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Cover photo: Block failures along the coast west of Komakuk Beach, Yukon, by N.J. Couture, Geological Survey of Canada, August 17, 2008

TABLE OF CONTENTS

Abstract

This report provides coastal data and a classification of the Canadian Beaufort Sea coast and is part of the Coastal Information System (CIS) maintained by the Geological Survey of Canada. Coastal attributes such as the physical form of the coast and the materials which comprise it have been interpreted and mapped from aerial photography and video for over 1900 kilometres of coastline. These attributes are mapped as line segments for three different shore-parallel zones: the backshore, the foreshore, and the nearshore. Additional points of interest such as water bodies, anthropogenic sites, or ground ice features are also mapped. Qualitative coastal change was mapped along select portions of the coast based on the availability of repetitive, multi-year coastal video and imagery. A glossary has been developed to control the language used in the descriptions. The data are contained in a geographic information system. A published map file is also included, which provides examples for displaying and symbolizing the CIS data.

1. Introduction

Over the last 45 years, the Geological Survey of Canada (GSC) and partners have been conducting various studies along the Beaufort Sea coast, acquiring and interpreting data on coastal geology and processes. The Beaufort Sea coastal plain is a dynamic ice-rich sedimentary permafrost region subject to rapid erosion and changes in shoreline configuration (McDonald and Lewis, 1973; Forbes and Frobel, 1985; Harper, 1990; Héquette and Barnes, 1990; Solomon, 2005; Manson et al., 2005). Such changes can be induced by storms (Solomon and Covill, 1995), long-term sea level rise (Forbes et al., 2014), or climatic changes (Solomon et al., 1994). Rapid erosion mobilizes sediment while permafrost with massive ground ice creates the potential for thaw consolidation and promotes erosion. Changes in nearshore sea ice may also affect coastal infrastructure and harbour access. An understanding of coastal properties that control alterations in the coastline is useful to a variety of the region's stakeholders. Oil and gas exploration and development requires coastal access to supplies, services, shelter and other shore-based facilities. This leads to the need for ports and harbours, aids to navigation, oil-spill preparedness, and other coastal infrastructure. Municipalities and existing critical port sites (e.g. Tuktoyaktuk) may see changes in their approaches as protecting lands (e.g. Tuktoyaktuk Island) are eroded away. Other areas that may be affected include wildlife habitat and archaeological sites (Solomon, 1995; Forbes, 1997). The data collected by the GSC over several decades have been applied to a shore-zone description and classification that provides information critical to the planning, site selection, regulation and management of harbour facilities and other coastal areas of the Canadian Beaufort Sea.

2. The Coastal Information System (CIS)

The shore-zone classification data for the Canadian Beaufort Sea coast form part of the Coastal Information System (CIS), developed in 1994 for coastal information management purposes (Sherin and Edwardson, 1996) and maintained by the Geological Survey of Canada (GSC-Atlantic). Coastal attributes in the CIS have been interpreted and mapped from low-level, oblique, aerial photography and video imagery with accompanying audio commentary acquired in 1984 (Forbes and Frobel, 1985, 1986), and supplemented with some video from 1999 and 2000 (unpublished). The mapping covers just over 1900 km of the Beaufort coastline, stretching from the Alaska-Yukon border to just east of Cape Dalhousie, with both the mainland and islands being mapped. The coastal data consist of line segments with attributes describing the physical form and material composition, at scales ranging from 1:10 000 to 1:250 000. The CIS is hierarchical in that coastal forms are classified based on four increasingly detailed levels of description (super-type, type, sub-type, and feature). In addition, the coast is divided into three shore-parallel zones: the backshore, foreshore, and nearshore. Each zone is segmented separately based on homogeneous physical characteristics. A glossary has been developed to control the language used to describe each zone. The use of objective physical criteria for coastal classification enhances the utility of the CIS for a wide variety of applications.

The CIS contains feature classes with form and material attributes for each of the backshore, foreshore and nearshore zones. Additional feature classes contain further information for each of the zones; this includes an Ice Feature class, containing information in areas where ice was visible in the source data, and a CIS Points feature class, which contains coastal features that are best represented by points (e.g. buildings, watercourses). Finally, two change mapping feature classes (Change Mapping and Change Mapping Points) show areas where qualitative coastal changes were mapped based on multi-year repetitive video and aerial photography. A brief general description of each CIS feature class is provided below, and a full listing of all the forms and materials is included in Appendix 1.

