

**REPORT TO CORE AREA LIQUID WASTE MANAGEMENT COMMITTEE  
MEETING OF WEDNESDAY, 22 NOVEMBER 2006**

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**SUBJECT**      **MACAULAY AND CLOVER POINT WASTEWATER AND MARINE ENVIRONMENT  
PROGRAM – 2005 ANNUAL REPORT**

**PURPOSE**

To present the results of the Macaulay and Clover Point 2005 Wastewater and Marine Environment program (WMEP) and the comments and recommendations of the Marine Monitoring Advisory group (MMAG).

**BACKGROUND**

The Core Area Liquid Waste Management Plan (LWMP) commits to reporting on the WMEP annually to the Capital Regional District (CRD) Board and the Ministry of Environment (MOE). The report, *Macaulay and Clover Point Wastewater and Marine Environment Program – 2005 Annual Report*, by CRD Scientific Programs, has been reviewed by the MMAG and has now been completed. The report's executive summary is attached as Appendix A. The complete report is available on request from the CRD Environmental Services department. The 2005 annual report presents monitoring results (parameters monitored are listed in Appendix B) and additional investigations for the Macaulay and Clover Point outfalls. This staff report also presents the MMAG's report that reviews the 2005 program.

**1.      2005 ANNUAL REPORT**

**WASTEWATER QUALITY**

The Macaulay Point and Clover Point wastewater discharges met receiving water quality guidelines for the protection of aquatic life well within the 100m initial dilution zone (IDZ) for both outfalls.

**SURFACE WATER QUALITY**

Surface water above the Clover or Macaulay Point outfalls was generally well below the recreational guideline (fecal coliform geometric mean less than 200 CFU/100 mL). The data indicate the effluent plume behaved as predicted by the hydrodynamic model and was trapped below the surface during monitoring events.

**SEAFLOOR MONITORING**

**Macaulay Point Outfall**

Sediment Chemistry

As observed in previous years, very few substances measured in sediments were above the CRD sediment quality guidelines (SQGs) in 2005 and exceedences were restricted to the 100m IDZ and to two stations within 200m of the outfall diffuser. It is important to note that values above the SQGs are only an indication of potential effects on the receiving environment. A complete assessment requires additional measures, such as assessing the health of the biological communities living within the sediments. The recent review conducted by the Society of Environmental Toxicology and Chemistry (SETAC) panel concluded that the sediment chemistry findings do not indicate a negative change over time.

### Seafloor Communities

In 2005, there were more animals at all the outfall stations than at the reference area. The number of types of animals was generally also higher at outfall stations. These results are consistent with the SETAC panel report findings. The indicators used for the seafloor community showed an area of effect confined to within 200m away from the outfall terminus, similar to previous years.

### **Clover Point Outfall**

#### Sediment Chemistry

No substances were above the CRD SQGs in 2005. This is an improvement over 2004 when mercury was above CRD SQGs within the IDZ, and 2003 when five substances exceeded SQGs within the IDZ, and mercury exceeded outside the IDZ. Similar to Macaulay Point, it is important to note that values above the SQGs are only an indication of potential effects on the receiving environment. A complete assessment requires additional measures, such as assessing the health of the biological communities living on the seafloor.

#### Mussel Communities

Results indicated no negative effects on mussel communities. Mussels closer to the outfall were fatter and longer than those at the reference area. These results are consistent with the SETAC panel report findings.

Chemical analysis of mussel tissue showed that most metal concentrations were lower near the outfall than at the reference area. Most organic compounds were not detected in mussel samples.

### **ADDITIONAL INVESTIGATIONS**

Additional investigations are important elements of the WMEP. These investigations are conducted to address issues that pertain to the WMEP, clarifying certain aspects of the regular program and providing data for the assessment of environmental effects. Investigations undertaken in 2005 and planned for 2006 are summarized in the attached executive summary (Appendix A). Planned investigations include collaborative studies with Environment Canada and the University of Victoria on pharmaceuticals and personal care products.

#### **2. MMAG REPORT TO MOE**

The MMAG was established to advise on, provide an independent assessment of, and provide recommendations on the marine environment programs to the CRD. The group consists of scientists and experts from government and academia.

In the LWMP approval letter of 26 March 2003, the minister of environment required the yearly submission of an independent report by the MMAG with comments on the Macaulay and Clover Point WMEP. This report has been completed by the MMAG and forwarded by the MMAG chair to the MOE. The letter report is attached as Appendix C.

The MMAG report indicates a general level of satisfaction with the current program. The general comment made was that the monitoring program is very thorough and the MMAG appreciates how responsive CRD staff is to the MMAG's comments. Minor suggestions for improvement were made and a number of potential additional investigations were proposed. The MMAG discussed and prioritized these investigations in March 2006, resulting in a table that was included in the letter report (see Attachment B of Appendix C). The MMAG anticipates that the studies included in this list will need to be re-evaluated based on the type and location of sewage treatment (i.e., some investigations may not be necessary; others may need to be added, etc.).

**ALTERNATIVES**

Not applicable.

**FINANCIAL IMPLICATIONS**

Funding for this work is included in the annual budgets for the northeast trunk (Clover) and northwest trunk (Macaulay) systems.

