Community of Bamfield
Conceptual Study for Wastewater Treatment

FINAL REPORT

Prepared by:

Mitchell Hahn, P.Eng.
Stantec Consulting Ltd.

Reviewed by:

Paul Agate, P.Eng.
Stantec Consulting Ltd.

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Executive Summary

Background

In May 2012 the Alberni Clayoquot Regional District (ACRD) retained Stantec Consulting Ltd. to provide a conceptual study for wastewater treatment options for the Community of Bamfield. Except for the Bamfield Marine Science Centre (BMSC), the community is currently not serviced by a wastewater treatment facility. This conceptual study is to provide public education to the Community of Bamfield on sewage issues and to assist with knowledgeable discussions on the future planning of wastewater treatment for the community.

A review of existing documentation and discussions with the Ministry of Environment (MOE) and the Vancouver Island Health Authority (VIHA)indicated that residences in Bamfield are serviced either by onsite sewage treatment (septic tanks and disposal fields), while approximately forty (40) residences discharge raw sewage directly into the Bamfield Inlet. In addition there are twelve authorized commercial wastewater treatment systems and approximately four un-authorized commercial systems that discharge into Bamfield Inlet's intertidal zone. To the south, the Huu-ay-aht First Nation's Village of Anacla also currently uses individual septic tanks and tile fields for sewage disposal. The Village of Anacla is currently undergoing relocation and feasibility studies for a new wastewater treatment facility, with possible partnership with the BMSC, are currently in progress.

Issues

In 2001/2002, the MOE undertook water quality sampling in the Bamfield and Grappler Inlets. The study found elevated fecal coliform levels during the summer months exceeding both shellfish consumption (14 CFU/100ml median) and *recreational use guidelines* (200 CFU/100ml geometric mean) in the Bamfield Inlet. These results prompted further monitoring in 2005-2007 to focus on the summer period, to fulfill the five weekly samples in 30 days requirement under the British Columbia water quality guidelines, and to increase the number of sampling locations and types of indicators.

The 2005-2007 MOE study included the use of the following indicators: fecal coliforms, enterococci, E.Coli, Nitrogen Isotopes, microbial source tracking, and caffeine. In general, this study found that the Bamfield Inlet is subject to bacteriological contamination most prevalent in the area adjacent to the homes and business along the inlet. The levels of contamination were most apparent in the peak months when bacteriological levels exceeded BC Water Quality Guidelines for primary and secondary recreational use. In addition, the results indicated that human sewage is the main contributor to microbiological contamination in the Bamfield and Grappler Inlet.

The current bacteriological contamination of Bamfield Inlet has led to VIHA, in partnership with MOE, , advising the public of the potential health risk in the Inlet due to the presence of human sewage. A sanitary closure to shellfish harvesting is also currently in place for the waters and intertidal foreshore of Bamfield and Grappler Inlet.

Wastewater Collection/Treatment/Disposal Options

The 2012 MOE report "Water Quality Assessment and Objectives for Bamfield Inlet" proposes both short-term (for primary and secondary recreational use) and long-term (for shellfish harvesting) water quality objectives for both fecal coliforms and enterococci. The proposed short-term (5-10 years) water quality objective is that the geometric mean of a minimum of five weekly samples collected within a 30-day period must not exceed 20 CFU/100 mL for enterococci and must not exceed 200 CFU/100 mL for fecal coliforms at all sites within Bamfield and Grappler Inlets. The proposed long-term (>10 years) water quality objective is that the median of a minimum of five weekly samples collected within a 30-day period must not exceed 4 CFU/100 mL for enterococci and must not exceed 14 CFU/100 mL for fecal coliforms at all sites within Bamfield and Grappler Inlets.

In order to achieve the MOE goals, the Community of Bamfield will have to look at a wastewater treatment system for its residence and commercial properties. A review of on-site, communal (cluster) and a centralized treatment system were reviewed. Currently the BMSC and Anacla Village are reviewing options for a combined wastewater treatment plant which gives the community a chance to potentially become part of this system and build a community wide treatment plant. This will require timely collaboration and a agreeing on means of governing the system with the three parties.

Alternative wastewater treatment systems which were reviewed included: preliminary, primary, advanced primary, secondary, and advanced wastewater treatment. This conceptual report outlines the type, location, area serviced and order of magnitude costs associated with these types of systems and narrows the options for further review in the preliminary design stage. Collection systems were also reviewed including: septic tank effluent pumping (STEP), septic tank effluent gravity (STEG), gravity and low pressure systems.

For the order of magnitude costs presented in Table E1 below, a population of ,1800 was used for a separate Bamfield WWTP to include for the high summer visitor population (and potential development with the paving of the road to Bamfield). This was increased to 2,200 for the single community wide central plant option to account for the 200 students at BMSC, and 200 future population from Anacla. Approximately 300 Litres per person per day was used.

System	Type	Population Serviced	Liters per Day	Cost per System
1	Individual On-site Septic Tank & Tile Field	2	600	$20,000 - $40,000
2	Communal On-site Septic Tank & Tile Field	10	3,000	$50,000 - $100,000
3	Communal On-site Septic Tank, Packaged Plant & Tile Field	20	6,000	$150,000 - $250,000
4	Bamfield Separate Plant (East Side)	1800	540,000	$800,000 - $1,000,000
5	Expansion HFN/BMSC centralized plant	2200	660,000	$700,000 - $900,000

Table E1 – Treatment System Order of Magnitude Costs

Collection system Infrastructure costs are summarized in Table E2 below and include for pipes, pumps, filters, valving, and service connections. Collection Systems 4 and 5 included for two lift stations ($300K each) and an inlet crossing from West to East Bamfield ($250K).

System	Treatment Type	Collection Type	Cost per system
1	Individual On-site Septic Tank & Tile Field	None	$0
2	Communal On-site Septic Tank & Tile Field	STEP	$50,000 - $75,000
3	Communal On-site Septic Tank & Packaged Plant	STEP	$50,000 - $75,000
4	Bamfield Separate Plant (East Side)	STEP/STEG	$3.5M – 4.0M
5	Expansion HFN/BMSC centralized plant	STEP/LP	$3.5M – 4.0M

Table E2 – Collection System Order of Magnitude Costs

Effluent disposal was also reviewed and could be accomplished either by discharge to ground or to the marine environment. It is expected that only some of the onsite septic systems are capable of discharging to ground due to unfavorable conditions for ground discharge in Bamfield. As such, any larger cluster systems or a centralized system would be required to discharge to the marine environment and would need to meet the new Federal Regulation for effluent quality: average cBOD of 25 mg/L, and average TSS of 25 mg/L.

An outfall serving a separate Bamfield outlet would be required to run approximately 2 km to reach Trevor Channel. This would have an order of magnitude cost of $600K. Using a central plant with the BMSC and HFN would utilize an upgraded BMSC existing outfall and would result in significant cost savings. Approximate outfall costs are summarized in Table E3 below.

System	Treatment Type	Outfall Length	Cost
1	Individual On-site Septic Tank & Tile Field	None	$0
2	Communal On-site Septic Tank & Tile Field	None	$0
3	Communal On-site Septic Tank & Packaged Plant	None	$0
4	Bamfield Separate Plant (East Side)	STEP/STEG	$600,000
5	Expansion HFN/BMSC centralized plant	STEP/LP	$60,00 (Bamfield

			Portion)

Table E3 – Collection System Order of Magnitude

Wastewater Management

Different wastewater management options are reviewed in the report including the Municipal Sewage Regulation (MWR) and the Liquid Waste Management Plan (LWMP). The MWR provides effluent quality parameters for discharge to water, ground and for re-use, as well as design criteria, sampling, and monitoring and reporting protocol for municipalities in all regions of BC. The LWMP process provides authority to discharge under an operating certificate and can be implemented in stages, taking into account the receiving environment, financing, and includes a strong public input to the waste management planning process. Upgrades and maintenance are planned out and approved with the LWMP through community involvement and participation during the planning process. The LWMP can also deal with additional wastewater management items as the required by the community.

Conclusion

The Community of Bamfield's existing waste water management practice has been shown, through testing by MOE, to be detrimentally impacting the Bamfield Inlet and poses a public health risk. Ultimately we draw that conclusion that the system that makes the most economical and environmental sense is for the Community of Bamfield to move toward a central treatment system involving both the HFN and BMSC. This can take effect over a period of time and could utilize the new forcemain from Anacla Village and a combination of STEP and LP system. A subsea forcemain could also be installed to transfer effluent from the West side to the East side for treatment.

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1.0 Introduction

1.1 Study Overview

The objective of this study is to provide an overview conceptual study on options for sewage treatment in the Community of Bamfield. In essence this study will look in broad strokes at what currently exists, what are the issues, how can they be addressed, and what could it all cost. This conceptual study serves first and foremost as an educational and informational tool for the Alberni Clayoquot Regional District (ACRD) and the Community of Bamfield to enable discussions on the future planning of wastewater treatment.

1.2 Study Location

The Community of Bamfield is located on the west coast of Vancouver Island and is situated on the south shore of the entrance to Barkley Sound where Trevor Channel meets the Pacific Ocean. Bamfield is divided by the Bamfield Inlet (approximately 180 m across – see Image 1) into West and East Bamfield. West Bamfield is linked to East Bamfield by boat only (no road exists to link the two sides); however many of the homes and businesses on the West side are connected by a wooden boardwalk which runs from the Government Dock to the Coast Guard Station. East Bamfield contains most of the community amenities (health unit, volunteer fire department, Bamfield Marine Science Centre and public school) and businesses. East Bamfield also includes the area known as Port Desire which is located on Grappler Inlet to the East. Approximately 2.5 kilometers to the south of East Bamfield is the Huu-ay-aht First Nation's (HFN) Anacla Village.

The Community of Bamfield is connected, via an unpaved logging road, to the City of Port Alberni (approximately 90 kilometers to the south west). A private gravel airport exists at Bamfield although there are no scheduled flights. Connection to Port Alberni is also made by the Francis Barkley, a freight and passenger ship, which makes frequent trips between Port Alberni and Bamfield.

Image 1 – View Across Bamfield Inlet to the West Side (Coast Guard Station and Francis Barkley)

1.3 Study Population

According to the 2011 Census, the Community of Bamfield has approximately 155 full time residences with 85 occupied private dwellings by usual residents. This is a 38% reduction in population from the 2006 census. [1] Bamfield is a summer eco-tourist and fishing destination and the Bamfield Marine Science Centre reaches peak occupancy in the summer, which results in a seasonal population reaching as high as 2,000.[2] There are several resorts and B&Bs in Bamfield that host this increase in population.

