# ASSESSMENT OF LOG YARD RUNOFF IN ALBERTA

## Preliminary Evaluation

Alberta ENVIRONMENT

**June 1996**

Prepared by
S. McDougall, P.Eng.
Environmental Service

# Executive Summary

In 1995 a survey of 33 Alberta log yards was conducted. This report summarizes the results of the survey including:

- current surface water runoff control measures at Alberta log yards;
- chemical characteristics of log yard runoff;
- environmental impacts of chemical constituents found in wood; and,
- the policy and guidelines for log yard runoff in other jurisdictions.

**Findings**

Storm water has been recognized within the last twenty years as a potential concern due to its impacts on water quality. The chemical and toxicological characteristics of log yard runoff are variable but can have an impact on the environment. Notwithstanding the variability of log yard runoff, several jurisdictions in Canada and the United States require log yards to implement pollution prevention plans to minimize impacts. Characterization of Alberta log yard runoff is required to determine if and what control measures should be implemented.

Surface runoff control measures in Alberta currently consist of passive and active measures ranging from infiltration or vegetated buffer strips, ditching to contain and direct the surface runoff, containment with dug outs or retention ponds and treatment. Twelve log yards have passive treatment, twelve redirect the runoff from the log yard by ditching, seven have retention ponds or dug outs and two treat the runoff with their process water by biological wastewater treatment.

A literature review of surface runoff from log yards demonstrate that the runoff can be highly variable, both in chemical characteristics and toxicity. Water quality parameters identified as potential concerns include $BOD_5$ and COD which measure the oxygen demand or organic load of a substance, phenolic compounds and substituted benzenes including resin and fatty acids and tannins which are known to be toxic to aquatic life at certain levels and total suspended solids.

The United States Environmental Protection Agency and Ontario Ministry of Environment and Energy require the development of prevention plans. The prevention plans require sites to characterize the runoff leaving the site and develop and implement Best Management Practices as a means of reducing contaminant loading to the maximum extent possible.

**Recommendations**

It is recommended that:

- good housekeeping practices be established at all log yards;
- a monitoring program be implemented to characterize log yard runoff at Alberta log yards;
- the results of the monitoring program be utilized to determine the necessity of additional runoff control measures at existing sites and provide information to refine Best Management Practices for log yards;
- Surface Runoff Management Plans shall have a minimum information such as a site map, description of the surrounding environment, estimate of runoff quantity and runoff control measures; and,
- new facilities be required to implement runoff control measures.

# Acknowledgements

I would like to acknowledge the companies that participated in the log yard surface runoff inventory, Neil Shelly of the Alberta Forest Products Association, Jay Nagendran, Harry Karasiuk, Jan Wombold, Olivia Hong, Andrew Cummins and David Spink of the Air and Water Approvals Division of Alberta Environmental Protection and the numerous people who contributed to this study and report with comments and suggestions.

# Table of Contents

# List of Figures and Tables

# Glossary

| | |
|---|---|
| Toxicity Testing | Is a procedure to determine the toxicity of a chemical or an effluent on a living organism. Its purpose is to estimate the degree of toxicity and express it in terms of a threshold concentration or time required to cause an effect. |
| Acute: | Refers to short term exposures lasting 96 hours or less. It always measures lethality. |
| Acute Bioassay: | The exposure of 10 juvenile raibow trout to a wastewater source for 96 hours. |
| Chronic: | Refers to long-term exposure lasting at least 1/10 of the life span of the organism. |
| Chronic Bioassay: | The exposure of *Ceriodaphnia* to a test solution (usually wastewater) for seven days measuring the reproduction and survival. Test concentrations are usually 6, 12, 25, 50 and 100 percent. |
| Microtoxicity: | Exposes photoluminescent bacteria to the test solution and measures reduced light output by the bacteria. The test requires very little test solution, about 2.5 ml for each test, but two or three runs are usually conducted because of the inherent variability of the test. Test concentrations are normally 5.6, 11.3, 22.5 and 45 percent of the water or effluent. This is a rapid test (15 minutes) and it has been used by others as a surrogate for more traditional acute bioassays. (NCASI, 1992) |
| LC50 | Concentration of test solution that is lethal to 50 percent of the test organisms. |
| EC50 | Effective Concentration for a 50 percent response. For the microtoxicity test an EC50 corresponds to a 50 percent reduction in photoluminescence. |
| 48 - hour static test | In this test 10 newborn *Ceriodaphnia dubia* are exposed to each of several concentrations of the water or effluent being tested. Typically the test solution concentrations being tested include 0, 1.0, 3.0, 10.0, 30.0, 100.0. The effect recorded is mortality of test organisms. This test requires 15 mL of test solution per replicate, 10 replicates per treatment. (NCASI, 1992) |
| BOD | Biochemical Oxygen Demand, the oxygen required for the biochemical degradation of organic matter. |
| COD | Chemical Oxygen Demand measures the oxygen equivalent of the organic matter content of a sample that is susceptible to oxidation by a chemical oxidant. |
| TOC | Total Organic Carbon that is independant of the oxidation state of the organic matter. |
| TSS | Total Suspended Solids |
| EDTA | Ethylenediamine tetraacetic acid, a chemical agent that removes cationic metals, the form of the metal ion and hardness of the water have a major effect on the toxicity of the metal. |

# 1.0 INTRODUCTION

Industrial stormwater management for the Province of Alberta is assessed on a site-specific basis. Limits have been established for certain industrial sectors. Historically, however, stormwater runoff from log yards has not been considered a high risk for adversely effecting the environment. As a result, monitoring or control requirements for runoff from log yards had not been required at most existing facilities. Log yard facilities constructed more recently have required stormwater runoff management systems.

In the late 1980's runoff from aspen log woodpiles in northern British Columbia became a concern. In response to these concerns the B.C. Ministry of the Environment requested a laboratory study be conducted to investigate the toxicity of leachate from aspen wood chips. The results (Goudey and Taylor, 1992) showed that the artificially produced leachate was toxic to aquatic life. Consequently, a field study was begun to determine the chemical characteristics and toxicity of aspen wood leachate produced from natural processes. Aspen logs were stacked in a field on a heavy tarpaulin catchbasin and leachate collected over a two year period. The field leachate was characterized by high conductivity, biochemical oxygen demand (BOD), total organic carbon (TOC), low pH and dissolved oxygen (DO) (Taylor, 1994) which was consistent with the laboratory study. Toxicity tests of the field produced leachate indicated the toxicity was variable and dependent on the test. The Microtox test indicated the leachate was toxic throughout most of the field study. Both the *Daphnia* and rainbow trout lethality test indicated the toxicity of the leachate was high in the spring and declined quickly.

To determine the chemical characteristics of runoff from log yards in Alberta, the Industrial Wastewater Branch of Alberta Environmental Protection collected preliminary samples of leachate at five saw mills and oriented-strand board log yards in Alberta in the summer of 1994. These samples were not representative runoff samples, it comprised mostly of stagnant water at log yard sites. Results of analysis of these samples showed relatively high BOD, TOC and toxicity. The need for further investigation was confirmed in the summer of 1995 when Alberta Environmental Protection received a public complaint that log yard runoff from a veneer plant was foaming and entering a receiving water. It was later confirmed that the runoff was entering a forested area and not entering a receiving water. A sample of the runoff was taken by Fish and Wildlife personnel and found to be toxic according to the Microtox test.

Alberta Environmental Protection initiated a study with the following objectives:

- provide an inventory of the current runoff control measures at Alberta log yards;
- summarize available data regarding log yard runoff quality and its impact on the environment;
- outline the current or proposed guidelines in other jurisdictions; and
- provide recommendations.

This report presents the results of the study in the six sections following this introduction. Section Two presents the results of the data inventory of run-off control measures at Alberta log yards. Section Three provides a brief background on wood chemistry. Section Four summarizes available literature regarding the chemical constituents of log yard runoff quality. Section Five details the guidelines and regulations in other jurisdictions. Conclusions are provided in Section Six and Recommendations are given in Section Seven.

# 2.0 INVENTORY OF RUNOFF CONTROL MEASURES AT ALBERTA LOG YARDS

Guidelines, limits and monitoring or sampling requirements are specified in approvals issued to companies under the Alberta Environmental Protection and Enhancement Act (AEPEA). Companies that are required to obtain approvals for construction, operation, and reclamation are specified in Alberta Regulation 10/93 Alberta Environmental Protection and Enhancement Act Activities Designation Regulation (AR 110/93). Currently approvals are issued for a maximum 10 year period. After an approval is issued amendments to the approval may be made as process or other facility changes occur. Requirements or limits for the control of stormwater runoff are therefore site specific. Historically stormwater runoff from log yards has not been considered a high risk of adversely affecting the environment and therefore log yards have generally not required extensive controls. Recently constructed log yard facilities, however, have implemented controls. To provide an overview of the current runoff control measures at Alberta log yards, an inventory of 33 log yards was conducted from September to December 1995. Figure 1 is a map showing the location of the log yards participating in the study.

**Methodology**

The inventory was compiled by reviewing relevant monitoring data, log yard operation and surface runoff management practises at each site. To assist in the inventory, a questionnaire was faxed to each of the participating companies prior to the site visit. The information requested in the questionnaire included the size of the log yard, log species and quantity stored at the site, the surface runoff drainage path and current runoff control measures, the surrounding environment (i.e., agricultural, muskeg, etc.) and the nearest water courses. Form 1 is an example of a questionnaire sent to participating companies. Of the 33 log yards included in the inventory, 27 of these were visited between September 8 and November 3, 1995. Phone interviews were conducted for the remaining six. Table 1 lists the name of the companies included in the inventory and the date of the site visit or phone interview. Log yard runoff reports were completed for each of the sites. Data from the reports are summarized in Appendix A Tables A.1 to A.3.

**Form 1: Log Yard Runoff Questionnaire**

Company: ______________________________________________

Location: ______________________________________________

Contact: ______________________________________________
Date: ____________________ Weather Conditions: ____________________

Size of the Log Yard (Acres, Hectares): ______________________________

Maximum, Minimum and Current Logs Stored ($ft^2$, $m^3$, FBM): ______________
______________________________________________

Approximate Length of Time Logs Stored at the Log Yard: ______________
______________________________________________

Log Species (and Approximate Percentage of Each): ______________________
______________________________________________

Cover of the Log Yard (e.g. Gravel, Clay, Previously Marsh?): ______________
______________________________________________

Any Other Materials Stored at the Log Yard: ______________________________
______________________________________________

Slope of the Log Yard: ______________________________________________
______________________________________________

Surrounding Environment (e.g., Forest, Agricultural, Residential): ____________
______________________________________________

Closest Receiving Water Location: ______________________________________

Have Any Samples Been Taken of the Runoff? ______________________________
______________________________________________

Current Runoff Control Practices (Where Does the Runoff Drain to, e.g. Pond, Lagoon, Ditch, Creek)? (Note Details of the Pond, Size, Material Constructed From, e.g. Lined, Vegetation): ______________________________________________
______________________________________________
______________________________________________