3. Feature Classes

3.1 Backshore

The backshore is defined as the landward zone lying between higher high-water at large (spring) tides and the upper limit of shore-zone processes; it is acted upon by slope-failure processes, waves, wind, rainfall, or ice and covered by seawater only during severe storms with exceptionally high water levels. It is typically horizontal or rising landward and may be divided from the foreshore by the crest of the most seaward berm. The landward backslope of a spit or barrier beach is also considered to be part of the backshore unless the bay or lagoon shore of the barrier is mapped separately. Typical mapped backshore forms include cliffs, slopes, dunes, and wetlands, as well as artificial forms such as docks, ramps, seawalls, revetments, or other shore protection forms. Materials include combinations of ice, organics, mud, sand, gravel and boulders, rock, or artificial materials such as concrete, wood, or steel. Combinations of zonal form and material types can be queried to build more sophisticated classifications based on multiple criteria or empirical indices.

3.2 Foreshore

The foreshore is defined as the seaward-sloping zone of the shore or beach lying between higher high-water and lower low-water at large (spring) tides. It is the intertidal zone regularly covered and uncovered by the rise and fall of the tide. Typical mapped foreshore forms include slopes, beaches, tidal flats, or wetlands, as well as artificial forms such as docks, ramps, seawalls, revetments, or other shore protection features. Materials are generally similar to those found in the backshore.

3.3 Nearshore

The nearshore is defined as the lowest or outer zone of the shore or beach extending seaward an indefinite but generally short distance from the outer limit of the foreshore. It is the subtidal zone extending from lower low-water at large (spring) tides through the surf-zone, defining the area of wave breaking and littoral currents. Typical mapped nearshore forms include bars, channels, ebb-tidal deltas, deltas, peat and mud outcrops, or ice-scour features. Again, materials are similar to those found in other zones, but are less commonly recognizable in airborne video.

3.4 CIS Points

Coastal features which are best represented by points were mapped along the coast for each of the three shore-parallel zones (nearshore, foreshore, and backshore). Typical mapped features are water bodies and anthropogenic sites

3.5 Ice Features

Because of their potential importance in coastal stability, ice features that are exposed in any of the three shore-parallel zones (backshore, foreshore, nearshore) are mapped in a separate layer. These features may be various forms of ground ice or sea ice. Typical ice features include massive ice and ice wedges within permafrost, or accumulations of drift ice in the shore zone. Ground ice features may be further characterized by ice content. In addition to these exposed ice features, other landforms in the three CIS zones such as retrogressive thaw failures (RTF) or polygonal tundra may be indicative of ice-rich ground, but they are not included here because the presence of ground ice is only inferred in those situations and is not actually visible. The CIS can be queried for the presence of these indicative geomorphic features in the foreshore or backshore.

3.6 Change Mapping

Qualitative coastal change was mapped along select portions of the coast based on the availability of repetitive, multi-year, coastal video and aerial photography. Coastal changes over the intervals from 1984 to 1999 and from 1999 to 2000 were mapped from repeat oblique aerial video coverage. Additionally, along a small section of coastline, longer term changes were estimated by comparing 1958 aerial photography and 1999 oblique aerial video. Change mapping comments are based on the tendency of change (erosion, aggradation, and re-orientation), the extent of change (moderate, extensive, not discernable), or changes in specific features or materials (spit formation, mud flows, retrogressive thaw failures, accumulation of driftwood).

3.7 Change Mapping Points

Qualitative coastal change best represented by point features was mapped along select portions of the coast based on the availability of repetitive, multi-year, coastal video and aerial photography. Coastal changes over the interval from 1984 to 1999 were mapped based on repeat oblique aerial video coverage. Typical changes mapped as point features include buildings and watercourses.