1.4 Climate

The regional climate is characterized by mild temperatures and heavy winter rains. The Average temperature is 4.8 °C in January and 14.8 °C in August (average daily maximum of 18.8 °C in August). The mean annual rainfall is 290 cm, with the heaviest rains occurring from November to February. Snowfall is rare although winter storms can be expected from mid- October to mid-March. The driest months are July and August. [3]

1.5 Oceanography

Bamfield Inlet consists of an inner and outer basin with an average depth of 3 m and maximum depth of 9 m. Several small islands (Burlo and Rance Islands) exists in the inlet. The head of the inlet is comprised of a large mud flat area fed by two seasonal streams. A shallow shelf, approximately 1 m in depth, separating the two basins is expected to reduce the flushing action of the inner inlet. The mid-basin zone (or start of the outer basin), where most of the residential area is located, has an average depth of 10 m. Near the mouth of the inlet it has an average depth of 20 m and a maximum depth of 45 m at the entrance. [4] The Bamfield Marine Science Centre's (BMSC) 200mm outfall (Sclair Pipe Series 60) is located at a depth of approximately 35m below mean low water level at a distance of 150m off shore.

To the East, Grappler Inlet has a narrow entrance with an average depth of 7 m. This opens up into Port Desire, the first basin, with an average depth of 5 m. Another narrow and shallow channel (passable only during moderate to high tides) then connects Port Desire to another inner basin. The inner basin is open and shallow, with an average depth of 2 m. [4]

The surface water temperature ranges from 8-17°C with a thermocline at 4-6 meters. Below the thermocline, the temperatures range from 7-10°C. The surface water salinity ranges from 13-32 ppt with a shallow halocline in the top few meters. Below 10 meters the salinity is 31-32 ppt. The surface water oxygen concentration averages 6-7 ml//L, dropping off at 40 meters to 4-5 ml/L. Tides in the Barkley Sound area are the mixed semi-diurnal type with two unequal cycles per day. The maximum predicted amplitude is 3.9 m. [5]

2.0 Background (Existing Conditions)

2.1 Existing Treatment Systems

Currently no community sewage collection or treatment system serves in the Community of Bamfield. Some private residences and B&Bs have primary treatment (septic tanks) with the effluent being further treated by tile fields or raised mounds prior to the tile fields, while some systems discharge directly into Bamfield Inlet's intertidal zone without treatment. In total there are approximately 40 residential raw sewage outlets into the inlet. [6]

There are also twelve authorized commercial wastewater treatment systems and approximately four un-authorized commercial systems that discharge into Bamfield Inlet's intertidal zone. These systems are of various ages and states of repair. The Ministry of Environment indicated that they would be surveying these commercial operations later in 2012 to identify non-compliant systems. [6] There were no pump-out facilities for vessels at the docks observed during Stantec's site visit on May 3rd, 2012.

The Bamfield Marine Science Centre is serviced by its own a 70 m^3/day Chicago Pump rated aeration activated sludge package plant. The plant typical operates at 40 m^3/day, with peaks up to 55 m^3/day during the summer months. This packaged plant is over 30 years old and is currently being considered for replacement. The plants 200mm diameter outfall location is not exactly known, as it is unmarked and visual inspection would indicate it may differ for the original design drawings. The BMSC's Director noted that they plan to map the outfall location and do a video condition assessment later this year if possible.[7]

The Village of Anacla to the south currently uses individual septic tanks and tile fields for sewage disposal. Most of the houses (36 single family homes) are located in the southeast sector of the Village, which is located in a flood plain less than 3m in elevation. The Village is currently undergoing relocation and feasibility studies for a new wastewater treatment facility are in the review stage at this time.

3.0 Water Quality

3.1 Previous Water Quality Assessment

As part of this options report Stantec and the ACRD met with the MOE and VIHA to discuss the historical and present issues with water quality in the marine environment surrounding the Community of Bamfield. MOE staff presented the results of their preliminary assessment (2001/2002) and subsequent assessment (2005-2007). The MOE also invited both the ACRD and VIHA to be present during their follow up assessment this fall.

The MOE reported that during their initial discussions with Bamfield, that residents noted that the inlet had changed over the last 20 years with more visible algae and visible contamination of waste, but wanted the Ministry to prove the inlet was contaminated.[6] A preliminary marine environment assessment of Bamfield and Grappler Inlets was conducted in 2001/2002 through a joint effort between the Ministry of Water, Land and Air Protection (now MOE), the ACRD, Environment Canada, local area shellfish growers, BMSC, and the Ministry of Health. Sampling was conducted from October 2001 to September 2002 at twelve locations (see Figure 1) within the Bamfield inlet and consisted of monthly grab samples for fecal coliform analyses. The study found elevated fecal coliform levels during the summer months exceeding both shellfish consumption (14 CFU/100ml median) and *recreational use guidelines* (200 CFU/100ml geometric mean) in the Bamfield Inlet.[4] The results are included in Appendix A. These results prompted further monitoring to focus on the summer period, to fulfill the five weekly samples in 30 days requirement under the British Columbia water quality guidelines, and to increase the number of sampling locations and types of indicators.

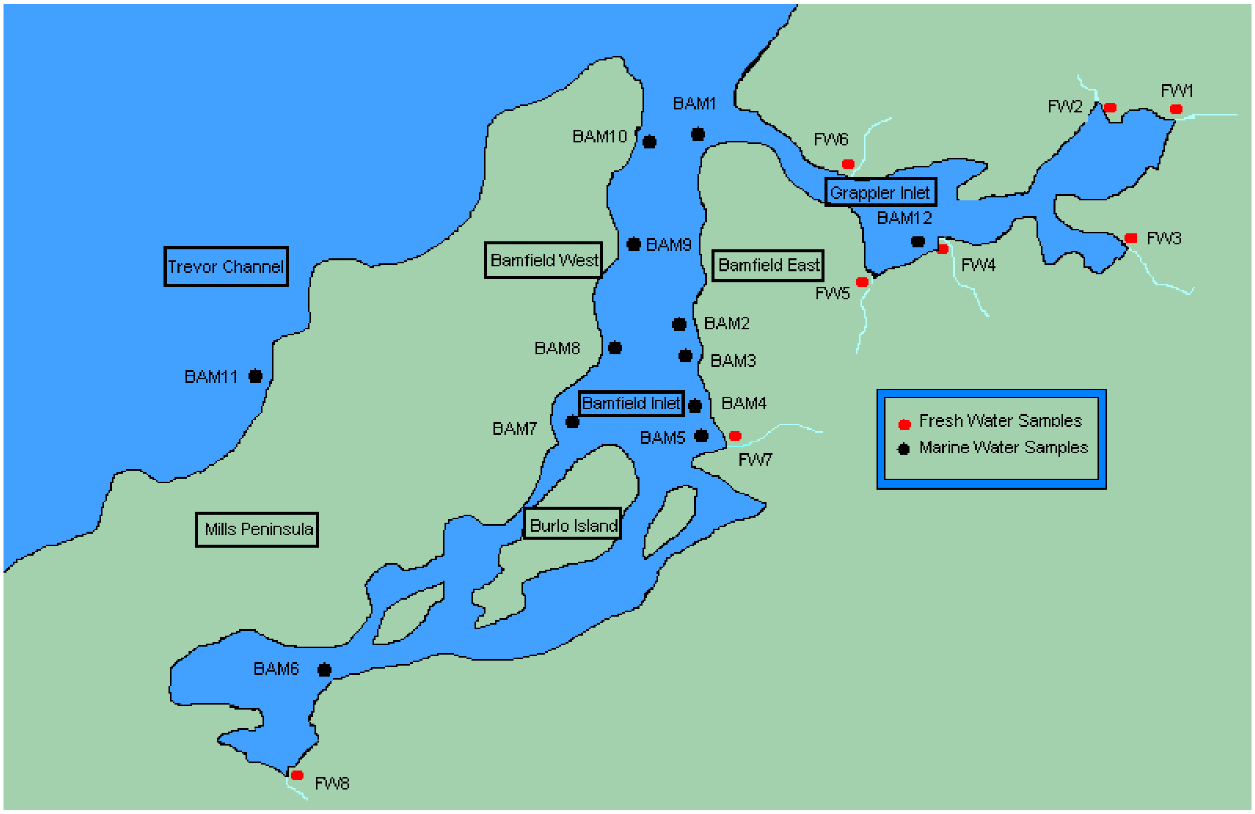

Figure 1 – MOE Marine and Freshwater Sampling Points 2001/2002 (Source – MOE)

From 2005 to 2007, a three-year sampling program was established by the MOE, ACRD, BMSC, HFN, and the Community of Bamfield to address the recommendations from the 2001/2002 study and to identify the source of the bacteriological contamination. The number of marine sampling locations was increased to eighteen (including one control site – Brady's Beach), and two freshwater sites were added to address potential upstream contamination (see Table 1 and Figure 2). Sources of contamination were identified using new monitoring tools which provided a weight-of-evidence approach to demonstrate human contributions to fecal contamination in the study area. These included nitrogen isotope signatures, bacterial source tracking, and caffeine tracing.

In 2005, samples were collected on July 12, 19, 26, August 2, 10 and 16. In 2006 sampling was conducted on August 10, 15, 22, 29 and September 6. In 2007, sampling was conducted on August 8, 14, 21, 28 and September 4. Sampling was generally done in the morning between 8:00am and 10:00am in order to have the samples shipped to Port Alberni in time. This resulted in samples not necessarily being taken during the worst conditions (incoming tide).

