



2018

COMPLIANCE AUDIT REPORT

ENVIRONMENTAL DATA QUALITY ASSURANCE REGULATION

SPLIT SAMPLE AUDIT PROGRAM ASSESSMENT: PULP MILL EFFLUENT



EXECUTIVE SUMMARY

The Split Sample Audit Program Assessment for Pulp Mill Effluent (SSAP Assessment) was conducted by the B.C. Ministry of Environment and Climate Change Strategy (ENV) to assess the adequacy of quality control deployed by the pulp and paper sector and the quality of effluent monitoring data submitted to ENV, and to ensure compliance with sampling and laboratory methods and protocols. The ultimate goal of environmental monitoring data is the protection of human health and the environment. The SSAP Assessment helps ensure the data produced by permittees is both defensible and credible.

The SSAP Assessment was performed using results from ENV's annual Split Sample Audit Program (SSAP). The SSAP compares the analytical test results of a permittee's samples to those obtained by an ENV representative. A statistical evaluation of the test results is used to determine whether a permittee's sampling performance and their laboratory's analytical performance meet the quality standards that ENV are responsible to uphold on behalf of the people of British Columbia. The Environmental Data Quality Assurance Regulation (EDQAR) under the *Environmental Management Act* (EMA) authorizes the deployment of the split sampling program where required by a director.

The sample population for the SSAP Assessment consists of all pulp mills in British Columbia that discharged effluent to the receiving environment during the 2018/2019 audit year. This amounted to 14 out of a total of 15 operating pulp mills in B.C. (one mill was shutdown for maintenance, and therefore was not discharging at the time of the inspection).

The methodology of the SSAP Assessment included pre-audit coordination and communication with permittees, on-site inspection, field QA/QC, sample collection and submission, laboratory analysis, and results reporting. ENV compiled the results of the individual split sample audits for each of the 13 permits (14 operations in total) included in the SSAP Assessment. These results were used to determine compliance rates with the EDQAR, to evaluate overall pulp mill sector performance with respect to effluent sample collection, submission, and laboratory analysis, and to identify opportunities for improvement.

Results of the SSAP Assessment demonstrate that all permit holders included in the SSAP Assessment complied with Section 2(2)(a) of the EDQAR, which requires that permittees submit one part of the split samples to a qualified laboratory for analysis.

Twelve out of the thirteen permits included in the SSAP Assessment passed their split sample audits. To pass an audit, the 'Percent of Failed Tests' can not exceed 25% and a Performance Evaluation must achieve 70%.

This SSAP Assessment also scrutinized individual test result evaluations to identify potential trends that might be useful in identifying opportunities for improvement. Despite the small data set, it was revealed that over 50% of the analytical data reported for total Kjeldahl nitrogen, dissolved phosphorus, total barium, total lead, total titanium, dissolved aluminum, and dissolved thallium exceeded their acceptable deviations and, as such, resulted in failure outcomes. In addition, the review revealed that permittees

did not produce and/or report pH values for 29% of required submissions, and that at least 25% of all tests performed for a variety of resin and fatty acid parameters had incalculable outcomes due to inflated reporting detection limits.

Analyses performed by in-house laboratories and contracted laboratories had respective audit split sample failure test rates of 18% and 15%.

Findings from the SSAP Assessment have identified the following areas for improvement:

Permittees are reminded that it is their responsibility to confirm that the analyses required by their permit are being performed by laboratories with a scope of proficiency that includes those parameters. It is also the responsibility of laboratories, whether in-house or contracted, to ensure they are published in the directory of qualified laboratories, complete with their scope of proficiency testing. To that end, future compliance inspections may include evaluation of compliance with EDQAR Section 5.

Permittees are encouraged to review individual test result evaluations that demonstrate a significant exceedance of the parameter's acceptable deviation. Permittees are reminded that deviations may be the result of inadequate QA/QC, improper sample collection methods, improper sample handling and preparation protocols and issues arising throughout the analytical procedure. For this reason, permittees are encouraged to involve both their samplers and their laboratories to determine the possible reasons for these failures. It is important that steps are taken to minimize the risk of future failures, especially for certain parameters that were identified across the sector for their higher occurrences of test failures and issues with inflated dilution limits. Further review of sample collection practices and/or sample analysis techniques for those parameters may be necessary. Permittees are also advised to review the latest version of the B.C. Field Sampling Manual with their sampling technicians to ensure adherence with proper sampling techniques.

The omissions of a test result for a parameter required by the permit is normally assigned an evaluation outcome of 'fail'. The 2018/2019 audit year included several first-time participants and so waived this protocol rule for this year only. Permittees are encouraged to consult with their ENV inspecting officer to confirm the analytical reporting requirements of their audit to avoid deductions in future performance evaluations.

Compliance assessment of whether permittee results were submitted within 45 days of sample collection as per requirements of Section 2(2)(b) of the EDQAR, as well as the reimbursement requirements of Section 4(1), should be included in compliance inspections involving a split sample audit.

