Assessment of the Environmental Sensitivity of Kingsburg Beach

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1.0 Introduction

Beaches and barrier island systems located along the Atlantic coast of Nova Scotia can generally be considered environmentally sensitive areas.

The Atlantic coastline of Nova Scotia is subject to expeditious rates of sea-level rise, caused primarily by the geologic subsidence of the coastal landmass of the Maritime Provinces, but also by higher global sea-levels induced from glacial melt and the thermal expansion of the oceanic water column (Grant 1970, Quinlan and Beaumont 1981).

The rate of sea-level rise along the Atlantic coast of Nova Scotia is among the highest anywhere along the eastern seaboard of North America. Long-term historic tidal gauge records from the Maritimes indicate sea-levels have increased approximately 30cm over the past century (Grant 1970, Shaw et al. 1993). This rate is expected to accelerate in coming years due to global climate warning, and some predictions place sea-levels along the Atlantic coast of Nova Scotia approximately 1m higher by the year 2100 A.D. (Taylor and Shaw 1994).

Beaches and barrier island systems located along the Atlantic coast of Nova Scotia are affected by these high rates of sea-level rise (Shaw et al. 1993, Orford and Carter 1995, Orford et al. 1995a). Even modest increases of sea-level position can translate into substantial horizontal changes in the position of the coastline. This relationship is described by Bruun's Rule, which demonstrates that rates of shoreline retreat (R) are a function of sea-level rise (S) and nearshore gradients (G) (Komar 1991).

$$R = S / G$$

Thus, increases of sea-level position along the Atlantic coast of Nova Scotia can be expected to induce episodic shifts in the position of beach and barrier profiles, causing these systems to migrate landwards over time.

Numerous studies have been published showing the dynamic nature of beaches and barrier islands along the Atlantic coast of Nova Scotia (e.g. Taylor et al. 1985, Boyd et al. 1987, Carter et al. 1990, Orford et al. 1991, Taylor and Frobel 1999). These beaches are among the best-studied coastal systems in Canada.

Beaches and barrier islands located along this stretch of coast undergo alternating phases of progradation (oceanward migration of the beach) and transgression (landwards migration of the beach), superimposed upon an overall framework of rapid coastal submergence (Boyd et al. 1987). Here, beaches and barrier island systems initially develop at points along the coast where there is an abundance of sediment supply, usually near eroding headlands or drumlins (Taylor et al. 1985,

Carter et al. 1990, and Forbes et al. 1990). Large quantities of sediment supplied to longshore currents from these eroding surfaces are subsequently deposited down-current atop the beach and barrier systems, sometimes enabling the beaches to temporarily keep pace with increases of sea-level position. Progradation occurs until sediment supplies are used-up, after which beaches and barrier islands rapidly degrade and are forced to migrate landwards until they encounter new sediment supplies further inland (Boyd et al. 1987, Carter et al. 1989, Orford et al. 1995b)

The history of Kingsburg Beach appears to conform with this cyclic evolutionary model. It exhibits geomorphic features indicative of both progradation (*e.g. beach ridges*) and retreat (*e.g. eroding bluffs, washovers, landwards translation of shoreface*).

This paper uses a series of reports written about Kingsburg Beach to assess its environmental sensitivity.

2.0 Environmental Sensitivity

In recognition of its importance and environmental sensitivity, Kingsburg Beach was designated as protected in 1993 under the Beaches Act.

This Act requires the province to "provide for the protection of beaches and associated dune systems as significant and sensitive environmental and recreational resources" (Beaches Act, Section 2(2)(a)).

There are several reasons why Kingsburg Beach can be considered environmentally sensitive. These are described below.

2.1 Dynamic coastal system

Kingsburg Beach is a dynamic coastal environment that is influenced by a number of coastal processes, including winds, tides, waves, sediment supply, longshore currents, storm surges, and sea-level change. These processes interact to create an environment that changes quickly, sometimes in response to a single event or disturbance.

Storm surges associated with the approach of hurricanes, for instance, have over-topped the primary dune-line at Kingsburg Beach in the recent past, resulting in the rapid re-distribution of sediment on the landwards side of the beach (Taylor and Shaw 1994).

Perhaps the best example of the dynamic nature of Kingsburg Beach, however, involves its ongoing retreat under rising sea-level conditions. Bruun's Rule predicts

that Kingsburg Beach will retreat 8m to 13m over the next century, given calculated nearshore gradients of 0.03 to 0.05 and increases of sea-level position of 0.3m to 0.4m/100years, respectively (JWEL and CSRL 1994).