**SUMMARY/CONCLUSIONS**

The WMEP is one of the most comprehensive programs to assess the effects of sewage discharges in marine environments (SETAC panel report). Results of the 2005 monitoring showed that wastewater met receiving water quality guidelines for the protection of aquatic life and that surface waters off the outfalls were not at levels of concern for human health. The seafloor monitoring component showed some effects on seafloor organisms (higher numbers of animals and types of animals) and deep-water mussels (longer and fatter mussels), restricted to within the 100m IDZ at Clover Point and at Macaulay Point to the IDZ and to 200m southeast of the outfall diffuser. Additional investigations to provide data for the assessment of environmental effects are an important component of the WMEP.

The MMAG reviewed the 2005 WMEP and indicated it was generally satisfied with the current program. Recommendations that will be incorporated into the WMEP were made in the MMAG letter report.

**RECOMMENDATIONS**

That the Core Area Liquid Waste Management committee recommend to the Board that:

1. the executive summary of the report, *Macaulay and Clover Point Wastewater and Marine Environment Program – 2005 Annual Report*, be received for information;
2. the Marine Monitoring Advisory group letter report, *Review of the 2005 Macaulay and Clover Point Wastewater and Marine Environment Program*, be received for information; and
3. the report, *Macaulay and Clover Point Wastewater and Marine Environment Program – 2005 Annual Report*, be forwarded to the Ministry of Environment.

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Concurrence

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**COMMENTS**

CL:bc  
Attachments: 3

**MACAULAY AND CLOVER POINT WASTEWATER AND  
MARINE ENVIRONMENT PROGRAM  
2005 ANNUAL REPORT**

**Executive Summary**

Monitoring of wastewater discharges, surface waters and the seafloor environment in the vicinity of the Capital Regional District (CRD) Macaulay and Clover Point outfalls has been conducted as part of the Wastewater and Marine Environment program (WMEP) on a regular basis since the late 1980s. In addition, special investigations have been undertaken to define more clearly the effects of the outfalls on the receiving environment. The program has undergone a number of changes over the years.

In March 2003, the CRD Core Area Liquid Waste Management Plan (LWMP) was approved. This LWMP outlined the plans of the CRD to manage liquid wastes for the next 25 years. Commitments made in this plan were designed to protect public health and the environment from the impacts of liquid waste discharges. The plan committed to a number of actions pertaining to the WMEP, including the development of a seawater trigger. On July 21, 2006, the CRD received a letter from the minister of environment requesting that an amendment to the Core Area LWMP detailing a fixed schedule for the provision of sewage treatment be provided to him by June 30, 2007. Ministry of Environment (MoE) staff have indicated that the development of a seawater trigger is no longer necessary. In past reports, data collected under the WMEP were compared to the seafloor trigger effects parameters to assess the need for treatment. However, as a fixed schedule for treatment will be developed, comparisons of data as part of the seafloor trigger or the early indication process are no longer necessary and, therefore, were not included in the 2005 report.

The 2005 WMEP consisted of:

- Wastewater monitoring and analysis for over 180 substances, including conventional parameters and priority substances (conducted monthly for each outfall)
- Surface water monitoring and analysis for risk to public health, using fecal coliforms as indicators (conducted monthly at each outfall)
- Seafloor monitoring for chemical (sediment and mussel tissue contaminant concentrations) and biological parameters (health of seafloor communities – benthic organisms and mussels) on a yearly basis
- Additional investigations [that address specific questions about wastewater, water column and seafloor monitoring components and that look into emerging scientific issues regarding wastewater discharges and environmental effects, such as pharmaceuticals and personal care products (PPCPs)]

The 2005 annual report presents results and updates for the different elements of the Macaulay and Clover Point WMEP, including the monitoring components and the additional investigations.

### **WASTEWATER MONITORING**

Wastewater monitoring results for conventional parameters (i.e., pH, biological oxygen demand, total suspended solids and nutrients) indicated that the quality of the discharge from Macaulay Point and Clover Point during 2005 was similar to 2003 and 2004. Concentrations of all conventional parameters were within the expected range for fine-screened wastewater and did not exceed BC Water Quality Guidelines (BC WQG) after minimum initial dilution.

There were 187 substances analyzed for in both discharges and almost half of these substances were never detected in 2005. In general, substances detected greater than 50% of the time included conventionals, total and dissolved metals, some polycyclic aromatic hydrocarbons (PAHs), phthalates, phenolic compounds, a few miscellaneous volatile organics and terpenes. Some substances that were detected greater than 50% of the time in 2003 and 2004 were not detected at this frequency in 2005 (i.e.,

some phenolic compounds and PAHs at both Clover and Macaulay outfalls and some phthalates, isophorone and xylenes at Clover Point outfall). For those substances that were detected, a minimum initial dilution factor was applied to predict concentrations in the receiving environment (within the initial dilution zone (IDZ)). Results were compared to available WQGs. In 2005 (similar to previous years), all chemicals that had guidelines showed concentrations well below these guidelines at the minimum initial dilution (well within the IDZ), with most being below guidelines in effluent even before discharge to the marine environment.

A detailed statistical analysis of substances frequently detected in effluent was conducted in 2006 to identify, among other things, changes in wastewater concentrations and loads from 1990 to 2005. Results showed a general decrease over time of metal concentrations (for metals of greatest environmental concern) at both outfalls. The total concentrations of cadmium, chromium, copper, lead, mercury, nickel and zinc (i.e., metals of greatest concern for environmental toxicity) all exhibited significant negative trends over the 1990 to 2005 time period. The only metals that showed significant increases were total arsenic, total antimony (at Macaulay Point) and calcium, magnesium, molybdenum, potassium and phosphorus (at both outfalls).