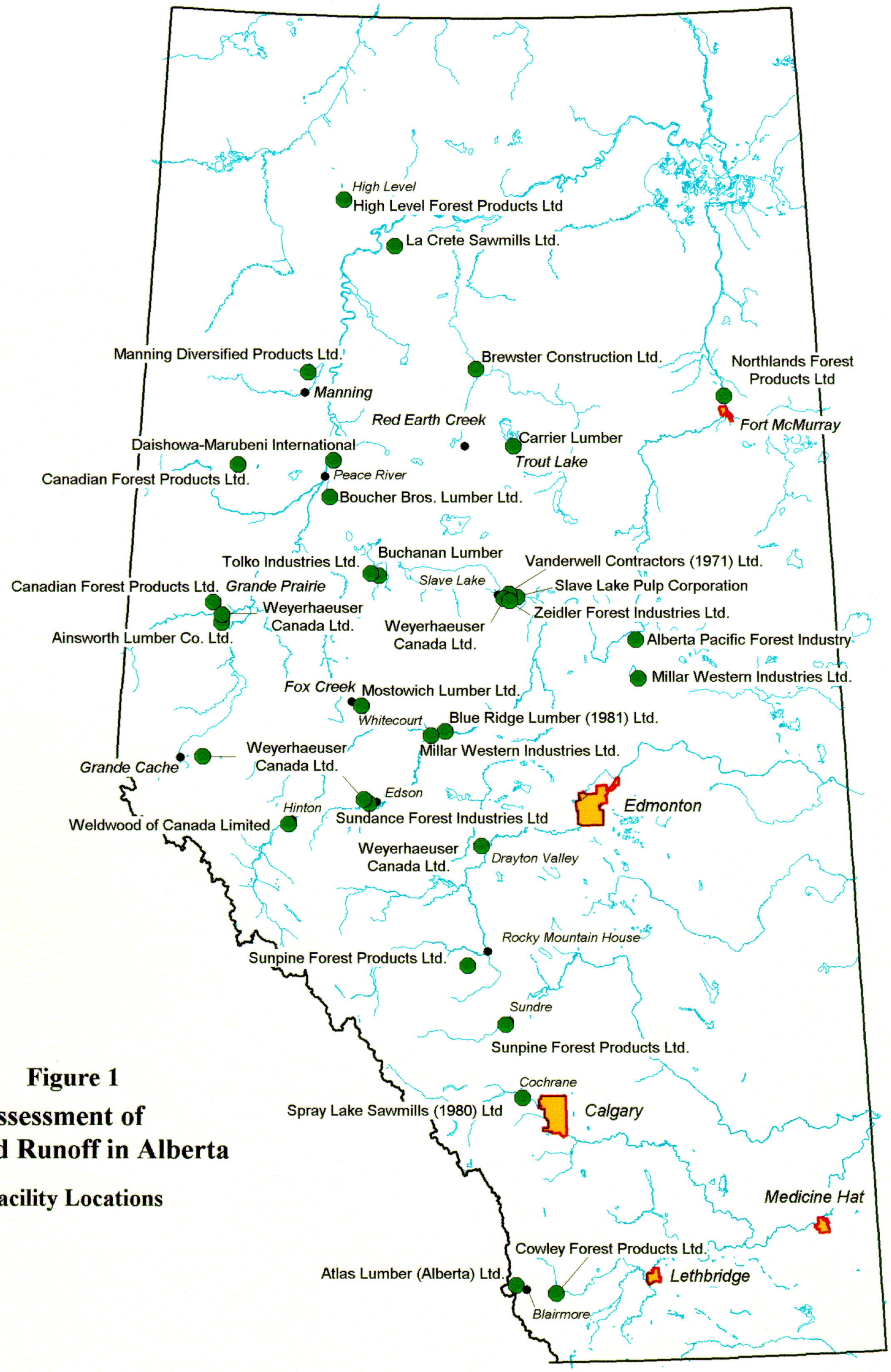


**Figure 1**

**Assessment of Log Yard Runoff in Alberta**

**Facility Locations**

**Table 1. Companies included in Log Yard Runoff Control Measures Inventory (Cont'd)**

| No | Company | Code | Location | Inventory |
|---|---|---|---|---|
| **1** | Ainsworth Lumber Co. Ltd.<br>(*Grande Prairie)* | Oriented Strand Board Plant | Grande Prairie<br>LSD 6-70-5-W6M | Oct-10-95 |
| **2** | West Fraser Mills Ltd. c/o<br>Blue Ridge Lumber (1981) Ltd.<br>(*Blue Ridge)* | Medium Density Fiberboard Plant | Blue Ridge<br>LSD N1/2 25, S1/2 36-59-10 W5M | Oct-27-95 |
| **3** | Alberta Pacific Forest Industries<br>(*Athabasca)* | Pulp Mill | Athabasca<br>LSD 20-68-19-W4M | Oct-18-95 |
| **4** | Atlas Lumber (Alberta) Ltd.<br>(*Sentinel)* | Sawmill | Sentinel<br>LSD SW1/4 11-8-5-W5M | Nov-3-95 |
| **5** | Boucher Bros. Lumber Ltd.<br>(*Nampa)* | Sawmill | Nampa<br>LSD NW1/4 27-81-21-W5M | Oct-11-95 |
| **6** | Brewster Construction Ltd.<br>(a subdivision of Daishowa -Marubeni International Limited)<br>(*Red Earth Creek)* | Sawmill | Red Earth Creek<br>LSD SW1/4 5-94-7-W5M and<br>LSD SE1/4, N1/2 4-94-W5M | Phone Interview |
| **7** | Buchanan Lumber<br>(*High Prairie)* | Sawmill | High Prairie<br>LSD 23-74-17-W5M | Sept-27-95 |
| **8** | Canadian Forest Products Ltd.<br>(*Grande Prairie)* | Sawmill | Grande Prairie<br>9401 - 108 Street | Oct-12-95 |
| **9** | Canadian Forest Products Ltd.<br>(*Hines Creek)* | Sawmill | Hines Creek<br>LSD N 15-84-W6M | Sept-21-95 |
| **10** | Carrier Lumber<br>(*Trout Lake)* | Sawmill | Trout Lake<br>LSD SE1/4 28, SW1/4 27-86-4-W5M | Phone Interview |
| **11** | Cowley Forest Products Ltd.<br>(*Cowley)* | Sawmill | Cowley | Nov-3-95 |
| **12** | Daishowa-Marubeni International<br>(*Peace River)* | Pulp Mill | Peace River<br>LSD 11, 12, 24-85-21 W5M | Sept-20-95 |
| **13** | High Level Forest Products Ltd.<br>(a subdivision of Daishowa-Marubeni International Ltd.)<br>(*High Level)* | Sawmill | High Level<br>LSD NE1/4 & W1/2 29,<br>SE1/4 30, S1/2 32-109-19-W5M | Phone Interview |
| **14** | La Crete Sawmills Ltd.<br>(*La Crete)* | Sawmill | La Crete<br>LSD NE1/4 26-105-15-W5M | Phone Interview |
| **15** | Manning Diversified Products<br>(*Manning)* | Sawmill | Manning<br>LSD 26-93-23-W5M | Sept-20-95 |
| **16** | Millar Western Industries Ltd.<br>(*Boyle*) | Sawmill | Boyle<br>LSD 33-64-19-W5M | Sept-8-95 |

**Table 1. Companies included in Log Yard Runoff Control Measures Inventory (Cont'd)**

| No | Company | Code | Location | Inventory |
|---|---|---|---|---|
| **17** | Millar Western Industries Ltd.<br>Millar Western Pulp Ltd.<br>(*Whitecourt)* | Sawmill<br>Pulp Mill | Whitecourt<br>LSD NW1/4 35-59-12-W5M | Oct-27-95 |
| **18** | Mostowich Lumber Ltd.<br>(*Fox Creek)* | Sawmill | Fox Creek<br>LSD SW1/4-18-62-18-W5M | Phone Interview |
| **19** | Northlands Forest Products Ltd.<br>(Fort McMurray) | Sawmill | Fort McMurray<br>LSD S1/2 4 & 7-91-9-W4M | Oct-31-95 |
| **20** | Slave Lake Pulp Corporation<br>(*Slave Lake*) | Pulp Mill | Slave Lake<br>LSD 26-72-4-W4 | Sep-28-95 |
| **21** | Spray Lake Sawmills (1980)<br>(*Cochrane*) | Wood Treating Plant | Cochrane<br>LSD SW1/4 34-25-4-W5M | Nov-2-95 |
| **22** | Sundance Forest Industries Ltd<br>(*Edson*) | Sawmill | Edson<br>LSD SW1/4 10-53-18-W5M | Phone Interview |
| **23** | Sunpine Forest Products Ltd.<br>(*Strachan*) | Laminated Veneer Lumber Plant | Strachan<br>LSD SW1/4 2, SE1/4 3-38-9-W5M | Oct-3-95 |
| **24** | Sunpine Forest Products Ltd.<br>(*Sundre*) | Wood Treating Plant | Sundre<br>LSD SW1/4 29-72-4-W5M | Nov-2-95 |
| **25** | Tolko Industries Ltd.<br>(*High Prairie*) | Oriented Strand Board Plant | High Prairie<br>LSD 25-74-18-W5M | Sept-27-95 |
| **26** | Vanderwell Contractors (1971)<br>(*Slave Lake*) | Sawmill | Slave Lake<br>LSD SW1/4 29-72-4-W5M | Sept-26-95 |
| **27** | Weldwood of Canada Limited<br>HI-ATHA Sawmill Division c/o<br>Weldwood (*Hinton*) | Pulp Mill<br>Sawmill | Hinton<br>LSD 23-51-25-W5M | Oct-5-95 |
| **28** | Weyerhaeuser Canada Ltd<br>(*Drayton Valley*) | Oriented Strand Board Plant | Drayton Valley<br>LSD NE1/4 8-49-7-W5M | Sept-14-95 |
| **29** | Weyerhaeuser Canada Ltd<br>(*Edson*) | Oriented Strand Board Plant | Edson<br>LSD NE1/4 23-53-17-W5M | Oct-5-95 |
| **30** | Weyerhaeuser Canada Ltd<br>(*Grande Cache*) | Sawmill | Grande Cache<br>LSD E1/2 9, W1/2 10-57-6-W6M | Oct-6-95 |
| **31** | Weyerhaeuser Canada Ltd<br>(*Grande Prairie*) | Pulp Mill | Grande Prairie<br>LSD 14, 15, 22, 23-70-5-W6M | Oct-10-95 |
| **32** | Weyerhaeuser Canada Ltd<br>(*Slave Lake*) | Sawmill | Slave Lake<br>LSD NW 1/4 29-72-4-W5M | Sept-19-95 |
| **33** | Zeidler Forest Industries Ltd.<br>(*Slave Lake*) | Sawmill | Slave Lake<br>LSD 31 & 32-72-4-W5M | Sept-26-95 |

## Inventory of Approval Requirements

Table A.1 (Appendix A) summarizes the approval information associated with each log yard including the location, approval number, expiry and current approval requirements such as Surface Runoff Management Plans (SRMP) and sampling requirements. Facilities required to submit a SRMP are to provide information regarding the path the surface runoff takes from their site and practises in place to control the surface runoff. Currently, 18 of the 33 log yard facilities in Alberta are required to submit a SRMP.

## Surface Water Monitoring

Currently, eight of the 33 facilities are required to collect a grab sample of surface runoff leaving their site or of the facility's retention pond. The eight facilities include Ainsworth Lumber Co. Ltd., High Level Forest Products Ltd., Manning Diversified Products Ltd., Spray Lake Sawmills (1980) Ltd., Sunpine Forest Products Ltd. (Strachan and Sundre facilities), Tolko Industries Ltd. and Weyerhaeuser Canada Ltd. (Edson). These facilities have generally been constructed or have upgraded within the last few years. Four of these facilities have just recently been required to collect and analyze their surface runoff and therefore data are not yet available. These facilities include Ainsworth Lumber Co. Ltd., Tolko Industries Ltd., Weyerhaeuser Canada Ltd. (Edson) which all have retention ponds and High Level Forest Products Ltd.

The two wood treatment facilities at Spray Lake Sawmills and Sunpine Forest Industries (Sundre) analyze surface water runoff samples for chromium, copper, arsenic and pH. The remaining six facilities are required to analyze for chemical oxygen demand, total organic carbon, total phenols, ammonia-nitrogen, oil and grease, pH and in some cases toxicity, total suspended solids and biochemical oxygen demand. Table 2 presents results of analysis of surface water runoff samples collected either for process control or as required in the approval to operate the wood processing facility. Total suspended solids ranged from 70 to 98 mg/L, chemical oxygen demand ranged from 75 to 1660 mg/L, biochemical oxygen demand ranged from 4 to 465 mg/L, and phenols ranged from 0.005 to 0.546 mg/L.