The complete results of the 2012 MOE report titled "Water Quality Assessment and Objectives for Bamfield Inlet " has been shared with the ACRD and the MOE has noted that it should be posted on its website soon. A brief summary of the results of this sampling program is as follows:

Sample ID	Site Description
BAM1	At Bamfield Marine Station outfall
BAM2	Off of Kingfisher Marina, blue roof
BAM3	Out from storm drain just south of station
BAM4	In front of Hawkeye Marina
BAM5	Just south of loading area Federal Dock
BAM6	At head of Bamfield inlet, on east side
BAM7	At McKay Bay Lodge, north of dock
BAM8	In front of Mills Landing cottages
BAM9	Spore residence, blue house
BAM10	Dock in front of general store
BAM11	Brady's Beach - North end of swimming area
BAM12	Dock in front of SeaBeam Resort - Grappler's Inlet
BAM13	Adjacent to greenhouses near BMSC
BAM14	House across from Community hall
BAM15	Dock in front of Imperial Eagle Lodge
BAM16	Mid-inlet next to red buoy Y54
BAM17	Mid-inlet between Burlo and Rance islands
BAM18	Head of Grappler inlet, out from dock
BAM FW7	East side, south of BAM5 and Federal Dock
BAM FW8	Far end of Bamfield Inlet, south BAM6

Table 1 – 2005-2007 Sample Locations

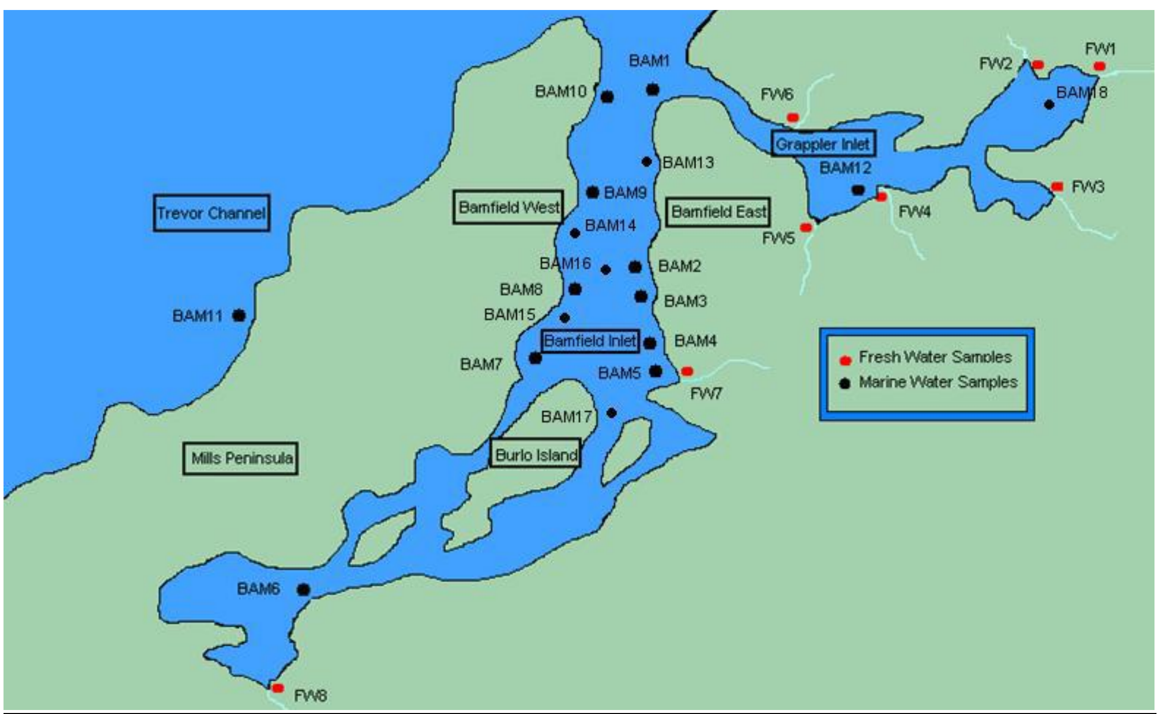

Figure 2 – MOE Marine and Freshwater Sampling Points 2005-2007 (Source – MOE) [4]

Fecal Coliforms:

Values for fecal coliforms ranged from below detection limits (<1 CFU/100 mL) to a maximum of 1,600 CFU/100 mL. The geometric mean for all sites ranged from 2 CFU/100 mL at BAM 11 (2007) to 144 CFU/100 mL at BAM 4 (2006). Although fecal coliform geometric means were elevated in the inner Bamfield Inlet (*i.e.*, area around the vicinity of Federal dock extending over to the fisheries dock) all sampling met the fecal coliform *primary recreation guideline* of 200 CFU/100ml. The fecal coliform median values exceeded the *shellfish guideline* (<14 CFU/100 ml median) at some sites in all three years, with the most prevalent in the inner Bamfield Inlet. Both the freshwater sources exceeded the *shellfish guideline* in at least one year indicating that upland sources such as failed tile fields and wildlife were contributing to the contamination of the Bamfield Inlet.

Enterococci:

This indicator is considered more reliable as an indicator of health risk than coliforms. Sites where the *primary recreation guidelines* were exceeded were found to be clustered within the inner Bamfield Inlet area. Sampled values ranged from below detectable limits (<0.5 CFU/100 mL) to a maximum of 682 CFU/100 mL. Geometric means calculated for all sites ranged from 1 CFU/100 mL at BAM 11 (2006) to 144 CFU/100 mL at BAM 4 (2006). The *primary recreation guideline* (20 CFU/100 mL) for enterococci was exceeded 6 times throughout the sampling period: 4 sites (BAM 4, 5, 6, and 8) in 2006; and 2 sites (BAM 5 and 8) in 2007. The *secondary recreation guideline* (100 CFU/mL) was only exceeded at BAM 4 in 2006. As well, of the 18 sites sampled, there were 11 exceedances in 2005, 17 in 2006 and 14 in 2007 of the shellfish harvesting guideline for enterococci (≤4 CFU/100ml).

E.Coli:

This indicator is considered more reliable as a fecal indicator than coliforms (which typical reports non-fecal coliforms in addition to fecal coliforms). E. coli concentrations were only measured in the two freshwater sites. E. coli concentrations ranged from below detectable limits (< 1 CFU/100 mL) to 102 CFU/100 mL (FW7-2007). The geometric means for these two sites ranged from 2 CFU/100 mL (FW7- 2006) to 15 CFU/100 mL (FW8-2006), which are well below both the primary and secondary recreation guidelines for E. coli. Median values were ranged from 2 CFU/100 mL at site FW7 (2006) to 11 CFU/100 mL at site FW8 (2006), which are below the shellfish harvesting guideline (≤14 CFU/100 ml).

Nitrogen Isotopes:

The δ15N isotopic signature results obtained from the mussels collected in the inlet range from 7.4‰ in 2007 (BAM 11) to a maximum of 11.1‰ (BAM 18) in 2006. Normal oceanic δ15N levels are approximately 6.7‰ whereas sewage effluent generally has observed δ15N levels of 10-

20‰. The highest value comes from either the head of Bamfield Inlet or Grappler Inlet. In general, the δ15N data indicates a potential enrichment of up to 3‰ in the head waters of Bamfield and Grappler Inlet sites relative to the reference location at Brady's Beach (BAM 11). However, as there has not been extensive research looking at the use of nitrogen isotopes marine environments, the MOE report indicated that further work is required in this area before definitive conclusions can be drawn from the nitrogen isotope results.

Microbial Source Tracking (MST):

Bacteroides analyses were conducted on twelve of the fifteen sample dates. In all samples submitted, human markers were identified. The results are consistent with the elevated bacteriological levels found in the inner harbor (BAM 4, 5, 6, 9 and 14) along with the presence of caffeine and elevated nitrogen isotope levels. In addition to identifying human fecal matter, the MST analysis also identified ruminants (i.e. deer), horse, and dog as sources of contamination. There have been horses present on occasion in the Bamfield area and two were witnessed roaming free along Binnacle Road during Stantec's site visit in May 2012.

Caffeine:

Caffeine was also tested by the MOE as a marker for surveillance of human fecal input into source water. In theory, as an active ingredient in many beverages, pharmaceuticals, and food products that humans consume, and the fact it is only partially metabolized in the human body, caffeine may be found in discharge environments. Higher caffeine values were located at sites within the inner Bamfield Inlet area, particularly on the west side of the inlet (BAM 7, 8, 9, 15 and 16). In general, the caffeine results are supportive of the microbiological data and the MST results which indicate the presence of human sewage in Bamfield inlet.

In summary, the MOE report finds that the Bamfield Inlet is subject to bacteriological contamination and most notably in the area adjacent to the homes and business along the inlet. This is especially apparent in the peak tourist months when bacteriological levels can exceed BC Water Quality Guidelines for primary and secondary recreational use. The results of the combined testing indicate that human sewage is the main contributor to microbiological contamination in the Bamfield and Grappler Inlet. The study suggests that some contamination may be coming from sources outside of the inlet, but that the main source is the anthropogenic sources within.

3.2 Impacts on the Community

Threat to Human Health and Aquatic Life:

With the high seasonal populations and increased inlet usage that Bamfield receives in the summer season, there has been growing concern over the health of the inlet and the potential impacts on human health. The current bacteriological contamination of Bamfield Inlet has led to

VIHA, in partnership with MOE, posting a warning in Bamfield Inlet in July 2010, advising the public of the potential health risk in the Inlet due to the presence of human sewage.

Most illnesses that arise from contact with raw sewage are caused by pathogens, which are biological agents that cause disease or illness in a host. The most common pathogens in sewage are bacteria, parasites, and viruses which can cause a wide variety of acute illnesses including diarrhea and infections. In some cases pathogens can cause serious long-term illnesses or even death. Certain groups such as children, the elderly, and those with a weakened immune system are particularly vulnerable to these long-term effects

In addition to pathogens, untreated sewage can cause illness when they create algae blooms. The nutrients in sewage act as fertilizers which result in a rapid increases in the population of phytoplankton algae, or single-celled plants and a subsequent bloom. Some algae are toxic to humans who can come in contact with them from eating shellfish, swimming, fishing, diving, or boating in contaminated water. Symptoms from exposure include memory loss, vomiting, diarrhea, abdominal pain, liver failure, respiratory paralysis, and coma. If an affected person does not receive proper medical attention, some toxins can be fatal. A sanitary closure to shellfish harvesting is currently in place for the waters and intertidal foreshore of Bamfield Inlet and Grappler Inlet lying inside a line drawn from Aguilar Point light to the harbour limit on the opposite shore (see Figure 2)

