1 Town of Placentia, Newfoundland, Water Resources Infrastructure

Figure A- 6 Town of Placentia, Newfoundland

1.1 Background

Water resources infrastructure vulnerability was one of four priority areas selected for review as part of the First National Engineering Vulnerability Assessment.

The Town of Placentia, Newfoundland, was chosen as the focus for one of the two water-resources case studies.

This case study centers on four pieces of infrastructure in the Town of Placentia, located on Newfoundland's Avalon Peninsula and on the east coast of Placentia Bay. The community encompasses Dunville, which forms the northwestern section of the town and is connected to downtown by a lift bridge. The Placentia area is subject to frequent storms, which have caused serious flooding in low-lying locations.

Specific infrastructures assessed were a breakwater, a steel floodwall, a stretch of highway and related culvert systems, and a building within the flood plain in downtown Placentia.

This case study provides a useful snapshot of engineering and municipal considerations presented by the prospect of rising sea levels and other factors associated with climate change.

Cameron Consulting Incorporated of Halifax, Nova Scotia, and AMEC Earth & Environmental (a Division of AMEC Americas Limited) of St. John's, Newfoundland, prepared the report for PIEVC and Newfoundland and Labrador Environment and Conservation. Data gathering for the case resulted from site visits, teleconferences, a workshop as well as through information provided by the Newfoundland and Labrador departments of Transportation and Works; Municipal Affairs; Environment and Conservation, and the Town of Placentia. OURANOS supplied climate-change modeling data.

1.2 Where, What and How

Located in southeast Newfoundland, about 100 km southwest of St John's, the historic Town of Placentia lies on the east side of Placentia Bay. The bay is bounded by the Burin Peninsula to the west and the Avalon Peninsula to the east.

With a current population of about 4,000, Placentia was first settled early in the 17th century. Fishery has been a traditional mainstay but the economy also benefited, starting in the Second World War, from the nearby but now-closed U.S. Armed Forces Northwest Atlantic Operations. The Newfoundland ferry terminal of Argentia–North Sydney, operated by Marine Atlantic Inc., is in the area.

Figure A- 7 Floodwall

Placentia Bay has an abundant and diverse marine ecosystem and is considered an environmentally sensitive area. The region is the site of present and planned petroleum refineries as well the proposed locale for processing ore from the Voisey's Bay nickel-copper-cobalt deposit. Its low-lying location on a flood plain adjacent to the sea has contributed to the town historically having to deal with serious flooding. In response to this threat, two pieces of

infrastructure were built to hold back seawater. A stone and timber breakwater – begun in the 1960s and extended in the 1990s – was built. To prevent flooding by water diverted by the breakwater, a sheet-steel pile floodwall was constructed in 1993 along the inside (northeast) face of the downtown peninsula.

This case study reviews both the breakwater and the floodwall. Two other infrastructure elements of the case study are:

- the Town Hall located in Placentia's downtown floodplain; and
- the main coast highway, along with related culverts, where it runs through the Dunville area of Placentia. (Dunville is linked to the downtown by a lift bridge.)

Figure A- 9 Breakwater

For this case study, key climate-change considerations are sea level rise, wind-assisted surge waves and intense rainfall events with resulting runoff. Besides causing flooding, such phenomena can increase possibilities of erosion. Placentia-area infrastructure located in low-lying sites in communities and along roadways is vulnerable to flooding. For example, in August 2007, heavy rain from the post-tropical storm Chantal washed out bridges and submerged roads, basements and parking lots. One road collapsed under a car's weight when a culvert beneath the pavement washed away, creating a gap six meters wide and six meters deep. In 2007, Dunville experienced flooding related to Chantal but downtown Placentia escaped flooding.

Eastern Newfoundland's climate is mid-boreal, marked by cool summers and winters. Communities fringing Placentia Bay, like Newfoundland and Labrador in general, currently are subject to a wide range of climatic events, including mid-latitude storms, hurricanes and tropical storms, snowfall and frost, plus summer drought. Recent trends suggest that such events are becoming more frequent and intense.

The need to understand and adapt to changes in the coastal environment is becoming increasingly clear. Most of Atlantic Canada, for example, has experienced a rising sea level for thousands of years and further rises in sea levels are anticipated due to climate change.

1.3 Technical Summary

Climate Modeling

Portions of the Town of Placentia, including those behind the breakwater and the floodwall, now lie at sea level (0m). This is an important consideration relative to future climate-change scenarios.

Data from two climate simulations provided by OURANOS, the climate research and development consortium, target the year 2050.

