

APPENDIX B

**FECAL COLIFORM SAMPLING QUALITY
ASSURANCE AND QUALITY CONTROL
PROGRAM**

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QUALITY ASSURANCE AND QUALITY CONTROL FOR 2005/2006

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1.0 INTRODUCTION

Quality assurance and quality control (QA/QC) programs are a set of protocols that are adopted to ensure that the results of any study are valid, internally consistent and comparable with other similar projects. These protocols are set out in writing and are based on the most current and relevant research on the related topics. This appendix discusses:

- field sampling methods
- sample handling procedures
- analytical procedures
- field and laboratory replication (quality control)
- data assessment

The data collected for the quality assurance program are used to ensure consistency in field handling and analytical methods. If the data exceed a specified precision criterion then the lab is notified of a potential problem in the procedure and steps are taken to resolve the issue. The QA protocols presented in this appendix are based on two CRD memorandums (Drinnan, 1995 and Hutcheson, 1995).

2.0 METHODS FOR FECAL COLIFORM SAMPLING

All water samples were collected in 500 mL wide-mouth disposable bottles containing 1.5 mL of sodium thiosulphate (a sample preservative). Bottles were supplied by Cantest in Victoria, BC. Labelled samples were stored in an insulated cooler with ice packs for protection from prolonged exposure to UV light and delivered the same day to the laboratory. Samples were analyzed for fecal coliform bacteria following the procedures in Standard Methods (APHA, 1998) and reported as colony forming units/100 mL (CFU/100 mL). However, to assist the reader, the more commonly used reporting of fecal coliform per 100 millilitres (FC/100 mL) is used in this survey.

Care was taken to ensure that the weather on sampling days were representative of the sampling season (wet or dry). Conditions such as "first flush", major storms or any other effect that might tend to prejudice the results were avoided.

2.1 Stormwater Discharge Sampling

Where possible, stormwater discharge samples were collected from the point of discharge. Where this was not possible, the watercourse was followed upstream to the nearest point where the sample could be taken. A five metre inflatable boat was used to visit discharges located in areas difficult to access from the shore.

2.2 Nearshore Surface Water Sampling

Nearshore surface water (salt water) samples were collected by boat at 28 sites in Sooke inlet, harbour and basin. All sites were sampled in 2005 and 2006, once during wet and once during dry weather conditions. The samples were collected by rapidly submerging an inverted 500 mL sample bottle to a depth of approximately 200 mm and then turning it upright and allowing the bottle to fill.

2.3 Quality Assurance

2.3.1 Stormwater Sample Replicates (Field Splits)

Ten per cent of the samples collected were replicated and the field replicate samples identified as "field splits". A single sample was collected in a laboratory prepared one litre (1 L) sample bottle and inverted 30 times to ensure that the sample was well-mixed. The sample was then split evenly into two separate sample bottles. The two bottles were then labelled and sent to Cantest for analysis. These samples were submitted to the laboratory as blind samples (not identified as field splits).

2.3.2 Nearshore Surface Water Sampling Replication

Approximately 10% of the surface water samples collected in Sooke Inlet, Harbour and Basin were replicated. Two separate grab samples were collected in 250 mL sample bottles at the same location, one immediately after the other.

2.3.3 Quality Control Assessment

To establish the precision criteria (Section 2.3.4) 18 field splits were collected from six stormwater discharges in the core area of the CRD and analyzed for fecal coliform levels (the QA assessment was for the CRD core area, District of Sooke and Juan de Fuca Electoral Area (JdF EA) sampling programs). The sampling program for the precision criteria is repeated at the beginning of each year. The discharges were chosen based on previous high, moderate or low levels of fecal coliform concentrations (two discharges sampled for each category) to represent the varying fecal coliform counts that would be analyzed during the sampling program. Three individual 1 L grab samples were taken at each of the six stations and split into two replicate 250 mL sample bottles. Three blank samples of potable water were also collected in 250 mL sample bottles as part of the assessment. All samples were submitted with unique identifying numbers to Cantest.

2.3.4 Calculation of Quality Assurance Results

Laboratory precision for fecal coliform analysis (e.g., a measure of consistency by the lab) is determined by analyzing 18 pairs of field samples (field splits). The following, taken from Standard Methods, 18th edition (APHA, 1998), explains the procedure for calculating the precision criteria and determining whether the log ranges for the field splits are "acceptable" or "unacceptable":

- The data are arranged in pairs (D_1 and D_2). The log of each field measurement is determined (L_1 , L_2) and the difference (range) in the log value between each pair of field splits is calculated: $R = (L_2 - L_1)$. An average range (Mean-R) is then determined for all of the pairs.
- The precision criterion is calculated by multiplying the Mean-R by 3.27 and is rounded to one decimal place.
- The log range (R) is calculated for each of the field splits and compared to the precision criterion, to determine whether the sample is acceptable or not, according to the following criteria:

Acceptable (A) - If the calculation is less than the precision criterion, then the field data are within normal variability.