TABLE OF CONTENTS

Executive Summary.....	i
List of Abbreviations Used	iv
Introduction	1
Purpose of this Report	1
Split Sample Audit Program	1
About the Industry Sector.....	2
Selection	2
Description.....	2
Regulatory Oversight	2
Description of the Audited Premises.....	4
Potential Environmental Issues and Key Methods of Pollution Control	5
SSAP Assessment Methodology.....	6
Pre-Audit Activities	6
On-Site Sample Collection and Submission	6
SSAP Assessment Analysis	8
Summary of Findings of Compliance Audits	8
Results by Parameter Performance	10
Test Failures.....	12
Report Omissions.....	12
Inflated Laboratory Detection Limits.....	13
Combination of Issues	13
Laboratories Used in Effluent Analysis	14
Discussion and Recommendations	15
Appendices.....	17

LIST OF ABBREVIATIONS USED

Acronym	Definition
AOX	Adsorbable organic halides
BCELM	British Columbia Environmental Laboratory Manual
BCFSM	British Columbia Field Sampling Manual
BOD	Biochemical/biological oxygen demand
CALA	Canadian Association for Laboratory Accreditation
COD	Chemical oxygen demand
DO	Dissolved oxygen
EDQAR	Environmental Data Quality Assurance Regulation
EMA	<i>Environmental Management Act</i>
ENV	B.C. Ministry of Environment and Climate Change Strategy
LSQA	Laboratory Standards & Quality Assurance
PYLET	Pacific Yukon Laboratory for Environmental Testing
QA/QC	Quality Assurance/Quality Control
RDL	Reporting detection limit
SSAP	Split Sample Audit Program
WDR	Waste Discharge Regulation

INTRODUCTION

PURPOSE OF THIS REPORT

The objective of the Split Sample Audit Program Assessment for Pulp Mill Effluent (SSAP Assessment) is to assess quality control of the pulp and paper sector's effluent monitoring data and ensure compliance with sampling methods and laboratory methods and protocols. This audit process ensures that the environmental data provided by permit holders ('permittees') is defensible, credible and compliant with the requirements of their waste discharge authorization (permit). The SSAP Assessment was performed using results from the B.C. Ministry of Environment and Climate Change Strategy's (ENV) annual Split Sample Audit Program (SSAP) during the 2018/2019 audit year.

SPLIT SAMPLE AUDIT PROGRAM

Industries prescribed under the Waste Discharge Regulation (WDR) that operate within British Columbia are often required to monitor and test the quality of the effluent they are authorized to discharge. ENV evaluates analytical data provided by permittees to ensure compliance with their permit requirements. The discharge limits stipulated in permits are determined to ensure the discharge will not have a significant impact on, and will therefore be protective of, the receiving environment. For this reason, it is incumbent upon ENV to ensure that the analytical data provided by permittees meets an acceptably high level of quality.

The SSAP, a Quality Assurance Program administered by ENV since 1990, is a robust, reliable mechanism that evaluates and monitors that data quality. The SSAP uses split samples (homogenized samples obtained using a sample splitter, or side-by-side sampling for fish toxicity) which reduce the potential impacts of media heterogeneity. The reduction of this potential interference allows for a more robust, isolated study of the remaining aspects of producing representative environmental parameters. These remaining aspects include field QA/QC, sample handling, processing, preservation, shipping, laboratory processing and sample handling, laboratory equipment and instrumentation, laboratory QA/QC, and reporting. In other words, the SSAP compares the analytical results of a permittee's samples to those obtained by an ENV representative of the same media, to determine whether a permittee's sampling performance and their laboratory's analytical performance meet the quality standards that ENV are responsible to uphold on behalf of the people of British Columbia. The findings of each audit are reported in SSAP summary letters and tables that are provided to participating permittees. An audit produces two outcomes; a 'percentage of failed tests' and an 'overall performance evaluation'. An audit pass requires an overall performance evaluation score of at least 70% and a percentage of failed tests to be 25% or less.

The primary scope for the SSAP is heavy industry facilities that discharge effluent to surface water, such as active pulp and paper mills throughout the province. The objective is to ensure a split sample audit is conducted annually at each of these sites. All of the parameters listed within a permit may be included in a split sample audit.

ABOUT THE INDUSTRY SECTOR

SELECTION

Industry sectors targeted by the ENV's annual audit program are selected based on their inclusion in the WDR, as well as existing policy and direction such as Environmental Protection Division Inspection Policy and the 2018 B.C. Service Plan.

DESCRIPTION

PULP AND PAPER INDUSTRY

B.C.'s pulp and paper industry is an essential part of B.C.'s highly integrated forest industry landscape. The industry is vitally linked to the forest sector as an outlet for residual chips, shavings, sawdust and hog fuel from sawmills in the creation of value-added products from these fibre streams. The sector has also become a major producer of bioenergy in North America, and one of the largest users of railways in B.C. and of the Port of Vancouver.¹

Pulp is used primarily as a raw material for paper and paperboard products, packaging as well as personal hygiene products and rayon. The main B.C. pulp products are currently bleached softwood kraft pulp and chemi-thermo-mechanical pulp. Most of the paper produced in B.C. is newsprint.²

There are currently 15 operating pulp mills in B.C.

REGULATORY OVERSIGHT

The *Environmental Management Act* (EMA) and the Waste Discharge Regulation (WDR) are the principal pieces of legislation that protect water quality in British Columbia. Under this legislation, the introduction of waste into the environment from identified "prescribed" industries, trades, businesses, operations, and activities requires authorization (e.g., permit or approval) or registration under an applicable regulation or code of practice from the ENV. The **Pulp Industry** and the **Paper Industry** are prescribed industries listed under Schedule 1 of the WDR and, as such, require a site-specific permit to discharge waste (such as effluent) into the environment.

The Environmental Data Quality Assurance Regulation (EDQAR) [B.C. Reg. 19/2017, January 31, 2017] under EMA contains provisions for ENV to ensure that analytical data provided by permit holders to demonstrate compliance with their permit criteria meets an acceptable level of quality via a split sample auditing program. More specifically, Section 2(1) of the EDQAR states:

¹ Ministry of Forests, Lands and Natural Resource Operations. August 2016. British Columbia Pulp and Paper Sector Sustainability: Sector Challenges and Future Opportunities. Accessed February 2018 at < https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/competitive-forest-industry/pulp_and_paper_sept_2016.pdf >

² Ministry of Forests, Lands, Natural Resource Operations and Rural Development. January 2018. Major Primary Timber Processing Facilities in British Columbia: 2016. Accessed February 2018 at <https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/fibre-mills/2016_mill_list_report_final5.pdf>.