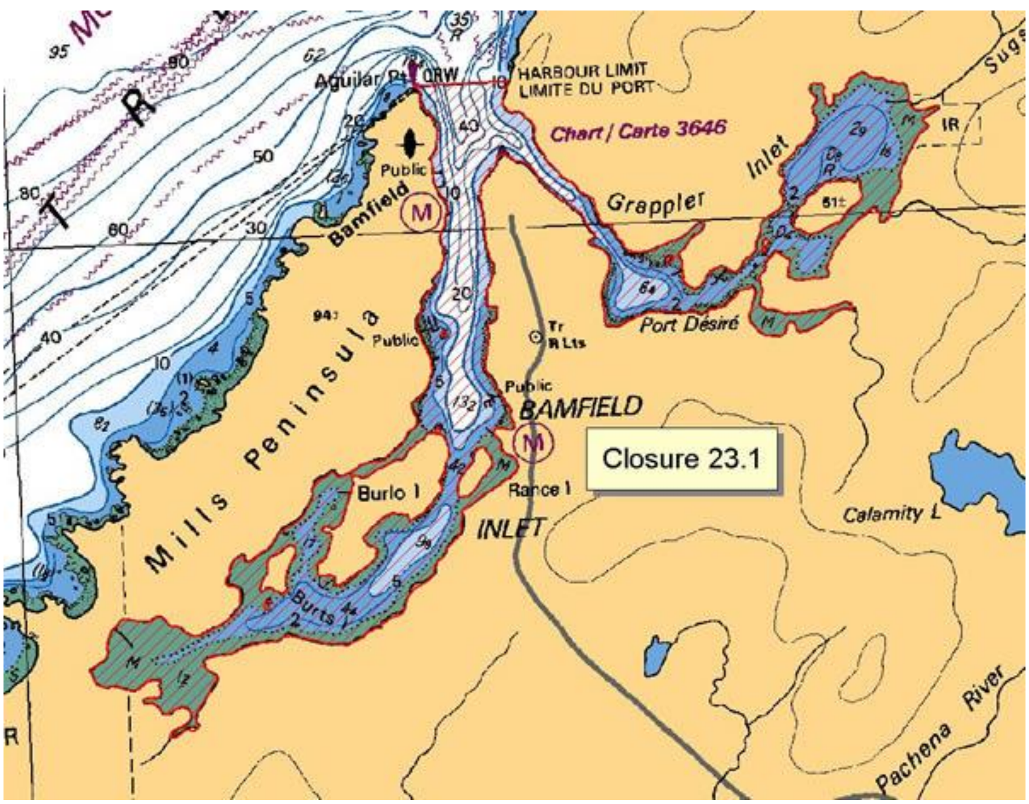

Figure 2 – Shellfish Closure Area (Source – Fisheries and Oceans Canada, 2012)

Illnesses can also be caused by pharmaceuticals, synthetic hormones, personal care products and other pollutants which enter the waterways though the sewage system. Certain compounds called endocrine disruptors may disrupt processes in humans that are controlled by hormones, including reproduction, development, and growth. These compounds are already thought to be causing cancer and genetic defects in fish. The area includes many fish species of interest including: salmon, halibut, rockfish, and ling cod as well as other marine life such as otters, seals and whales. How these chemicals affect human and aquatic health over time is still being determined.

Local Economy Impacts:

Bamfield has a number of parks, beaches and trails that highlight its unique appeal to those looking for a wilderness experience and natural beauty. It is one of the end points of the West Coast trail which hosts thousands of hikers each year. The inlet is a significant source of Bamfield's identity and boating, canoeing, and kayaking are all popular in Bamfield Inlet while the many docks and beaches provide access for swimming in the summer months.

With its population increase 10 to 15 fold in the summer, Bamfield businesses and residents benefit from the influx to the local economy. If the inlet continues to change and/or the current level of visible contamination not be address tourism to this area could decrease.

In addition, the ACRD's ability to prevent development from those parcels unable to provide secondary wastewater treatment may prevent possible growth along the waterfront which are typically higher priced properties than those inland. The economic impact of this may become more apparent when the road to Bamfield is paved. [2] This is expected to happen in the near future now that the Village of Anacla's forcemain has been installed. The forcemain will either connect to a separate or joint HFN/BMSC plant or lead to a separate HFN outfall.

4.0 Adjacent Wastewater Initiatives

4.1 Bamfield Marine Science Centre

Currently the Bamfield Marine Science Centre operates its own wastewater treatment plant operating under permit PE01622. The BMSC wastewater treatment plant (WWTP) was put into operation in 1972. It consists of a 70 m^3/day Chicago Pump rated aeration activated sludge packaged plant. The plant also services the wastewater from the Bamfield Community School. The plant, although operationally is performing well for its age, has several issues which has prompted the Centre to undertake preliminary studies on its replacement. The Centre is looking at replacement with a similar extended aeration type plant at a cost of approximately $700,000.

The BMSC is also discussing partnering with the Huu-ay-aht First Nation (HFN) to build a combined plant on BMSC property or to allow HFN to share the BMSC's outfall if they build their own plant to serve just Anacla Village. In Stantec's conversation with the Director of the Centre, it was noted that the community was approached several years earlier in partnering with both the Centre and the HFN on a Community wastewater treatment plant, but that the Community did not wish to proceed. The Director noted that if a combined BMSC/HFN plant is built on the Centre's property that consideration may be given to the siting of the plant to allow for expansion if the Community wished to join into the treatment system.

4.2 Anacla Village

The Village of Anacla is being relocated from the southeast sector to the northwest sector due to the threat of Tsunami to the existing village. The new village site was determined to be not suitable for individual septic and tile fields. In 2008, Chatwin Engineering completed a feasibility report which reviewed options for a regional sewer authority that could include the Community of Bamfield and the BMSC. In November 2008, the ACRD informed the HFN that the Community of Bamfield did not wish to participate in a regional wastewater system, as such HFN has only continued to look at options for providing treatment of their own sewage flows and/or combined with the BMSC's flows.

The HFN has recently completed a forcemain which runs from Anacla Village to Frigate Road in Bamfield. Bamfield residents may be able to tie a collection system (s) into certain locations of the forcemain; however, as this was not pursued as the forcemain was being installed it will be at a premium cost. Currently the HFN is engaged in discussions with the BMSC to build a combined plant on BMSC property or to allow HFN to share the BMSC's outfall if they build their own plant to serve only Anacla. The plant design currently on the table for discussion is a combined 242 m^3/d (Max Day Flow) Extended Aeration Type plant.

5.0 Wastewater Options

When people use water it doesn't go away; it becomes wastewater or sewage. Wastewater contains pathogens, nutrients, chemicals, and is made up of solids and liquids. In Canada, the typical water consumption is 330 litres of water per person per day, and in BC this figure rises to over 400 liters.[9] Wastewater must be treated before it is returned to the environment (either in land or in water) where through natural processes it becomes recycled. Wastewater is a community problem. All individuals and members of the Community of Bamfield must take responsibility for the wastewater generated and how it is treated. Bamfield's natural marine environment is currently undergoing degradation due to untreated wastewater being discharged into the inlet.

5.1 MOE Water Quality Objectives

The 2012 MOE report "Water Quality Assessment and Objectives for Bamfield Inlet" proposes both short-term and long-term water quality objectives for both fecal coliforms and enterococci. The short-term objectives are based on primary and secondary recreation uses, while long-term objectives are proposed for future shellfish harvesting. Both objectives have direct impacts on human health and Bamfield's economy.

The proposed short-term (5-10 years) water quality objective is that the geometric mean of a minimum of five weekly samples collected within a 30-day period must not exceed 20 CFU/100 mL for enterococci and must not exceed 200 CFU/100 mL for fecal coliforms at all sites within Bamfield and Grappler Inlets. The proposed long-term (>10 years) water quality objective is that the median of a minimum of five weekly samples collected within a 30-day period must not exceed 4 CFU/100 mL for enterococci and must not exceed 14 CFU/100 mL for fecal coliforms at all sites within Bamfield and Grappler Inlets.[4]

5.2 Wastewater Systems

In order to meet the short and long term objectives the Community of Bamfield will require improvements to their current wastewater collection, treatment and disposal regime through decentralized wastewater management. Decentralized wastewater management is defined as the integration of onsite, cluster, and centralized systems in an economically and environmentally optimal manner within a sustainable management framework that is consistent with the community's land-use and growth plans.[8] A combination of these types of treatment approaches summarized below may be required for the most viable solution.

On-site Systems:
This is the simplest types of treatment systems whereby the wastewater is treated and returned to the environment at the location where it is generated without the need for a community-wide sewer collection or treatment system. Onsite systems are associated with low-density communities and developments such as rural residential and small commercial developments such as village centers.

For single homes, this is most commonly a septic system using a septic tank for primary treatment, a tile field to provide subsurface final treatment of effluent, and offsite disposal of sludge. More advanced treatment such as intermittent and recirculating packed-bed filters and various aerobic treatment systems have also been used on-site. Commercial systems, such as those for restaurants, require further treatment beyond primary settling to remove oils and grease. On site treatment is the current approach used in Bamfield by the permitted discharge commercial systems (authorized by MOE) and residential systems using septic tanks and tiled fields or raised mounds (authorized by VIHA).

On site wastewater disposal has several natural limiting factors including topography, depth to bedrock, depth to restrictive layers, soil texture and permeability, degree of soil saturation and proximity to sensitive environmental areas. The more of these factors present, the greater the potential environmental risk and the need for more stringent management and/or engineering required to keep the field operating without risk to the environment or human health. A geotechnical investigation of this area would be required on a site by site basis to verify site suitability.

Cluster and Communal Systems:

Cluster systems can serve a small to large number of connections (two to hundreds of structures). Cluster systems play a critical role in decentralized wastewater plans by enabling an optimal mixture of onsite, cluster, and centralized systems to be achieved in area-wide Smaller cluster systems serving a few structures resemble onsite systems, while large cluster systems serving hundreds of structures tend to resemble centralized systems. The technologies available for cluster systems are generally the same as for on-site and central systems only they are adjusted for the number of homes/businesses serving. These systems dispose of effluent to either ground (tile fields) or to surface water.

It may also be possible for the upgrading of some of the commercial treatment plants to allow for connection of nearby residents to the system. Although this requires an increased amount of responsibility and collaboration between community members especially if failures occur and when maintenance and repairs are required.

Central System:

Municipal style collection (gravity, pressure or vacuum) and centralized treatment with surface discharge (treatment involves primary, secondary, and perhaps tertiary processes). Centralized systems are associated with high-density communities and developments such as cities and commercial areas. They generally consist of a collection system that gathers and transports wastewater from multiple generation points to a large centralized treatment facility. These systems transport treated effluent to one or more points of dispersal, where it is typically returned to surface or ground waters.

