddy-sand range).

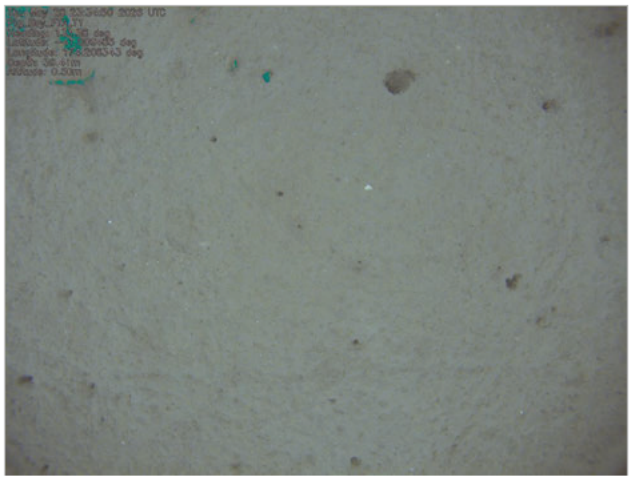
Attachment D:

AUV Photographs of Benthic Habitat

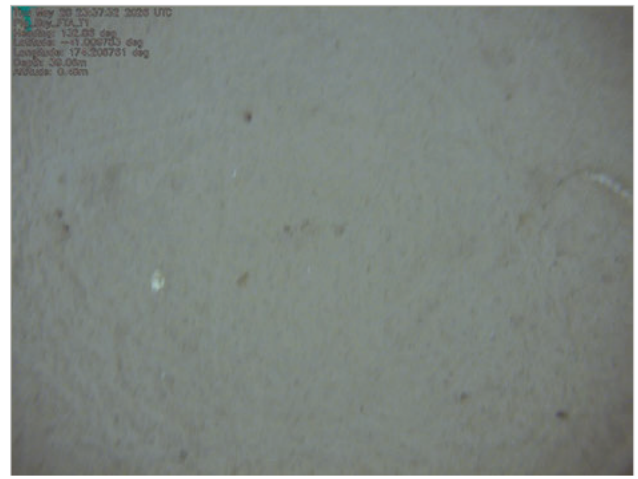
The complete set of 57 georeferenced, colour-corrected AUV seabed stills (Photo_No 1-57) is reproduced below as a photoquadrat catalogue, grouped by transect. Each frame carries its per-still data: depth, substratum and the seabed biota note.

Plate D-1. Catalogue of all 57 georeferenced, colour-corrected AUV seabed stills (1-57), keyed to Table C-2 and Figure B-4. Note stills are in transect order (T1: 1-21; T2: 22-39; T3: 40-57); each records soft fine sediment with bioturbation the dominant biological signal.

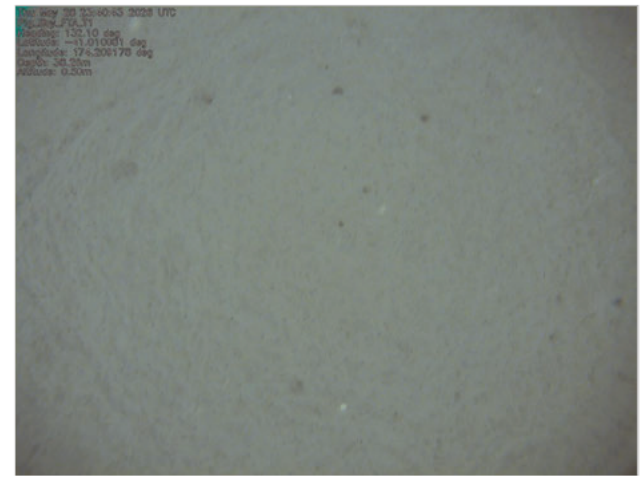
D.1 Transect T1 (Photo_No 1-21)



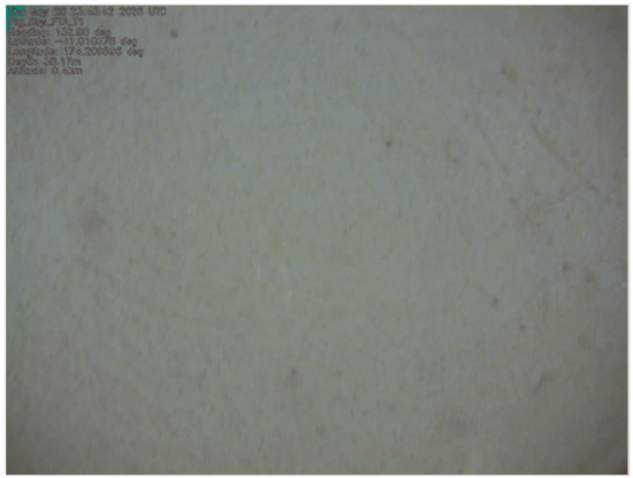
1 T1 38.8 m
mud
burrows/bioturbation; worm tubes



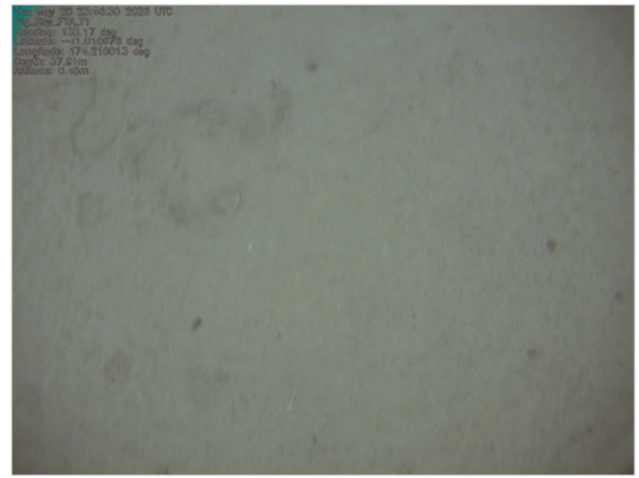
2 T1 38.9 m
sandy mud
burrows/bioturbation; worm tubes