Increases in concentrations over time were identified for a few of the PAHs, including chrysene (Macaulay Point effluent only), fluoranthene and total high molecular weight PAHs; however, most PAH concentrations did not change significantly over time. The greatest rates of decline in miscellaneous organics concentrations were observed for tetrachloroethene, 1,4-dichlorobenzene (1,4-DCB) and xylenes for both discharges.

Decreases in contaminant concentrations are partly attributed to the efforts of the CRD Regional Source Control program (RSCP). Contaminants of concern (such as arsenic and some PAHs) for which some increases were observed will be investigated further in cooperation with the RSCP.

## **SURFACE WATER MONITORING**

### **Macaulay Point**

Results of the monthly surface fecal coliform monitoring component for Macaulay Point indicated that the effluent plume behaved according to modelling predictions (i.e., effluent is trapped below the surface most of the time). Fecal coliforms stations' geometric means were generally well below 200CFU/100mL, indicating that risks to recreational primary contact are not expected. Only seven individual measurements out of 456 (representing 1.5% of surface water samples) were above the value of 200 CFU/100mL.

An assessment of surface water fecal coliform data was conducted in 2006 to identify potential temporal and spatial trends from 1990 to 2005. Results show low interannual variation in fecal coliform concentrations and suggest that, overall, there are no apparent increasing or decreasing temporal trends on an annual scale during the 16-year monitoring period. Concentrations were generally lower at Macaulay Point, in comparison to Clover Point, for this time period. There was a weak but statistically significant negative relationship between fecal coliform concentrations and distance at the Macaulay Point outfall in winter and summer (i.e., concentrations tended to be higher closer to the outfall and decreased with distance from the outfall).

### **Clover Point**

Fecal coliforms stations' geometric means were generally well below 200 CFU/100mL in 2005, indicating that risks to recreational primary contact are not expected. There were 30 individual measurements out of 456 (representing 6.6% of surface water samples) above the value of 200 CFU/100mL. Of these 30 measurements, all but two occurred in December 2005. There was a spike in fecal coliform counts from 2004 to 2005 and more data are required to establish whether this is a continuing trend or an unusual event, possibly influenced by the higher counts in December 2005.

An assessment of surface water fecal coliform data was conducted in 2006 to identify potential temporal and spatial trends from 1990 to 2005. Results show low interannual variation in fecal coliform concentrations and suggest that, overall, there are no apparent increasing or decreasing temporal trends on an annual scale during the 16-year monitoring period. Concentrations were generally higher at Clover Point in comparison to Macaulay Point. Clover Point displayed a wider range of concentrations than Macaulay Point, with the highest concentrations measured in the 1990 to 1999 period. Concentrations were higher for northern stations as compared to southern stations. No clear distance gradients were identified for Clover Point.

## **SEAFLOOR MONITORING**

### **Macaulay Point**

#### Sediment Chemistry

A total of 120 substances were analyzed in sediments at the outfall station (M0) and the reference station (PB1). Of these, 54 substances were detected (45%). For the remaining stations at Macaulay Point, 73 substances were analyzed and 53 of these substances were detected (73%). As observed in previous years, very few substances were above the CRD sediment quality guidelines (SQGs) in 2005 and exceedences were restricted to the 100m IDZ and to two stations within 200m of the outfall diffuser (di-n-butyl phthalate and 1,4-DCB within the IDZ, and di-n-butyl phthalate outside the IDZ at stations M2E and M2SW). It is important to note that values above the SQGs are only an indication of potential effects on the receiving environment. A complete assessment requires additional measures, such as assessing the health of the biological communities living within the sediments.

Analytical laboratories are working on developing methodologies that will reduce common phthalate contamination of samples, a potential source of the elevated results. The CRD RSCP has been, and will continue to be, actively promoting the use of alternative products to those containing 1,4-DCB by providing educational materials aimed at the business sectors and large organizations that use deodorizer tablets (i.e., the main product containing 1,4-DCB).

The 2005 results are consistent with previous years. The recent review conducted by the Society of Environmental Toxicology and Chemistry (SETAC) panel concluded that the sediment chemistry findings do not indicate a negative change over time.

#### Benthic Communities

The 2005 results were similar to the 2002 to 2004 results. These results are consistent with the findings of the SETAC panel. As for previous years, a spatial trend of decreasing overall abundance and polychaete abundance (PA) with distance from the outfall terminus was observed in 2005. The trend in total abundance (TA) is attributable in large part to abundances of a few taxa, particularly mobile polychaetes, sedentary polychaetes of the species complex *Capitella capitata* and amphipods. These species have responded to the organic concentrations of the near-field stations and are present in larger numbers than other species. Taxonomic richness did not exhibit a significant spatial gradient over the study area. The consistency in taxonomic richness across the study area indicates that biodiversity is not significantly affected by the outfall discharge. Swartz dominance index indicated a trend of decreased dominance with distance from the outfall diffuser.

Spatial trends were evident in the analysis of major taxonomic groups. Several taxa exhibited trends of decreased abundance with distance from the outfall terminus, including polychaetes (*Errantia* and *Capitella capitata* complex) and amphipods. Other crustaceans exhibited a weak trend of increased abundance with distance from the outfall. Bivalve, echinoderm, gastropod and sedentary polychaete abundances did not exhibit any distance-related trends.