Climate-change projections for 2050 assume Placentia will face:

- Mean rise in sea level of 0.15m from 0m at present;
- Wind-assisted storm waves (surge waves), whose elevation will vary depending on the affected infrastructure (0.25m for breakwater and for the floodwall); and
- 12% increase in the rainfall intensity.

This means that at the breakwater and the floodwall, when sea-rise increases are combined with a potential storm surge, the total anticipated rise would amount to 0.4m.

At the breakwater, currently the potential exists for of a surge wave of 7m or about 1.2m higher than the breakwater. Similarly, at present along the floodwall, the potential exists for a surge wave of 5 to 5.25m or about 3m higher than the current top of the floodwall.

The increased rainfall intensity is anticipated temporarily but repeatedly to elevate the groundwater table elevation by 0.45m, from 0m.

It is also noted that data records indicate that the temperature pattern in Newfoundland does not follow the general trend of the interior of North America. While the areas may be subject to climate variability currently occurring in Atlantic Canada, no statistically significant long-term warming trend is observed in the Avalon Peninsula. Though climate warming may not be directly evident in eastern Newfoundland at present, global warming trends will impact the sea level along Newfoundland's coast.

Climate-model projections, provided by OURANOS, forecast little anticipated change in wind intensities at Placentia by 2050.

Other Influencing Factors

The North Atlantic Oscillation (NAO) could influence projected increases in rainfall intensity in Newfoundland. The NAO results from cyclic variations in the pressure regimes produced by differences in atmospheric pressure regimes in the Atlantic Ocean. Changes in these relationships can produce differing weather patterns manifested by cyclical changes in temperature, wind, precipitation, sea ice and snow cover.

Scientific literature included with the case study suggests that sea-level changes also can involve complex interplay of factors that include:

- Melting polar glaciers; and
- Gradual rebounding or rising of land as glacier disappear.

Studies have also noted that, depending on the localized geographic features factors and tide pattern, the impact of sea-level change can vary considerably even among geographically adjacent locations.

Performance Measures

The impact of climate changes, including hydrological alterations, were assessed for the four Placentia infrastructure components. The assessment took into account the following performance measures:

- Strength;
- Capacity;
- Stability;
- Maintenance, operations and monitoring;
- Emergency planning;
- Property protection (insurance);
- Policy and procedures; and
- Lifecycle planning.

Main Breakwater

The breakwater is owned by the Town of Placentia and located along the west side of the main community, including the downtown area. The breakwater is constructed from stone, used creosoted railway ties, and pressure-treated wood in one portion. A boardwalk runs along the top. The breakwater, which receives continuous wave action, runs parallel to the main beach along Beach Road and forms the western limit of development for the downtown peninsula section of the Town of Placentia. The breakwater deflects storm surge seawater along the perimeter of the downtown peninsula. The typical top elevation of the breakwater is 5.8m and under normal conditions the top of the breakwater is between 2 and 4m above beach sediment on the seaward side.

For the main breakwater, the climate factors of interest are:

- Sea-level elevation change;
- Storm surge seawater elevation change (associated with wind speed).

A catastrophic failure of the breakwater would flood portions of downtown Placentia. Although spray and slush have reached the adjacent road, to date the breakwater has prevented flooding.

According to the consultants, insufficient human, equipment, time, opportunity and financial resources are being directed toward the breakwater. Based on the defined performance measures, specific recommendations are made to deal with:

- Strength;
- Capacity;
- Maintenance, operations; monitoring – including for sediment and erosion; and
- Lifecycle planning.

For other performance measures, sufficient adaptive capacity exists.

Steel Sheet Pile Floodwall

The steel sheet pile floodwall was constructed in 1993 along the back of the peninsula (northeast) of the newer portion of the Town of Placentia. The floodwall is build at a location where the geodetic elevation is 0m and typical tide (1992) is 1.2m under calm conditions. The infrastructure runs parallel to and between the main beach and a road.

The top elevation is 2.2m at typical sections of the floodwall, which has been effective in conveying the deflected storm-surge water away from the town.

For the floodwall, climate factors of interest are:

- Sea-level elevation change;
- Storm-surge sea water elevation change (associated with wind speed).

Catastrophic failure of the floodwall would flood much of downtown Placentia Bay. According to the consultants, insufficient human equipment time, opportunity and financial resources are being directed to the floodwall. Based on the defined performance measures, specific recommendations are made to deal with:

- Capacity;
- Maintenance, operations and monitoring;
- Lifecycle planning; and
- Strength.