Unacceptable (U) - If the calculation is greater than the precision criterion, then the field data are outside of the normal variability. All data collected after the last "acceptable" set of data should be discarded and no further analysis should be done until the source of the problem is identified by the lab.

It is important not to put too severe an interpretation on the results from the QA calculation, especially when they are close to the "unacceptable" guideline. Each result represents a value within a 95% confidence interval, which gets proportionately larger as the actual result gets smaller. Therefore, one can expect,

through randomness, 5% of the samples to be outside of the precision criterion. Also, any fecal coliform count under 200 FC/100 mL is considered too small an amount to accurately calculate or compare to a precision criterion (APHA, 1998). It is also important to note that discharges with fecal coliform counts lower than 200 FC/100 mL receive a low public health concern rating.

The results should be rounded to one decimal place and compared to the precision criterion (e.g., 0.3). If the calculated value from the duplicate results still exceeds the criterion (e.g., 0.35 or greater) then an informal investigation of the laboratory should be initiated. If only a few duplicates are unacceptable (e.g., one out of every 20 pairs of duplicates) the lab is probably meeting the guideline.

The overall process is intended to act as an "alarm", alerting the study group to potential problems with the sampling and analytical procedures. As part of the review, the following elements are considered:

- the number of pairs exceeding the criterion
- the actual fecal coliform value of the pairs of data
- field notes on the "field split" procedure
- comments from the laboratory

3.0 RESULTS

3.1 Quality Assurance Results

For the 2005 and the 2006 QA program, 18 pairs of stormwater samples were collected from six discharges having high, moderate or low levels of fecal coliform bacteria in January of each year. The samples were sent to the lab for analysis of the fecal coliform concentration and the data used to calculate the precision criteria.

3.1.1 Blanks

Three blank samples (Greater Victoria tap water) for each sampling session (wet weather conditions and dry weather conditions) were submitted to Cantest along with the field samples. All three blanks sampled for both QA sampling sessions were reported as having <10 FC/100 mL. Therefore, the results meet the QA requirements.

3.1.2 Precision Criteria

Table 1 shows the lab results of the 18 pairs of samples used to determine the precision criteria for 2005 stormwater monitoring program. The calculated precision criterion for this laboratory, using these 18 sets of duplicates, was 0.43401. For comparison with subsequent field replicates this result was rounded to 0.4.

Table 2 shows the lab results of the 18 pairs of samples used to determine the precision criteria for 2006 stormwater monitoring program. The calculated precision criterion for this laboratory, using these 18 sets of duplicates, was 0.32327. For comparison with subsequent field replicates this result was rounded to 0.3.

3.1.3 2005 Field Splits

Wet Weather Sampling

Table 3 presents the results for the two field splits collected from the JDF EA during the wet period of the 2005 stormwater sampling programs (April of 2005). Data were compared to the precision criteria of 0.4, as described in Section 3.1.2. Of the two field splits analyzed, one exceeded the precision criteria. Since the results were below 200 FC/100 mL they are too low to be expected to meet the criteria. Therefore, the results meet the QA requirements.

Dry Weather Sampling

Table 3 presents the results for the two field split collected from the JdF EA during the dry period of the 2005 stormwater sampling program (September of 2005). Data were compared to the precision criteria of 0.4, as described in Section 3.1.2. The two sets of replicates did not exceed the precision criteria. Therefore, the results meet the QA requirements.

3.1.4 2006 Field Splits

Wet Weather Sampling

Table 4 presents the results for the five field splits collected from the JDF EA during the wet period of the 2006 stormwater sampling programs (February and April of 2006). Data were compared to the precision criteria of 0.3, as described in Section 3.1.2. Two of the field splits exceeded the precision criteria. Since the results were below 200 FC/100 mL they are too low to be expected to meet the criteria. Therefore, the results meet the QA requirements.

Dry Weather Sampling

Table 4 presents the results for the field split collected from the JdF EA during the dry period of the 2006 stormwater sampling program (September of 2005). Data were compared to the precision criteria of 0.4, as described in Section 3.1.2. The replicates did not exceed the precision criteria. Therefore, the results meet the QA requirements.