4. Coastal Information System (CIS) Mapping for the Beaufort Sea

The CIS can be queried to extract and map information about the morphological and material make-up of the Beaufort Sea coast. For example, at the super-type level, the coast is relatively uniform and, except for a few sites with anthropogenic infrastructure, the entire length of coastline consists of unlithified materials. When broken down by form type, however, a sample query of the CIS database shows the variability within the backshore and foreshore zones of the Beaufort Sea coast (Table 1). As seen in Figure 1, the backshore consists predominantly of cliffs (62.7%). Of these, 80% are classified as low (2-5 m) or very low (<2 m), with the very low cliffs found primarily in the Mackenzie Delta. High cliffs are concentrated on the Yukon coast from Herschel Island to just east of Shingle Point and on the islands north of the delta. The remaining backshore is made up primarily of flats (27.0%), with some slopes, dunes, wetlands, and beaches. Figure 2 indicates that in the foreshore, beaches are the major landform (71.4%), followed by flats (16.5%), with only a few instances of cliffs, wetlands, slopes and bars. The only landforms mapped in the nearshore are bars, and they occur mostly east of Tibjak Point. The dominant material in all three zones is inorganic clastics (primarily pebbles, sand, and mud), constituting 69% of the backshore, 84% of the foreshore, and 99% of the nearshore. The remaining material type is made up of organics such as peat (note that although ground ice may also be a significant constituent of coastal materials, as stated earlier, it is mapped separately). An understanding of dynamic coastal regions can be gleaned by querying the changes occurring. For instance, 38% of the coastline shows some form of retreat over time. By contrast, only 21% of the coastline experienced aggradation over time. The data contained within the CIS can thus be customized and used by various stakeholders to obtain information on coastal geology and dynamics relevant to their particular application in coastal management and planning.

Table 1. Summary showing the variability and prevalence of coastal forms in the backshore and foreshore zones along the Canadian Beaufort Sea coast.

Landform types			
Backshore form type		**Length (km)**	**Percentage**
Cliff		1073.7	62.7
Flat		463.3	27.0
Slope		95.6	5.6
Dune		46.3	2.7
Wetland		32.4	1.9
Beach		1.3	0.1
Anthropogenic		0.5	< 0.1
Bar		0.0	< 0.1
	Total	**1712.4**	**100.0**
Foreshore form type		**Length (km)**	**Percentage**
Beach		1357.8	71.4
Flat		312.9	16.5
Watercourse		156.2	8.2
Cliff		41.3	2.2
Wetland		18.9	1.0
Bar		11.1	0.6
Delta		1.1	0.1
Slope		1.0	0.1
Anthropogenic		0.2	< 0.1
	Total	**1900.4**	**100.0**