In the summer of 1994, samples of leachate from stagnant ponded water in log yards were collected at five saw mills and oriented strand board log yards in Alberta. The result of analysis for these samples is presented in Table 3. Biochemical oxygen demand ranged from 87 to 1940 mg/L, chemical oxygen demand from 373 to 2900 mg/L, total suspended solids from 20 to 795 mg/L, phenols from 0.464 to 16.1 mg/L and resin and fatty acids from 0.02 to 10.2 mg/L. Microtoxicity tests indicated that the samples were all toxic.

**Table 2. Results of Analysis of Samples Collected from Alberta Log Yards**

| Parameter (mg/L) | Slave Lake Pulp Corp Log / Chip Holding Pond | | | Sunpine Forest Products Ltd. - Strachan | | Manning Forest Products (May 1995) | | |
|---|---|---|---|---|---|---|---|---|
| | 16/04/94 | 25/05/94 | 27/06/94 | Ditch 95/3/14 | Ditch 95/6/13 | Dugout West Ditch | Lumber Yard | Log Yard |
| pH | | | | 7.50 | 6 .92 | 7.34 | 7.43 | 7.18 |
| BOD | | | | 465 | N.R. | 4 | 23 | 76 |
| COD | | | | 1320 | 1660 | 75 | 260 | 442 |
| Phenols | 0.257 | N/A | 0.139 | 0.229 | 0.436 | 0.009 | 0.026 | 0.546 |
| TSS | | | | 70 | 812 | 7 | 27 | 98 |
| TDS | | | | | | | | |
| TKN | 14.5 | 10.8 | 31.3 | | | | | |
| $NH_3$-N | 6.92 | 0.03 | 16.9 | < 1 | N.R. | 0.1 | 0.1 | 0.1 |
| Total Phosphorus | | | | | | | | |
| Oil and Grease | | | | < 1 | N.R. | 0.4 | 8.3 | 4.6 |
| TOC | | | | 387 | | | | |

**Table 3. Analytical Results of Log Yard Leachate Grab Samples - Summer 1994 (Collected from Stagnant Ponded Water, Not Representative of Runoff)**

| PARAMETERS | WEYERHAEUSER | | | | | ZIEDLER | BLUE RIDGE |
|---|---|---|---|---|---|---|---|
| | Drayton Valley | | Edson | | Slave Lake | Slave Lake | Blue Ridge |
| | SE Conifer | NE Aspen | Pond | Log Deck | Log Deck | Log Deck | SRO Pond Inlet |
| Tree Type | Conifer | Aspen | | | Aspen | Aspen | |
| pH (units) | 7.5 | 6.5 | 7.1 | 6.6 | 7.5 | 7.2 | 7.8 |
| Conductivity (µmohs/cm) | 1320 | 1940 | 1084 | 1420 | 1540 | 1330 | |
| BOD (mg/L) | ** 211 | ** 1940 | 345 | 1490 | 255 | 866 | 87.4 |
| COD (mg/L) | 1180 | 2900 | 636 | 2429 | 506 | 2190 | 373 |
| TSS (mg/L) | 30 | 20 | 795 | 244 | 47 | 134 | |
| Oil &Grease (mg/L) | 5.37 | 5.13 | 1.05 | 2.07 | 2.34 | 7.5 | |
| Phenols (mg/L) | 1.17 | 13.9 | 2.79 | 16.1 | 3.15 | 3.64 | 0.464 |
| Tannins & Lignins (mg/L) | 35.2 | 243 | 35.5 | 244 | 21.7 | 100 | |
| Colour H5P (Pt-Co units) | 625 | 2010 | 625 | 1730 | 270 | 1440 | |
| TKN (mg/L) | 3.71 | 4.98 | 4.85 | 4.94 | 2.74 | 6.42 | |
| NH3-N (mg/L) | 0.021 | 0.038 | 0.057 | 0.062 | 0.29 | 0.153 | |
| T-Phosphorus (mg/L) | 1.49 | 0.779 | 1.44 | 1.68 | 0.247 | 0.247 | |
| Microtox (%) *** | 37.9 | 0.7 | 18.9 | 0.8 | 12.6 | 7.4 | |
| Resin & Fatty Acid (mg/L) | 1.98 | 0.091 | 0.518 | 0.174 | 0.02 | 10.2 | |

Note: ** Initial BOD tests went septic - BOD tests were rerun a week later
*** Toxicity is ranked as follows: < 25%, Extremely Toxic; 25 - 50 %, Very Toxic; 51 - 75%, Moderately Toxic; 76 - 100%, Slightly Toxic; >100% = No Toxic Effect

**Inventory of Log Yard Operation Data**

Table A.2 (Appendix A) summarizes information related to the log yard operation including the log yard area, log species and approximate percentage of each species, the annual log use and the maximum and minimum amounts of the logs stored. The amount of logs stored at the log yard varies with the size of the facility, process and time of year. Most facilities typically store the maximum amount of logs in the spring after the winter haul period. Logs may be stored at the site for longer than a year or may be used as they are brought in. Table 4 groups the log yards according to the quantity of logs utilized per year.

**Inventory of Surface Runoff Control Measures at Log Yards**

Table A.3 summarizes for each facility, the watershed basin, proximity to water bodies, the current surface runoff control measures and comments. Possible runoff control measures include berms, diversion dikes, ditches, preservation of natural vegetation or vegetated filter strips, dug outs, retention ponds and treatment of runoff. Berms and diversion dikes prevent runoff from entering the site. Ditches direct the runoff from the site. Preservation of natural vegetation or vegetative filter strips minimize erosion and protect the water quality. These two control measures are referred to as passive. Dug outs or retention ponds collect the runoff to allow solids to settle and natural aeration to degrade any organic material in the runoff. In some cases, runoff may be directed to a treatment system along with other process waters before it is discharged.

Table 5 groups the log yards according to the surface runoff practises at the site and identifies those sites within 500 m of a receiving water body. Twelve log yards have passive treatment, twelve redirect the runoff from the log yard by ditching, seven have retention ponds or dug outs and two treat the runoff with their wastewater by biological wastewater treatment.

## Table 4. Log Yards Grouped According to Logs Utilized per Year

| Greater than 1,000,000 $m^3$ | 500,000 to 1,000,000 $m^3$ | 200,000 to 500,000 $m^3$ | Less than 200,000 $m^3$ |
|---|---|---|---|
| Alberta Pacific Forest Industries Inc. | Ainsworth Lumber Co. Ltd. | Brewster Construction Ltd. | Atlas Lumber (Alberta) Ltd. |
| Daishowa-Marubeni International Limited (Peace River) | Blue Ridge Lumber (1981) Ltd. | Buchanan Lumber | Boucher Bros. Lumber Ltd. |
| High Level Forest Products Ltd. | Canadian Forest Products Ltd. (Grande Prairie) | Canadian Forest Products Ltd. (Hines Creek) | Carrier Lumber |
| Millar Western Industries Ltd. (Whitecourt) | Tolko Industries Ltd. | La Crete Sawmills Ltd. | Cowley Forest Products Ltd. |
| Weldwood of Canada Limited | Weyerhaeuser Canada Ltd. (Edson) | Manning Diversified Products Ltd. | Mostowich Lumber Ltd. |
| Weyerhaeuser Canada Ltd. (Drayton Valley) | | Millar Western Industries Ltd. (Boyle) | Northlands Forest Products Ltd. |
| Weyerhaeuser Canada Ltd. (Grande Prairie) | | Slave Lake Pulp Corporation | |
| | | Spray Lake Sawmills (1980) Ltd. | |
| | | Sundance Forest Products Ltd. | |
| | | Sunpine Forest Products Ltd. (Sundre) | |
| | | Vanderwell Contractors (1971) Ltd. | |
| | | Weyerhaeuser Canada Ltd. (Grande Cache) | |
| | | Weyerhaeuser Canada Ltd. (Slave Lake) | |
| | | Zeidler Forest Industries Ltd. | |

**Table 5. Log Yards Grouped According to Runoff Control Measures and Proximity to Water Bodies**

| Passive Treatment | Ditching | Retention Pond or Dug Out | Treat Runoff | Proximity to Water Body < 500 m |
|---|---|---|---|---|
| Buchanan Lumber | Atlas Lumber (Alberta) Ltd. | Ainsworth Lumber Co. Ltd. | Alberta Pacific Forest Industries Inc. | Atlas Lumber (Alberta) Ltd. |
| Daishowa-Marubeni International Ltd (Peace River) | Brewster Construction Ltd. | Blue Ridge Lumber (1981) Ltd. | Slave Lake Pulp Corporation | Brewster Construction Ltd. |
| Manning Diversified Products Ltd. | High Level Forest Products Ltd. | Boucher Bros. Lumber Ltd. | | Canadian Forest Products Ltd. (Grande Prairie) |
| Millar Western Industries Ltd. (Whitecourt) | Canadian Forest Products Ltd. (Grande Prairie) | Canadian Forest Products Ltd. (Hines Creek) | | Daishowa-Marubeni International Ltd. (Peace River) |
| Northlands Forest Products Ltd | Carrier Lumber | Millar Western Industries Ltd. (Boyle) | | Manning Diversified Products Ltd. |
| Spray Lake Sawmills (1980) Ltd. | Cowley Forest Products Ltd. | Tolko Industries Ltd. | | Millar Western Industries Ltd. (Whitecourt) |
| Sunpine Forest Products Ltd. (Sundre) | La Crete Sawmills Ltd. | Weyerhaeuser Canada Ltd. (Edson) | | Northlands Forest Products Ltd. |
| Vanderwell Contractors (1971) Ltd. | Mostowich Lumber Ltd. | | | Weldwood of Canada Limited |
| Weldwood of Canada Limited | Sundance Forest Industries Ltd. | | | Weyerhaeuser Canada Ltd. (Grande Cache) |
| Weyerhaeuser Canada Ltd (Grande Prairie) | Sunpine Forest Products Ltd. (Strachan) | | | Weyerhaeuser Canada Ltd. (Grande Prairie) |
| Weyerhaeuser Canada Ltd (Slave Lake) | Weyerhaeuser Canada Ltd. (Drayton Valley) | | | |
| Zeidler Forest Industries Ltd. | Weyerhaeuser Canada Ltd. (Grande Cache) | | | |

# 3.0 WOOD CHEMISTRY

The naturally occurring chemicals in wood fibre may dissolve or leach from the wood fibre into water due to their exposure to rainfall or snow melt. This section provides a brief description of wood chemistry to provide a background of the possible chemical parameters which may be found in runoff from log yards.

The chemical constituents of wood vary between tree species, age, geographical location and part of the tree. The major constituents in wood, other than water, include carbohydrates, lignins, and wood extractives. Table 6 provides the chemical composition of various wood species.

Carbohydrates include cellulose, hemicellulose, starch and pectin, which are all polysaccharides, i.e., long chain sugars, and water soluble wood sugars, which are typically monosaccharides, i.e., short chain sugars. Carbohydrates are considered to be biodegradable because they can be broken down by microorganisms into shorter fragments and wood sugars.

Cellulose forms a skeleton of the wood cells and makes up 40 % to 45 % of the dry weight of wood. Cellulose molecules are made of polysaccharides and are completely linear. Bundles of cellulose molecules make up microfibrils which build up to fibrils and finally cellulose fibres. Cellulose has a high tensile strength and is insoluble in most solvents.

Hemicellulose surrounds cellulose and acts as a matrix or supporting material in the cell wall. In softwoods approximately 20 % (dry weight) of the wood is made up of hemicellulose which consists primarily of a polysaccharide known as glucomannans. In hardwoods, approximately 15 % to 30 % (dry weight) of wood is made up of hemicellulose. The major polysaccharide in hemicellulose in hardwood is glucurononxylan.