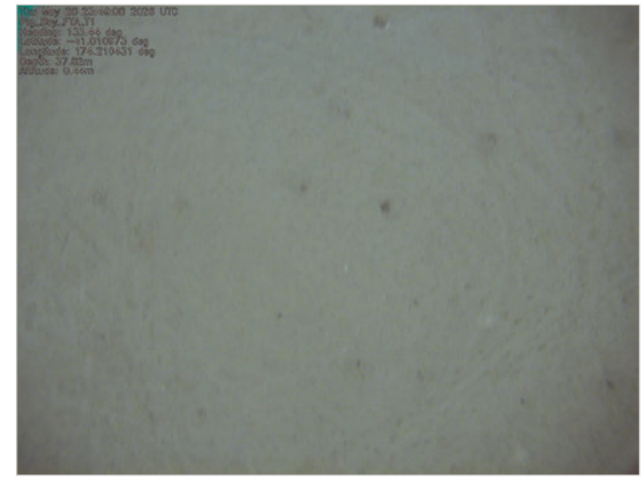
3 T1 38.2 m
mud
burrows/bioturbation



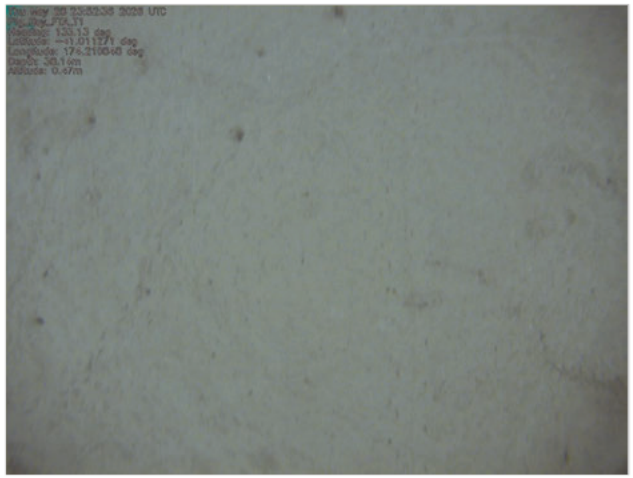
4 T1 37.9 m
sandy mud
burrows/bioturbation



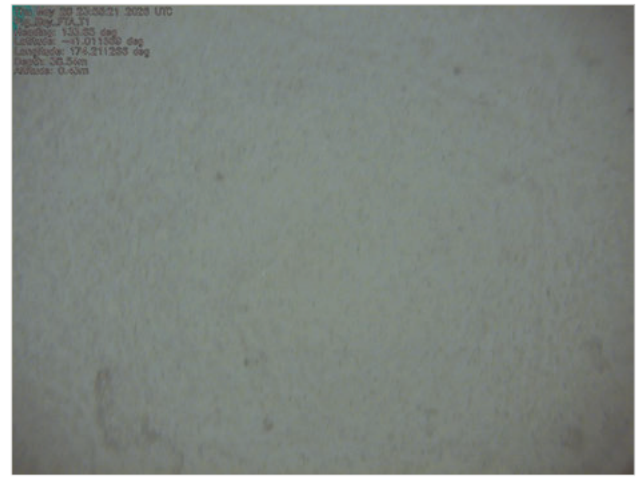
5 T1 38.0 m
mud
burrows/bioturbation; worm tubes



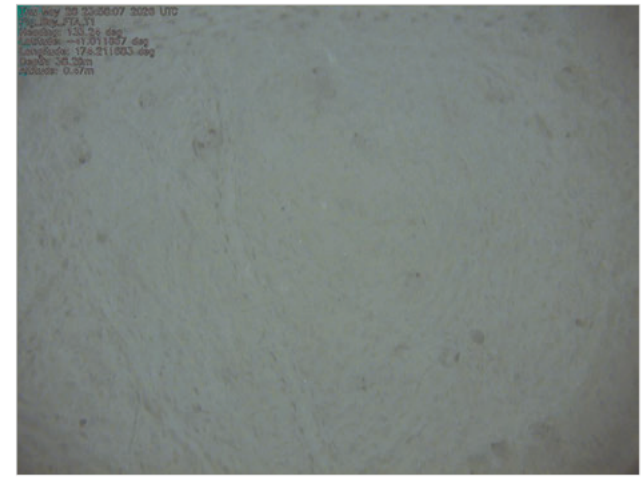
6 T1 38.0 m
sandy mud
burrows/bioturbation