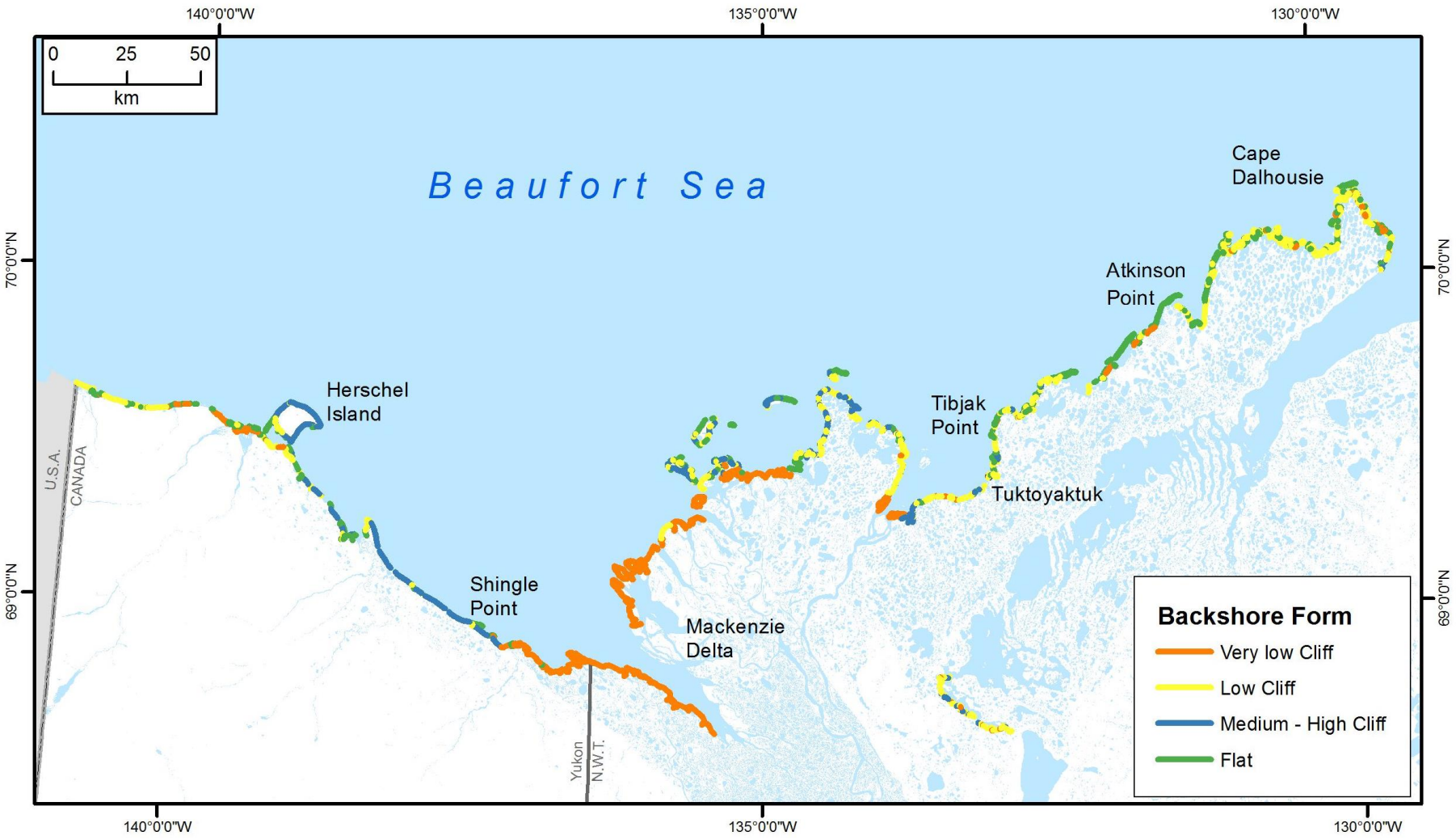

Figure 1. The most common coastal forms in the backshore zone include cliffs of varying heights and flats. The lowest cliffs are in the Mackenzie Delta, while most of the higher ones are along the Yukon coast.