Measurements carried out at Kingsburg Beach demonstrate that the beach appears to be conforming with predictions set-out by Bruun's Rule. Aerial photograph analyses indicate that between 1955 and 1992 Kingsburg Beach migrated landwards between 5m and 13m, creating net migration rates of 0.15m/year and 0.45m/year, respectively (JWEL and CSRL 1994).

The rate of recession for the coastal bluffs near Kingsburg Beach has also been assessed. It was determined to be 0.4m/year from aerial photographs (JWEL and CSRL 1994) and between 0.6m/year and 1.4m/year from cliff-top measurements (Taylor et al. 1985, and Shaw et al. 1993).

Likewise, the dune systems of Kingsburg Beach have also been shown to be migrating, with blowouts and washover features documented at several locations (JWEL and CSRL 1994)). Once again, aerial photographs have been used to quantify migration rates. Measurements indicate that the dune crest at Kingsburg Beach has migrated landwards approximately 18m from 1955 to 1992, creating a long-term net migration rate of approximately 0.5m/year (JWEL and CSRL 1994).

2.2 Sediment impoverishment

Beaches and barriers located along the Atlantic coast of Nova Scotia often develop at points along the coast where there is an abundance or over-abundance of sediment supply, usually near outcrops of glacial till (Boyd et al. 1987). Erosion provides ample sediments to the beach and barrier shorefaces, which may enable them to prograde under otherwise transgressive sea-level conditions. Once sediment supplies become exhausted over time, however, vertical accumulation atop the beaches and barriers may no longer be able to keep pace with rising sea-levels. Rapid degradation will occur, and the beaches and barriers will be forced to migrate landwards until newer onshore sedimentary supplies are encountered further inland (Boyd et al. 1987, Carter et al. 1989). Some beaches and barrier islands from Nova Scotia have been left behind by rising sea-levels altogether and now occur as relict lag deposits on the continental shelf (Piper et al. 1986, Forbes and Boyd 1987, Forbes et al. 1991).

There are places along the Atlantic coast of Nova Scotia that are naturally impoverished of glacial sediment, particularly along the South Shore of the province (see: Piper et al. 1986). At these locations, sediment conservation becomes particularly important to the management of beach and barrier island systems because the influx of sediments from onshore deposits may be insufficient to supplement deficiencies in the sediment budget of the beach. This appears to be the case for Kingsburg Beach.

Several studies have examined the sediment supply at Kingsburg Beach (Urquhart 1977, JWEL and CSRL 1994, Taylor and Shaw 1994). These reports suggest that existing sediments from beach, dune, and backshore environments must be recycled back into the system for Kingsburg Beach to avoid submergence under rising sea-level conditions, given that new sediments are not being supplied to the beach system from onshore sources.

> "It is concluded from these studies that the present supply of new sediment to Kingsburg is insufficient to offset natural changes caused by rising sea level, storms, and other factors." (Taylor and Shaw, 1994, pg. 22)

> "There is a scarcity of local external sediment (ie. alongshore or offshore) from which to draw upon to supplement the beach building process." (NSDNR, 2004, pg. 2).

> "Kings Bay and Hartling Bay are being subjected to continued submergence due to relative rise in sea level. Since the sediment influx is unable to restrain this rise by building up beach ridges the coastline is slowly receding…" (Urquhart, 1977, pg. 52).

The lack of sufficient onshore glacial sediment stores near Kingsburg Beach makes the system particularly sensitive to environmental change. Development that might armour dune and backshore sediments from coastal processes, or otherwise block the landwards transferal of sediment, could threaten the sediment supply required for Kingsburg Beach to avoid submergence under future conditions of sea-level rise.

Other beaches and barriers along the Atlantic coast of Nova Scotia, particularly those located adjacent eroding drumlins, are less vulnerable to long-term sea-level rise in this regard.

2.3 Diverse geomorphic features

Kingsburg Beach contains a rich diversity of geomorphic features, including beach ridges, primary dunes, secondary dunes, inter-dunal troughs, washovers, lagoons, deltaic deposits, backbarrier ponds, and backbarrier wetlands.

Moreover, it is one of only about twenty sites in Nova Scotia that contains a preserved suite of prograded beach ridges (Taylor and Shaw 1994). These ridges increase in height with increasing distance toward the ocean, since the oldest of the ridges furthest from the beach would have formed under lower sea-level conditions.