A person required to collect samples and submit environmental monitoring data as a requirement of an order, permit, licence, approval or certificate issued under an enactment administered by the minister must

- (a) cause the samples to be analyzed by a qualified laboratory for the analytes specified in the order, permit, licence, approval or certificate, and
- (b) provide to the director, not later than 45 days after the date the sample is collected, the results of the qualified laboratory's analysis.

Section 2(2) of the EDQAR states:

If a director requires that an officer, or another person the director designates, collect a split sample in respect of monitoring required under an order, permit, licence, approval or certificate referred to in subsection (1), the person subject to the order, permit, licence, approval or certificate must

- (a) cause one part of the split sample to be analyzed by a qualified laboratory for the analytes specified by the director, and
- (b) provide to the director, not later than 45 days after the date the sample is collected, the results of the qualified laboratory's analysis.

The permittee is also responsible to cover the costs of the audit as stated in section 4(1) of the EDQAR.

A person required to submit environmental monitoring data as a requirement of an order, permit, licence, approval or certificate under an enactment administered by the Minister of Environment shall reimburse the Ministry of Environment for the ministry's costs of auditing samples, analytical results and data submitted to the director.

Note the following definitions:

"split sample" means a liquid sample which is split and added to two separate containers so that each part of the split sample has identical analytes whose reference concentration values are assigned by analysis by a reference laboratory. They are used to obtain the magnitude of errors owing to contamination, random and systematic errors, and any other variability, which may be introduced at the time of sampling, or through analysis at the laboratory(ies). Split samples are commonly used to compare two or more laboratories. Care must be taken to ensure that the samples are split in a way to ensure homogeneity (a sample splitter must be used for samples containing suspended solids or effluents).

"qualified laboratory", in respect of a test, means a laboratory that is listed in the directory of qualified laboratories³ as qualified to perform the test. To become and remain listed in the directory of qualified laboratories, a laboratory must participate in the Proficiency Testing Program.

The Proficiency Testing Program is the inter-laboratory comparison program operated by the Canadian Association for Laboratory Accreditation (CALA) under which labs analyze reference samples provided by

³ The directory of qualified laboratories can be accessed here: <<http://www.nrs.gov.bc.ca/qualified-labs/>>

CALA, or by a provider approved by CALA, and report results for evaluation in accordance with CALA requirements.

"reference laboratory" means a laboratory, designated by the director, whose performance is unbiased as demonstrated in inter-laboratory performance studies or blind audits.

It should also be noted that these permits require permittees to collect samples in accordance with the latest edition of the British Columbia Field Sampling Manual (BCFSM)⁴, while laboratories must perform analyses in accordance with the latest edition of the British Columbia Environmental Laboratory Manual (BCELM)⁵.

DESCRIPTION OF THE AUDITED PREMISES

The sample population for the SSAP Assessment consists of all pulp mills in British Columbia that discharged effluent to the receiving environment in 2018/2019 and were in operation at the time of the split sample audits, which amounted to a total of 14 pulp mills.

The pulp mills included in this Assessment, and their respective effluent discharge authorization numbers, are as listed below in Table 1.

Table 1 - Pulp mills and permits included in the SSAP Assessment

Authorization Number	Permittee	Location
PE-157	Canadian Forest Products (Canfor) – Northwood Pulp Mill	Prince George
PE-3900	Canfor – Prince George Pulp & Paper Mill, and Canfor – Intercontinental Pulp Mill	Prince George
PE-114	Catalyst Paper – Crofton Mill	Crofton
PE-266	Catalyst Paper – Port Alberni Mill	Port Alberni
PE-153	Catalyst Paper – Powell River Mill	Powell River
PE-1199	Domtar – Kamloops Mill	Kamloops
PE-1272	Mercer International – Zellstoff Celgar Mill	Castlegar
PE-1214	Nanaimo Forest Products – Harmac Pacific Mill	Nanaimo
PE-1149	Paper Excellence Group – Howe Sound Pulp and Paper Mill	Howe Sound
PE-1138	Paper Excellence Group – Mackenzie Pulp Mill	Mackenzie
PE-240	Paper Excellence Group – Skookumchuck Pulp Mill	Cranbrook
PE-1152	West Fraser Mills – Cariboo Pulp & Paper Mill	Quesnel
PE-5803	West Fraser Mills – Quesnel River Pulp Mill	Quesnel

⁴ The B.C. Field Sampling Manual can be accessed here: <<https://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/monitoring/laboratory-standards-quality-assurance/bc-field-sampling-manual>>

⁵ The B.C. Environmental Laboratory Manual can be accessed here: <<https://www2.gov.bc.ca/gov/content/environment/research-monitoring-reporting/monitoring/laboratory-standards-quality-assurance/bc-environmental-laboratory-manual>>

Canfor's Prince George Pulp and Paper Mill and Intercontinental Pulp Mill share one effluent discharge permit; therefore, while 13 permits were included in this Assessment, these covered effluent from 14 pulp mills.

Canfor's Taylor Pulp Mill (Permit PE-7772) was not included in the SSAP Assessment as it was in shutdown for maintenance and therefore not discharging at the time of the site inspection.

POTENTIAL ENVIRONMENTAL ISSUES AND KEY METHODS OF POLLUTION CONTROL

Common waste discharges from pulp and paper mills include air (e.g. stack emissions from various boilers, kilns, incinerators, etc.), solid waste (e.g. landfilling of sludge and residues), and wastewater effluent (e.g. process effluent, cooling water, landfill leachate, stormwater runoff, and sanitary wastewater). The scope of the SSAP Assessment is limited to effluent discharges.