Although benthic community assemblages were different adjacent to the outfall, there was little or no evidence of impairment of the communities in terms of providing ecosystem functions. The spatial

patterns of effects near the outfall indicated a trend to the south and east of the diffuser (within 200m), consistent with the local patterns of current and sediment deposition. When examining TA values, only the outfall terminus was significantly different from the rest of the stations, indicating outfall effects are mainly limited to the IDZ (and the 200m stations to the east and southeast of the outfall diffuser).

## **Clover Point**

### Sediment Chemistry

A total of 120 substances were analyzed in sediments at the outfall station (C0) and the reference station (CB). Of these, 49 substances were detected (41%). No substances were above the CRD SQGs in 2005. This is an improvement over 2004 when mercury was above CRD SQGs within the IDZ, and 2003 when five substances exceeded SQGs within the IDZ and mercury exceeded outside the IDZ. However, additional data are needed to confirm if mercury concentrations are decreasing. Similar to Macaulay Point, it is important to note that values above the SQGs are only an indication of potential effects on the receiving environment. A complete assessment requires additional measures, such as assessing the health of the biological communities living on the seafloor.

### Mussel Communities

Mussel mean lengths and weights for 2005 were greater at most locations than at the reference stations (i.e., growth enhancement or stimulation occurred around the outfall). These results are consistent with the findings of the SETAC panel. The qualitative temporal trend assessments revealed no apparent patterns over time for mussel length or weight when comparing 2005 results to 1995 to 2004 data indicating that, in general, mean mussel sizes have not changed over this time period. In previous years, mussels near the outfall have been either older or younger than the reference mussels; in 2005, ages at all stations were similar to those at the reference stations. Overall, there are no indications of biological impairment of the mussel community in the cohort analysis data. The mean gonad index and reproductive timing index values indicated that the majority of mussels were either three quarters or fully ripe.

The 2005 data do not provide any indication of adverse effects to the resident mussel communities.

### Tissue Chemistry

A total of 17 metals and 38 organic substances were analyzed in mussel tissue in 2005. Fourteen metals were detected in tissue samples. In 2005, copper, lead and zinc concentrations were all significantly higher near the outfall compared to reference, while most other metal concentrations were lower near the outfall as compared to the reference areas. These results are similar to previous years and may be partly attributed to growth dilution. Other factors (i.e., physiological or seasonal) could also be contributing to the concentrations of substances in mussels. Mussel tissue metal concentrations were lower than recognized tissue benchmarks for the protection of wildlife and consumers of mussels. Temporal assessments of metal concentrations over the 1995 to 2004 time period showed little change.

Of the 38 organic substances measured, 20 were detected. The detection pattern is similar to previous years. Mussel tissue organic concentrations (e.g., PAHs) were lower than recognized tissue benchmarks. Lipid content was significantly negatively correlated with distance from the outfall, indicating that mussels had higher lipid content near the outfall, supporting the assumption of a continuous source of food near the outfall.

Overall, the 2005 mussel tissue chemistry data do not provide any indication of adverse effects to the resident mussel communities, or to higher trophic level organisms as a result of bioaccumulation/biomagnification of contaminants.

## **ADDITIONAL INVESTIGATIONS**

Additional investigations are important elements of the WMEP. These investigations are conducted to address issues that clarify aspects of the WMEP and provide data for the assessment of environmental effects. Investigations that deal with new emerging scientific issues are best undertaken under a collaborative research program. Some of the additional investigations undertaken were part of the requirements under the March 2003 Core Area LWMP approval letter from MoE. These included:

- high resolution analyses for persistent organic pollutants (POPs) and emerging chemicals
- review of methods for the assessment of marine sediment transport (as part of an overall sediment transport study)
- collaborative studies with the University of Victoria, Environment Canada and Fisheries and Oceans Canada on PPCPs and emerging chemicals

### **Investigations Completed in 2005**

#### Potential Environmental Effects of the Macaulay and Clover Point Outfalls and Review of the Wastewater and Marine Environment Program

An independent assessment was conducted in 2005 to evaluate, using a weight-of-evidence risk assessment approach, the potential effects of the Macaulay and Clover Point wastewater discharges on the marine receiving environment. Results from this assessment were provided to, and reviewed by, the SETAC panel. Although the annual WMEP reports present all the data from the program and evaluate potential environmental effects, they emphasize snapshots in time (i.e., one to four years) and do not integrate findings of multiple years in a weight-of-evidence risk-based approach framework. The 2005 assessment focused on environmental quality data collected from 2000 to 2004, and included an overview of data collected from 1992 to 2000, but it also considered the results of studies conducted in the 1980s and 1990s.

Assessment of the effects of the outfall was based on a risk assessment approach. This framework was used to evaluate risks to humans, wildlife (seabirds and marine mammals) and aquatic life (shellfish, soft-bodied organisms and finfish). Seafloor communities were evaluated using a formal weight-of-evidence approach because the seafloor serves as a sink for the accumulation of contaminants released from the wastewater discharge.

Results of the seafloor community risk assessment indicated a low to moderate level of effects for stations close to the Macaulay Point outfall and affecting a limited area of sediment (mainly within 200m). At Macaulay Point far-field stations (400 to 800m) and at Clover Point near-field (100 to 200m) and far-field (400 to 800m) stations, risks to seafloor communities are negligible to low. The overall risk to water column invertebrates is negligible to low. Whole effluent toxicity test results, and comparison of whole effluent chemistry data to ambient WQGs, indicate that risks to fish from outfall-related contamination are low. Risk estimates for wildlife were based on comparisons of estimated daily doses of contaminants to representative animals. All substances of interest, except zinc, pose negligible risks to wildlife; zinc poses a low risk of potential effects on wildlife.