Lignins, like hemicellulose, surround cellulose and act as an encrusting material which bonds wood cells together into a rigid structure. Lignins are polymers of phenylpropane units. In normal softwoods lignins make up 26 % to 32 % of the dry weight of wood. In normal hardwoods he dry weight of lignin ranges from 20 % to 28 %.

Wood extractives make up approximately 1 % to 5 % dry weight of wood. They are the wood constituents which can be extracted with organic solvents. The content of the extractives and their composition vary greatly among different wood species and also within the different parts of the same tree. Wood extractives can be divided into 3 subgroups: aliphatic compounds (mainly fats and waxes), terpenes and terpenoids and phenolic compounds.

**Table 6. Chemical Composition of Various Wood Species[a]**

| Species | Common Name | Total Extractives | Lignin | Cellulose | Glucomannan[b] | Glucurononxylan[c] | Other Polysaccharides | Residual Constituents |
|---|---|---|---|---|---|---|---|---|
| Softwoods | | | | | | | | |
| *Abies balsamea* | Balsam fir | 2.7 | 29.1 | 38.8 | 17.4 | 8.4 | 2.7 | 0.9 |
| *Pseudotsuga menziesii* | Douglas fir | 5.3 | 29.3 | 38.8 | 17.5 | 5.4 | 3.4 | 0.0 |
| *Tsuga canadensis* | Eastern hemlock | 3.4 | 30.5 | 37.7 | 18.5 | 6.5 | 2.9 | 0.5 |
| *Juniperus communis* | Common juniper | 3.2 | 32.1 | 33.0 | 16.4 | 10.7 | 3.2 | 1.4 |
| *Pinus radiata* | Monterey pine | 1.8 | 27.3 | 37.4 | 20.4 | 8.5 | 4.3 | 0.4 |
| *Pinus sylvestris* | Scots pine | 3.5 | 27.7 | 40.0 | 16.0 | 8.9 | 3.6 | 0.3 |
| *Picea abies* | Norway spruce | 1.7 | 27.4 | 41.7 | 16.3 | 8.6 | 3.4 | 0.9 |
| *Picea glauca* | White spruce | 2.1 | 27.5 | 39.5 | 17.2 | 10.4 | 3.0 | 0.3 |
| *Larix sibirica* | Siberian larch | 1.8 | 26.8 | 41.4 | 14.1 | 6.8 | 8.7 | 0.4 |
| Hardwoods | | | | | | | | |
| *Acer rubrun* | Red maple | 3.2 | 25.4 | 42.0 | 3.1 | 22.1 | 3.7 | 0.5 |
| *Acer saccharum* | Sugar maple | 2.5 | 25.2 | 40.7 | 3.7 | 23.6 | 3.5 | 0.8 |
| *Fagus sylvatica* | Common beech | 1.2 | 24.8 | 39.4 | 1.3 | 27.8 | 4.2 | 1.3 |
| *Betula verrucosa* | Silver birch | 3.2 | 22.0 | 41.0 | 2.3 | 27.5 | 2.6 | 1.4 |
| *Betula papyrifera* | Paper birch | 2.6 | 21.4 | 39.4 | 1.4 | 29.7 | 3.4 | 2.1 |
| *Alnus incana* | Gray alder | 4.6 | 24.8 | 38.3 | 2.8 | 25.8 | 2.3 | 1.4 |
| *Eucalyptus camaldulensis* | River red gum | 2.8 | 31.3 | 45.0 | 3.1 | 14.1 | 2.0 | 1.7 |
| *Eucalyptus globulus* | Blue gum | 1.3 | 21.9 | 51.3 | 1.4 | 19.9 | 3.9 | 0.3 |
| *Gmelina arborea* | Yemane | 4.6 | 26.1 | 47.3 | 3.2 | 15.4 | 2.5 | 0.9 |
| *Acacia mollissima* | Black wattle | 1.8 | 20.8 | 42.9 | 2.6 | 28.2 | 2.8 | 0.9 |
| *Ochroma lagopus* | Balsa | 2.0 | 21.5 | 47.7 | 3.0 | 21.7 | 2.9 | 1.2 |

[a]Sjöström, E. 1981. Wood Chemistry: Fundamentals and Applications. Academic Press, New York, N.Y. Appendix 1. J. Janson, P. Haglund, and E. Sjöström, unpublished data. All values are given as % of the dry wood weight.

[b]Including galactose and acetyl in softwood.
[c]Including arabinose in softwood and acetyl in hardwood.

Aliphatic acids are a source of stored energy for trees and are found in seed tissues (cones and fruit) and in the wood resins in softwoods and hardwoods. They are water insoluble and include fats (glycerol esters) usually present as triglycerides, waxes (esters of aliphatic and terpenoid alcohols) and unsaturated fatty acids such as linoleic acid.

Terpenes and terpenoids are water insoluble compounds that exist primarily in softwoods such as pines, spruces, larches and Douglas-fir. They provide a defense against wood boring insects. After a tree is harvested resin acids can become more water soluble due to oxidation. Terpenes consist of resin acids (non-volatile terpenes) and volatile oils or the turpentine fraction (volatile terpenes) found in resin canals in the bark and sapwood.

Phenolic extractives function as fungicides, insecticides and antioxidants to protect the tree from decay. Phenolic extractives and related constituents can be grouped into 5 compounds: hydrolyzable tannins; flavonoids (condensed tannins); lignans; stilbene and tropolones.

Bark amounts to approximately 10 to 15 percent of the total weight of the tree. Although the chemical components in bark are the same as in wood, the proportions are different. The extractives present in bark are usually higher than wood, ranging from 20 to 40 percent of the dry weight. The insoluble constituents include polysaccharides (approximately 30 percent of the dry weight), lignin, reported for coniferous bark to range from 15 to 30 percent, and suberin found to range from 20 to 40 percent in birch bark. Inorganic constituents such as calcium, potassium, silicates and phosphates are found at levels of two to five percent.

## 4.0 LITERATURE REVIEW OF CHEMICAL CHARACTERISTICS OF RUNOFF FROM LOG YARDS

A literature review was conducted to obtain information regarding the chemical characteristics of log yard runoff. The Water Resources Abstract (1/94 - 7/95), AGRICOLA (1984 - 12/91) and Water Resources (1967-10/94) databases were searched with the following keywords and sequence: (log or logging or sawmill or oriented strand board) and (runoff or run off or leachate). From the search it became obvious that there is minimal information published regarding log yard runoff based on the keywords and databases used. The majority of the information presented here is based on National Council of the Paper Industry for the Air and Stream Improvement Inc. (NCASI) reports and published studies by the B. C. Ministry of the Environment.

Roughly one percent of wood dissolves in cold water (NCASI, 1992) this percentage increases with temperature. Log yard runoff contains the naturally occurring chemicals present in wood which have dissolved from logs due to their exposure to runoff. This component of the runoff is referred to as leachate. Research on the effects of runoff from log yards was conducted in the 1970's in the U.S. for the EPA and in Canada by Environment Canada and the Canadian Pulp and Paper Industry. Table 7 presents the results of water quality analysis of leachates and runoff from log decks and piles of chips, bark, and saw dust based on data collected in the 1970's (NCASI, 1992).

**Table 7. Range of Values for Water Quality Parameters of Leachates and Runoff from Log Decks and Piles of Chips, Bark and Saw Dust (NCASI, 1992)**

| Parameter (mg/L) | Log Yard | Wet Deck | Dry Deck | Chip Pile | Bark Pile | Sawdust Pile | Redwood Chip Pile |
|---|---|---|---|---|---|---|---|
| BOD | 352 | 11 - 52 | 110 - 300 | 117 - 630 | - | 210 - 339 | 840 |
| COD | - | 83 - 115 | 590 - 11000 | 280 - 4400 | 8700 | 240 - 4400 | 460 - 2500 |
| TSS | 1580 | 76 - 440 | 132 - 164 | 1100 - 4100 | 4800 | 1665 - 5400 | - |
| N | - | 0.3 - 2.2 | 0.8 | 9.2 | - | - | - |
| $PO_4$ | - | 0.1 - 2.9 | 0.6 | 2 | - | - | - |
| Color c.u. | 1937 | 29 - 150 | 409 | | 1600 | 250 - 2297 | - |

Schaumburg (Schaumburg, 1973) studied leachate from short floating logs under laboratory conditions and measured various parameters including chemical oxygen demand (COD), biochemical oxygen demand (BOD) and acute toxicity. He found that the colour producing substances were primarily associated with leachate from the bark and that the leachate was toxic to fish. Schuytema and Shankland (Schuytema, G.S., Shankland, R.D., 1976) acknowledged in their research that wet deck runoff (runoff from log storage areas in which water is sprinkled on the logs) has the "potential to degrade water quality in a receiving stream" but did not quantify the effect. In 1975, the Northern California North Coast Regional Water Quality Board initiated a study to establish water quality standards for runoff from log decks (NCASI, 1992). The study consisted of a literature review, data collection from industrial sites and preparation of a report. Seventeen log decks were monitored for three years and 23 parameters were sampled at various frequencies. Table 8 presents results for settleable solids, volatile non-filterable suspended solids and chemical oxygen demand. Toxicity testing was based on percent survival of rainbow trout exposed to runoff from log decks which averaged to about 70 percent.

**Table 8. Northern California Study (NCASI, 1992)**

| Parameter | Minimum | Maximum | Mean |
|---|---|---|---|
| Settleable Solids | trace | 57 | 1.1 |
| VNSS[1] | | 9,100 | 460 |
| COD | 35 | 11,000 | 675 |

[1] Volatile non-filterable settleable solids

Monitoring of surface runoff from a log storage and mill site was conducted as part of the National Pollution Discharge Elimination System (NPDES) requirements in Washington from October 1978 to September 1988 (NCASI, 1992). Monitoring was conducted in a roadside ditch and below a wastewater pond. Parameters monitored included pH, settleable solids, temperature, flow, dissolved oxygen, biochemical oxygen demand, total suspended solids, faecal coliform and priority pollutants. "Fish bioassays were also conducted 11 times at the mill site between 1986 - 1989. Survival from two storm water monitoring sites was 100 percent for 16 of the 21 site-days tested. Another four bioassays had 90 percent survival and one bioassay had a 70 percent survival." (NCASI, 1992).