The pulp production industry discharges high volumes of effluent, ranking second to municipalities in wastewater output to the Canadian environment. The pulp and paper making process (debarking, pulp washing, bleaching) generates process wastewater. Although most pulp mill facilities recover and reuse most of the process chemicals, the unrecoverable portion is discharged into the environment after on-site wastewater treatment. Primary wastewater treatment consists of removing suspended solids via clarifiers and/or settling basins, resulting in the generation of sludge as solid waste. Secondary wastewater treatment serves to decrease the amount of biodegradable material, nutrients, and toxic components via bacterial degradation. The treated effluent is then discharged into the environment.⁶

Depending on the process technologies deployed and the performance of the wastewater treatment system, there may be remaining contaminants of concern in wastewater discharges. Chlorinated organics such as adsorbable organic halides (AOX) may persist and accumulate in aquatic ecosystems with potentially detrimental impacts on biota. Residual solids have the potential to form fibre mats that smother bottom-dwelling communities and reduce fish habitat, irritate fish gills and restrict the penetration of sunlight, affecting growth and activity of aquatic life forms. Organic solids and nutrients in the effluent may encourage bacterial and algal blooms which place a high demand on levels of dissolved oxygen in the receiving waters, therefore reducing the amount available for other aquatic organisms.⁷

The pulp mill facilities included in the SSAP Assessment discharge into surface (freshwater) and marine waters. Discharge points in B.C. include the Fraser River, Quesnel River, Powell River, Kootenay River,

⁶ Environment and Climate Change Canada (2016). Canadian Environmental Sustainability Indicators: Managing Pulp and Paper Effluent Quality in Canada. Accessed at <www.ec.gc.ca/indicateurs-indicators/default.asp?lang=en&n=E20C2E23-1>.

⁷ British Columbia. Office of the Auditor General. 1999/2000. Pulp and paper mill effluent permit monitoring; Standards of conduct in the education and health sectors; 1999 status of Public Accounts Committee recommendations relating to prior years' compliance audits. Accessed at <<https://www.bcauditor.com/sites/default/files/publications/1999/report9/report/pulp-and-paper-mill-effluent-permit-monitoring-standards-conduct-education-.pdf>>

Thompson River, Columbia River, Stuart Channel, Thornbrough Channel, Northumberland Channel, Malaspina Strait, Alberni Inlet, and Williston Lake.

SSAP ASSESSMENT METHODOLOGY

PRE-AUDIT ACTIVITIES

ENV compliance officers were responsible for scheduling and coordinating the split sample audits at each site and notifying the permittees to be audited in advance. The notification included requisition forms that list all parameters to be sampled and analyzed for the audit, and the date and approximate time that the audit would take place. Permittees received program information from ENV where requested or required.

ON-SITE SAMPLE COLLECTION AND SUBMISSION

ENV conducted on-site split sample audits on all but one of the operating pulp mills in British Columbia that discharge effluent to the receiving environment (the excluded pulp mill was shutdown for maintenance at the time of the audit).

During the on-site visit, ENV also examined the condition of the permittee's sampling and monitoring equipment, observed the permittee's sampling practices, and recorded notable observations and descriptions of the sampling environment, any discrepancies in sampling procedures, and potential sources of contamination. Photographs of the sampling event were taken as necessary. The site environmental manager, environmental coordinator, environmental technician or lab technicians may have been questioned on sampling procedures, sample submission and sample analysis techniques as well, particularly at sites with in-house laboratories.

The split sample audit was conducted with each of the permittees at one of their main discharge locations and assessed only parameters that are required to be monitored as required by the effluent discharge authorization under EMA. If the permit required annual sampling of specific parameters, and the annual sample for that specific parameter had already been collected for that year, the parameter would be excluded from the SSAP.

The list of parameters sampled and analysed for these split sample audits included:

- Water Chemistry
 - Total suspended solids, total ammonia, pH, colour, and other physical tests
 - Biological oxygen demand and other dissolved oxygen markers
 - Resin and fatty acids
 - Adsorbable organic halides (AOX)
 - Nutrients (nitrogen, carbon, and phosphorus compounds) and anions (cyanide, fluoride)
 - Total and dissolved metals

- Extractable petroleum hydrocarbons (light and heavy)
- Toxicity via LT50 *Daphnia magna* and LC50 rainbow trout bioassays
- Coliform bacteria

The following insert describes the Split Sample Audit Program.

SPLIT SAMPLE AUDIT PROGRAM

Split samples of effluent discharge are collected by both ENV compliance officers and the permittees for parameters that are required to be monitored (in whole or in part) as a condition of the waste discharge authorization. Sample collection for a split sample audit is conducted at one authorized discharge location each year per permittee site. For sites with more than one authorized discharge point with monitoring requirements, each discharge point will be audited on a rotating basis.

ENV collects split samples in accordance with the latest edition (2013) of the British Columbia Field Sampling Manual. In the event of any discrepancies in sampling procedure between the manual and the permittee's usual practice, the discrepancies are noted and shared with ENV's Laboratory Standards & Quality Assurance (LSQA) unit. The split samples that are collected by ENV are submitted to ENV reference laboratories, which include ALS Global, and Environment and Climate Change Canada's Pacific Yukon Laboratory for Environmental Testing (PYLET). ENV's reference laboratories are subject to monthly blind audits and assessments. ENV officers are proficient samplers competently trained in the methods specified in the BCFSM. The collection and handling of samples by ENV's proficient samplers combined with the analytical procedures of ENV's reference laboratories create the reference values against which the permittee's analytical data is evaluated.