Surface water fecal coliform data for both outfalls indicate that human health risks are negligible. Semi-quantitative analyses of direct contact pathways, such as windsurfing, kayaking and other public uses of the marine water near the Macaulay and Clover Point outfalls, indicated negligible health risks.

The report also compared the marine biological effects observed in this assessment to other jurisdictions to put the results and their significance into context. Some of the jurisdictions incorporate secondary effluent treatment. Review of multiple wastewater discharge programs from the west coast of North America indicated that the environmental effects observed adjacent to the Macaulay and Clover Point outfalls are qualitatively similar to those observed in other jurisdictions. Despite variations in the type of wastewater treatment, the sediment concentrations of copper, zinc and total polychlorinated biphenyls (PCBs) in sediments were similar among jurisdictions.

## Macaulay and Clover Point Additional Investigations – High Resolution Chemical Analyses

As part of the additional investigations identified by the MMAG, high resolution analyses for several analytes in either wastewater, sediment or mussel tissue samples from the Macaulay Point and Clover Point outfalls were conducted from 2003 to 2005. High resolution substances analyzed included PCBs, polybrominated diphenyl ethers (PBDEs), nonylphenols, chlorobenzenes, organochlorine pesticides, organophosphate pesticides and herbicides. PBDEs were collected in collaboration with Environment Canada as part of the Georgia Basin Action Plan initiative. These data were evaluated in terms of their environmental relevance and potential effects. A comparison of results for the Macaulay and Clover Point outfalls to other jurisdictions was conducted where possible (i.e., when there were data available for comparisons).

For most substances in wastewater, ambient WQGs were met even within the wastewater stream prior to discharge. This provides an additional degree of confidence that ecological risks attributable to these substances are negligible. Although there were no ambient WQGs for PBDEs, comparison of chemistry data to literature-based effects information indicated negligible ecological risks for this contaminant group.

Using lower-bound (conservative) sediment guidelines for screening, no significant ecological risks attributable to PCBs were identified. In addition, comparison of sediment PCB concentrations to regional background concentrations and other jurisdictions indicated that ecological risks attributable to sediment-associated PCBs are negligible. The only exceedences of lower-bound sediment guidelines were observed for nonylphenol toxic equivalent unit. However, the assessment of nonylphenol was based on a small number of samples. Additional samples will be collected for a more comprehensive assessment in 2006. The CRD RSCP is undertaking a program to promote reductions in the use of detergents, which are the largest source of nonylphenol.

Comparisons of mussel tissue data to relevant environmental effects benchmarks indicated no exceedences. Available information indicates that observed tissue concentrations of PAHs, phthalates, PBDEs and PCBs are well below concentrations shown to cause adverse effects.

Concentrations associated with the WMEP samples were not consistently higher or lower than corresponding concentrations reported for other jurisdictions. Measured or estimated concentrations in environmental media were generally below concentrations associated with adverse effects to marine aquatic organisms.

### Assessment of Plume Trapping and Dilution at the Macaulay and Clover Point Outfalls

The upgraded modelling system (C3/UM) was used to simulate representative seasonal scenarios for both outfalls in 2005/2006. These data were used to assess plume trapping characteristics and corresponding dilutions within the IDZ and at the 100m IDZ boundary.

Results showed that the most frequent trapping depths are 45m at Macaulay Point and 50 to 55m at Clover Point where trapping is slightly deeper in summer. The most frequent dilutions at Macaulay range from 600:1 (summer) to over 1300:1 (winter); while at Clover, these values range from 700:1 to 1800:1. Approximately 95% of the time dilutions range from 450:1 (summer) to 720:1 (winter) at Macaulay and 410:1 (summer) to 550:1 (winter) at Clover. The minimum predicted dilutions (worst-case conditions) were 245:1 at Macaulay Point and 175:1 at Clover, both occurring deep in the water column.

Plume surfacing is predicted to occur during winter at both diffusers but not during summer months. Surfacing is predicted to be infrequent (4.8% of the time at Macaulay and 1.7% at Clover) and could occur during slack water on the turn of the tide with the longest durations during the neap tide period. Average dilutions during these events are predicted to be 1800:1 at Macaulay and 1588:1 at Clover.

## Review of Methods for Assessing Marine Sediment Transport

The Core Area LWMP approval letter of March 2003 contained a condition for approval of the plan for the development of a sediment transport study for the Clover and Macaulay Point outfalls. The principal objective cited for this study was the assessment of the fate of sediments being discharged through the outfalls.

In 2005, a review of methods and models available to assess sediment transport was carried out. Disadvantages and advantages of each method and/or technology were identified with specific comments on their applicability to the outfalls and the dynamic processes that govern sediment movement in this area of Juan de Fuca Strait.

The study pointed out that there is considerable uncertainty in the prediction of sediment transport, primarily due to the complicated processes involved in sediment entrainment, transport and deposition. There is no single method which can address all the issues. Developing a detailed understanding of the size distribution, density and flocculation characteristics of effluent solids will be critical to assess transport of solids from the Clover and Macaulay Point outfalls.