In 1989 the Idaho Division of Environmental Quality developed recommendations to improve stormwater drainage including installation of stormwater handling and treatment facilities. These recommendations were developed in response to complaints of foam in a river receiving the stormwater runoff after storm events and concerns of possible excess nutrients, sediments and oxygen demand in stormwater runoff. Stormwater control measures were implemented prior to initiation of the study. Some of the measures included construction of a dry deck pond, annual cleanout to maintain runoff detention capacity, annual cleanout of the wet deck pond at the end of the irrigation season to remove tannin material, routine cleanout of a road-side ditch receiving some stormwater runoff and installation of hay bales to trap particulates. Sampling and analysis of stormwater was conducted during the spring breakup on March 29, 1990, and during a storm event on May 18, 1990. Five locations were sampled including: (1) the outflow from the dry deck pond; (2) flow from outside the mill site and runoff in a perimeter ditch; (3) outflow of the wet-deck pond; (4) inflow from property above the mill site; (5) river water above the outlet from the mill site. Tables 9a and 9b present some of the results of the analysis

**Table 9a. Dissolved Oxygen and pH of Runoff Samples (NCASI, 1992)**

| Sample Location No. | DO (mg/L) March 29, 1990 | pH March 29, 1990 | pH May 18, 1990 |
|---|---|---|---|
| 1 | 5 | 6.2 | 5.9 |
| 2 | | 6.7 | |
| 3 | 8.4 | 6.9 | 6.7 |
| 4 | | 6.7 | |
| 5 | 8.5 | 6.8 | |

**Table 9b. Organic Analytical Results for May 18 Sample from Outflow of Dry Deck Pond - Sample Location No. 1 (NCASI, 1992)**

| Parameter (in ppb) | Analysis A | Analysis B | Analysis C |
|---|---|---|---|
| Phenol | 567 | 670 | |
| p-Cymene | 42.2 | | |
| Benzyl alcohol | 51 | | |
| m-Cresol | | 547 | |
| o-Cresol | 12.3 | | |
| Acetophenone | 12.3 | | |
| p-Cresol | 1160 | 1670 | |
| Fenchone | 108 | | |
| Guaiacol | 379 | 185 | |
| Catechol | | 998 | |
| Fenchyl alcohol | 34.7 | | |
| Terpine-4-ol | 153 | | |
| a-Terpineol | 286 | | |
| Verbenone | 172 | | |
| Dehydrobietol | 157 | | |
| Resorcinal | | 50.5 | |
| Benzoic Acid | | | 1930 |
| p-Hydroxybenzoic Acid | | | 22.4 |
| Linoleic Acid | | | 57.5 |
| Oleic Acid | | | 39.4 |
| Pimaric Acid | | | 32.6 |
| Sandracopimaric Acid | | | 24.5 |
| Palustric Acid | | | 120 |
| Isopimaric Acid | | | 41.9 |
| Dehydroabietic Acid | | | 104 |
| Abietic Acid | | | 409 |
| 7-Oxodehydroabietic Acid | | | 403 |

Analysis A by GC/MS for Neutral and Acid Organics
Analysis B by GC/MS for CP-86.01 for Phenolics
Analysis C by GC/MS for Resin Acids, Fatty Acids and other Carboxylic Acids by RA/FA-85

Two bioassay tests were conducted including a 48-hour static Ceriodaphnia test and a Microtox test to characterize the samples. Results of microtoxicity testing of samples collected on March 29, 1990 indicated no response to samples 2, 4, and 5 , i.e., no toxicity, and an effective concentration for a 50 percent reduction in photoluminescence (EC%) for sample 3, the outflow of the wet-deck pond, of 135 percent. This indicated minimal or no response. Sample 1, the outflow from the dry deck pond, had an EC50 of 16.6 percent, a response indicating some toxicity. Microtoxicity testing of samples collected on May 19, 1990 indicated an EC50 of 5.6 and 1.3 percent for sample 1, again indicating toxicity.

The acute 48-hour *Ceriodaphnia* bioassays indicated that with no dilution of the stormwater runoff sample, i.e. 100 percent, sample 1 was toxic as replicate tests showed 100 percent and 80 percent mortality of the *Ceriodaphnia*. Mortality in other samples was between 0 and 10 percent, indicating no response.

The results of the chemical analysis (Table 9b) did not indicate highly unusual concentrations to account for the bioassay response. A couple of compounds which were at relatively high concentrations compared to pulp and paper effluent samples included p-cresol and benzoic acid.

The result of field monitoring of the wet-deck recycle pond indicated a dissolved oxygen level of 1.7 mg/L. This was due to the exposure of pond water to wood and bark. Prior to cleanout of the pond a sample was collected and found to have a COD of 950 mg/L and over 4000 color units. In spite of these results, the bioassay response was minimal. This was likely due to dilution of the pond water as a result of runoff from the surrounding area entering the pond.

Stormwater assessment was conducted at four industrial log handling and sawmill sites between 1989 and the early 1990s (Weyerhaeuser, pers. comm., April, 1996). The first site contained approximately 25 acres of paved sort yard, an inventory of six million board feet of timber with large quantities of fir/hemlock bark from the mechanical debarker and two discharge points. This site was sampled five times during the early 1990s. Results of the analysis indicated elevated levels of zinc and copper (14 to 1100 $\mu$g/L), $BOD_5$ and COD (60 to 2000 mg/L) and resin and fatty acids (2 to 10 mg/L). Storm water samples were found to be toxic to rainbow trout. The second site was sampled at 17 stormwater discharge points on and adjacent to the site during storm events in 1990. The samples had varying levels of $BOD_5$ (6 to 770 mg/L), COD (55 to 4230), and TOC (20 to 1572) which indicated organic contamination. Bioassay testing using rainbow trout showed that samples collected from 11 of the 17 discharge points were acutely toxic to rainbow trout. A treatability study with addition of EDTA to remove cationic metals and extended aeration resulted in decreased toxicity of the sample. The third site, Triple R Forest Products, had a non-paved sort yard and lumber mill. A mechanical debarker was on-site with debris piles consisting primarily of debris from pine. Sampling was conducted in 1991 from four sources and bioassays indicated the samples were not toxic. It was hypothesized that the plants in and adjacent to the ditch may act as a filter to remove nutrients and potential toxicants. The fourth site, Longview Woods Products, was sampled at two stormwater outfalls in

1989 and 1990. These sources were not acutely toxic to rainbow trout. Based on the monitoring data it was concluded that:

- stormwater quality can vary from toxic to non-toxic;
- the aquatic toxicity of an outfall does not change during a storm event, but may change with the season;
- water quality parameters can exceed state and federal standards; and,
- the pollutants which may be a problem include metals (zinc and copper), resin and fatty acids from bark debris, other organics from wood debris, temperature, total suspended solids, $BOD_5$ and wood preservatives.

The U.S. EPA and state agencies have been developing monitoring and control requirements for storm-water runoff from industries and large municipalities. As part of these requirements, the U.S. EPA required industrial facilities to apply for permits for any stormwater flowing directly into surface waters or into municipal separate sewer systems in 1990. One type of permit which facilities could apply for is a Multi-sector Stormwater General Permit (MSSGP). Monitoring of stormwater was conducted for the proposed MSSGP by timber products facilities (U.S. EPA, 1995). Table 10 summarizes eight pollutants monitored in stormwater by log storage and handling facilities. More details are provided in Section Six regarding the policy and guidelines implemented in the U.S. for storm water from log yard areas.

**Table 10. Statistics for Selected Pollutants Reported by Log Storage and Handling Facilities Submitting Part II Sampling Data (mg/L unless otherwise specified)**

| Pollutant | # of Facilities | | # of Samples | | Mean | | Minimum | | Maximum | | Median | | 95th Percentile | | 99th Percentile | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Type | Grab | Comp | Grab | Comp | Grab | Comp | Grab | Comp | Grab | Comp | Grab | Comp | Grab | Comp | Grab | Comp |
| $BOD_5$ | 22 | 24 | 52 | 56 | 18.7 | 22.6 | 0 | 0 | 260 | 130 | 8.3 | 7.3 | 66.4 | 89.3 | 151 | 207 |
| COD | 21 | 23 | 51 | 54 | 287 | 262 | 0 | 0 | 1500 | 1500 | 136 | 110 | 1127.8 | 941 | 2713 | 2111 |
| Nitrate+Nitrite Nitrogen | 15 | 17 | 43 | 46 | 0.17 | 0.19 | 0 | 0 | 0.82 | 1.1 | 0.09 | 0.11 | 0.74 | 0.74 | 1.61 | 1.48 |
| Total Kjedahl Nitrogen | 14 | 17 | 40 | 45 | 2.3 | 2.14 | 0 | 0 | 9.3 | 12.2 | 1.46 | 1.3 | 8.12 | 5.98 | 15.6 | 10.5 |
| Oil and Grease | 25 | N/A | 57 | N/A | 3.8 | N/A | 0 | N/A | 37 | N/A | 1.8 | N/A | 12.9 | N/A | 24.5 | N/A |
| pH (pH units) | 25 | N/A | 57 | N/A | N/A | N/A | 2.8 | N/A | 8.3 | N/A | 7 | N/A | 9.3 | N/A | 10.5 | N/A |
| Total Phosphorus | 22 | 24 | 52 | 55 | 89.5 | 21.4 | 0 | 0 | 3000 | 1160 | 0.2 | 0.23 | 15.63 | 3.86 | 87.17 | 13.5 |
| Total Suspended Solids | 22 | 24 | 52 | 55 | 1024 | 567 | 0 | 0 | 16520 | 5192 | 518 | 164 | 6657 | 3121 | 25663 | 10723 |

Reference: Federal Register/Vol. 60, No. 189/Friday, September 29, 1995/Notices Table A-3, p. 50839.

A two-part study conducted by the B.C. Ministry of the Environment consisted of a laboratory (Goudey and Taylor, 1992) and field study (Taylor, 1994). In the laboratory study an artificial leachate was produced from a 9:1 ratio of water to ground chips. The laboratory study indicated that decomposition of the organic constituents of the leachate resulted in decreased dissolved oxygen, increased pH, and colour. The increase in color seemed to indicate the destruction of light organic acids and the formation of stable, polycyclic organic compounds from phenolic skeletons. Toxicity decreased some time after the leachate turned black.

The field study consisted of stacking a standard truckload of aspen logs onto a heavy tarpaulin catchbasin. This experimental "log yard" was located in an open field west of Dawson Creek. The study commenced November 1991 and continued for two years. Samples were taken during and after spring melt and major rainstorms, but at least one sample was taken each month during the ice-free period. An average of 250 litres of leachate was collected after rainstorm or snowmelt in every season for two years. Runoff from the log pile was collected beginning in February 1992 and chemical analysis conducted for pH, conductivity, five-day biochemical oxygen demand ($BOD_5$), chemical oxygen demand (COD), total phenols, total organic carbon (TOC) and total colour. The runoff toxicity was characterized by the bacterial luminescence (Microtox) assay, and acute lethality assays using *Daphnia* and rainbow trout.

The leachate produced in the field had similar elevated chemical and toxicological parameters to the laboratory produced leachate. Results of the chemical analysis of the laboratory and field study are presented in Table 11.

**Table 11. Toxicity of Aspen Wood Leachate to Aquatic Life (Goudey and Taylor, 1992, Taylor, 1994)**

| Parameter mg/L | Laboratory | Field Max | Field Median |
|---|---|---|---|
| pH | 4 | 5 | 6.1 |
| Conductivity | 1140 | 708 | 465 |
| BOD | > 2600 | 4970 | 748 |
| COD | 5170 | 6530 | 1695 |
| Phenols | 29.9 | 27.3 | 4.5 |
| TOC | 2480 | 2230 | 620 |
| Toxicity Index | 4.3 | 4.7 | 3.5 |
| Total Color | 500 | 1510 | 873 |

The leachate produced from the field study had an acidic pH (5.0 - 6.5), conductivity (200 - 500 μS/cm), varying BOD (500 - 5,000 mg/L), low dissolved oxygen (< 2 mg/L), and high phenols (2.5 - 27 mg/L). Most chemical variables varied widely from one sample to the next. Concentrations of TOC, BOD and COD were at their maximum in the first spring (TOC 2,230 mg/L, BOD 4,970 mg/L, COD 6,530 mg/L) and declined steadily to the end of the study with concentrations of TOC of 330 mg/L, BOD 136 mg/L and COD 786 mg/L. Phenols concentration increased steadily through the first 8 collections to a peak of 27 mg/L in June 1992, thereafter phenols concentration decreased and remained below 5 mg/L through the second year of the study. During the study period the total precipitation increased with time. This resulted in a decreased concentration of constituents in the second year due to higher dilution. The mass loading of material from the wood remained approximately constant

Results of the three bioassays were consolidated into an index of average toxicity. The index of average toxicity was developed by assigning a rank value for each test depending on the strength of the toxic response. The ranks range from five (extremely toxic) to zero (not acutely toxic). The rank and corresponding LC50 or EC50 is indicated below:

| Rank | LC50 or EC50 (%) |
|---|---|
| 0 | > 100 |
| 1 | 99 - 50 |
| 2 | 49 - 25 |
| 3 | 24 - 10 |
| 4 | 10 - 1 |
| 5 | < 1 |

The Microtox test indicated the leachate was severely toxic throughout most of the field study. Both the *Daphnia* and rainbow trout lethality test indicated the leachate was toxic in the first spring and declined quickly. The toxicity returned in the second spring and declined to non-toxic by the last sample. The toxicity index considers all three bioassays with a consistent decline in toxicity of the leachate over the two year period of the study. Taylor has developed a relationship between the toxicity of leachate in the field and its pH and BOD.