In accordance with the EDQAR, permittees required to collect split samples must submit those samples to a qualified laboratory for analysis and provide to ENV the results of the analysis no later than 45 days after the sample was collected. Permittees must sample in accordance with the B.C. Field Sampling Manual, as required by their permit. The split samples that are collected by the permittee should be submitted to their regular laboratories to maintain consistency with their usual sampling program.

All analytical reports, which must contain all test results including reporting detection limits (RDLs) and QA/QC test results, are submitted to the LSQA unit of ENV for evaluation. LSQA is responsible for maintaining the Split Sample Audit program, which includes performance evaluations of ENV's reference laboratories, audit assessment protocol, and maintenance of individual permittee audit results and evaluation spreadsheets.

Each submission of split samples constitutes an *audit*. Audit testing is divided into *Water Chemistry*, *Toxicity and Microbiological* components, as applicable. Water chemistry results are evaluated via a statistical comparison of the permittee's laboratory results with ENV laboratory results which takes

SPLIT SAMPLE AUDIT PROGRAM

into consideration the analyte being tested, the RDL for that analyte reported by the reference laboratory and the concentration of the analyte reported by the reference laboratory.

Microbiological test results are assessed using an industry standard grading table for drinking water (grading scale developed for the Clinical Microbiology Proficiency Testing data assessment protocol). Toxicity test results are assessed by absolute deviation, with the maximum allowable deviation being 30%.

Analytical test result evaluations produce a performance score of 5, 4, 2 or 0 points where 5 is the highest score and both 2 and 0 indicate an unacceptable (failed) test result. The 'deviation factor' indicates the degree of variation between the 'acceptable deviation' and the 'absolute deviation' between a permittee's test result and the reference value provided by the ENV's test result. The average of all performance scores produced in a single split sample audit constitutes the overall Performance Evaluation. For more details on the split sample evaluations, please refer to Appendix I.

Two criteria are applied to each audit: a percent of failed tests with a 25% threshold and an overall performance evaluation which must achieve 70%. Evaluations that result in a percent of failed tests at or below 25 and an overall performance evaluation equal to or greater than 70% constitutes an audit pass.

The LSQA will provide an Audit Results Letter report and Audit Table to both the permittee and ENV. In the event of a split sample audit failure, the permittee is advised to conduct a thorough investigation to determine the root cause of the failure, and follow up split sample audits may be conducted when repeat or significant failures occur.

SSAP ASSESSMENT ANALYSIS

ENV compiled the results of the individual split sample audits for each of the 13 permits (and 14 operations) included in the SSAP Assessment to determine compliance rates with the EDQAR and evaluate overall pulp mill sector performance with respect to effluent sample collection, submission, and laboratory analysis. Sampling and analytical procedures were assessed against the methods and procedures detailed in the B.C. Field Sampling Manual and the B.C. Environmental Laboratory Manual, as required by the respective permits, enabling ENV to identify any sector wide issues and target areas of improvement.

SUMMARY OF FINDINGS OF COMPLIANCE AUDITS

All permit holders included in the SSAP Assessment complied with Section 2(2)(a) of the EDQAR, which requires that permittees submit one part of the split samples to their qualified laboratory for analysis and report the results to ENV of the sampling event (compliance with the 45-day submission deadline as required by Section 2(2)(b), or Section 4(1) reimbursement requirements were not evaluated during this Assessment).

Twelve out of the thirteen total permits included in the SSAP Assessment passed their split sample audits (percent of failed tests of at most 25% and a performance evaluation score of at least 70%). The overall average performance evaluation score was 82%, and the overall average percent of failed tests was 13%. The failed split sample audit had a performance evaluation score of 68% and a percent of failed tests of 8%. The split sample audits that passed had performance evaluation scores ranging from 72% to 100% and percent of failed tests ranging from 0% to 25%.

Tests for parameters in the split sample audit for each permittee had three outcomes: Pass, Fail, or Non-Calculable.

Analytical results of permittee's samples that were reported within parameter-specific 'acceptable deviation' values received an evaluation outcome of '**PASS**'.

Analytical results that exceeded their parameter-specific 'acceptable deviations' (the variation was too great), received an evaluation outcome of '**FAIL**'.

In some instances, analytical test result evaluations were **incalculable**. This was due to the following reasons:

Omissions

- The parameter is a permit requirement but was missing from the permittee's split sample submissions (not reported). Normally, this would result in an automatic test failure outcome; however, as this was the first year of participation in the split sample audit program for many permittees, failure by omission has been waived for this year only but will be enforced in the future. Such omissions are non-compliances of permitted sampling requirements that would be addressed as part of future annual compliance inspections. The affected permittees have been notified of this in their split sample audit letters and spreadsheets.
- The missing parameter is part of a test suite required to be monitored in the permit (e.g. resin and fatty acids), but the full list of parameters included in the test suite is not specified in the permit. Additionally, one issue identified during this SSAP Assessment was that there is variation in reporting amongst laboratories regarding which parameters are included in their test suite packages. For these reasons, analytical results that were not reported for parameters within a test suite have not been included in split sample audit evaluations for this year; nevertheless, they are non-compliances of permitted sampling requirements that would be addressed as part of future annual compliance inspections.

Dilution and inflated detection limits

- The reporting detection limits (RDL) provided by the permittee's laboratory were inflated due to sample dilution, and therefore any parameter concentrations below the RDL could not be meaningfully compared with the ENV reference values.

Other

- Parameter concentrations reported by either the permittee or ENV were at concentrations below the standard RDLs (<RDL). Analytical test results reported as <RDL are considered valid reports and as such, and where possible, were evaluated using technical scoring.
- Any other reason such as sample loss/compromises en route to the laboratory.

RESULTS BY PARAMETER PERFORMANCE

To isolate whether certain parameters were more prone to quality issues, in the context of split sample audits, all parameters that had test failures, omissions, or inflated laboratory detection limits have been compiled in Table 2.