Although it is not uncommon for beaches along the Atlantic coast of Nova Scotia to exist in a state of progradation, it is rare for prograded beach ridge features to be so well preserved under conditions of expedited sea-level rise. These prograded beach

ridges represent an uncommon geomorphic feature for beach and barrier island systems along the Atlantic coast of Nova Scotia. It is far more common along this stretch of coast to find beach features indicative of shoreline retreat.

2.4 Kingsburg Pond

Kingsburg Pond is a freshwater area located landwards of Kingsburg Beach. Prior to 1500 years before present, Kingsburg Pond was an estuarine system open to the sea. Spits emanating from nearby headlands, however, began to close-off the embayment and by approximately 600 years before present the freshwater system of Kingsburg Pond had developed (Taylor and Shaw 1994).

In Nova Scotia, many coastal water bodies have switched from freshwater to marine as sea-levels have increased, but fewer are known to have switched from marine to freshwater under these same conditions. In this regard, the Kingsburg Beach complex with its associated backbarrier freshwater ponds represents an important landscape feature not well documented in the province.

> "Kingsburg Pond represents one of the few documented cases in Nova Scotia where a water body has switched from marine to fresh…" (Taylor and Shaw, 1994, pg. 21)

The aquatic and wetland areas of Kingsburg Pond also provide important habitat for migrating aquatic bird species. The ecological significance of Kingsburg Beach is discussed in the next section.

> "Kingsburg Pond and its associated wetlands provide a convenient feeding and staging area for migrating aquatic birds" (JWEL and CSRL, 1994, pg. 43)

Moreover, Kingsburg Pond is an environmentally sensitive area that may be prone to eutrophication (JWEL and CSRL 1994). Eutrophication (the artificial fertilization of an aquatic area) can result from a number of factors, including agricultural run-off, residential run-off, and septic fields, among others. Eutrophication can cause algal blooms, which can be harmful to aquatic ecoystems by using up available oxygen.

2.5 Ecological diversity

Kingsburg Beach contains a rich diversity of ecosystems and species. An ecological study carried out in the vicinity of the beach identified 12 distinct habitat types, including open fresh water, open salt water, beach, marsh, fen, low shrub dominated swamp, low shrub dominated thicket, tall shrub dominated thicket, dune, heath, rough pasture, and abandoned pasture (JWEL and CSRL 1994).

Within these twelve habitat types, 155 species of vascular plants were identified, 57 species of birds, 12 mammal species, 4 amphibian species, and 1 reptilian species. (JWEL and CSRL 1994). Although not observed during the field survey, the endangered piping plover (*Charadrius melodus*) is also known to visit Kingsburg Beach (JWEL and CSRL 1994). Other rare bird species documented near Kingsburg Beach include Ruddy Duck (*Oxyura jamaicensis*), Tricolored Heron (*Egretta tricolor*), Snowy Egret (*Egretta thula*), and Little Blue Heron (*Egretta caerulea*) (JWEL and CSRL 1994).

Because Kingsburg Peninsula protrudes a fair distance from the mainland coast proper, this area may be functioning as an important focal point and staging area for bird species flying along the coast.

> "The Kingsburg area appears to be a focal point for birds migrating along the coast…" (JWEL and CSRL, 1994, pg. 42)

> "The heavy use of the Kingsburg Beach study area (particularly the wetland habitats) by migrating birds is also a significant feature of this area." (JWEL and CSRL, 1994, pg. 50)

Because of its relatively high diversity of ecosystems and species, and its particular importance to migratory birds, the vicinity of Kingsburg Beach can be considered environmentally significant. Moreover, many of the habitat types that support these species, including marshes, fens, and thickets, are sensitive to human disturbance.

> "Three wetland habitat types are found in the Kingsburg study area, all of which are sensitive to anthropogenic activities…Marsh and fen habitats are particularly sensitive in this respect since the dominant species are generally low and herbaceous." (JWEL and CSRL, 1994, pg. 58)

2.6 Inter-dunal swales

Kingsburg Beach is one of only five locations within the province where dune slack wetlands can be found (see: Hale 1992).

> "Other ecological features of note at Kingsburg Beach include the presence of dune slack wetlands (Large Cranberry/Baltic Rush and Broad-leaf/Rush species associations)…" (JWEL and CSRL, 1994, pg. 50).