### Other Components of Log Yard Runoff

Log yard runoff has also been known to contain particulate matter such as bark, chips and pulp fiber, oil and grease, sediment and foam. Particulate matter such as bark, chips and pulp fibers can exert a high BOD. Oil and grease content in runoff is due to vehicles used in the log yard and sediment is as a result of erosion. Foam is formed when the resin and fatty acids and lignin content in the log yard runoff lowers the surface tension enabling air to be entrained in the runoff.

### Summary

The literature review showed that there is limited information available regarding log yard runoff. Information was primarily obtained from NCASI reports and published studies by the B.C. Ministry of the Environment. Log yard runoff quality can vary from toxic to non-toxic and have varying chemical characteristics with BOD levels ranging from 6 mg/L to 4,950 mg/L, COD levels ranging from 11 mg/L to 6,530 mg/L and TOC levels ranging from 20 to 2,230 mg/L.

# 5.0 POLICY AND GUIDELINES ADOPTED IN OTHER JURISDICTIONS

The policies and guidelines presented here are based on those implemented or proposed by the United States Environmental Protection Agency, the State of Washington Department of Ecology, the B.C. Ministry of the Environment, the New Brunswick Department of Environment and the Ontario Ministry of Environment and Energy.

**United States Environmental Protection Agency**

For 20 years, the United States Environmental Protection Agency (U.S. EPA) and state agencies have been developing monitoring and control requirements for storm-water runoff from industries and large municipalities. On November 16, 1990 EPA announced stormwater regulations requiring all industrial facilities to apply for and obtain National Pollutant Discharge Elimination System (NPDES) permits for any stormwater flowing directly into surface waters or into municipal separate sewer systems. Facilities could apply for the NPDES stormwater permit by means of an individual permit, a baseline general permit or a Multi-sector Stormwater General Permit (MSSGP). The EPA finalized the NPDES Multi-sector Stormwater General Permit (MSSGP) for industrial facilities on September 29, 1995. The foundation of the MSSGP is the development and implementation of a stormwater pollution plan. Results of monitoring stormwater conducted by timber product facilities for the proposed MSSGP is provided in Section Four, Table 11.

The U.S. EPA has defined stormwater as "... surface runoff... infiltration... and drainage related to storm events or snow melt " (NCASI, 1992). Stormwater discharges from log storage areas, dealt with under the Timber Products Facilities Sector, are defined as point sources by the following: "any discernible, confined and discrete conveyance related to rock crushing, gravel washing, log sorting or log storage facilities, which are operated in connection with silvicultural activities and from which pollutants are discharged into waters of the United States." (U.S. EPA, 1995). Various materials that may come into contact with storm water discharges at log storage facilities include uncut logs (hardwoods and softwoods), wood bark, wood chips, coarse saw dust, other waste wood material, petroleum and other products for equipment maintenance (fuels, motor oils, hydraulic oils, lubricant fluid, and antifreeze), herbicides, pesticides, fertilizers, material handling equipment such as forklifts, loaders, vehicles, chippers, debarker and cranes. As a result, the U.S. EPA identified potential pollutants in stormwater to include bark and wood debris, total suspended solids (TSS) and leachates. The leachate generated from these operations from the decay of wood products can contain high levels of TSS and biochemical oxygen demand ($BOD_5$).

Alternative methods were considered to reduce or eliminate stormwater pollution from municipal and industrial point sources and eliminate surface water quality standards violations caused by stormwater. In the EPA's evaluation of these alternatives to control pollutants at timber products facilities there was a recognition that industrial activities and stormwater discharges are site specific and that currently characterization of stormwater is insufficient to develop effluent limitations. This led the EPA to require facilities to develop **storm water pollution prevention plans (SWPPP)** as a means to ensure pollutants are controlled with the Best Available Technology Economically Achievable (BAT) and Best Conventional Pollutants Control Technology (BCT) as required by the Clean Water Act. As part of the storm water pollution prevention plan, Best Management Practises (BMPs) are developed by each facility enabling site specific factors to be taken into account and allow relatively inexpensive BMPs to be implemented. Effective pollutant control options identified by the EPA are outlined below (Federal Register/Vol.60, NO.189/Friday, September 29, 1995/Notices Table a-5, p. 50840).

- Divert storm water around storage areas with ditches, swales and/or berms.
- Locate storage areas on stable, well-drained soils with slopes of 2-5 percent.
- Line storage areas with crushed rock or gravel or porous pavement to promote infiltration
- Minimize discharge and provide sediment and erosion control.
- Stack materials to minimize surface areas of materials exposed to precipitation. Practice good housekeeping measures such as frequent removal of debris.
- Provide collection and treatment of runoff with containment basins containment basins, sedimentation ponds and infiltration basins.
- Use ponds for collection, containment and recycle for log spraying operations.
- Use of silt fence and rip rap check dams
- Locate stored residues away from drainage pathways and surface waters.

Erosion and sediment controls have also been identified to minimize sediment leaving the site. Controls include, but are not limited to: stabilization measures such as seeding, mulching, chemical stabilization, sodding, soil retaining measures and dust control and structural measures such as sediment traps, contouring, sediment basins, check dams and silt fences (U.S. EPA., 1995).

**The State of Washington Department of Ecology**

Certain states are designated as "permitting authority states" meaning that they can issue their own permits, except for federally owned or operated facilities or facilities on Indian Tribal lands. The permits issued by the state must be as stringent as the U.S. EPA permits. The State of Washington Department of Ecology issued a NPDES and State Waste Discharge Baseline General Permit for Stormwater Discharges Associated with Industrial Activities on November 18, 1995 which will expire November 18, 2000. This State issued permit exceeds the U.S. EPA requirements by additionally requiring the eventual compliance with groundwater quality and sediment management standards. Compliance is expected to be achieved through the development, implementation and maintenance of SWPPPs. The overall approach in developing and maintaining the SWPPP is:

1. “The assessment of activities and handling of materials and equipment on-site that causes or has the potential to cause pollution by stormwater;

2. Development, implementation and maintenance of BMPs to reduce, eliminate and/or prevent surface water, groundwater or sediment pollution." (Washington State Department of Ecology, November, 1995)

a brief description of the SWPPP contents and requirements are listed below. a more detailed description is provided in the State of Washington Department of Ecology's "National Pollutant Discharge Elimination System and State Waste Discharge Baseline General Permit for Stormwater Discharges Associated with Industrial Activities", issued November 18, 1995 and the "Best Management Practises to Prevent Stormwater Pollution at Log Yards" published May 1995.

1. Assessment and description of existing and potential pollutant sources including:

    - a certification by a responsible official
    - a site map showing stormwater drainage and discharge structures
    - a listing of pollutants, that are or have reasonable potential to be present in the stormwater discharge

2. A description of the BMPs that are needed for the facility to reduce the potential for the discharge of significant amounts of pollutants. The description shall include the following minimum requirements:

a) Operational BMPs including: the establishment of a pollution prevention team; good housekeeping; preventative maintenance; spill prevention and emergency cleanup plan; employee training; inspections and record keeping. Inspections conducted semi-annually during the wet and dry season to verify the description of potential pollutant sources and to observe the presence of floating material, suspended solids, oil and grease, visible sheen, discolourations, etc. and record keeping such as report summarizing the scope of the inspection, inspection personnel and dates and major observances.

b) Source Control BMPs such as sloping all high activity paved and rock areas to prevent erosion and minimize the formation of leachate , paving the area if feasible.

c) Erosion and Sediment Control BMPs to identify areas which have a high potential for significant soil erosion and measures to limit erosion such as *cover practices* such as vegetative growth-cover such as grass, trees, and preserve with natural vegetation and *structural practices* such as conveyance system and grading to minimize run-off velocities, vegetative swale or strip.

d) Stormwater Peak Runoff Rate and Volume Control BMPs

3. Additional BMPs to Reduce Pollutants Below a Significant Amount

a) a description of additional available and reasonable BMPs necessary for the facility if the identified BMPs (above) are deemed to be insufficient to prevent or remove all pollutants amenable to available and reasonable methods of prevention or treatment.

b) a description of additional available and reasonable BMPs selected for the facility necessary for the facility if the identified BMPs (above) are deemed to be insufficient to prevent or remove pollutants to a level where there is not a reasonable potential to cause a violation of surface water or ground water or sediment management standards. Implementation of such BMPs are strongly encouraged but not required.

c) Discharge targets may be used by the permittee as criteria for the application of additional and reasonable BMPs.

d) Additional available and reasonable BMPs may include:
Enhancements to BMPs

Treatment BMPs such as settling basins, oil/water separator, activated carbon filter, infiltration basin, biofiltration, catchbasin filter. In areas with low rainfall, a no discharge option to storm drains or to surface water can be considered as long as ground water will not be significantly contaminated with pollutants.

5. An implementation schedule including interim and final compliance milestone dates for the BMPs and other activities as described in the SWPPP. This schedule shall not extend beyond the implementation deadlines.

**British Columbia Ministry of the Environment**

Industrial operations require permits for the discharge of contaminants or business waste under the Waste Management Act in B.C. Currently, a permit is typically not required for the discharge of stormwater from log yards, however, if there were significant environmental concerns, discharge of stormwater could be regulated as part of a permit. A clause may be included in a permit regarding management of the logs and stormwater such as "Leachate generation shall be avoided through prudent management of the wood residue stockpile and surface drainage. The stockpile shall be maintained on high, properly graded ground. Surface drainage shall be diverted around the stockpile. Should leachate pollution occur, additional measures must be taken to control or treat it. " (B.C. Environmental Protection, Lower Mainland Region, pers. comm. January 1996). The permit may include a clause allowing the Regional Waste Manager to require further controls or to curtail activity if pollution is occurring. Log yard permits also require operators to prepare and annually update a waste disposal plan. These plans encourage steps such as paving yards so there is less chance for precipitation to pool and saturate wood that is mixed into the mud on the yard.

Landfills on log yards require a refuse permit. Relevant requirements under the Landfill Criteria are a drainage system which prevents runoff from entering the refuse and capping to minimize percolation of rainwater. Log yards that carry out burning require air permits, and these usually contain clauses that requires leachate generation be avoided through prudent management of the wood residue stockpile and surface drainage. There is also a clause providing for collection and treatment of leachate if needed. Permits usually require that burn piles be at least 30 meters from surface waters. An Antisapstain Chemical Waste Control Regulation exists which specifies limits of antisapstain chemicals in effluent, the design of various equipment related to antisapstain chemical and the management of sludges and wood residue.

Concerns regarding the runoff from log yards in remote areas initiated studies into the toxicity of aspen wood leachate to aquatic life (Goudey and Taylor, 1992, Taylor, 1994). Draft regional working guidelines were developed by the Northern Interior Region of Environmental Protection in July 1993 for the storage of aspen wood and chipped wood residue to control aspen leachate for the remote decking of aspen wood i.e. aspen storage areas located away from industrial operations permitted under the Waste Management Act. These draft guidelines would apply at sites that are:

- less than 500 m from natural surface waters (ponds, lakes, streams, etc.) or where the potential exists for loss of leachate from the site to natural surface waters; and,

- where existing ground slope does not completely contain the surface runoff.

The remote operator will commit to:

- ▹ contain all aspen leachate within perimeter ditching at each log deck or chip residue site, using roughing ponds on a site specific basis as necessary;

- ▹ construct this containment to hold the leachate volume generated by the aspen on site, recommended as 25 % of the log and /or chip residue volume, plus a one in 2 year equivalent storm event on the deck surface;

- ▹ construct diversion ditching, where necessary, uphill from decks or residue piles to prevent inflow of surface waters;

- ▹ in the event of potential discharge from any containment ditch or pond, spray at least 50 % of the ditch/pond leachate volume over the log or residue pile. Alternatively, spray leachate over the forest floor in a manner that does not cause water to run off. Have portable spray (i.e. usually fire) equipment available at all times;
- ▹ manage each log or residual pile in this manner until residue at each deck is adequately disposed of, or until the freshly generated leachate is found to be non-acutely toxic to rainbow trout using a 96 hour acute bioassay.