Table 2. Parameters with notable issues in the split sample audits

Parameters	Number of Total Tests in 2018/2019 SSAP	Number of Test Failures in 2018/2019 SSAP	Number of Tests in 2018/2019 SSAP Omitted from Permittee Reports (Incalculable)	Number of Tests in 2018/2019 SSAP with Inflated Detection Limit Issues (Incalculable)
PARAMETERS THAT HAD TEST FAILURES ONLY				
Total Suspended Solids	13	3	0	0
Total Kjeldahl Nitrogen	3	2	0	0
Total Nitrogen	1	1	0	0
Total Organic Nitrogen	1	1	0	0
Orthophosphate - Dissolved	3	1	0	0
Phosphorus Dissolved	5	3	0	0
Phosphorus Total	5	1	0	0
BOD	13	3	0	0
Adsorbable Organic Halide (AOX)	10	1	0	0
Aluminum (Total)	3	1	0	0
Barium (Total)	3	2	0	0
Boron (Total)	3	1	0	0
Cadmium (Total)	3	1	0	0
Copper (Total)	3	1	0	0
Iron (Total)	3	1	0	0
Lead (Total)	3	3	0	0
Manganese (Total)	3	1	0	0
Silver (Total)	3	1	0	0
Sodium (Total)	3	1	0	0
Tin (Total)	3	1	0	0
Titanium (Total)	3	2	0	0
Aluminum (Dissolved)	3	2	0	0
Antimony (Dissolved)	3	1	0	0
Barium (Dissolved)	3	1	0	0
Bismuth (Dissolved)	3	1	0	0
Boron (Dissolved)	2	1	0	0

Parameters	Number of Total Tests in 2018/2019 SSAP	Number of Test Failures in 2018/2019 SSAP	Number of Tests in 2018/2019 SSAP Omitted from Permittee Reports (Incalculable)	Number of Tests in 2018/2019 SSAP with Inflated Detection Limit Issues (Incalculable)
Chromium (Dissolved)	3	1	0	0
Cobalt (Dissolved)	3	1	0	0
Copper (Dissolved)	3	1	0	0
Iron (Dissolved)	3	1	0	0
Magnesium (Dissolved)	3	1	0	0
Manganese (Dissolved)	3	1	0	0
Molybdenum (Dissolved)	3	1	0	0
Nickel (Dissolved)	3	1	0	0
Phosphorus (Dissolved)	2	1	0	0
Selenium (Dissolved)	3	1	0	0
Silver (Dissolved)	3	1	0	0
Strontium (Dissolved)	3	1	0	0
Thallium (Dissolved)	3	2	0	0
Tin (Dissolved)	3	1	0	0
Titanium (Dissolved)	3	1	0	0
Uranium (Dissolved)	3	1	0	0

PARAMETERS THAT HAD OMISSIONS IN PERMITTEE REPORTS ONLY

Volatile Suspended Solids	5	0	1	0
pH	7	0	2	0
Levopimaric Acid	8	0	3	0
Lignoceric Acid	8	0	4	0
Linoleic Acid	8	0	1	0
Stearic Acid	7	0	1	0
Total Fatty Acids	8	0	1	0

PARAMETERS THAT HAD BOTH TEST FAILURES AND OMISSIONS IN PERMITTEE REPORTS

Ammonia Total (as N)	7	2	1	0
Colour	6	1	1	0
Specific Conductance	4	1	1	0
Nitrate Dissolved (as N)	5	1	1	0

PARAMETERS THAT HAD BOTH TEST FAILURES AND ISSUES WITH INFLATED LABORATORY DETECTION LIMITS

Total Resin Acids	8	2	0	1
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PARAMETERS THAT HAD OMISSIONS IN PERMITTEE REPORTS AND
ISSUES WITH INFLATED LABORATORY DETECTION LIMITS

Arachidic Acid	8	0	1	2
Behenic Acid	8	0	1	2
12-Chlorodehydroabiatic Acid	8	0	1	3
14-Chlorodehydroabiatic Acid	8	0	1	3
Dichlorodehydroabiatic Acid	8	0	1	2
Lauric Acid	8	0	1	3
Linolenic Acid	8	0	1	2
Myristic Acid	8	0	1	2
Neoabiatic Acid	8	0	1	2
Oleic Acid	8	0	1	1
Sandaracopimaric Acid	8	0	1	2

PARAMETERS THAT HAD TEST FAILURES, OMISSIONS IN PERMITTEE REPORTS, AND ISSUES WITH INFLATED LABORATORY
DETECTION LIMITS

Abiatic Acid	8	1	1	3
Dehydroabiatic Acid	8	3	1	1

Parameters	Number of Total Tests in 2018/2019 SSAP	Number of Test Failures in 2018/2019 SSAP	Number of Tests in 2018/2019 SSAP Omitted from Permittee Reports (Incalculable)	Number of Tests in 2018/2019 SSAP with Inflated Detection Limit Issues (Incalculable)
Isopimaric & Palustric Acid	8	2	1	2
Palmitic Acid	8	1	1	1
Pimaric Acid	8	2	1	2

The following sections discuss split sample audit issues by topic.