### **Investigations Underway**

#### Collaborative Study on PPCPs in Wastewater and the Marine Environment

A collaborative research project (initiated in 2005) involving a partnership between the CRD's Scientific Programs, the University of Victoria, Fisheries and Oceans Canada and Environment Canada has been developed. This study will focus on determining the fate of PPCPs in the marine environment around the Macaulay and Clover Point outfalls. The project will look at the concentrations of a select group of these compounds in Macaulay and Clover Point wastewater, sediment and mussel tissue samples.

#### Collaborative Program on Potential Effects of Emerging Chemicals from Municipal Wastewaters

A collaborative study between the CRD's Scientific Programs and Environment Canada's Pacific Environmental Science Centre was initiated in 2004 to determine the potential toxicogenomic effects of wastewater on marine fish using gene chip arrays and other toxicogenomic tools. As part of this study, effluent samples from the Macaulay and Clover Point outfalls were collected on a regular basis over the course of the study and marine fish species were exposed to different environmentally relevant concentrations. In addition to the exposure tests, effluent samples will be analyzed for a suite of PPCPs. The study is expected to be completed by 2009.

### **Investigations Planned for 2006**

- Continuation of high resolution analyses of wastewater, sediment and mussel tissue in 2006.
- Continuation of the collaborative program to study the potential effects of emerging chemicals present in municipal wastewaters, using gene chip arrays and other toxicogenomic tools with Environment Canada.
- Continuation of the research project with the University of Victoria on pharmaceuticals in wastewater and the receiving environment.
- Assemble a database of emerging chemicals/substances of potential interest or concern. This will include a library of environmentally relevant toxicity data.
- Undertake additional investigations as listed and prioritized by the MMAG as funding allows and as required under the LWMP.

Additional details on these investigations and preliminary results will be presented in the WMEP annual reports as they become available.

**MONITORING COMPONENTS OF THE MACAULAY AND CLOVER POINT WASTEWATER AND MARINE ENVIRONMENT PROGRAM**

<b>MACAULAY POINT OUTFALL</b>	<b>PARAMETER</b>	<b>MONITORING FREQUENCY</b>
Wastewater	flow	daily
	conventionals <sup>1</sup> and priority substances <sup>1</sup>	monthly
	priority substances <sup>1</sup>	quarterly (January, April, July and October)
Surface Water	indicator bacteria (fecal coliform)	monthly
Seafloor	particle size analysis, TOC <sup>2</sup> , AVS <sup>2</sup> and sediment chemistry <sup>1</sup>  benthic community structure (TR, SDI, PA) <sup>3</sup>	annually (September)
<b>CLOVER POINT OUTFALL</b>	<b>PARAMETER</b>	<b>MONITORING FREQUENCY</b>
Wastewater	flow	daily
	conventionals <sup>1</sup> and priority substances <sup>1</sup>	monthly
	priority substances <sup>1</sup>	quarterly (January, April, July and October)
Surface Water	indicator bacteria (fecal coliform)	monthly
Seafloor	particle size analysis, TOC <sup>2</sup> , AVS <sup>2</sup> and sediment chemistry <sup>1</sup>	annually (September) at C0 and CB, every three years at additional stations
	deep-sea mussel ( <i>Modiolus modiolus</i> ) - tissue weight, shell length, age structure, reproductive state  tissue chemistry <sup>1</sup>	annually (September)
Notes:		
<sup>1</sup> See <i>Macaulay and Clover Point Wastewater and Marine Environment Program, 2005 Annual Report</i> – Appendix A for list of substances		
<sup>2</sup> TOC – total organic carbon, AVS – acid volatile sulphide		
<sup>3</sup> TR – taxa richness, SDI – Swartz dominance index, PA – polychaete abundance		

**MARINE MONITORING ADVISORY GROUP  
REVIEW OF THE 2005 MACAULAY AND CLOVER POINT WASTEWATER AND  
MARINE ENVIRONMENT PROGRAM**

October 12, 2006

## **1.0 INTRODUCTION**

The Marine Monitoring Advisory Group (MMAG) was established to advise on, provide an independent assessment of, and provide recommendations on the Wastewater and Marine Environment Program (WMEP) to the Capital Regional District (CRD) (see Attachment A for the MMAG Terms of Reference). When requested by the CRD, the MMAG reviews data and reports generated as a result of these programs, and provides recommendations. The MMAG consists of independent scientists and experts associated with Environment Canada, BC Ministry of the Environment (MoE), Fisheries and Oceans Canada, Vancouver Island Health Authority, University of Victoria, and Simon Fraser University.

In a letter dated March 26, 2003, the Minister of the Environment (then Water, Land, and Air Protection) required the continuing involvement of the MMAG in this manner as part of her approval of CRD's Core Area Liquid Waste Management Plan. The letter also stated that the MMAG should complete an independent report on an annual basis with comments on the Wastewater and Marine Environment program (WMEP). The MMAG members agreed to complete such a report. The first MMAG report was submitted in 2004, and provided the group's review of the 2003 WMEP for the Macaulay and Clover Point Outfalls. This report reviews the 2005 WMEP, and as such does not include comments on any of the recent (i.e., 2006) events pertaining to the Macaulay and Clover Point outfalls (including the report by the Society of Environmental Toxicology and Chemistry and the letter from the Minister of Environment requiring the CRD to prepare and submit a schedule for sewage treatment).