For other performance measures, sufficient adaptive capacity exists.

It is noted that insufficient information is available but the potential does exist for a wave up to 5m high, or about 3m higher than top of the floodwall rolling up against it. Given the potential that already exists for a large wave to pass over the top of the floodwall, an additional increase of 10% in the level of wave water resulting from climate change is not considered an unacceptable threat to the performance of the floodwall.

Corrosion represents the most likely challenge to the floodwall's integrity (the town has proposed a $300,000 cathodic protection system).

Town Hall in Flood Plain – Town of Placentia

The Town Hall is used as representative of buildings located in the floodplain in downtown Placentia, an area of potential flooding identified in maps developed through the Canada-Newfoundland Agreement on Flood Damage Reduction.

Relevant considerations are: 0m the current mean sea level; 0.45m the anticipated upper future mean groundwater elevation; 0.55m approximate bottom of foundation footing; 1.75m floor elevation of the Town Hall; and the 2.2m typical top elevation of the floodwall. (See above.)

For the Town Hall, climate factors of interest are:

- Sea-level elevation change;
- Increased rainfall characterized by greater intensity duration and frequency, and more stormwater runoff; and
- Combined sea-level elevation and storm-surge wave elevation.

While there is a past history of flooding in downtown Placentia, it has not occurred (including during the post-tropical storm Chantal in August 2007) since construction of the breakwater and floodwall. If the floodwall and breakwater function effectively, the principal climate risks posed to the Town Hall are increased rainfall and decreased capacity of the ground to absorb stormwater due to rises in the groundwater or tidal elevations.

According to the consultants, insufficient human, equipment, time, opportunity and financial resources are being directed to potential downtown flooding, including of the Town Hall. Based on the defined performance measures, specific recommendations are made to deal with:

- Policies and procedures capacity; and
- Lifecycle planning.

For other performance measures, sufficient adaptive capacity exists.

Community of Dunville Road and Culvert System

A provincially owned, two-lane highway (Route 100) from St. John's runs through Dunville, which forms part of Placentia. Dunville, which lies northwest of the downtown, is reached by crossing the Sir Ambrose Shea Lift Bridge spanning the Placentia Gut.

To one side of the road is a steep slope with some residences, small evergreen trees on minimal soil cover, and outcrops of bedrock. There are some barren patches to the tree cover. The forest is not currently logged, but was in the past, and when the exposed soil blew away, barren patches without tree cover resulted. To the other side of the road, sloping downward steeply towards the water, are more residential homes. The road is almost perpendicular to the water runoff route.

Figure A-10 Dunville Road

The area has been subject to flooding events, partially and temporarily blocking culverts (with designs based on 1:100 year water flows) and water build-up along the upslope of the road. Results (including when post-tropical storm Chantal brought 200mm of rain to the area in August 2007) have entailed washout of portions of the road, need to replace sections of the road and culverts, flooding of homes and temporary isolation of part of the community.

For the Dunville road and culvert system, climate factors of interest are increased rainfall characterized by greater intensity duration and frequency, and more stormwater runoff.

According to the consultants, insufficient human, equipment, time, opportunity and financial resources are being directed to the Dunville road and culvert system. Based on the defined performance measures, specific recommendations are made to deal with:

- Capacity;
- Stability;
- Maintenance, operations and monitoring;
- Property protection (insurance);
- Policy and procedures; and
- Lifecycle planning.

For other performance measures, sufficient adaptive capacity exists.

1.4 Policy Makers Executive Summary

General Climate Change Impact

Over the time horizon to the year 2050, the Town of Placentia is likely to experience several climate-related changes that will impact local infrastructure, including the breakwater, floodwall, buildings in the downtown flood plain, and road and associated facilities in Dunville.

Influencing climate-related phenomena are:

- Sea level rise;
- Higher storm surges; and
- Increased rainfall intensity.

The first two factors could adversely affect the town's breakwater, floodwall, and the downtown flood plain, in and around the Town Hall. The latter could also be affected by increased rainfall intensity.

Road and culvert systems in Placentia's Dunville area are likely to be affected by the more intense rainfall leading to greater stormwater runoff from steep slopes.

Recommendations

- Establish a land-use plan to minimize storm water run-off on the steep slopes:
- Monitor corrosion rate of steel wall and establish a protocol and plans for wall replacement;
- Account for rise in flood plain groundwater for any new construction, including storm sewer;
- Set up and follow a monitoring protocol/schedule of sediment and erosion around the breakwater.