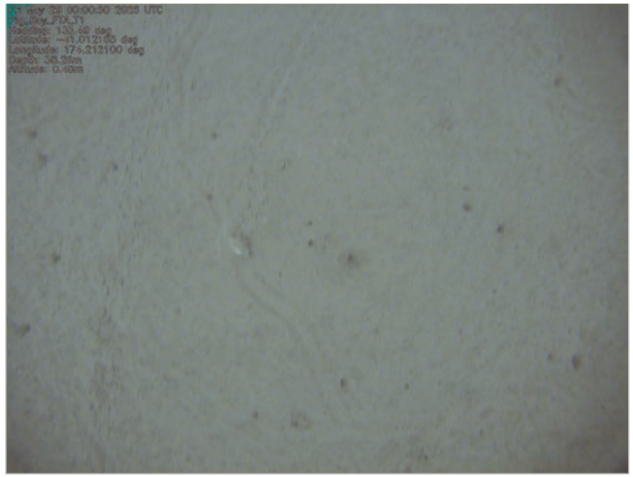
7 T1 38.1 m
mud
burrows/bioturbation



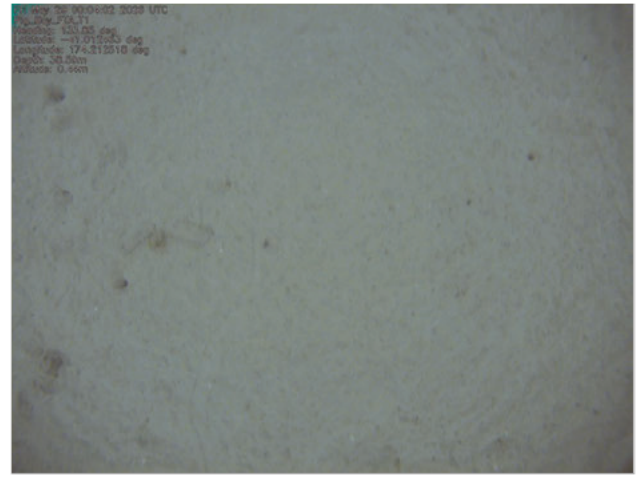
8 T1 38.0 m
mud
burrows/bioturbation



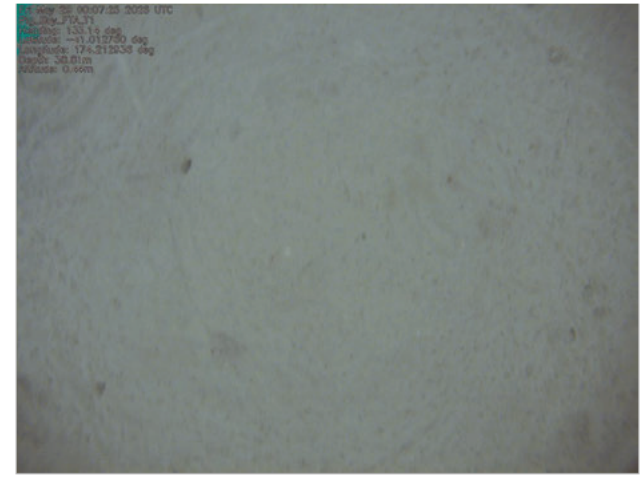
9 T1 37.8 m
mud
burrows/bioturbation; worm tubes



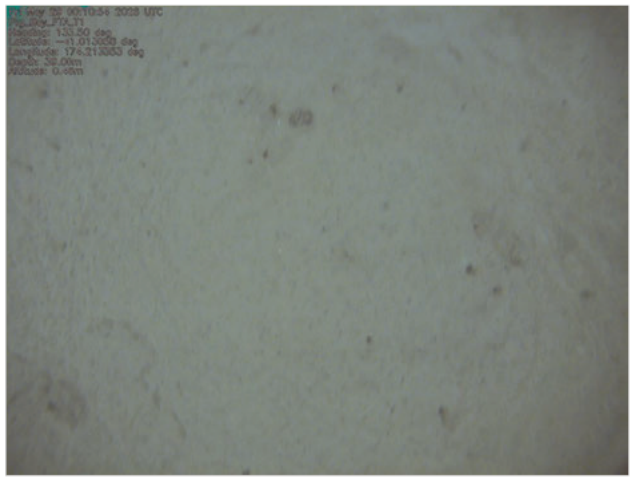
10 T1 37.6 m
mud
burrows/bioturbation; worm tubes



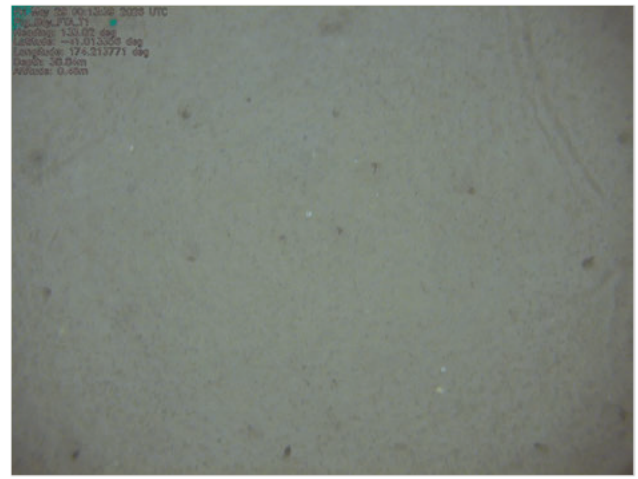
11 T1 36.8 m
mud
burrows/bioturbation; worm tubes