Although it would seem that this is not a suitable option for Bamfield, since a joint plant is being proposed for the BMSC and Anacla Village it continues to present the opportunity for the community, as a whole, to become a partner with these groups and have a centralized treatment system. If only portions of Bamfield can be connected to this plant, the system is no longer a centralized system by definition but a cluster system. The largest challenge would be a central system that can deal with the influx of summer residences which increases the population 15 fold.

5.3 Wastewater Treatment Options

Alternative wastewater treatment systems which could be considered for Bamfield are outlined in Table 2 below. The conceptual design process would identify the type, location, area serviced and order of magnitude costs associated with these types of systems and narrow the options to a select few for further review in the preliminary design stage. The conceptual and further preliminary stage will take into account criteria such as influent characteristics, effluent requirements, capital costs, and operating and maintenance costs, daily and seasonal flow, operational and maintenance requirements, system reliability and redundancy, and footprint (land requirements). A detailed lot by lot review and analysis is the best approach to determining the wastewater treatment needs. This prevents overlooking areas as well as grossly overestimating the wastewater needs of other areas.

Type of Treatment	Example Technology
Preliminary	Oil and grease removal
Primary	Septic tank
Advanced Primary	Septic tank with effluent filter vault
Secondary	Cyclic Activated sludge (eg. Extended Aeration, Sequencing Batch Reactor)
	Tile Field
	Aerated Lagoons
Advanced	Intermittent and recirculating packed bed filters
	Membrane Bioreactor
	Constructed Wetlands

Table 2 – Small System Treatment Options

Oil and Grease Removal:

These provide source control and consist of oil/ water separators, and grease traps.

Septic Tank:

Underground holding tank that settle solids to the bottom and effluent drains to a tile field for secondary treatment, and settled sludge is pumped. Many homes and some businesses in Bamfield drain to an ocean outfall without secondary treatment. These types of outfalls are no longer permitted by VIHA and as previously indicated are the main sources of contamination to the inlet.

New developments include watertight septic tanks made of concrete, fiberglass and plastic and the addition of advanced primary treatment through the use of filters. These fine screens (filters) increase the longevity and reliability of the downstream systems. They also have made it feasible to use high head STEP collection systems.

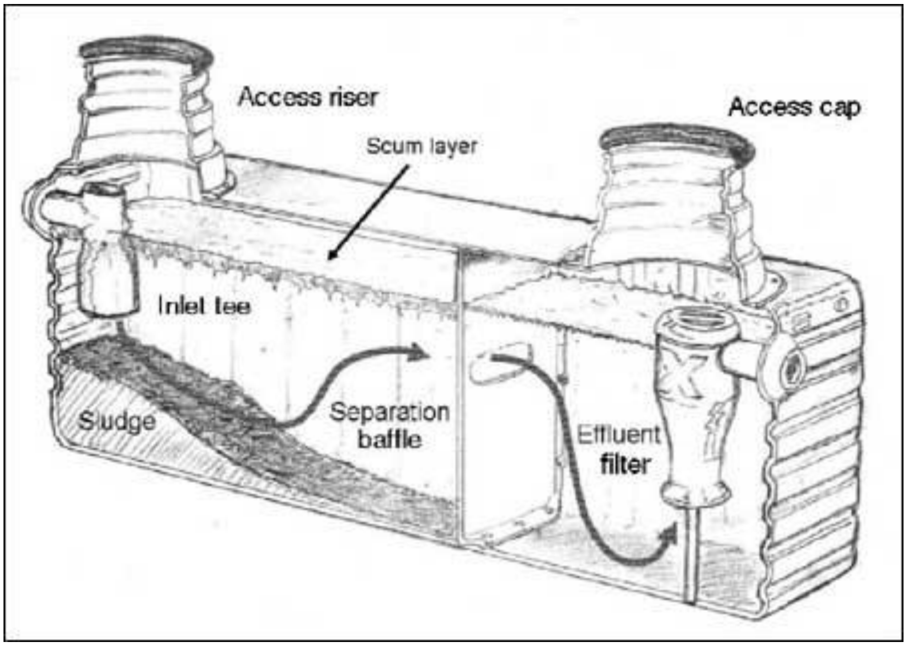

Figure 3 – Septic Tank with Filter
(Credit - Éric Brunet, Ontario Rural Wastewater Centre, University of Guelph)

Cyclic Activated Sludge:

These systems cycle the activated sludge treatment process through aerobic (oxygen present) and anaerobic (oxygen absent) periods to remove both nitrogen and phosphorous biologically. This process includes extended aeration (EA), and sequencing batch reactors (SBR). Sludge wasting is required approximately every 6-8 weeks. Odours are fairly low with these systems and generally non-offensive.

Extended aeration is a suspended growth system that utilizes a long hydraulic retention time which buffers flow variations. The system is basic in nature consisting of an aeration tank and a secondary clarifier. The process can handle moderate load variations. The system is relatively inexpensive to operate. Flow equalization upstream improves performance in load variant scenarios.

Sequencing Batch Reactor is a suspended growth system in which the air in the aerated tank is periodically shut off to allow settling of solids while effluent is decanted of the top. An equalization tank is typically not required upstream, and there are less pumps required than with an EA system. However the system is much more complex in terms of automated controls than the EA.

Intermittent Cycle Extended Aeration System (ICEAS) process, which is a modification and enhancement to conventional SBR and extended aeration technologies, allows a continuous influent flow throughout the cycle. This allows the process to be controlled on a time basis rather than a flow basis, which allows for equal loading and flow to all basins. This feature allows the ICEAS process to handle peak flows 3-6 times the average dry weather flow (ADWF) in comparison to the conventional SBR or EA in step mode which typically can efficiently handle flows of up to 3 times ADWF.

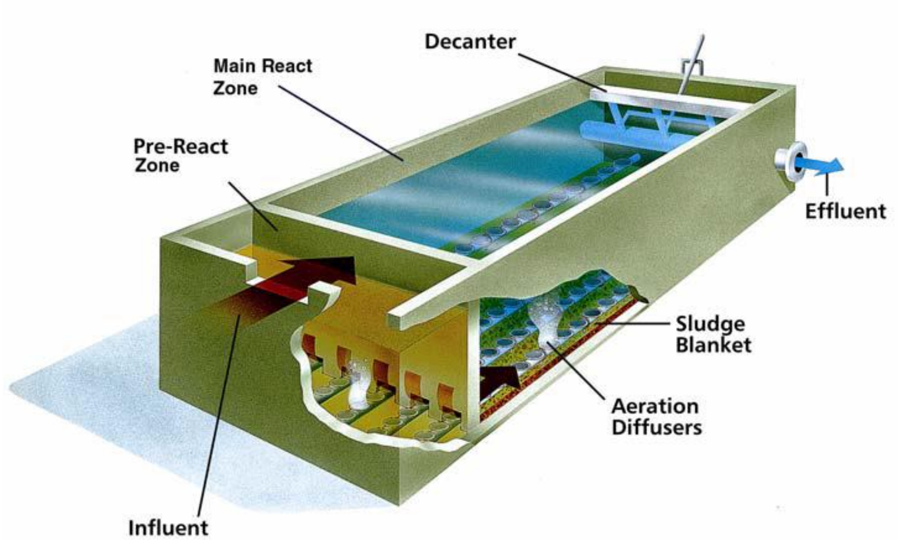

Figure 4 – ICEAS System (Source – www.sanitare.com)

These systems are relatively complex (mechanically and electrically) compared to septic systems and require a trained operator to maintain. The proposed joint BMSC/ Anacla Village WWTP is an extended aeration type plant. It would not be expected that the Community would build their own treatment system of this nature due to cost.

Aerated Lagoons:

Although typically earthen construction, aerated lagoons can also be concrete or steel. Typically at least two lagoons are provided in series, and sometimes include an effluent polishing unit (such as a rock filter), or are equipped with a submerged attached growth system to improve BOD and TSS removal. This type of system would not be suitable for areas treating high fluctuating flows (ie B&B's or resorts) and space may be difficult to find to site suitable space in Bamfield.

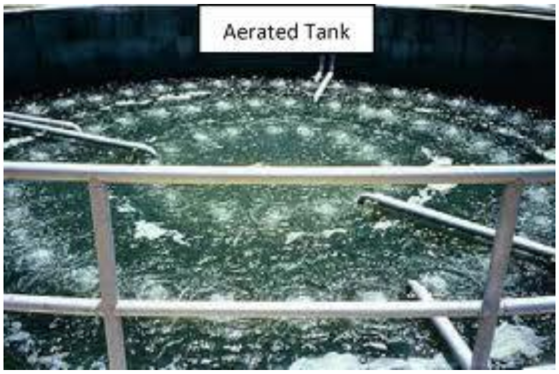

Figure 5 – Aeration Tank (Source – www.wecleanwater.com)

Membrane Bioreactor:

The MBR is similar to an EA process but instead of gravity settling it uses an immersed microfiltration membrane system to retain solids. As the wastewater draws through the membrane pores the solids are retained on the outside. The membrane requires periodic cleaning, and air scouring, as well as replacement approximately every five years. Effluent produced is of very high quality (tertiary treatment)and the process reduces the footprint required significantly. Sludge is typically wasted every 6-8 weeks.

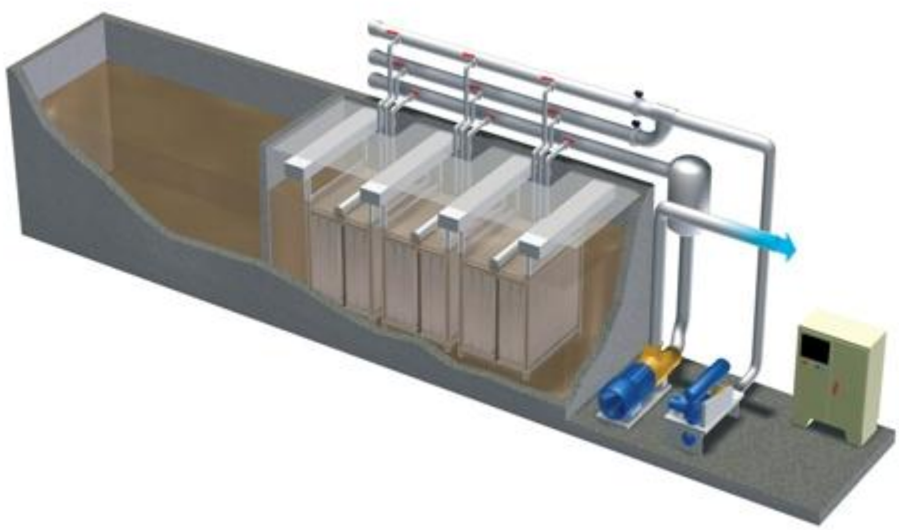

Figure 6 – MBR (Source – www.ge.com)

Intermittent and Recirculating Packed Bed Filters :

These sand and fine gravel filters have been successfully used for many years. The filter consists of a container with a liner for holding the medium, the filer medium, an under drain to remove effluent, and a distribution system to apply the wastewater to the medium. They typically produce a very high quality effluent which has been used in recycling applications (drip irrigation) in some parts of North America. These systems require knowledgeable contractors and close engineering observation during construction to ensure proper materials and construction techniques are followed. Properly sized these systems require only limited maintenance. If effluent cannot be used for irrigation then tile field dispersion or collection and discharge to marine environment could be used.