TEST FAILURES

Excessive deviation between the permittee's test result and ENV's reference value for a sample parameter was considered a test failure for that parameter. Parameters that were analyzed in the SSAP Assessment that had more than one instance of test failure (i.e. this occurred with more than one permittee) are listed as follows:

- **Total suspended solids** – 3 failures out of 13 audits (23%)
- **Total ammonia** – 2 failures out of 7 audits (29%)
- **Dissolved phosphorus** – 3 failures out of 5 audits (60%)
- **BOD** – 3 failures out of 13 audits (23%)
- **Dehydroabietic acid** – 3 failures out of 8 audits (38%)
- **Isopimaric and palustric acid** – 2 failures out of 8 audits (25%)
- **Pimaric acid** – 2 failures out of 8 audits (25%)
- **Total resin acids** – 2 failures out of 8 audits (25%)
- **Total Kjeldahl nitrogen** – 2 failures out of 3 audits (67%)
- **Total barium** – 2 failures out of 3 audits (67%)
- **Total lead** – 3 failures out of 3 audits (100%)
- **Total titanium** – 2 failures out of 3 audits (67%)
- **Dissolved aluminum** – 2 failures out of 3 audits (67%)
- **Dissolved thallium** – 2 failures out of 3 audits (67%)

Parameters with a failure rate of at least 50% include dissolved phosphorus and, albeit with a small sample size, total Kjeldahl nitrogen, total barium, total lead, total titanium, dissolved aluminum, and dissolved thallium.

REPORT OMISSIONS

In some instances, permittees did not report their lab results for a required general parameter, or a parameter within a test suite (e.g. arachidic acid in the resin and fatty acids test suite). Parameters that were analyzed in the SSAP Assessment that had more than one instance of omissions in a required report (i.e. this occurred with more than one permittee) are listed as follows:

- **pH** – 2 omissions out of 7 audits (29%)
- **Levopimaric acid** – 3 omissions out of 8 audits (38%)

- **Lignoceric acid** – 4 omissions out of 8 audits (50%)

It should be noted that levopimaric acid and lignoceric acid were part of the resin and fatty acids test suite, the reported parameters of which are not specified in the permit requirements and may vary among laboratories. Missing parameters within a test suite have not been evaluated in split sample audits this year; nevertheless, they are non-compliances of permitted sampling requirements that would be addressed as part of future annual compliance inspections.

Eight out of the 13 permits included in this audit sampled and reported on all of the parameters required for their split sample audit. Of the five permittees with missing analyses, one permittee was missing almost the full test suite of resin and fatty acids while the rest were missing one to four parameters each in the physical test suite (hardness, suspended solids, ammonia, colour, pH, and specific conductance).

INFLATED LABORATORY DETECTION LIMITS

In some instances, the sample was diluted in the laboratory utilized by the permittee, which resulted in an inflated RDL. In some cases, this impacted parameters reported at concentrations below the inflated RDL, as the test result evaluation could not be performed due to a significant discrepancy between the permittee's inflated RDL and the reference RDL.

Analytical test results that could not be evaluated due to inflated RDLs are listed as follows:

- Abietic acid, 12-chlorodehydroabietic acid, 14-chlorodehydroabietic acid, and lauric acid all had 3 instances of incompatible detection limits out of 8 audits (38%)
- Arachidic acid, behenic acid, dichlorodehydroabietic acid, isopimaric and palustric acid, linolenic acid, myristic acid, neoabietic acid, pimaric acid, and sandaracopimaric acid all had 2 instances of incompatible detection limits out of 8 audits (25%)

All of these parameters are included in the resin and fatty acids test suite stipulated in the B.C. Environmental Laboratory Manual.

COMBINATION OF ISSUES

Both test failures and omissions by the permittee were most commonly observed for total ammonia, colour, specific conductance, and dissolved nitrate.

Total resin acids had both test failures and issues with inflated laboratory detection limit issues.

Both omissions and inflated detection limit issues were most commonly observed for arachidic acid, behenic acid, 12-chlorodehydroabietic acid, 14-chlorodehydroabietic acid, dichlorodehydroabietic acid, lauric acid, linolenic acid, myristic acid, neoabietic acid, oleic acid, and sandaracopimaric acid (all included in the resin and fatty acids test suite stipulated in the B.C. Environmental Laboratory Manual).

Test failures, omissions, and inflated detection limit issues were all observed for abietic acid, dehydroabietic acid, isopimaric and palustric acid, palmitic acid, and pimaric acid (all included in the resin and fatty acids test suite stipulated in the B.C. Environmental Laboratory Manual).

LABORATORIES USED IN EFFLUENT ANALYSIS

The laboratories utilized by permittees to analyze the samples collected for split sample audits are as follows:

- Analyses for the **physical test** analytes (hardness, suspended solids, ammonia, colour, pH, and specific conductance) were carried out by Maxxam Analytics, ALS Laboratories, CARO Analytical Services, Kemetco Research, EXOVA, AGAT Laboratories, and permittee in-house laboratories. The majority of permittees used their in-house labs to conduct physical test analyses.
- Analyses for **anions and nutrients** (cyanide, fluoride, and forms of nitrogen, phosphorus, and carbon) were carried out by ALS Laboratories, Maxxam Analytics, EXOVA, AGAT Laboratories, and permittee in-house laboratories.
- Analyses for **bacteriological** analytes (fecal and total coliform bacteria) were carried out by ALS Laboratories.
- Analyses for **aggregate organics** analytes (BOD, COD, DO) were carried out by Maxxam Analytics, ALS Laboratories, CARO Analytical Services, Kemetco Research, EXOVA, AGAT Laboratories, and permittee in-house laboratories. The majority of permittees used their in-house labs to conduct aggregate organics tests.
- For **bioassays** (LT50 daphnia and LC50 trout), roughly half of the permittees in the SSAP Assessment submitted their samples to Nautilus Environmental Company, while the other half utilized Maxxam Analytics. One permittee submitted their samples to Aquatox Testing & Consulting.
- The permittee required to submit samples for **EPH** analyses in the split sample audit utilized the services of EXOVA.
- Analyses for **resin and fatty acid** analytes were carried out by ALS Laboratories, Kemetco Research, AGAT Laboratories, and Maxxam Analytics. The majority of permittees submitted their samples to ALS Laboratories for resin and fatty acids analyses.
- Analyses for **adsorbable organic halides (AOX)** were carried out by either Econotech Laboratory Services or Maxxam Analytics. The majority of permittees submitted their samples to Econotech Laboratory Services for AOX analyses.