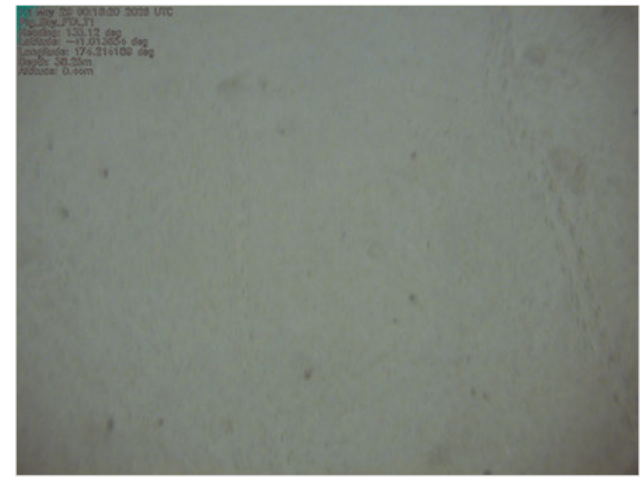
12 T1 36.1 m
mud
burrows/bioturbation



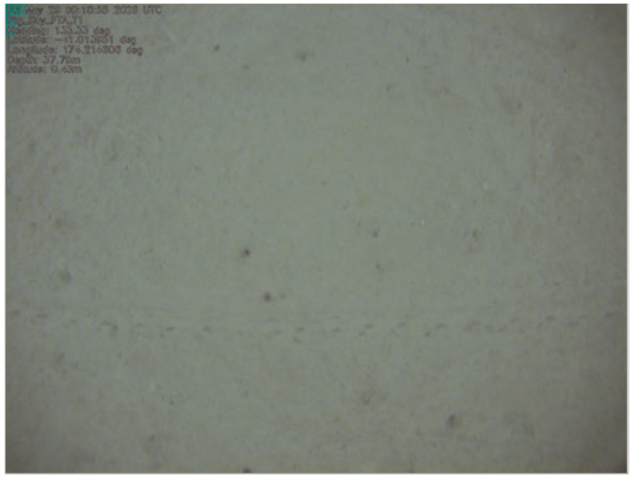
13 T1 35.7 m
mud
burrows/bioturbation



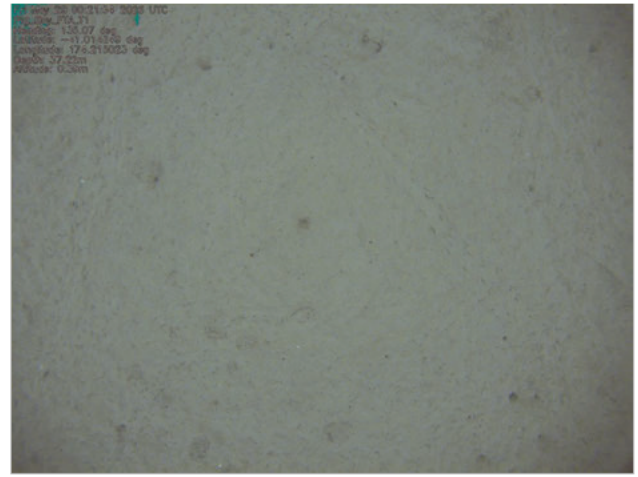
14 T1 35.7 m
sandy mud
burrows/bioturbation