5.4 Wastewater Collection

Wastewater collection is the conveyance of the wastewater from the source to the treatment system. Collection is achieved through the use of a septic tank effluent pumping (STEP) system, small diameter variable grade gravity sewers (STEG), conventional gravity, or low pressure (LP)systems. The type of collection system used is based upon topography, flow rates, population density, ground water table, soil conditions, conflicts with other utilities, ease of construction, minimum required velocities, and cost. Inflow and infiltration (I&I) can also be a major issue for collection systems, with high volumes of water being added to the system from high water tables (infiltration) and storm connections to the sewer (inflow). Sulfide generation can create an odour problem when sulfate concentrations are high (greater than 50 mg/L) as found with some septic systems. Additional carbon filtering at air releases is often beneficial to mitigate these odours.

STEP:

The septic tank effluent pumping (STEP) system involves disconnecting the tile field (if present) and pumping the liquid effluent into the collection main and ultimately to the treatment plant. Solids are still required to be pumped out from the septic tank periodically. A high head turbine pump is used to pump the screened effluent into the pressurized collection main via a 25-38mm diameter line. The pressurized collection main is typically 50mm in diameter. Pipes are placed just below frost penetration, and as they are pressurized are not affected by undulating topography or by Infiltration.

STEG:

The septic tank effluent gravity (STEG) system or small diameter variable grade gravity sewers utilize a 25-50mm pipe to convey filtered effluent from the septic tank to the collection main. As there are no solids to settle in the pipes they can be installed in the ground like the STEP system. As with the STEP system the pipes are water tight and not subject to infiltration. They are often combined with STEP system.

Conventional Gravity:

These are typical in areas where septic tanks are not used and a direct connection to the house or other structure is used. These are typically larger diameter 150-200mm diameter pipes (to allow for cleaning of accumulated solids). Velocities of greater than 0.6 m/s are required to avoid solids deposition. These systems are subject to high infiltration rates in high water table areas. Conventional gravity sewers would not be considered for the area due to the undulating topography which would require deep trenches and additional lift stations.

Low Pressure:

The low pressure system involves disconnecting both the septic tank and tile field and pumping both solids and liquids to the treatment plant. The house connects to a small diameter pump basin equipped with a grinder pump that cut up solids so they can be conveyed under pressure to the treatment system. As a result the treatment system sees higher levels of solids and grease and as such higher velocities are required. Existing septic tank need would need to be removed or have holes punched in it and filled with gravel. Pipes are placed just below frost penetration, and as they are pressurized are not affected by undulating topography or by Infiltration.

Collection Type	Ideal Topography	Sulfide Potential	Construction Cost in Rocky, High Groundwater Sites	Minimum Slope or Velocity Required
STEP	Undulating	High	Low	No
STEG	Downhill	High	Moderate	No
Conv. Gravity	Downhill	Moderate	High	Yes
LP	Uphill	Mod-High	Low	Yes
STEP/STEG Combo	Undulating	High	Low-Mod	No

Table 3 – Collection System Characteristics (Source – Crites, Tchobanoglous 1998)[8]

Table 3 provides the relative characteristics of the various considered collection system. The STEP, STEP/STEG combination and LP systems would be most suitable to Bamfield due to the steep and irregular topography that would make collection via gravity pipes extremely difficult, and cost prohibitive. Typically these systems join approximately 10 homes together before connection to a separate force main, lift station or treatment system(s) to minimize connections and potential leaks.

5.5 Effluent Disposal

Effluent could be disposed in one of two manners: to ground or to the marine environment. It is expected that only some of the onsite septic systems are capable of discharging to ground due to unfavorable conditions for ground discharge in Bamfield. As such any larger cluster systems or a centralized system for be required to discharge to the marine environment. In addition, discharge to Bamfield Inlet (an embayed discharge) would require additional treatment for phosphorous removal and it is expected that, due to the size of the inlet, authorization for discharge into the inlet would not be attained from the MOE.

With any marine discharge it will be necessary to meet the new Federal Regulation for effluent quality:

- Average cBOD of 25 mg/L
- Average TSS of 25 mg/L

A separate Bamfield outfall through the Bamfield Inlet would require consultation with DFO and would be required to be protected from anchors and boats. Jetting the pipe into the harbour floor may be an option, but hydrographic and geotechnical investigations would be required to adequately determine the sea bed characteristics. If a centralized plant is used, or if possible to share the BMSC existing 200mm diameter outfall, then this single outfall would provide a far better option than installing a separate outfall.

5.6 Wastewater Management

A successful community outcome to addressing wastewater treatment issues can often be more dependent on the process the community follows and garnering collaboration than it is on the type of wastewater treatment technologies available. Hence actively engaging members of the community early in the decision-making process leads to the best solutions and encourages responsibility. Communities that are successful in finding a technically effective, economical and publically accepted solution typically need to:

- Realize that only they can make the best decisions for their community and take responsibility for the problem at hand
- Clearly and completely understand their current situation before they start looking for solutions.
- Have or develop strong leadership from within
- Have clearly defined a vision and appropriate goals
- Identify and use a set of criteria to meet their goals
- Commit to the time and energy to identify and examine all options before making decisions
- Gather information from as many sources as possible before taking action
- Keep all affected parties involved and informed all along the way

<u>Official Community Plan (OCP):</u>

An official community plan (OCP) is a statement of objectives and policies regarding future land-use patterns in incorporated municipalities or in designated areas of regional districts. Bamfield's OCP was completed in May 2000 and is currently under review. The OCP provides a set of guidelines for future growth and development to the public and the province and provides the rational for land-use regulations and decision making. This identifies the link between land-use planning required of local governments in the Local Government Act and waste management plans in the Environmental Management Act.

To date, there is no clear direction for liquid waste management in the current OCP and as a policy it is noted that the Regional District is of the opinion that "standardized" Waste Management Planning options are neither justified, warranted or financially feasible. The ACRD did note that it was to review the implementation of language into the OCP regarding future developments and the requirements for secondary wastewater treatment for such development (including subdividing) to take place.[6]

Sewerage System Regulation (SSR):

Permits for discharges under the SSR are issued by VIHA. The Sewerage System Regulation falls under the *Health Act,* and applies to the construction, and maintenance of:

- a holding tank;
- a sewerage system that serves a **single family residence** or a duplex;
- a sewerage system or combination of sewerage systems with a combined design daily domestic sewage flow of less than 22,700 litres that serves structures on a single parcel; and,
- combination of sewerage systems with a combined design daily domestic sewage flow of less than 22,700 litres that serves structures on strata lots or on a shared interest.

The Sewerage System Regulation applies to domestic sewage, which includes:

- human excreta; and,
- waterborne waste from the preparation and consumption of food and drink, dishwashing, bathing, showering, and general household cleaning and laundry, except waterborne waste from a self-service Laundromat.

The SSR prohibits an owner of a sewerage system from discharging domestic sewage or effluent into a source of drinking water, surface waters, **tidal waters**, onto land or into a sewerage system that is not capable of containing or treating domestic sewage. The provisions of the Municipal Wastewater Regulation govern these types of discharges.[10] Residential discharges to the inlets in and around Bamfield are no longer authorized by VIHA and future single family residential discharges will have to become communal type systems registered under the MWR or addressed through a Liquid Waste Management Plan (LWMP).

Municipal Wastewater Regulation (MWR):

The Municipal Wastewater Regulation is the new regulation under the BC Environmental Management Act introduced in 2012, replacing the previous Municipal Sewage Regulation. It provides effluent quality parameters for discharge to water, ground and for re-use, as well as design criteria, sampling, and monitoring and reporting protocol for municipalities in all regions of BC.

This regulation applies to all discharges to water (if sewage system is for more than a single family residence or duplex), to ground if discharge is greater than 22,700 Litres per day, and to one or more sewerage systems serving one or more parcels, strata lots or shared interests. Registration of municipal or communal systems is exempted when there is an approved LWMP in Place. Enforcement is provide by the MOE for those registered discharges (or previously permitted).

If Bamfield did not wish to undergo the LWMP process, the MOE has suggested that communal systems could be registered under the MWR.[6] The ACRD would become responsible for meeting the protocols prescribed in the regulation.

The advantages of the MWR are:

- Lesser degree of public consultation required
- May be quicker to implement
- No cost of LWMP

The disadvantages of the MWR are:

- Referendum required for future spending
- Public may feel exclude from planning process (lack of acceptance)
- Not a comprehensive plan to deal with future issues

Liquid Waste Management Plans (LWMP):

The LWMP was introduced in 1992 as a municipal waste control strategy (including the management, collection, treatment and disposition of effluent) to minimize pollution and plan for the future. The guiding principles of the LWMP are environmental and public health, community consultation, source control, reduction, reuse and recycling. The plan is created through a collaborative effort involving residents, business, local government, First Nations and senior government. The Environmental Management Act allows municipalities and regional districts to develop LWMPs for approval by the Minister of Environment at which point it becomes a legal document.

The LWMP process provides authority to discharge under an operating certificate and can be implemented in stages, taking into account the assimilative capacity of the receiving environment, the ability to finance the upgraded sewage facilities, and public input to the waste management planning process. [4] Upgrades and maintenance are planned out and approved through community involvement and participation during the planning process, which allows a municipality to undertake these without going to referendum. The plan also can deal with lot sizes, development permits, zoning, water conservation, storm water management, public education programs and septic tank maintenance.