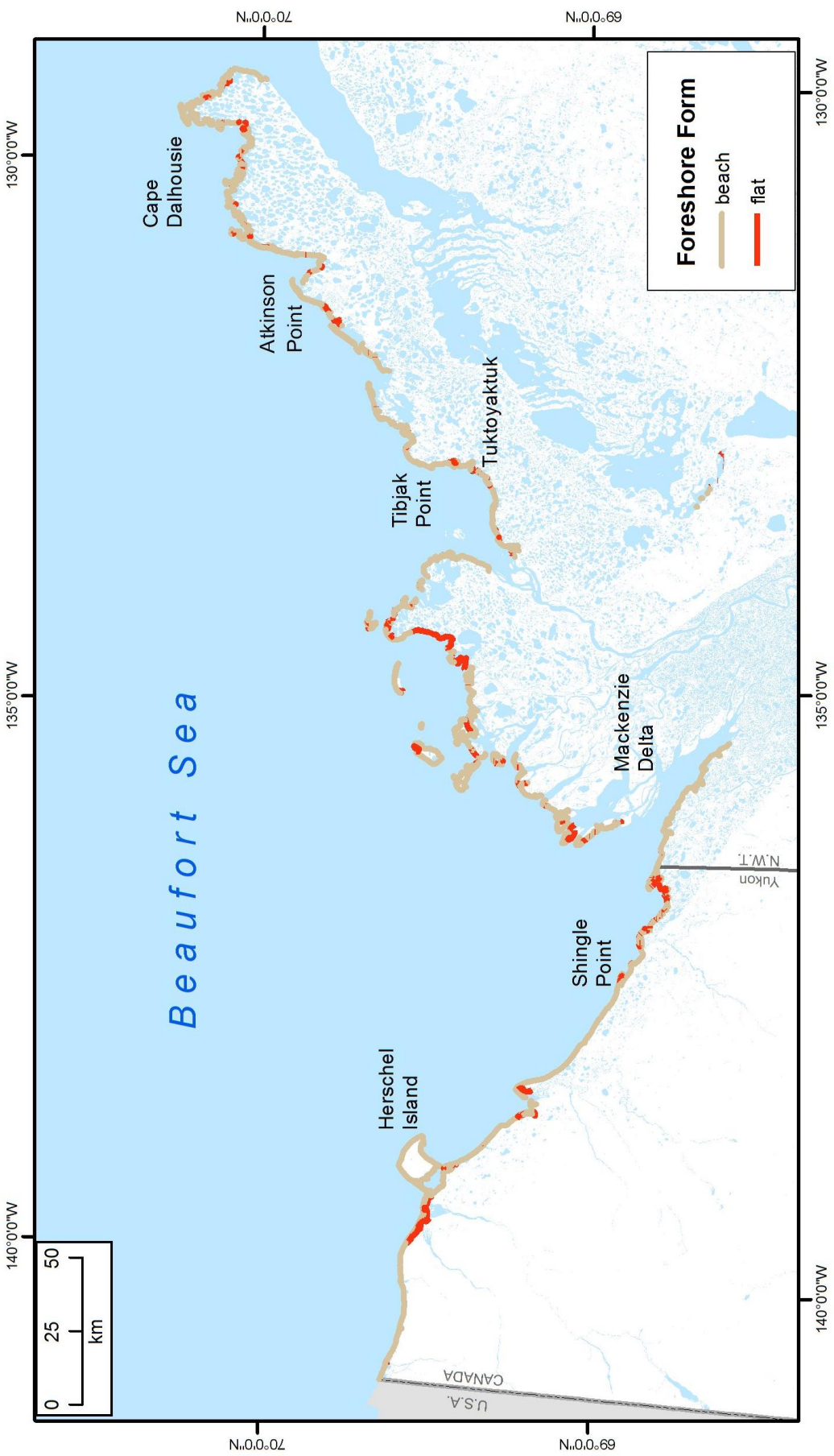

Figure 2. The most common coastal forms in the foreshore zone are beaches and flats.

5. The Geodatabase and Published Map File Layers

This open file contains the Beaufort CIS geodatabase with all the feature classes listed above. The CIS data were compiled using ESRI's ArcGIS 9™ software, but can be opened with other GIS software compatible with the ESRI format. The complete dataset can be viewed, manipulated and queried according to the software package being used. In addition, a published map file (.pmf) is also included, which contains a number of map layers showing some examples of the multitude of possibilities for displaying and symbolizing the CIS data. A brief description of each of these map layers is provided below. The published map file can be opened using ESRI's ArcReader™ software, a free desktop application that allows users to view and explore the data.

CIS Points
The CIS Points feature class symbolized based on the Form_Supertype, Form_Type, and Form_Subtype fields.

Nearshore Form
The Nearshore feature class symbolized based on the Form_Type, Form_Subtype, and Form_Features fields.

Nearshore Material
The Nearshore feature class symbolized based on the Mat_Type and Mat_Subtype fields.

Foreshore Form
The Foreshore feature class symbolized based on the Form_Type field. Not shown are anthropogenic, bar, and wetland forms.

Foreshore Material
The Foreshore feature class symbolized based on the Mat_Supertype, Mat_Type, and Mat_Subtype fields.

Foreshore Mudflows
The Foreshore feature class displayed using a definition query on the Foreshore_Features field to show only the Foreshore units with Mudflows.

Backshore Form
The Backshore feature class symbolized based on the Form_Type and Form_Height fields to show cliffs (very low, low, and medium – high) and flats. Not shown are anthropogenic, beach, dune, slope, and wetland forms.

Backshore Material
The Backshore feature class symbolized based on the Mat_Supertype and Mat_Type attributes.

Backshore Polygons
The Backshore feature class displayed using a definition query on the Backshore_Features field to show only the Backshore units containing polygons.

Backshore Driftwood
The Backshore feature class displayed using a definition query on the Backshore_Features field to show only the Backshore units containing driftwood.

Backshore Retrogressive Thaw Failures
The Backshore feature class displayed using a definition query on the Backshore_Features field to show only the Backshore units containing retrogressive thaw failures.

Ice
The Ice feature class symbolized based on the Form_Type and Form_Subtype attributes.

Change Mapping 1958 – 1999
The Change Mapping feature class symbolized to show changes mapped between 1958 and 1999.

Change Mapping 1984 – 1999
The Change Mapping feature class symbolized to show examples of changes mapped between 1984 and 1999.

Change Mapping 1999 – 2000
The Change Mapping feature class symbolized to show examples of changes mapped between 1999 and 2000.

Change Mapping Points 1984 -1999
The Change Mapping Points feature class symbolized to shown point changes mapped between 1984 and 1999.