- Analyses for **total and dissolved metals** were carried out by Maxxam Laboratories, AGAT Laboratories, or permittee in-house laboratories.

Dioxins and furans were not included in the 2018/2019 SSAP as their required monitoring frequency is only once per year, which posed logistical difficulties in coordinating the split sampling events with annually scheduled test events. Nonetheless, permittees reported contracting Pacific Rim Laboratories, Wellington Laboratories, and SGS AXYS Analytical Services to provide analytical services for routine monitoring of dioxins and furans.

All contracted laboratories utilized for sample analysis in the 2018/2019 SSAP are included in the EDQAR directory of qualified laboratories.

All in-house labs utilized by permittees reporting in-house analyzed sample results were included in the directory of qualified laboratories. The in-house laboratories utilized by permittees and their lab numbers in the EDQAR directory of qualified laboratories are listed in Table 3.

Table 3. Directory of qualified laboratory listings for pulp mills⁸

Authorization Number	Permittee	Lab #
PE-157	Canadian Forest Products (Canfor) – Northwood Pulp Mill	3014
PE-3900	Canfor – Prince George Pulp & Paper Mill, and Canfor – Intercontinental Pulp Mill	3017
PE-114	Catalyst Paper – Crofton Mill	3069
PE-266	Catalyst Paper – Port Alberni Mill	3015
PE-153	Catalyst Paper – Powell River Mill	3061
PE-1199	Domtar – Kamloops Mill	3055
PE-1272	Mercer International – Zellstoff Celgar Mill	3591
PE-1214	Nanaimo Forest Products – Harmac Pacific Mill	3012
PE-1138	Paper Excellence Group – Mackenzie Pulp Mill	3033
PE-1152	West Fraser Mills – Cariboo Pulp & Paper Mill	3049
PE-5803	West Fraser Mills – Quesnel River Pulp Mill	3021

Paper Excellence Group's Howe Sound Pulp and Paper Mill (Permit PE-1149) and Skookumchuck Pulp Mill (Permit PE-240) submit all samples required for permit compliance to contracted laboratories included in the directory of qualified laboratories.

Analyses performed by in-house laboratories had an audit split sample failure test rate of 18%, while analyses performed by contracted laboratories had an audit split sample failure test rate of 15%.

DISCUSSION AND RECOMMENDATIONS

⁸ The directory of qualified laboratories may be accessed at this link: <<http://www.nrs.gov.bc.ca/qualified-labs/>>.

Findings from the 2018/2019 SSAP Assessment conducted on the split sample audits performed for 14 out of a total of 15 operating pulp mills in B.C. has highlighted the following opportunities for improvement:

Laboratory Certification

Permittees should check with their laboratories to confirm that their laboratory is qualified to conduct the analyses required by their permit. Although the directory of qualified laboratories includes a scope of proficiency for each published laboratory, the Province does not assume responsibility for the completeness or accuracy of the information it provides. The responsibility to ensure that analytical testing required by permits is conducted by a qualified laboratory, as defined in the EDQAR, is that of the permit holder. It is also the responsibility of laboratories, whether in-house or contracted, to ensure that they are published in the directory. To that end, future compliance inspections may include an assessment of compliance against the requirements of EDQAR Section 5, which states:

To become and remain listed in the directory of qualified laboratories, a laboratory must

- (a) participate in the Proficiency Testing Program, and
- (b) ensure that CALA provides to the director, for each designated analyte in respect of which the laboratory participates in the Proficiency Testing Program, a copy of the results of proficiency testing performed by the laboratory on every reference sample provided by CALA, or by a provider approved by CALA, for the purpose of evaluating that laboratory's proficiency in testing for the designated analyte.

Test failures and inflated detection limits

- Each permittee that had test failures in their respective split sample audits should review these results with their samplers and their laboratory/ies to determine the possible reason/s for these failures. It is important that steps are taken to minimize the likelihood of future failures.
- Certain parameters were identified across the sector for their higher (25% and greater) occurrences of test failures and issues with inflated detection limits; this warrants a discussion for permittees and their laboratories on whether there are widespread consistent discrepancies in sample collection practice or sample analysis techniques.
- Permittees are reminded that sampling must be conducted in accordance with the B.C. Field Sampling Manual. Permittees are encouraged to review the sampling procedures of the latest version of the BCFSM with their sampling technicians on a regular basis to ensure adherence to proper sampling techniques and quality control measures designed to avoid contamination (e.g. use of disposable gloves), ensure adequate sample preservation practices (e.g. prompt addition of preservatives and ice in coolers where necessary), and confirm awareness of hold times, etc.

Report omissions

Omissions of parameters required to be sampled in the permit will be treated as test failures in the future. There have been some instances of where the omitted parameter was part of a laboratory test suite, and may have been included in one laboratory's standard test suite and not in another's. For this SSAP Assessment, such omissions occurred only for parameters within the resin and fatty acids test suite, and therefore, a recommended action would be for permittees to ensure that their laboratories' standard resin and fatty acids testing suites are consistent with that listed in the B.C. Environmental Laboratory Manual.

Reporting timeline

Compliance assessment of whether permittee results were submitted within 45 days of sample collection, as per requirements of Section 2(2) of the EDQAR, should be included in compliance inspections involving a split sample audit, as well as the reimbursement requirements of Section 4(1).

APPENDICES

Appendix I. Split Sample Audit Program Guidance Document for Permit Holders