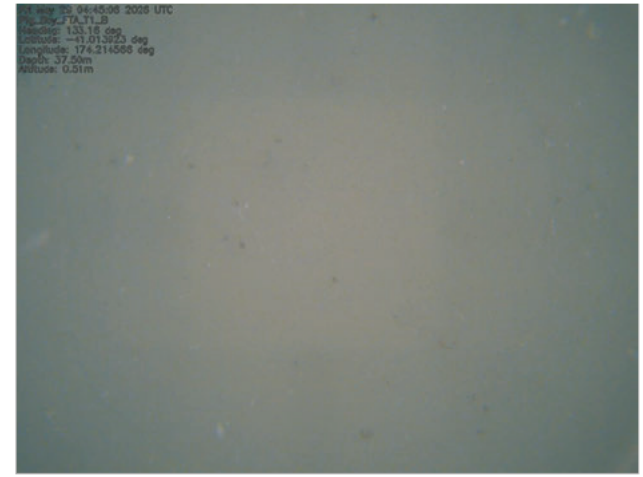
15 T1 35.8 m
mud
burrows/bioturbation



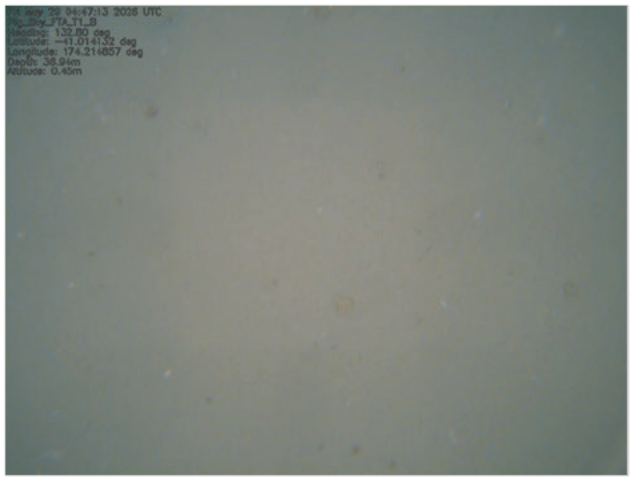
16 T1 36.0 m
mud
burrows/bioturbation



17 T1 35.9 m
sandy mud
burrows/bioturbation; worm tubes



18 T1 36.0 m
mud
burrows/bioturbation



19 T1 36.0 m
mud
burrows/bioturbation

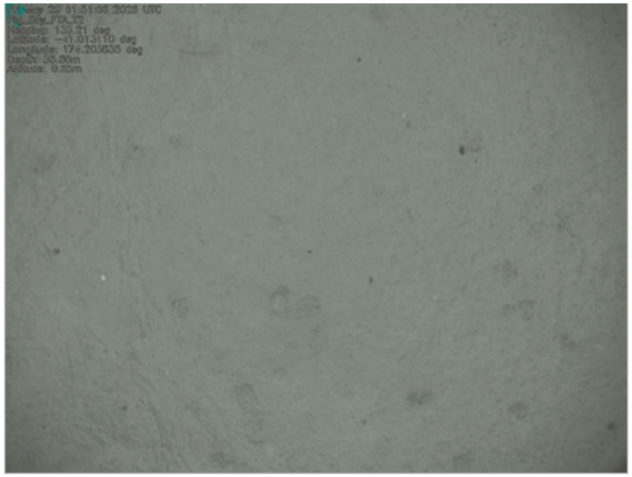


20 T1 35.8 m
mud
burrows/bioturbation

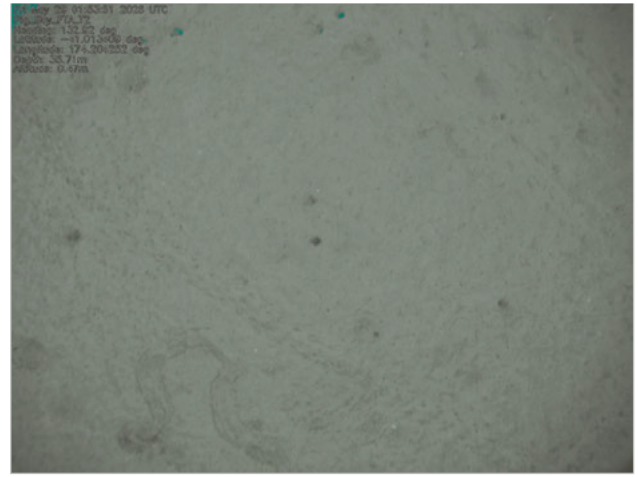


21 T1 36.0 m
mud
burrows/bioturbation

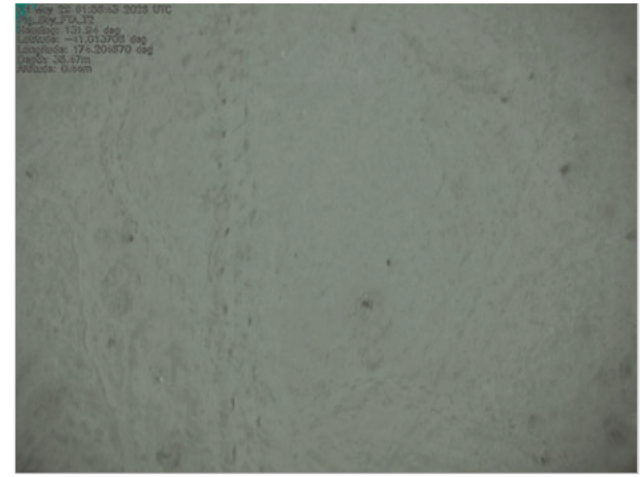
D.2 Transect T2 (Photo_No 22-39)



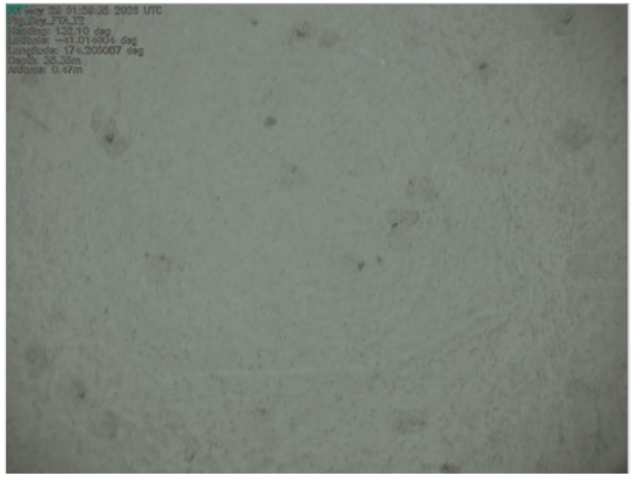
22 T2 36.2 m
sandy mud
scattered burrows; bioturbation



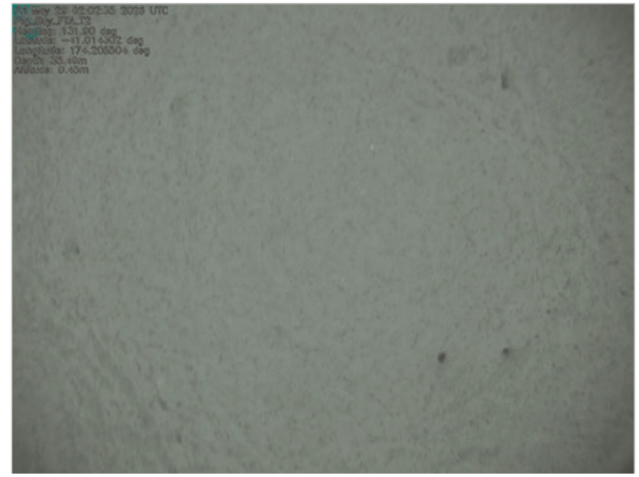
23 T2 36.0 m
sandy mud
burrows; bioturbation



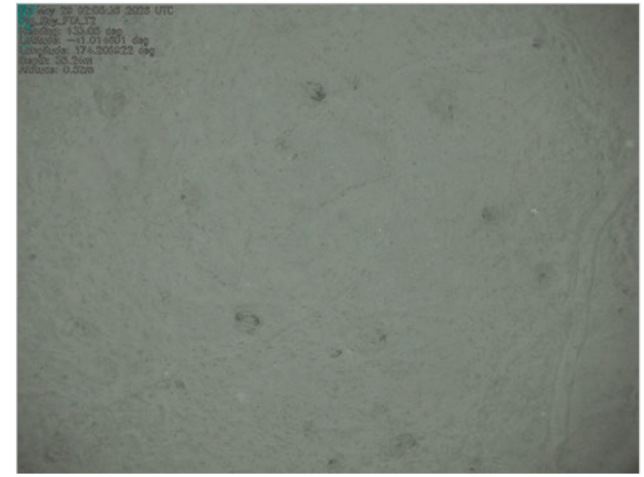
24 T2 36.0 m
sandy mud
burrows; bioturbation