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Appendix 1

List of forms cited in the Beaufort Sea CIS

Form supertype	Form type	Form subtype
solid	anthropogenic	building
		revetement
unlithified	anthropogenic	Longard tubes
	bar	deltaic
		littoral
	beach	attached spit
		barrier
		detached barrier
		fringing
		pocket
		tombolo
	cliff	vertical (very low, low, medium, high)
	delta	ebb-tidal
		flood-tidal
	dune	cliff-top
		multiple ridge
		primary ridge
		sheet
	flat	intertidal
		subaqueous
		supratidal
	ice	ice-wedge
		massive
		sea or drift ice
	slope	irregular
		smooth
	watercourse	distributary channel (delta)
		tidal inlet
	wetland	saline pond
		salt marsh

List of materials cited in the Beaufort Sea CIS

Material supertype	Material type	Material subtype
solid	anthropogenic	wood
unlithified	anthropogenic	rip rap
	clastic	cobble
		mud,sand
		mud,sand, pebble
		sand
		sand,pebble
		sand,pebble, cobble
		sand,pebble, cobble, boulder
		silt/peat
	organic	log strandline
		marsh grass
		peat

Appendix 2

Beaufort Sea CIS glossary of terms

- **active layer detachment (ALD)**: the downslope movement of sediment forming the active layer, i.e. the ground above the permafrost that thaws and re-freezes each year; the interface between the active layer and the permafrost acts as a slip plane.
- **aggradation**: the geologic process by which a surface such as a beach or delta plain is raised in elevation by the deposition of material eroded and transported from other areas by water or wind.
- **anthropogenic**: features influenced by human activities or made of artificial materials.
- **attached spit**: a point or narrow embankment of land, commonly consisting of sand or gravel, deposited by longshore sediment transport in the shore-zone and having one end attached to land and the other terminating in open water.
- **bar**: a generic term for any of various elongate nearshore ridges, banks or mounds of gravel or other unlithified material, submerged at least at high tide and built up by the action of waves and currents.
- **barrier**: a narrow, elongate ridge rising above the high-tide level and extending generally parallel to the shore, but separated from it by a lagoon, pond or marsh; equivalent to a spit connected at both ends or a detached spit (barrier island).
- **beach:** an accumulation of unlithified material formed by waves and currents, extending landward from the low-water line to a level where there is a distinct change in material or physiographic form (such as a cliff), or to the line of permanent vegetation (usually indicating the effective limit of the highest storm waves); a shore of a body of water formed and washed by waves and lacking a bare rock surface; the material and form of a beach can be highly variable.
- **berm**: a horizontal terrace or landward sloping ridge on the face of a beach (the beachface) in the foreshore or backshore.
- **block failure**: an erosional feature whereby a large volume of backshore material becomes detached from a cliff and typically collapses seaward.
- **boulder**: a clastic sediment particle with grain size (intermediate b-axis length) > 256 mm (Wentworth, 1922).
- **building**: roofed and walled structure built for permanent use.
- **clastic:** clastic sediments are those consisting of individual particles (rock or mineral fragments), called clasts, that have been detached and transported; they are classified primarily on the basis of grain size (Wentworth, 1922).
- **cliff:** a sloping face that is steeper than 20° formed by erosional processes and composed of unlithified material or a combination unlithified material and underlying bedrock [none in the Canadian Beaufort Sea]; may include material deposited at the base of cliffs by mass movement processes (e.g. slump or mudflow).
- **cliff-top dune:** a dune formed where wind-blown sand accumulates on top of a cliff.