Inter-dunal swale wetlands occur at Kingsburg Beach between the prograded beach ridges near Kingsburg Pond. These wetlands can be considered one of the rarest and under-studied wetland types in Nova Scotia. Only around twenty beaches in Nova Scotia contain prograded beach dune ridges (Taylor and Shaw 1994). Fewer still maintain wetland areas between these dune ridges.

Because of the geographic limitations imposed by the dune environment, inter-dunal swale wetlands tend to be relatively small in size. This is sometimes problematic, since broad evaluations of ecological features often lack sufficient spatial resolution to capture smaller ecosystems, regardless of their ecological significance.

The *Nova Scotia Wetland Atlas* prepared by the Department of Natural Resources, for instance, only examines wetland areas at least half a hectare in size (NSDNR 1991). Because inter-dunal swale wetlands are intrinsically small, these important wetland areas are not generally captured by this analysis. Subsequent evaluations that rely upon the wetland atlas, therefore, could miss the ecological importance of rare inter-dunal swale wetlands altogether.

With only five known inter-dunal swale wetlands occurring in Nova Scotia, the presence of inter-dunal swale wetlands at Kingsburg Beach adds to its environmental sensitivity and overall ecological significance.

3.0 Existing documents

The environmental sensitivity of Kingsburg Beach is noted in several site-specific reports. These include:

Fischer, A. 1997. Maintaining the ecological integrity of the Kingsburg Peninsula. In Leslie, S. (ed.). *Issues in protected areas management: the Kingsburg Peninsula*. Unpublished report to the School for Resource and Environmental Studies, Dalhousie University, Halifax, Nova Scotia: 12-21.

Jacques Whitford Environment Limited and Canadian Seabed Research Limited (JWEL and CSRL). 1994. *Ecological study of Kingsburg Beach, Kingsburg, Lunenburg County*. Unpublished report to Nova Scotia Department of Natural Resources. Project #9646. Pp. 69.

Nova Scotia Department of Natural Resources (NSDNR). 2003. *Managing development on protected beaches in Nova Scotia with Kingsburg Beach as a case study*. Unpublished report prepared by Jacques Whitford Environment Limited, Ekistics Planning and Design, and JM Environmental Consulting, Project #NSD17581. Pp. 39.

Nova Scotia Department of Natural Resources (NSDNR). 2004. *Kingsburg Management Report*. Unpublished report. Pp. 8.

Taylor, R.B. and J. Shaw. 1994. *Recent geological evolution of Kingsburg Beach: Kingsburg, Lunenburg County, Nova Scotia*. Unpublished report to Nova Scotia Department of Natural Resources. Geological Survey of Canada, Atlantic Geoscience Centre, Dartmouth, Nova Scotia. Pp. 39.

Urquhart, E.F. 1977. *Holocene history of Kings and Hartling Bays, Atlantic coast of Nova Scotia*. Unpublished Honours Thesis, Dalhousie University, Halifax, Nova Scotia. Pp. 113.

4.0 Summary

Kingsburg Beach can be considered environmentally sensitive for the following reasons:

- It is a dynamic system with sedimentary environments prone to rapid changes.
- Rising sea-levels are forcing Kingsburg Beach to migrate landwards over time.
- Sediment impoverishment from onshore sources requires beach, dune, and backshore sediments to be recycled for Kingsburg Beach to avoid submergence.
- Kingsburg Beach contains a rich diversity of geomorphic features including beach ridges, primary dunes, secondary dunes, inter-dunal troughs, washovers, lagoons, deltaic deposits, backbarrier ponds, and backbarrier wetlands.
- Kingsburg Beach is one of only about twenty sites in Nova Scotia that contains prograded beach ridges.
- Kingsburg Pond is an important area for migratory birds and represents one of only a few documented cases in Nova Scotia where a water body has switched from marine to fresh water under rising sea-level conditions.
- Kingsburg Beach contains an abundance of ecosystems (12 distinct habitat types) and species (at least 155 vascular plant species, 57 bird species, 12 mammal species, 4 amphibian species, and 1 reptilian species).
- The protrusion of Kingsburg Peninsula from the rest of the mainland coast makes the Kingsburg Beach area an important focal point and staging area for birds flying along the coast.
- Kingsburg Beach contains one of only five known inter-dunal swale wetlands in Nova Scotia, perhaps the rarest wetland type in the province.

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