25 T2 35.9 m
sandy mud
burrows; bioturbation



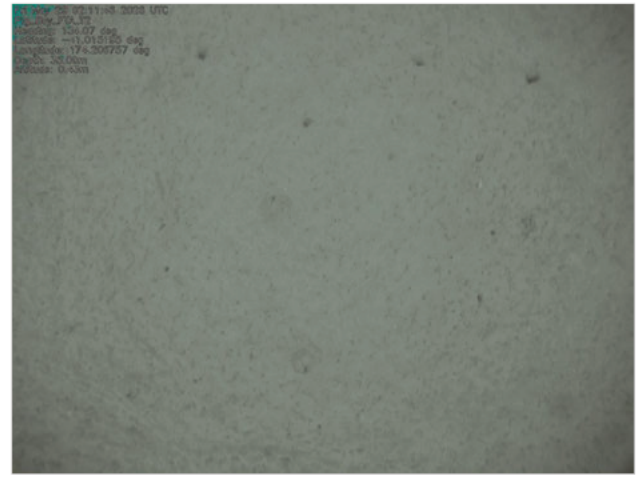
26 T2 35.8 m
sandy mud
burrows; bioturbation



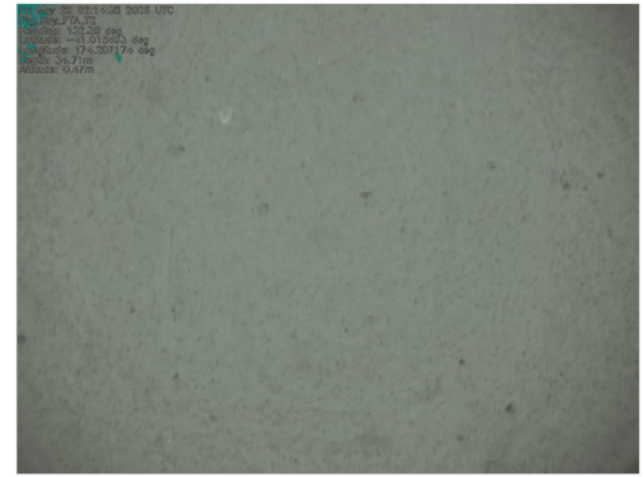
27 T2 35.4 m
sandy mud
burrows; bioturbation



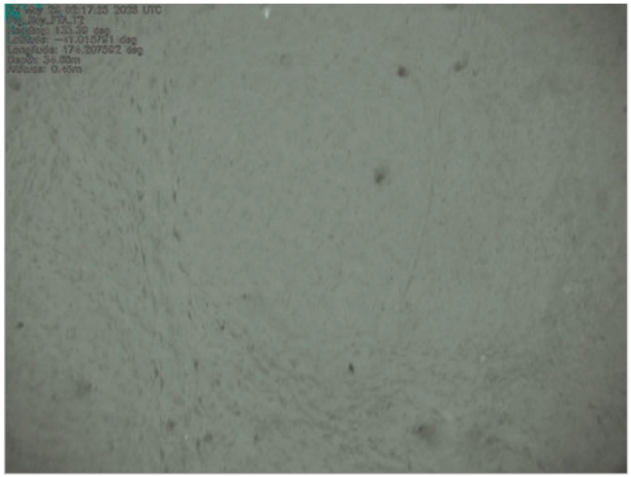
28 T2 34.9 m
sandy mud
burrows; bioturbation; possible sea cucumber; shell fragments.



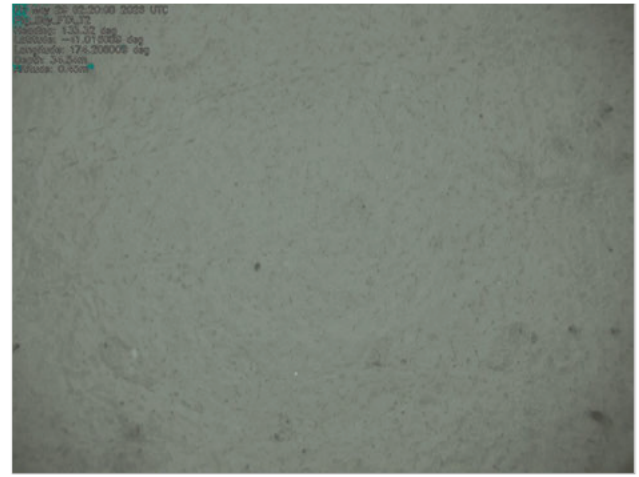
29 T2 34.5 m
sandy mud
burrows; bioturbation



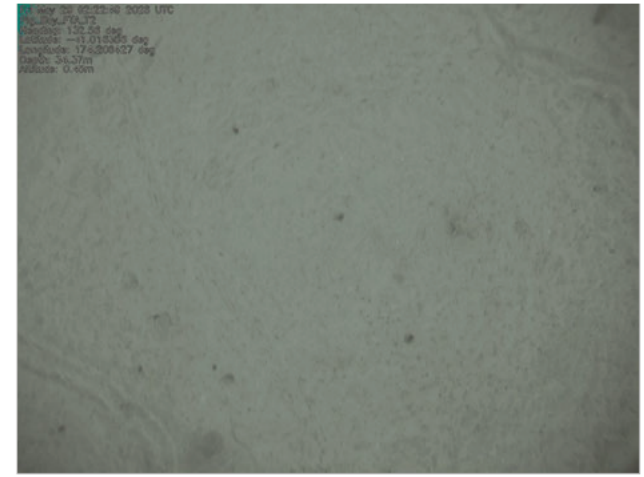
30 T2 34.1 m
sandy mud
burrows; bioturbation



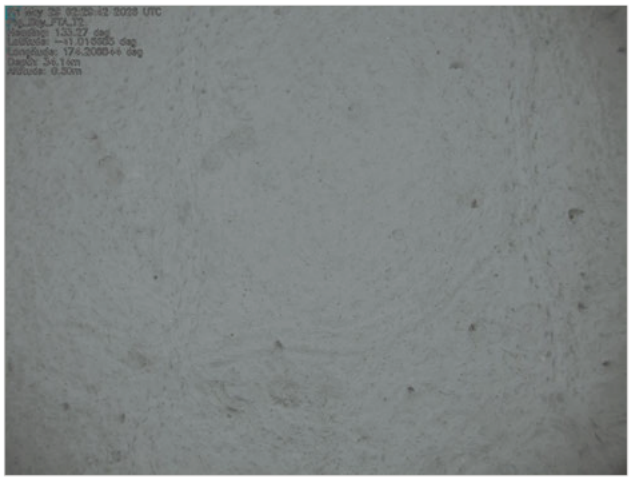
31 T2 33.8 m
sandy mud
burrows; bioturbation