- **cliff-top gravel**: a deposit of clastic material coarser than sand that accumulates on top of a cliff due to wind, wave, or ice action.
- **cobble**: a clastic sediment particle with grain size (intermediate b-axis length) between 64 and 256 mm (Wentworth, 1922).
- **degradation**: the geologic process by which a landscape or shore-zone surface is lowered by the removal of sediment.
- **delta**: a low-lying, near-horizontal surface where a river discharges into standing water; formed by accumulation of river-borne sediment that is not removed into deeper water by hydrodynamic processes in the receiving basin.
- **deltaic bar**: a sedimentary deposit formed by the accumulation of sediment at the mouth of a delta distributary channel.
- **detached barrier**: a narrow, elongate ridge rising above the high-tide level and extending generally parallel to the shore, but separated from it by a lagoon or bay; equivalent to a spit or barrier not connected to the mainland at either end (also known as a barrier island).
- **distributary channel (delta)**: a channel formed by division of a river channel into two or more channels near the river mouth in a delta.
- **distributary mouth bar (delta)**: a bar formed where a stream enters a body of standing water (see deltaic bar).
- **drained lake**: a lake with a floor above sea level, drained by erosion of the outlet channel or by coastal erosion causing shoreline retreat that intersects the lakeshore.
- **driftwood**: floating wood that has been deposited on shore by wave action.
- **drowned tundra**: tundra that has been partially or wholly inundated by rising sea level.
- **dune:** a low mound, ridge, bank or hill of wind-blown sand, either bare or partially covered with vegetation.
- **ebb-tidal delta**: a shoal or bar seaward of a tidal inlet to a lagoon or harbour and formed by ebbing tidal currents interacting with waves in the nearshore.
- **flat**: an extensive, nearly horizontal sedimentary deposit that is alternately covered and uncovered by the tide or storms and sometimes vegetated by seagrass.
- **flood-tidal delta**: a shoal or bar inside a tidal inlet to a lagoon or harbour and formed by flooding tidal currents; in most cases partially exposed at low tide.
- **fringing beach**: an accumulation of unlithified material formed by waves and currents, in a narrow shore-parallel strip fringing higher ground in the backshore.
- **gravel**: coarse clastic sediment consisting predominantly of particles larger than sand (grain size > 2 mm), including granules, pebbles, cobbles, and/or boulders (Wentworth, 1922); may also include a large proportion of sand.
- **gullied**: the form of a slope or cliff that is notched by small v-shaped depressions formed by surface runoff.
- **high salt marsh**: a coastal wetland covered only at the highest high tides and in storms; supports a higher diversity of plant species than lower marsh [in the Beaufort Sea, with its very restricted tidal range, this includes distinctive supratidal marsh surfaces flooded in storm surges and dominated by *Puccinellia phryganodes* (creeping goose grass), often

associated with irregular morphology of small mounds and thermokarst depressions] (see supratidal flat).

- **ice-wedge**: wedge-shaped, vertically foliated ground ice formed in permafrost by freezing of water in thermal contraction cracks.
- **ice-wedge polygon**: see polygon.
- **intertidal flat**: a near-horizontal surface composed of unlithified clastic sediment (predominantly mud and/or sand) between high and low tide.
- **linear**: the shape of an elongated sedimentary deposit such as a bar or beach.
- **littoral bar**: a sedimentary ridge (linear or crescentic) formed by waves and currents in the lower foreshore or nearshore zone.
- **log strandline:** driftwood logs which have accumulated at the high-water mark.
- **Longard tubes**: a patented tube composed of woven polyethylene fabric, filled with sand at installation; effectiveness as shore protection depends on the tube remaining intact and completely filled.
- **low salt marsh**: a marsh affected by brackish or saline water and covered by all moderate and high tides, with low plant species diversity.
- **marsh grass:** tall, smooth grass growing in salt marshes, that may be submerged at high tide.
- **massive ice**: ground ice consisting of tabular bodies of almost pure ice; widespread in permafrost regions of the world, including the Beaufort Sea coast.
- **mud**: fine-grained, unlithified, clastic sediment consisting of silt and/or clay with grain size finer than 63 μm (Wentworth, 1922).
- **mudflow - continuous**: a deposit or flow of mud originating from a retrogressive thaw failure depression and extending uninterrupted across the beach.
- **mudflow - discontinuous**: a deposit or flow of mud originating from a retrogressive thaw failure depression and extending intermittently across the beach.
- **mudflow - wave truncated**: a deposit or flow of mud originating from a retrogressive thaw failure depression, extending across the beach, but trimmed by wave erosion.
- **multiple-ridge dune**: well-established dune system with two or more ridges in the backshore.
- **niche/notch**: a deep, narrow cut or hollow at the base of a cliff produced by wave erosion and/or thermal abrasion.
- **not stabilized**: an area of sloping unlithified material that is not stabilized by vegetation.
- **organic:** of, relating to, or derived from living organisms.
- **partially stabilized**: an area of sloping unlithified material that is partially vegetated.
- **peat**: an unlithified deposit of partially decayed plant remains.
- **peat block**: peat that has become detached from an unlithified cliff due to erosion.
- **peat/mud outcrop**: an outcrop, terrace, or shoal comprised of peat and/or mud extending seaward from the shoreline.