**New Brunswick Department of the Environment**

There are no specific regulations or guidelines on log yards in New Brunswick. Guidelines or operating practices are specified in Certificates of Approval for the operations of sawmills and pulp mills and may include control measures for log yard runoff (N.B. Department of the Environment, pers. comm. April 1996). Below are listed examples of control measures specified in approvals.

> The Company shall stabilize the bank on the sawmill property and then develop and maintain a vegetated buffer zone, for the purpose of reducing sedimentation runoff into the receiving water, that is:
>
> (a) 15 to 30 metres wide - where no current permanent structure prevents this, and
>
> (b) as wide as practical in areas where current permanent structures, such as the hot pond, limit the buffer zone.
>
> (c) If, the width of (b) is less than 5 metres then a fence shall be constructed that presents runoff or fugitive sawdust, etc. from entering the receiving water.
>
> No activity is to take place inside this buffer zone, including but not limited to stockpiling of logs, lumber, or woodwaste or piling of snow from snow clearance or vehicle traffic.

**Ontario Ministry of Environment and Energy**

The Ontario Ministry of Environment and Energy implemented the Municipal/Industrial Strategy for Abatement (MISA) program to obtain " "virtual elimination" of persistent toxic contaminants from all discharges into Ontario waterways" (Ontario Ministry of Environment and Energy, 1994). Under the MISA Monitoring Regulations, storm water discharges were monitored for all sectors. This provided preliminary information on the potential concentration/loadings of contaminants to the environment. As a result of this study, each discharger, including pulp and paper and saw mills which have log storage areas, is required to conduct a Storm Water Control Study (SWCS) and prepare a report once every three years. This report, although not submitted to the Ministry must be made available. The goal of stormwater control is to reduce contaminant loadings to the maximum extent practicable and to ensure that storm water discharges are not acutely lethal.

In conducting a SWCS, a discharger shall:

- determine the quantity and quality of the storm water discharge;
- identify all known sources of storm water contamination;

- identify the need for control based on the nature of the problem(s);
- evaluate control and prevention measures;
- develop a storm water control program (SWCP) which identifies preferred control or prevention measures where necessary

The elements of a SWCP are briefly outlined below:

1. Collect and analyze four representative storm events to determine the contaminants in the storm water and the acute lethality of the storm waters to rainbow trout and *Daphnia magna*. One of the sampling events is recommended to be during the spring thaw.

2. Prepare a site map showing drainage areas and sampling locations.

3. Determine daily and monthly rainfall over study period, estimate the total area drained.

4. Estimate the volume of storm water discharged during representative rainfall events.

5. Verify that no process effluent or contaminated ground water is discharged through storm sewers.

6. Calculate the loadings of untreated storm water discharges.

7. Prepare a report of the study including the following:

    - a record of results from steps 1 to 6 above;
    - Identify sources of potential storm water contamination;
    - The relative contributions of loadings from storm water to the daily plant loadings
    - Results of rainbow trout and *Daphnia magna* tests and probable sources of lethality
    - The current prevention and control measures to reduce storm water contamination
    - Evaluation of prevention alternatives including the following measures at a minimum:

interception of storm water, reduction of the accumulation and/or deposition of the debris, control of discharge from roofs, inclusion of reuse/recycling of storm water in process, good housekeeping and employee training and education.

- Evaluation of control alternatives including the following measures at a minimum: oil/grit separation, sedimentation facilities, storm water retention ponds, biological treatment systems, screening, spill control, infiltration techniques (where applicable), decontamination of soils in contact with storm water

- Based on an evaluation of prevention and control measures, the report will provide:
  - ▹ preferred methods for controlling storm water discharges;
  - ▹ timetable and costs for implementing the preferred methods.

Where the quality of the storm water identifies the need for prevention or control measures, the Ministry urges all the discharges to voluntarily implement the preferred prevention and control measures identified in the SWCP, as expeditiously as possible, as a contribution towards a cleaner environment.

Implementation of the SWCP may result in the construction of sewage works, which will require the discharger to make an application for approval under the Ontario Water Resources Act. This Act defines "sewage works" to include storm sewers and storm water control facilities.

# 6.0 CONCLUSIONS

This report provides results of a preliminary assessment of runoff control measures at Alberta log yards, log yard runoff quality and policies and guidelines in other jurisdictions. This assessment is based on:

- an inventory of runoff control measures at 33 Alberta log yards conducted through site visits at 27 log yards and telephone interviews at six log yards between September and November 1995;

- a literature review of log yard runoff quality; and,

- telephone interviews with regulatory agencies in other jurisdictions to compile information on their policies and guidelines regarding log yard runoff.

The major findings of this preliminary study are summarized below.

1. Of the 33 log yard sites, processing capacity ranges from 90,000 $m^3$ to 2,000,000 $m^3$. Log yards are typically full in the spring after the winter hauling period and are depleted by the beginning of winter.

2. Surface runoff control measures vary at log yards. Of the 33 log yards, 12 have passive treatment, i.e., infiltration, vegetated buffer strips, twelve redirect runoff via ditching, seven have retention ponds or dug outs and two treat their runoff.

3. Ten of the log yards are within 500 m of a receiving water.

4. Literature review identified pollutants which may be a concern including metals such as zinc and copper, primarily from galvanized roofs at the site, resin and fatty acids, phenolic compounds including tannins, substituted benzenes including benzoic acid, total suspended solids and the total organic loading measured by $BOD_5$ and COD. Some of these parameters are related to associated activities adjoining log yards.

5. Literature review of log yard runoff indicates varying levels of chemical constituents and toxicity.

6. Colour producing substances were primarily associated with leachate from bark.

7. The current level of characterization of log yard runoff is insufficient to develop effluent limitations.

8. The New Brunswick Department of Environment and British Columbia Ministry of the Environment do not have a policy on log yard runoff and specify requirements for facilities in their issued approvals or certificates to operate.

9. The U.S. EPA and the Ontario Ministry of Environment and Energy require facilities to develop and implement pollution prevention plans which may include conducting storm water studies and developing best management practices at the site to minimize impacts.

# 7.0 RECOMMENDATIONS

This study has revealed that there are information deficiencies with regard to log yard runoff quality and its impact on the environment. In order to determine the effects on the environment, information on log yard runoff should be augmented. Notwithstanding this, other jurisdictions require facilities to implement pollution prevention plans and have developed Best Management Practices for log yards (Washington State Department of Ecology, 1995). This information can be utilized to assist log yard facility operators in the management of their log yards.

Based on the results of the study the following recommendations are provided.

1. A representative monitoring program should be implemented to characterize log yard runoff from Alberta log yards.

2. Good housekeeping and Best Management Practices for log yards should be established and enhanced if necessary.

3. Factors specific to the site should be taken into consideration in assessing log yard runoff impact due to the variability in the surrounding environment and the operation of the log yard and facility.

4. Priority should be given for further assessment of sites that are less than 500 m from natural surface waters (ponds, lakes, streams, etc.) or where the potential exists for loss of leachate from the site to natural surface waters.

5. Based on the results of items 1, 2 and 3 above, some existing facilities may also have to implement control practices identified in item 8.

6. All new and where appropriate, existing facilities should be required to develop and implement a Surface Runoff Management Plan (SRMP).

7. The SRMP shall contain as a minimum the following information:

    - a site map showing the plant location and the surrounding environment;
    - a description of the surrounding environment including land use and proximity to receiving waters;
    - a site map showing the industrial runoff drainage path and control structures;

- an estimate of the runoff quantity; and
- Best Management Practices for the control and minimization of log yard surface runoff

8. New log yard facilities should incorporate the following control practices to minimize potential impacts:
   - Divert storm water around storage areas with ditches, swales and/or berms.
   - Locate storage areas on stable, well-drained soils with slopes of 2-5 percent.
   - Minimize discharge and provide sediment and erosion control.
   - Stack materials to minimize surface areas of materials exposed to precipitation.
   - Practice good housekeeping measures such as frequent removal of debris.
   - Provide collection and treatment of runoff with containment basins, sedimentation ponds and infiltration basins.
   - Use a silt fence and rip rap check dams; and
   - Locate stored residues away from drainage pathways and surface waters.

## 8.0 REFERENCES


Alberta Environmental Protection. 1990. Alberta Timber Harvest Planning and Operating Ground Rules. Land and Forest Services, Alberta Environmental Protection, Pub. No.: Ref. 71, 1994.

Alberta Environmental Protection. 1990. Best Management Practices and Spill Response Guidance Document. Industrial Wastewater Branch, Air and Water Approvals Division, Alberta Environmental Protection. July 1994.

British Columbia Environmental Protection. Lands and Parks, Lower Mainland Region personal communications, January 1996.

Goudey, J.S. and Taylor, B.R. 1992. Toxicity of Aspen Wood Leachate to Aquatic Life Part I: Laboratory Studies. Prepared for Environmental Protection Branch, Northern Interior Region, B.C. Ministry of the Environment by HydroQual, 1992.

National Council of the Paper Industry for Air and Stream Improvement, Inc. Storm Water from Log Storage Sites: a Literature Review and Case Study. Tech. Bull. No. 637 (July 1992).

National Council of the Paper Industry for Air and Stream Improvement, Inc. a Review of Laboratory and Field Procedures for Evaluating the Behaviour of Landfill Leachate Constituents. Tech. Bull. No. 396. 1983.

National Council of the Paper Industry for Air and Stream Improvement, Inc. The Effectiveness of Buffer Strips for Ameliorating Offsite Transport of Sediment, Nutrients, and Pesticides from Silvicultural Operations. Tech. Bull. No. 631 (June 1992).

New Brunswick Department of the Environment, Industrial Programs Section Operations Branch, personal communications, April, 1996.

Ontario Ministry of Environment and Energy, 1994. Protocol for Conducting a Storm Water Control Study (August, 1994).

Schaumburg, F.D. Atkinson, S. Biochemical Oxygen Demand and Toxicity Associated with Log Leachates. Western Division of the American Fisheries Society. July 13-16, 1970 SK 352 W525 1970.

Schaumburg, F.D. The Influence of Log Handling on Water Quality. U.S. Environmental Protection Agency. EPA-R2-73-085 (1973).

Schuytema, G.S., Shankland, R.D. Effects of Log Handling and Storage on Water Quality. EPA-600/2-76-262 (September, 1976).

Sjöstrom, E. 1981. Wood Chemistry: Fundamentals and Applications. Academic Press, New York, N.Y.

Smoley, C.K. Storm Water Management for Industrial Activities Pollution Prevention Plans and Best Management Practices. United States Environmental Protection Agency. Office of Water, 1993.

Sproul, O.J., Sharpe C.A. Water Quality Degradation by Wood Bark Pollutants. Water Resources Center Publications Number 5, June 1968.

Taylor, B.R., 1994. Toxicity of Aspen Wood Leachate to Aquatic Life Part II: Field Study. Prepared for Environmental Protection Branch, Northern Interior Region, B.C. Ministry of the Environment November 1994.

Taylor et. al., 1988. Scientific Criteria Document for Development of Provincial Water Quality Objectives and Guidelines: Resin Acids, Environment Ontario, Queen's Printer for Ontario.

United States Environmental Protection Agency. October 1973. Processes, Procedures, and Methods to Control Pollution Resulting from Silvicultural Activities. U.S. Environmental Protection Agency, Office of Air and Water Programs, Washington D.C. 20460 EPA 430/9-73-010.