The advantages of the LWMP are:

- Local governments can borrow money without the approval of electors for implementation of an approved LWMP
- Opportunities for elector participation through public review and consultation
- Additional means to address water conservation, drinking water source protection, resources from waste, energy conservation, climate change adaptation, and mitigation and sustainable financing and asset management
- Plans for future growth and development with strategy to ensure management and treatment systems in place to protect public health and the environment (proactive verusus reactive solutions)
- Increased likelihood of obtaining grant money for implementation of LWMP

The disadvantages of the LWMP are:

- Higher initial cost to undertake
- Can take a year to several years to complete
- Community participation is mandatory (time commitments)

THE LWMP is a three stage process which begins with the ACRD first recognizing the need for a LWMP and notifying the MOE of its intent. It must then retain consultant(s), and form committee(s) to assist and provide input into the process. A Diagram of the typical three-stage LWMP can be found in Appendix B. The stages outlined in the Interim Guidelines for Preparing Liquid Waste Management Plans can be summarized as follows:

Stage 1: Inventory of Existing Conditions and Development Projection:

- Identify existing situation including known environmental and health issues with respect to wastewater(s);
- Identify possible future issues with respect to wastewater(s);
- Identify potential options for the management of wastewater(s) to resolve the issues, including source control and volume reduction;
- Develop order of magnitude costs, and
- Complete public consultation process at the draft report stage.

Stage 2: Detailed Evaluation and Preferred Option(s):

- Provide clear and reasoned explanation for those options that are technically impractical – develop short list of options;

- Develop identified options in sufficient detail to permit comparison between different options;
- Undertake Environmental Impact Study (if required to further refine options);
- Continue public consultation process, and
- Present the preferred option recommended by the advisory committee to the Regional Board for consideration based upon the information developed throughout the LWMP process.

Stage 3: Summary, Financing and Implementation:

- Summary of LWMP Stages 1 & 2.
- Details of the selected option supported by the majority of the residents of the plan area by means of a survey and feed-back from public open house(s);
- Rationale for options not selected and why;
- An outline of what is to be done – recommendations including level of treatment and effluent disposal/reuse required;
- Develop a schedule of phase for sewage collection and treatment plant installation and planned upgrades (including costs and timing of each stage);
- Further develop stormwater and biosolids management (if required);
- Prepare cost estimates including construction, O&M for the options – include a present worth analysis;
- Identify any required Bylaws to be developed;
- Include a summary of public involvement, including the public meetings, presentations, media advertising, surveys, and other information that was made available to the public during the process;
- Note how amendments to the LWMP will be addressed, and
- Prepare Draft Operational Certificates for treatment plants (as required)

Although community involvement is part of the process, the community does not have the final word on what goes into the plan. As such a community that is unwilling to spend the dollars required for necessary upgrades or maintenance can be obligated to do so through this process. The MOE has noted that the Ministry of Community, Sport and Cultural development favours funding of municipal capital works that have undergone the LWMP. [4]

6.0 COST

6.1 Wastewater Treatment

Costs associated with treatment would depend on the type of treatment required (level) and the type of system (cluster, centralized, on site). It is impossible to provide a reflective cost of an overall onsite system scheme as it is unknown the status of each existing individual system and the suitability of individual lots. The same applies to large cluster systems with ground discharge. As such only the order of magnitude cost of individual systems is provided. It is beyond the scope of this report to provide costing for the various options for the numerous lodges, and resorts that host the 1800 plus seasonal travelers to the area. These systems would need to be looked at on an individual basis.

It was chosen to provide order of magnitude pricing on five types of treatments and systems: on-site septic with tile field (individual), on-site septic with community tile field (5 homes), on-site septic with cluster packaged treatment (10 homes), Bamfield's separate WWTP (excluding BMSC and Anacla Village), and the expansion of proposed HFN/BMSC centralized plant.

For the order of magnitude costs a population of 1800 was used for a separate Bamfield to WWTP to include for the high summer visitor population and potential development with the paving of the road to Bamfield. This was increased to 2200 for the single central plant to account for the 200 students at BMSC, and a future population of 200 from Anacla. Approximately 300 Litres per person per day was used.

System	Type	Population Serviced	Liters per Day	Cost per System
1	Individual On-site Septic Tank & Tile Field	2	600	$20,000 - $40,000
2	Communal On-site Septic Tank & Tile Field	10	3,000	$50,000 - $100,000
3	Communal On-site Septic Tank, Packaged Plant & Tile Field	20	6,000	$150,000 - $250,000
4	Bamfield Separate Plant (East Side)	1800	540,000	$800,000 - $1,000,000
5	Expansion HFN/BMSC centralized plant	2200	660,000	$700,000 - $900,000

Table 4 – Treatment System Order of Magnitude Costs

6.2 Wastewater Collection

Infrastructure costs for pipes, pumps, filters, valving, and service connections. Systems 4 and 5 include two lift stations ($300K each) and an inlet crossing from West to East Bamfield ($250K).

System	Treatment Type	Collection Type	Cost per system
1	Individual On-site Septic Tank & Tile Field	None	$0
2	Communal On-site Septic Tank & Tile Field	STEP	$50,000 - $75,000
3	Communal On-site Septic Tank & Packaged Plant	STEP	$50,000 - $75,000
4	Bamfield Separate Plant (East Side)	STEP/STEG	$3.5M – 4.0M
5	Expansion HFN/BMSC centralized plant	STEP/LP	$3.5M – 4.0M

Table 5 – Collection System Order of Magnitude Costs

6.3 Effluent Disposal

An outfall serving a separate Bamfield outlet would be required to run approximately 2 km to reach Trevor Channel. This would have an order of magnitude cost of $600K. Using a central plant with the BMSC and HFN would utilized the BMSC existing outfall, although it is expected that this outfall is required to be extended approximately 600m to no longer be embayed at a cost of approximately $180K. This could be shared by the three parties at $60K.

System	Treatment Type	Outfall Length	Cost
1	Individual On-site Septic Tank & Tile Field	None	$0
2	Communal On-site Septic Tank & Tile Field	None	$0
3	Communal On-site Septic Tank & Packaged Plant	None	$0
4	Bamfield Separate Plant (East Side)	STEP/STEG	$600,000
5	Expansion HFN/BMSC centralized plant	STEP/LP	$60,000

Table 5 – Collection System Order of Magnitude

6.4 Wastewater Management

Costs associated with the administrative components are not explored as part of this report. Typically municipalities are exempt from paying securities or capital replacement funds associated with MWR registration. LWMPs costs can vary extensively based on the amount of information that the committees want to be explored, level of refinement for options, number of committee meetings, difficulty in finding suitable technologies, and how quickly consensus can be achieved on a solution(s). For the Community of Bamfield, it is estimated that a basic LWMP would have an order of magnitude cost of $75K +/-$25K.

7.0 CONCLUSION

The Community of Bamfield's existing waste water management practice has been shown, through testing by MOE, to be detrimentally impacting the Bamfield Inlet and poses a public health risk. To date shellfish harvest closures, and public notices of health hazard have been posted.

This report outlined the existing systems, their issues, the results of the MOE testing, and provided an overview of treatment technologies which could be utilized to improve the water quality of Bamfield inlet. The type of treatment used will depend upon the type of waste management strategy used. Waste management practices have been introduced and the associated benefits and challenges.

Ultimately we recommend that the Community of Bamfield move toward a central treatment system involving both the HFN and BMSC. This type of system makes the most economical sense as the expansion of a treatment plant is far less costly than building new treatment facility, and the operation and maintenance costs of a single plant and outfall is less. It is environmentally more favorable to have a single site, a single point of discharge to monitor, less carbon footprint, and potential reopening of shellfish harvesting.

This can take effect over a period of time, having those on the East side with easiest access able to connect to the new HFN forcemain connected first. Then a combination of STEP and LP systems could be installed to collect the remaining East side. Then a connection forcemain, under the Bamfield Inlet, could be installed to transfer effluent from the West side to the East side. Then the STEP systems on the West side could be installed and a lift station to convey the effluent through the East/West connection forcemain.

Initially not all residents will have to join. Properties that have properly working, onsite system may wish to defer connection, but as those properties apply for development, or wish to join later then an higher latecomer fee would be paid instead of the mainline contribution fee.

Stantec wishes to acknowledge the Ministry of Environment (Nanaimo Branch) and the Alberni-Clayoquot Regional District for their efforts in producing this report.