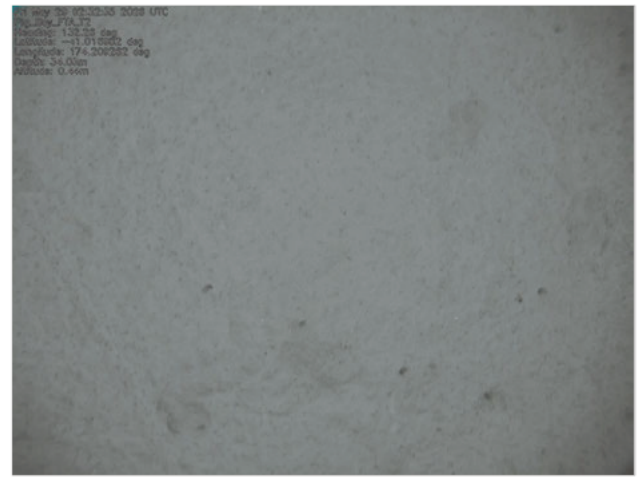
32 T2 33.6 m
sandy mud
burrows; bioturbation



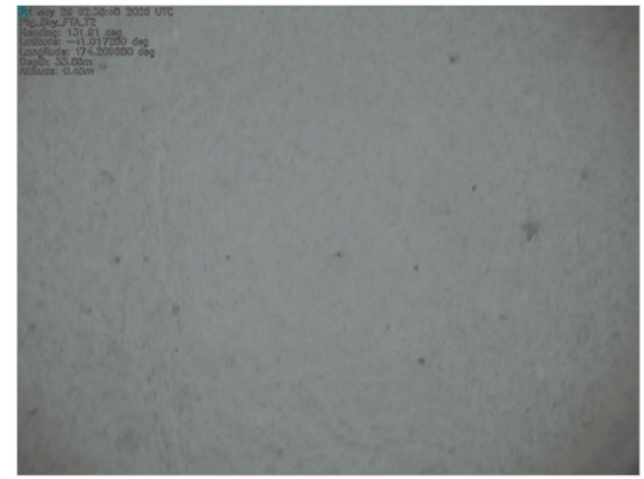
33 T2 32.3 m
sandy mud
burrows; bioturbation



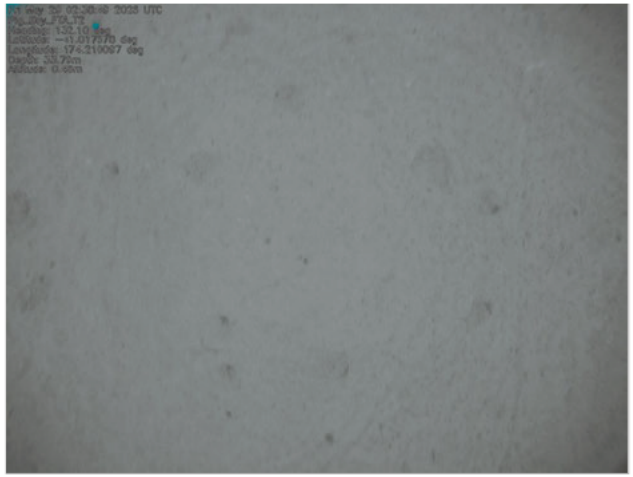
34 T2 32.0 m
muddy sand
burrows; bioturbation; shell fragments



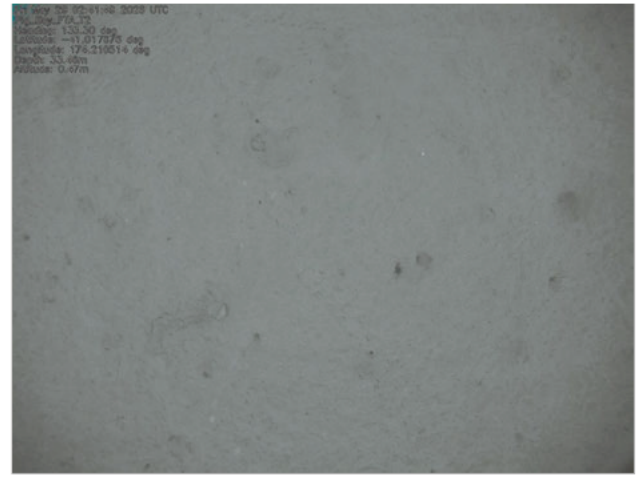
35 T2 32.0 m
muddy sand
burrows; bioturbation; shell fragments



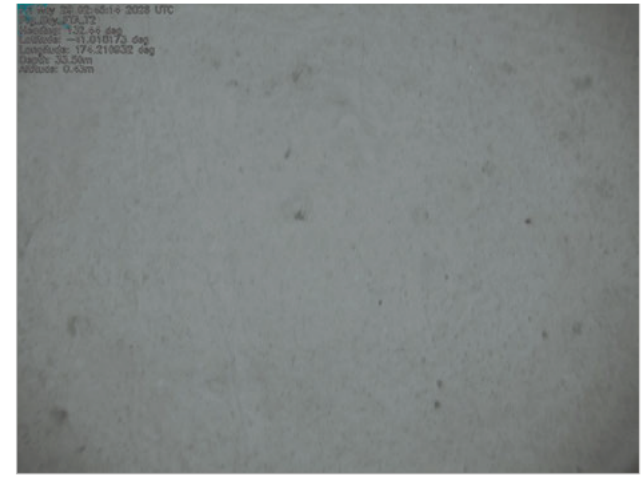
36 T2 32.1 m
muddy sand
burrows; bioturbation