- **pebble**: a clastic sediment particle with grain size (intermediate b-axis length) between 4 and 64 mm) (Wentworth, 1922).
- **pingo**: a large, conical, ice-cored mound or hill, formed in drained thaw lakes in permafrost terrain and other intrapermafrost settings.
- **pocket beach**: a concave beach, flanked by bedrock headlands, with limited linear extent.
- **polygon (or ice-wedge polygon)**: a polygon formed in permafrost terrain by intersecting thermal contraction cracks and associated ice wedges.
- **primary (ridge) dune**: frontline (most seaward) coastal dune with a well-developed ridge.
- **relict ridge(s)**: abandoned beach or dune ridge(s) in the backshore marking former location or successive positions of advancing shoreline, or raised above present sea level by uplift and coastal emergence.
- **re-orientation**: realignment (rotation) of a beach or shoreline by sediment redistribution in response to changes in wave conditions.
- **retreat**: landward migration of a shoreline in response to sea-level rise (also called marine transgression) and/or coastal erosion.
- **retrogressive thaw failure (RTF)**: a progressively expanding slope failure resulting from permafrost thaw and melt-out of massive ground ice exposed in a retreating headwall, with downslope transport of sediment in mudflows; RTF form bowl-shaped depressions or more extensive terraces where amalgamated; in most cases they do not contribute directly to coastal retreat, but promote rapid local landscape denudation and delivery of sediment to the ocean; RTF exhibit cycles of activity, stabilization, and reactivation; they are reliable indicators of ice-rich permafrost.
- **revetment**: a facing of stone or concrete to protect a shoreline or embankment from wave damage.
- **ridge and runnel**: small-scale bars forming a repetitive pattern of ridges and troughs parallel to the shoreline on intertidal flats.
- **rip rap**: large fragments of broken rock dumped or placed to form a revetment or breakwater as shore protection.
- **saline pond**: a depression in the backshore containing brackish water derived from storm-surge or high- tide overwash and flooding.
- **salt marsh**: a coastal wetland that is periodically inundated by tidal brackish or saline water and which supports significant non-woody vascular vegetation.
- **sand**: unlithified clastic sediment particles with grain size between 0.063 mm and 2 mm (63−2000 μm) (Wentworth, 1922).
- **sea ice**: ice formed by the freezing of sea water.
- **sheet dune**: a layer of wind-deposited sand that has accumulated across the surface of a land form but has not formed ridges typically associated with dunes and which is otherwise featureless.
- **silt/peat**: an unlithified deposit of semicarbonized plant remains and interbedded sediment formed in a water-saturated environment.

- **slope:** gently sloping (less than 20°) backshore surface composed of unlithified material, with a smooth, undulating, or irregular morphology; in some cases, may extend into the foreshore.
- **slump block**: a mass of material transported downslope as a coherent unit in a slump or rotational slope failure.
- **snow ramp**: a snow drift formed against a cliff or backshore slope, covering the adjacent beach.
- **stabilized**: the condition of a cliff or slope in unlithified sediment that is fully vegetated.
- **storm ridge**: a backshore ridge crest at the top of a beach, formed by storm waves.
- **subaqueous flat**: nearshore terrace or flooded surface not uncovered at low tide.
- **supratidal flat**: a landscape surface or marsh above the high tide level but frequently flooded by the extreme tides or minor storm surges.
- **tidal inlet**: a channel through a barrier allowing regular tidal exchange of water between the ocean and the back-barrier water body (bay, lagoon, or harbour).
- **tombolo**: a sediment deposit or beach that connects an island to an adjacent land mass (another island or the mainland).
- **transverse bar**: a lower foreshore or nearshore bar at a steep angle (up to 90º) to the shoreline.
- **tundra**: a treeless landscape at high latitude with distinctive herbaceous vegetation.
- **unlithified**: clastic sediments that have not been cemented.
- **vertical cliff**: a cliff face with an angle of 50º or greater.
- **washover channel**: a channel formed by storm-wave runup and overwash of the ridge or dunes.
- **washover fan**: a fan shaped deposit of sediment landward of a washover on the back slope of a barrier.
- **watercourse:** a natural or artificial channel containing continuously or periodically flowing water; or forming a connecting link between two bodies of water.
- **wetland:** a landscape feature characterized by continuous or intermittent standing water; coastal wetlands range from saline salt marshes to brackish or nearly fresh marshes at higher elevation.
- **wood**: lumber used for building purposes such as docks, pilings, and buildings.