Initial comments on WMEP program components were provided to CRD Scientific Programs at the May 29, 2006 MMAG meeting, which were recorded by an independent consultant. The independent consultant compiled the comments from the meeting and provided them to the chair of the MMAG for member review and additional contributions. CRD Scientific Programs then provided the MMAG members with the 2005 Annual Report on September 5, 2006. The Seafloor Trigger and Early Indication process were not included in the 2005 annual report, consequently, MMAG members did not comment on these items. The MMAG reviewed the Annual Report and provided additional comments on the WMEP to CRD Scientific Programs at the MMAG meeting on October 11, 2006. These comments were forwarded to the independent consultant, who integrated all comments, including those from both meetings, and provided them to the chair of the MMAG for review and finalization of the letter report.

## **2.0 MARINE MONITORING ADVISORY GROUP COMMENTS BY PROGRAM COMPONENT**

The following consensus comments were provided by the MMAG on the WMEP, organized below by program component (see the WMEP 2005 annual report for a detailed description of these components). Any dissenting comments are also recorded below (at present there are none).

MMAG members attending the May 29, 2006 meeting included Chris Kennedy, Deanna Lee, Eric McGreer, and Sophie Johannessen. No comments were received prior to this meeting. Members who did not attend this meeting (Christine Bender, Chris Garrett and Diana Varela) were contacted via teleconference to discuss the WMEP. Members subsequently forwarded their comments and recommendations to the consultant who integrated them into the report. MMAG members attending the October 11, 2006 meeting included Chris Kennedy, Sophie Johannessen, Deanna Lee, Diana Varela, Chris Garrett, Eric McGreer and Christine Bender.

### **2.1 Wastewater Monitoring**

#### **Comments**

There was general support for this how this monitoring component is being conducted, including sampling frequency, detection limits, and parameters.

#### **Suggestions**

There were two specific suggestions on this monitoring component:

- Present comparison to CCME guidelines (in addition to the BC criteria) if they are lower than or newer than current BC criteria.
- Look at the variability of past data to determine whether it would be useful to do a one-time more intensive study of variability for any particular parameter.

### **2.2 Surface Water Monitoring**

#### **Comments:**

There was general support for how this monitoring component is being conducted, including support for continuing with the *enterococci* pilot study to determine the feasibility of including this parameter in the annual monitoring program.

#### **Suggestions:**

There were no specific suggestions on this monitoring component.

### **2.3 Seafloor Monitoring – Sediment Chemistry**

#### **Comments:**

There was general support for how this monitoring component is being conducted. It was noted that there was a laboratory QA problem resulting in high variability among replicates. The CRD and MMAG will decide whether any changes are needed to the program once it is determined

what caused this problem. In the meantime, CRD is taking additional precautions by visiting the lab during sample homogenization and preparation procedures.

**Suggestions:**

There was one specific suggestion for this monitoring component:

- It was noted that the additional investigation proposed re: sediment cores (see Attachment B) may help interpret surface sediment chemistry results.

## **2.4 Seafloor Monitoring – Benthic Communities**

**Comments:**

There was general support for how this monitoring component is being conducted.

**Suggestions:**

There were no specific suggestions on this monitoring component.

## **2.5 Seafloor Monitoring – Mussel Communities**

**Comments:**

There was general support for how this monitoring component is being conducted.

**Suggestions:**

There was one specific suggestion on data evaluation for this component:

- Be aware of and report significant changes in any direction (e.g., mussel growth).

## **2.6 Seafloor Monitoring – Mussel Tissue Chemistry**

**Comments:**

There was general support for how this monitoring component is being conducted.

**Suggestions:**

There were no specific suggestions on this monitoring component.

## **2.7 Additional Investigations**

In the 2005 MMAG report it was noted that there were a variety of additional investigations that had been proposed by members of the MMAG, but that the MMAG as a whole had not yet had an opportunity to discuss and rank them. At the March 15, 2006 meeting, the MMAG discussed and ranked the additional investigations that have been proposed to date, resulting in the table included as Attachment B. This was generally agreed to be a useful process for tracking and prioritizing proposals for additional investigations, which should be continued in the future. To that end, a form is being prepared which will include all the information required for the table, for use when a new additional investigation is proposed. This will allow these proposals to be prioritized and tracked alongside existing investigation proposals.

### **3.0 MARINE MONITORING ADVISORY GROUP GENERAL COMMENTS ON WMEP AND QUESTIONS TO THE BC MINISTRY OF ENVIRONMENT**

#### **3.1 General Comments**

One general comment was provided on the WMEP and CRD staff:

- The monitoring program is very thorough, and the MMAG appreciates how responsive CRD is to the MMAG's comments.

#### **3.2 Questions for the BC Ministry of Environment**

No questions were raised for the BC Ministry of Environment.

**CAPITAL REGIONAL DISTRICT (CRD)  
MARINE MONITORING ADVISORY GROUP (MMAG)**

**Terms of Reference  
Revised September 2003**

**ROLE OF THE MMAG**

- A)** To advise on, provide an independent assessment of, and provide recommendations on the marine environment programs to the CRD, specifically:
  - (1)** Program design
  - (2)** Interpretation of monitoring results and conclusions
  - (3)** When requested, consultant's proposals and reports
  - (4)** When requested, appropriate levels of expenditures
  - (5)** Quality assurance/quality control
  - (6)** One-time investigations
- B)** To review the state of the receiving environments near CRD wastewater outfalls.
- C)** To review CRD environmental quality (water and sediment) guidelines.
- D)** To consider information particularly relevant to the marine monitoring program.
- E)** To periodically review the Terms of Reference of the MMAG.
- F)** When requested, to provide independent advice to the CRD on other marine or liquid waste issues.
- G)** To prepare an annual letter report that will include the MMAG's comments on the conclusions presented in the Macaulay and Clover Point outfalls Wastewater and Marine Environment Program report. This letter will also include the MMAG's recommendations on the program (noting any disagreement).