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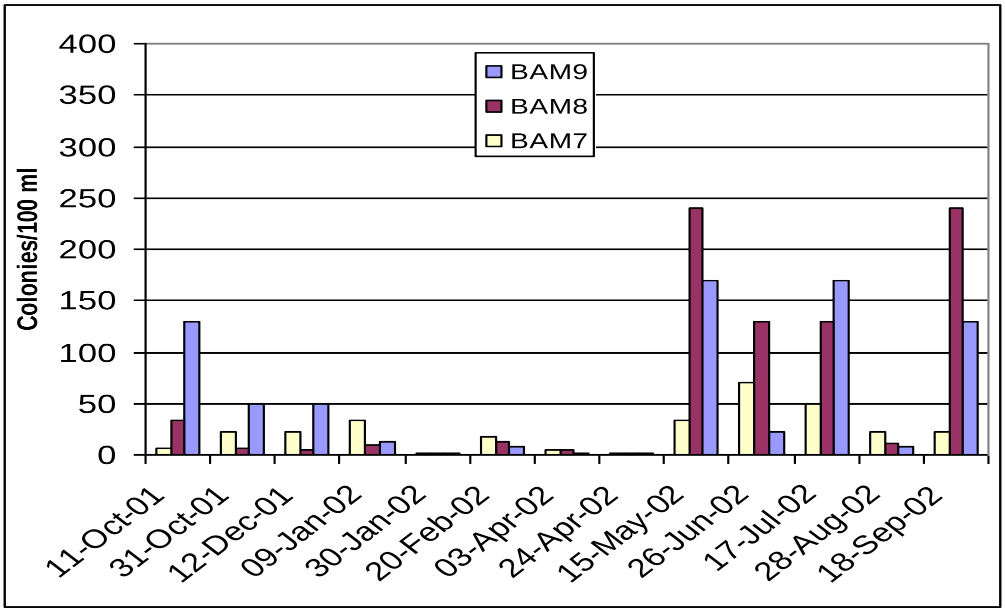
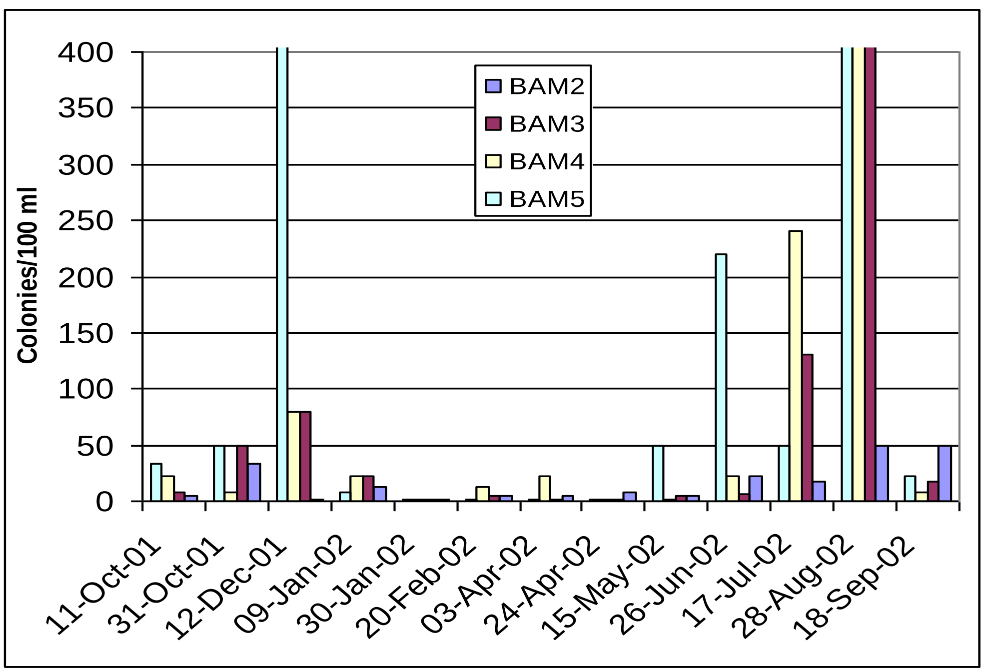
10. British Columbia Onsite Sewage Association. September 2007. *Sewerage System Standard Practice Manual – Version 2.*
11. Province of BC. Ministry of Environment. *Interim Guidelines for Preparing Liquid Waste Management Plans – Revised Edition.* July 2011.

APPENDIX A

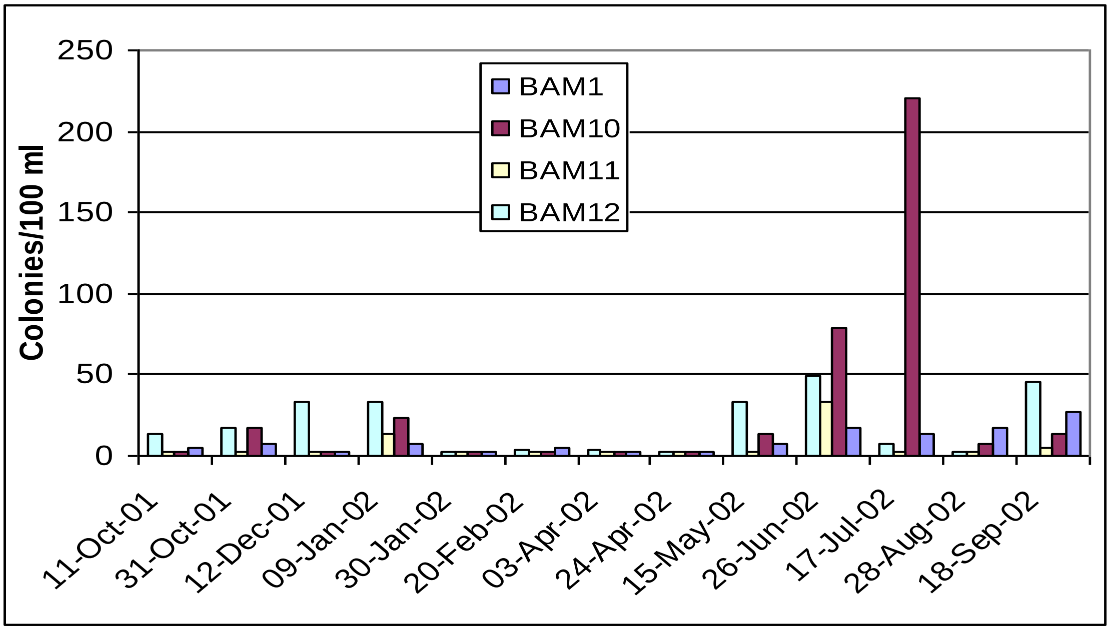
Summary of 2001/02 Bamfield Sampling Project results.



West shore marine fecal coliforms, by date.



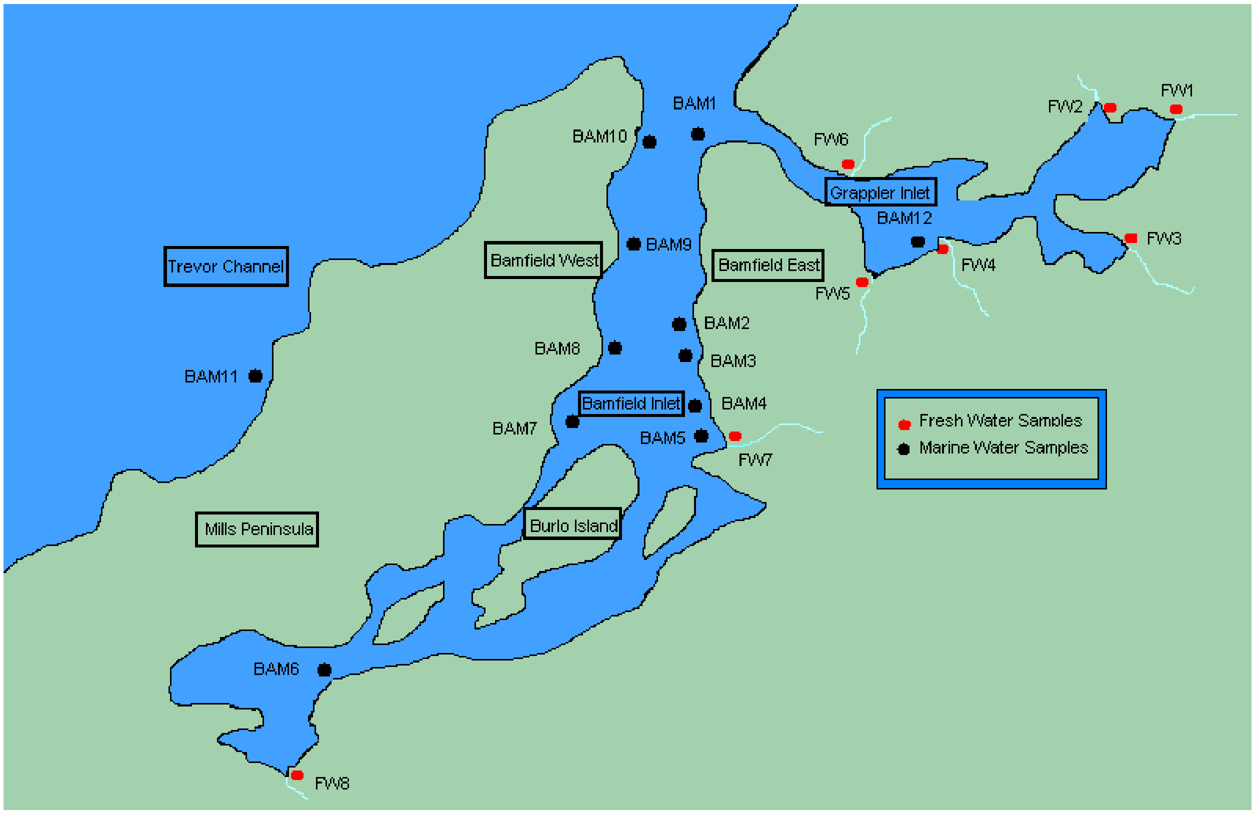
East shore marine fecal coliforms, by date.



Marine fecal coliforms outside and at the mouth of Bamfield Inlet, by date.

Conclusions and Recommendations:

- High microbiological indicator levels in parts of Bamfield Inlet during the summer months.
- Further sampling is recommended for this time period.
- Sampling should fulfill the 5 weekly samples in 30 days requirement under the BC MOE Water Quality guidelines.
- Enterococci sampling should be included in marine monitoring.
- More sample sites should be considered.



Marine and freshwater sampling points .

APPENDIX B

Diagram 1: Typical Three-Stage Planning Process

(Refer to Section 4.4 of the Guidelines for the Three Stage Process)

- Local government initiates plan voluntarily OR minister directs local government to prepare a plan
- Local government passes a resolution
- Local government establishes advisory committees and informs the ministry and other agencies
- Determine scope of work for Stage 1 and initiate public consultation process

Stage 1

(Existing conditions, development projections, and list of options)

- Draft Stage 1 report with input from advisory committees
- Public review of draft report and the long list of options
- Incorporate public feedback, evaluate and short list options, determine scope of work for Stage 2, and revise draft Stage 1 report
- Obtain input and endorsement from advisory committees and complete Stage 1 report
- Submit Stage 1 report to ministry regional office for review

Stage 2

(Detailed evaluation, selection of preferred option(s), and planning recommendations)

- Draft Stage 2 report with input from advisory committees
- Public review of draft report, short listed options, costs, and draft recommendations
- Incorporate public feedback, evaluate options, determine scope of work for Stage 3, and revise draft Stage 2 report
- Obtain input and endorsement from advisory committees and complete Stage 2 report
- Submit Stage 2 report to ministry regional office for review

Stage 3

(Plan summary with projected funding and implementation schedule)

- Develop draft operational certificates, bylaws, and other Stage 3 plan components
- Draft Stage 3 summary report with input from advisory committees
- Continue public consultation and public review of draft Stage 3 summary report
- Incorporate public feedback and obtain input and endorsement from advisory committees to finalize Stage 3 summary report
- Submit Stage 3 summary report to ministry regional office for review

Resolution passed by local government to accept the final Stage 3 summary report

Submit Stage 3 summary report to the minister for approval, with a copy to ministry regional office

When the minister issues a letter of approval, the Stage 3 report is approved as the LWMP.
The minister may impose additional requirements as a condition of plan approval.