37 T2 32.5 m
muddy sand
burrows; bioturbation

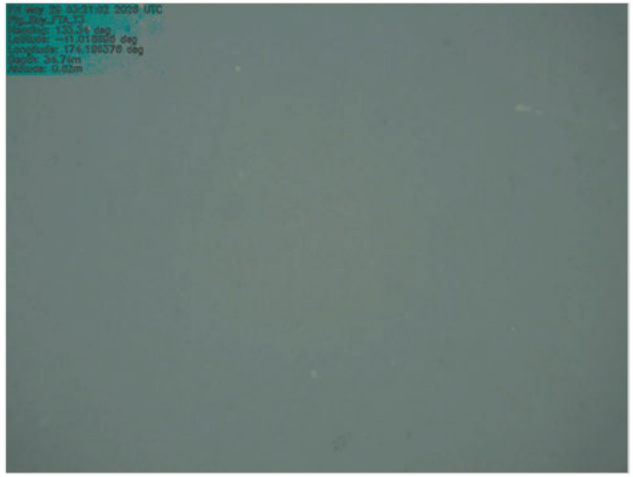


38 T2 33.4 m
muddy sand
burrows; bioturbation

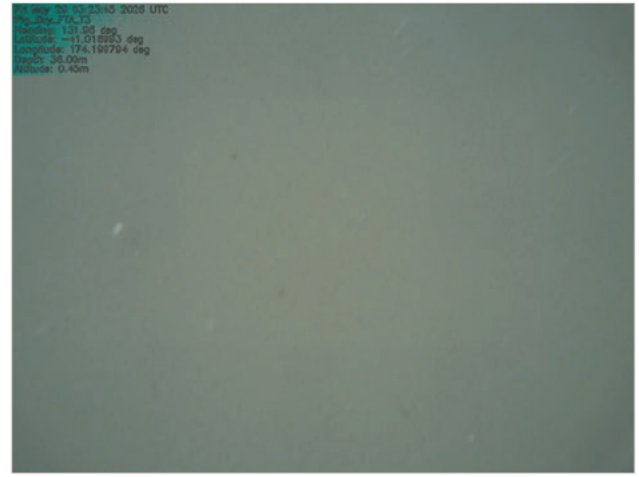


39 T2 33.9 m
muddy sand
burrows; bioturbation

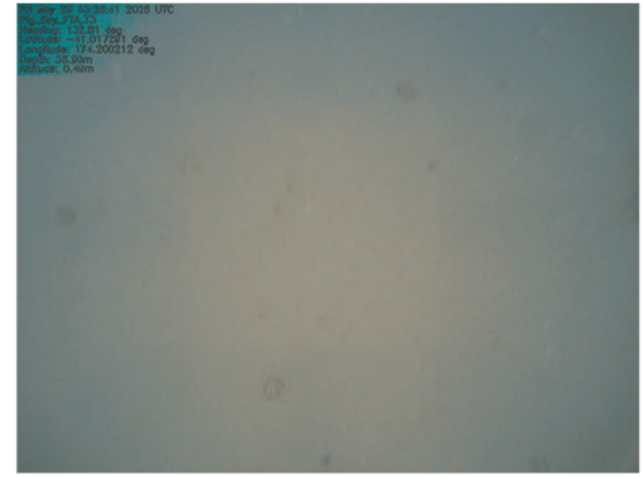
D.3 Transect T3 (Photo_No 40-57)



40 T3 35.6 m
mud
none visible



41 T3 36.2 m
mud
bioturbation



42 T3 37.4 m
sandy mud
burrows/bioturbation



43 T3 39.5 m
sandy mud
bioturbation



44 T3 40.0 m
sandy mud
bioturbation



45 T3 41.5 m
sandy mud
bioturbation



46 T3 41.9 m
sandy mud
none visible



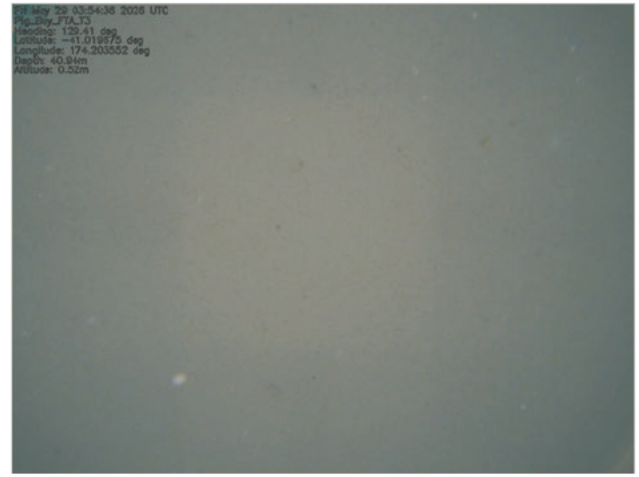
47 T3 41.8 m
sandy mud
none visible



48 T3 41.1 m
sandy mud
bioturbation



49 T3 39.9 m
sandy mud
burrows/bioturbation



50 T3 38.5 m
sandy mud
bioturbation



51 T3 36.8 m
sandy mud
bioturbation



52 T3 36.1 m
sandy mud
burrows/bioturbation; possible small shell fragments



53 T3 35.8 m
sandy mud
bioturbation



54 T3 35.1 m
sandy mud
burrows/bioturbation; worm tubes



55 T3 35.8 m
sandy mud
none visible



56 T3 35.5 m
sandy mud
bioturbation



57 T3 36.3 m
sandy mud
bioturbation

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