**MEMBERSHIP**

Membership will be determined by the MMAG through the Chair.

Membership will consist of scientists with expertise appropriate to the terms of reference of the MMAG.

Invitations will be extended to representatives from Environment Canada, Fisheries and Oceans Canada, Provincial Ministry of Water, Land and Air Protection, and Vancouver Island Health Authority.

Members of the CRD Environmental Services Department normally attend the MMAG meetings as non-voting participants. The Chair may request of specific meetings that CRD staff do not attend.

The Chair may invite other participants and/or observers from time to time.

**CHAIR**

The Chair is selected by the members, and shall be reviewed every two years.

The incumbent chair may serve additional terms.

### ***MEETING SCHEDULE AND AGENDA***

Meetings will be held at the call of the Chair.

The Chair will determine the agenda in consultation with the CRD and members of the group.

### ***DECISION MAKING***

Decisions will be made by consensus. If consensus is not reached on an issue, it will be so stated.

### ***REPORTING PROTOCOL***

The MMAG will report to the CRD Environment Committee through the General Manager, Environmental Services.

### ***CRD SUPPORT***

The CRD will provide administrative support to the MMAG.

The CRD staff will keep MMAG informed of issues related to the mandate of the MMAG.

Macaulay and Clover Point Additional Investigations Prioritization – March 2006

Category	Investigation	Description and Characteristics	2006 Rating	Status
<b>Contaminant Source</b>	Study to address the presence of endocrine disrupter compounds and pharmaceuticals and personal care products in wastewater and the potential effects on the receiving environment.	<p>The first part of an overall phased-approach to study these substances will be to measure the concentrations of a group of substances in wastewater and potentially sediment and mussel tissue (depending on funding to develop methodology to analyze for these substances).</p> <p>This is an area of emerging concern related to human health and potential environmental effects (from the chemical, biological and toxicological aspects).</p>	High	Initiated
	Assessment of contaminants associated with oil and grease.	<p>Determination of contaminants associated with oil and grease originating from the outfalls. Relates to the potential human health and environmental effects issues (e.g., windsurfers, seagulls, etc.).</p> <p>The first phase of this investigation will be to undertake a literature review.</p>	Medium	
	Identification of pathogens in wastewater and the presence of these in surface waters around the outfalls.	Analysis of wastewater for different types of pathogens that have the potential to affect human health and determine if these pathogens are present in the receiving environment around the outfalls (related to die-offs, etc. in marine waters).	Low	
	Bacteria source identification.	Determine the different sources of fecal coliform to differentiate between various mammals, such as cows, dogs and humans.	Low	

Macaulay and Clover Point Additional Investigations Prioritization – March 2006 (*continued*)

Category	Investigation	Description and Characteristics	2006 Rating	Status
Pathways	Sediment transport/deposition/re-suspension (will include a review/analysis of contaminant partitioning in wastewater and particles).	<p>The first step in this investigation would include a determination of the different particle size fractions in wastewater (this could be conducted through a literature review and/or through laboratory experiments).</p> <p>The second phase would include the determination of the settling of particles from the discharge onto sediments.</p> <p>Results from these analyses would be used in the overall assessment of sediment particle deposition and the subsequent movement of sediments around the outfalls.</p>	High	Initiated
	Conduct a sediment core sampling program	<p>Determination of sedimentation and mixing rates and the fluxes of contaminants near the outfalls and at reference sites. A mass balance approach could be used where rates of contaminant accumulation in sediments are compared with the rate of contaminant discharge from the outfalls in an attempt to determine the proportion of each contaminant captured by and stored in the sediments.</p> <p>A sediment trap study could be added to study contaminant transport in the near bottom nepheloid layer.</p>	Medium	Initiated

Macaulay and Clover Point Additional Investigations Prioritization – March 2006 (*continued*)

Category	Description	Description and Characteristics	2006 Rating	Status
<b>Receptors and Potential Effects</b>	Effects of EDCs and PPCPs on the receiving environment.	As part of a phased-approach to study effects of EDCs, laboratory exposures, bioassay and/or caged studies (or an organism found around the outfall) could be conducted to assess the potential effects of these substances on the receiving environment around the outfalls.	High	
	Assessment of chemical concentrations in tissue of different trophic level organisms (including higher trophic levels).	Measurement of contaminants in crab, finfish or other organisms near the outfalls would provide a basis for a food-ingestion human health risk assessment. This information could also be used to model bioconcentration and biomagnification of contaminants to higher trophic levels near the outfalls.	High	
	Identification of biological resources.	Identification of the harvestable organisms around the outfalls.	Low	
	Clover Point mussel population biology.	Conduct some additional studies on the mussel population around the Clover Point outfall (e.g., reproductive cycle, health, etc.). Additional data relates to the current monitoring and to potential studies on emerging chemicals.	Low	
	Levels of pathogens in biota (epibenthic, etc.).	Assess the presence and concentration of pathogens in biota near the outfalls.	Low	
	Assess potential risks associated with pathogens/antibacterial resistance.	A literature review, risk assessment or a pilot study could be conducted to study antibiotic bacteria and the relevance as a potential emerging concern to human health, wildlife and domestic animals.	Low	