Table 1. 2005 Establishment of Precision Criterion

CRD Data, Batch Samples: 18 pairs, January 12 and 14, 2005 and February 24, 2005						
Disch. No.	Pair No.	1st Duplicate D1	2nd Duplicate D2	Log D1 L1	Log D2 L2	Range of Logs (Rlog) (Log L1 - Log L2)
245	1	21000	18000	4.32222	4.25527	0.06695
	2	9500	7800	3.97772	3.89209	0.08563
	3	8400	7500	3.92428	3.87506	0.04922
323	4	40	10	1.60206	1.00000	0.60206
	5	30	10	1.47712	1.00000	0.47712
	6	10	10	1.00000	1.00000	0.00000
503	7	570	420	2.75587	2.62325	0.13263
	8	560	560	2.74849	2.74819	0.00000
	9	480	450	2.68124	2.65321	0.02803
641	10	4300	3700	3.63347	3.56820	0.06527
	11	5700	4100	3.75587	3.61278	0.14309
	12	4100	3900	3.61278	3.59106	0.02172
805	13	32000	28000	4.50515	4.44716	0.05799
	14	33000	22000	4.51851	4.34242	0.17609
	15	37000	27000	4.56820	4.43136	0.13684
813	16	540	380	2.73239	2.57978	0.15261
	17	550	440	2.74036	2.64345	0.09691
	18	600	480	2.77815	2.68124	0.09691
Mean - Rlog (Sum Rlog/18)						0.13273
Precision Criterion (3.27 x Mean-Rlog)						0.43401

Table 2. 2006 Establishment of Precision Criterion

CRD Data, Batch Samples: 18 pairs January 16 and 25, 2006						
Disch. No.	Pair No.	1 st Duplicate D1	2 nd Duplicate D2	Log D1 L1	Log D2 L2	Range of Logs (Rlog) (Log L1 - Log L2)
238	1	20	10	1.30103	1.00000	0.30103
	2	20	10	1.30103	1.00000	0.30103
	3	30	10	1.47712	1.00000	0.47712
245	4	2000	1400	3.30103	3.14613	0.15490
	5	2000	1900	3.30103	3.27875	0.02228
	6	1500	1500	3.17609	3.17609	0.00000
301	7	10	10	1.00000	1.00000	0.00000
	8	10	10	1.00000	1.00000	0.00000
	9	10	10	1.00000	1.00000	0.00000
320	10	490	430	2.69020	2.63347	0.05673
	11	690	630	2.83885	2.79934	0.03951
	12	470	450	2.67210	2.65321	0.01889
641	13	4500	4200	3.65321	3.62325	0.02996
	14	7200	4400	3.85733	3.64345	0.21388
	15	5900	5200	3.77085	3.71600	0.05485
777A	16	35000	34000	4.54407	4.53148	0.01259
	17	26000	22000	4.41497	4.34242	0.07255
	18	7400	7000	3.86923	3.84510	0.02413
Mean - Rlog (Sum Rlog/18)						0.09886
Precision Criterion (3.27 x Mean-Rlog)						0.32327

Table 3. 2005 Laboratory Quality Assurance Results – Wet and Dry Periods

Date	Discharge Number	Fecal Coliform Counts for Field Splits	Log	Log Range	Acceptable (A) or Unacceptable (U)
Wet Period					
Apr.15	2005A	40	3.68887945	1.386294361	A ²
		10	2.30258509		
Apr.19	4004	10	2.30258509	0	A
		10	2.30258509		
Dry Period					
Sep.29	2805	6000	8.69951475	0.333144447	A
		4300	8.3663703		
Sep.29	2607	21000	9.95227772	0.100083459	A
		19000	9.85219426		

¹ It is possible, due to randomness, that 5% of the samples may exceed the precision criteria.

² Any fecal coliform count under 200 is considered too small an amount to calculate a precision criterion (APHA, 1992). However, any discharge lower than 200 FC/100 mL receives a lower rating for public health concern.

Table 4. 2006 Laboratory Quality Assurance Results – Wet and Dry Periods

Date	Discharge Number	Fecal Coliform Counts for Field Splits	Log	Log Range	Acceptable (A) or Unacceptable (U)
Wet Period					
Feb.27	2001H	20	2.995732274	2.995732274	A ²
		1	0		
Apr.27	2021	30	3.401197382	0.405465108	A ²
		20	2.995732274		
Apr.27	2016	1	0	0	A
		1	0		
Apr.28	2002	10	2.302585093	0	A
		10	2.302585093		
May 4	2407	53000	10.87804719	0.163629424	A
		45000	10.71441777		
Dry Period					
Sep.25	2407	11000	9.305650552	0.293761119	A
		8200	9.011889433		

¹ It is possible, due to randomness, that 5% of the samples may exceed the precision criteria.

² Any fecal coliform count under 200 is considered too small an amount to calculate a precision criterion (APHA, 1992). However, any discharge lower than 200 FC/100 mL receives a lower rating for public health concern.

4.0 CONCLUSIONS

All requirements for the JdF EA program QA/QC program were carried out in 2005 and in 2006. All of the QA/QC results were acceptable for use to rate stormwater discharges for public health concern.

5.0 REFERENCES

APHA, 1998. American Public Health Association, American Water Works Association, Water Pollution Control Federation, 20th Edition. Standard Methods for the Examination of Water and Wastewater.

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