United States Environmental Protection Agency. August 1974. Development Document for Proposed Effluent Limitations Guidelines and New Source Performance Standards for the Wet Storage, Sawmills, Particleboard and Insulation Board Segment of the Timber Products Processing Point Source Category. U.S. Environmental Protection Agency. EPA-440/1-74-033.

United States Environmental Protection Agency. Final National Pollution Discharge Elimination System Stormwater Multi-Sector General Permit for Industrial Facilities. Federal Register 60 (189). 50834-51319 (September 29, 1995).

Washington State Department of Ecology. National Pollutant Discharge Elimination System and State Waste Discharge Baseline General Permit for Stormwater Discharges Associated with Industrial Activities. Olympia. Washington. November 18, 1995.

Washington State Department of Ecology. Stormwater Unit. Best Management Practises to Prevent Stormwater Pollution at Log Yards. Publication # 95-53 Olympia, Washington. May 1995.

Weyerhaeuser Canada Ltd., personal communications, April, 1996.

# APPENDIX A

## Table A.1 Data Inventory of Log Yards - Approval Requirements

| No | Company | Code | Location | Approval no. | Expiry | SRMP Required | Surface Water Sampling | Groundwater Sampling | Soils Sampling |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Ainsworth Lumber Co. Ltd. | OSB | Grande Prairie | 94-IND-189 | 1 Sept. '04 | NO | Yes, 1 grab | NO | NO |
| | (Grande Prairie) | | LSD 6-70-5-W6M | | | | | | |
| 2 | West Fraser Mills Ltd. c/o | WP | Blue Ridge | 94-IND-058A | 30 Mar. '05 | YES | NO | NO | NO |
| | Blue Ridge Lumber (1981) Ltd. | | LSD N$^1/_2$ 25,S$^1/_2$ 36-59-10 W5M | | | | | | |
| | (Blue Ridge) | | | | | | | | |
| 3 | Alberta Pacific Forest Industries Inc. | PM | Athabasca | 93-WL-137D | 4 Aug. '96 | NO | NO | YES | NO* |
| | (Athabasca) | | LSD 20-68-19-W4M | | | | | (* implement soils sampling in '98) | |
| 4 | Atlas Lumber (Alberta) Ltd. | WP | Sentinel | 95-IND-061 | 30 Mar. '05 | YES | NO | NO | NO |
| | (Sentinel) | | LSD SW$^1/_4$ 11-8-5-W5M | | | | | | |
| 5 | Boucher Bros. Lumber Ltd. | WP | Nampa | 330-010-01 | semi-active | NO | NO | NO | NO |
| | (Nampa) | | LSD NW$^1/_4$ 27-81-21-W5M | | | | | | |
| 6 | Brewster Construction Ltd. | WP | Red Earth Creek | 95-IND-066 | 31 Mar. '05 | YES | NO | NO | NO |
| | (a sub of Diashowa-Marubeni Intern'l Ltd.) | | LSD SW$^1/_4$ 5-94-7-W5M & | | | | | | |
| | (Red Earth Creek) | | SE$^1/_4$ , N $^1/_2$ 4-94-7-W5M | | | | | | |
| 7 | Buchanan Lumber | WP | High Prairie | 95-IND-113 | 1 Jun. '05 | YES | NO | NO | NO |
| | (High Prairie) | | LSD 23-74-17-W5M | | | | | | |
| 8 | Canadian Forest Products Ltd. | WP | Grande Prairie | 92-WL-123 | 1 Jul. '97 | NO | NO | NO | NO |
| | (Grande Prairie) | | 9401-108 Street | | | | | | |
| 9 | Canadian Forest Products Ltd. | WP | Hines Creek | 95-IND-069 | 31 Mar. '05 | YES | NO | YES | NO |
| | (Hines Creek) | | LSD N15-84-4-W6M | | | | | | |

Table A.1 Data Inventory of Log Yards - Approval Requirements

| No | Company | Code | Location | Approval no. | Expiry | SRMP Required | Surface Water Sampling | Groundwater Sampling | Soils Sampling |
|---|---|---|---|---|---|---|---|---|---|
| 10 | Carrier Lumber | SM | Trout Lake | 95-IND-186 | 1 Jul. '05 | YES | NO | NO | NO |
| | (Trout Lake) | | SE $^1/_4$ 28, SW $^1/_4$ 27-86-4-W5M | | | | | | |
| 11 | Cowley Forest Products Ltd. | SM | Cowley | 92-AP-020 | | NO | NO | NO | NO |
| | (Cowley) | | | | | | | | |
| 12 | Daishowa-Marubeni International Limited | PM | Peace River | 93-WL-080 | 30 Apr. '98 | NO | NO | YES | YES |
| | (Peace River) | | LSD 11, 12, 24-85-21 W5M | 93-AL-110 | | | | | |
| 13 | High Level Forest Products Ltd. | WP | High Level | 95-IND-157 | 1 Jul. '05 | YES | YES, 1 grab | YES | NO |
| | (a sub of Daishowa -Marubeni Intern'l Ltd.) | | LSD NE $^1/_4$ & W $^1/_2$ 29, SE $^1/_4$ 30 | | | | | (submit proposal) | |
| | (High Level) | | S $^1/_2$ 32-109-19 W5M | | | | | | |
| 14 | La Crete Sawmills Ltd. | SM | La Crete | 93-AL-225 | 30 Sept. '05 | YES | NO | NO | NO |
| | (La Crete) | | LSD NE $^1/_4$ 26-105-15-W5M | | | | | | |
| 15 | Manning Diversified Products Ltd. | WP | Manning | 94-IND-064 | 1 May '04 | YES | YES, 1 grab | NO | NO |
| | (Manning) | | LSD 26-93-23 W5M | | | | | | |
| 16 | Millar Western Industries Ltd. | WP | Boyle | 95-IND-067 | 1 Apr. '05 | NO | NO | NO | NO |
| | (Boyle) | | LSD 33-64-19 W5M | | | | | | |
| 17 | Millar Western Industries Ltd. | WP | Whitecourt | 92-WL-203A | 1 May '96 | NO | NO | YES | YES |
| | Millar Western Pulp Ltd. | PM | LSD NW $^1/_4$ 35-59-12 W5M | 94-IND-213A | | | | | |
| | (Whitecourt) | | | | | | | | |
| 18 | Mostowich Lumber Ltd. | SM | Fox Creek | 95-IND-060 | 1 Mar. '05 | YES | NO | NO | NO |
| | (Fox Creek) | | LSD SW $^1/_4$ 18-62-18 W5M | | | | | | |

Table A.1 Data Inventory of Log Yards - Approval Requirements

| No | Company | Code | Location | Approval no. | Expiry | SRMP Required | Surface Water Sampling | Groundwater Sampling | Soils Sampling |
|---|---|---|---|---|---|---|---|---|---|
| 19 | Northlands Forest Products Ltd |  | Fort McMurray | 95-IND-241 | 20 Nov. '05 | YES | NO | NO | NO |
|  | (Fort McMurray) |  | LSD $S^1/_2$ 5 & 7-91-9-W4M |  |  |  |  |  |  |
| 20 | Slave Lake Pulp Corporation | PM | Slave Lake | 94-IND-190A | 31 Oct. '04 | NO | NO | YES | YES |
|  | (Slave Lake) |  | LSD 26-72-4-W4 |  |  |  |  |  |  |
| 21 | Spray Lake Sawmills (1980) Ltd. | WP | Cochrane | 92-WL-089C | 1 Feb. '97 | YES | YES, 1 grab | YES | YES |
|  | (Cochrane) | WT | LSD $S^1/_2$ 34-25-4-W5M |  |  |  |  |  |  |
| 22 | Sundance Forest Industries Ltd. | WP | Edson | 10276 01 00 | 28 Feb. '06 | YES | NO | NO | NO |
|  | (Edson) |  | LSD $SW^1/_4$ 10-53-18-W5M |  |  |  |  |  |  |
| 23 | Sunpine Forest Products Ltd. | WP | Strachan | 94-IND-149 | 1 Sept. '04 | YES | YES, 1 grab | YES | NO |
|  | (Strachan) |  | LSD $SW^1/_4$ 2, $SE^1/_4$ 3-38-9-W5M |  |  |  |  |  |  |
| 24 | Sunpine Forest Products Ltd. | WP | Sundre | 93-WL-134 | 1 Jul. '97 | YES | YES, 2 grabs | YES | YES |
|  | (Sundre) | WT | LSD $NW^1/_4$ 31-32-5-W5M | 93-SA-233 |  |  |  |  |  |
| 25 | Tolko Industries Ltd. | WP | High Prairie | 94-IND-096 | 1 Jun. '04 | YES | YES, 1 grab | NO | NO |
|  | (High Prairie) |  | LSD 25-74-18 W5M |  |  |  |  |  |  |
| 26 | Vanderwell Contractors (1971) Ltd. |  | Slave Lake | 95-IND-075 | 1 May '05 | YES | NO | NO | NO |
|  | (Slave Lake) |  | LSD SW $^1/_4$ 29-72-4-W5M |  |  |  |  |  |  |
| 27 | Weldwood of Canada Limited | PM | Hinton | 93-WL-014D | 1 Jan. '98 | NO | NO | YES | YES |
|  | HI-ATHA Sawmill Division c/o Weldwood | SM | LSD 23-51-25-W5M |  |  |  |  |  |  |
|  | (HInton) |  |  |  |  |  |  |  |  |

Table A.1 Data Inventory of Log Yards - Approval Requirements

| No | Company | Code | Location | Approval no. | Expiry | SRMP Required | Surface Water Sampling | Groundwater Sampling | Soils Sampling |
|---|---|---|---|---|---|---|---|---|---|
| 28 | Weyerhaeuser Canada Ltd | OSB | Drayton Valley | 95-IND-112 | 1 May '97 | YES | NO | NO | NO |
| | (Drayton Valley) | SM | LSD SW$^1/_4$ 8-49-7 W5M | | | | | | |
| 29 | Weyerhaeuser Canada Ltd | OSB | Edson | 95-IND-107 | 1 Jun. '05 | NO | YES, 1 grab | NO | NO |
| | (Edson) | | LSD NE$^1/_4$ 23-53-17 W5M | | | | | | |
| 30 | Weyerhaeuser Canada Ltd | WP | Grande Cache | 92-WL-233 | 1 Jun. '97 | NO | NO | YES | NO |
| | (Grande Cache) | | LSD E$^1/_2$ 9, W$^1/_2$ 10-57-6-W6M | | | | | | |
| 31 | Weyerhaeuser Canada Ltd | OSB | Grande Prairie | 92-WL-234F | 1 Dec. '97 | NO | NO | YES | YES |
| | (Grande Prairie) | | LSD 14, 15, 22, 23-70-5-W6M | | | | | | |
| 32 | Weyerhaeuser Canada Ltd | WP | Slave Lake | 93-WL-3020 | 1 Apr. '98 | NO | NO | YES | NO |
| | (Slave Lake) | | LSD NW$^1/_4$ 29-72-4-W5M | | | | | | |
| 33 | Zeidler Forest Industries Ltd. | WP | Slave Lake | 92-WL-060 | 1 Apr. '97 | NO | NO | YES | NO |
| | (Slave Lake) | | LSD 31 & 32-72-4 W5M | | | | | | |
| Codes | | | | | | | | | |
| PM | Pulp Mill | | | | | | | | |
| LF | Land Fill | | | | | | | | |
| WP | Wood Processing | | | | | | | | |
| OSB | Oriented Strand Board | | | | | | | | |
| WT | Wood Processing | | | | | | | | |
| SM | Saw Mill | | | | | | | | |

## Table A.2 Data Inventory of Log Yards - Log Yard Operation

| No | Company | Log Yard Area (acres) | Species | approximate percent | Approximate Annual Logs Stored ($m^3$) | Max Log ($m^3$) | Min Log ($m^3$) |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| 1 | Ainsworth Lumber Co. Ltd. | 80 | balsam poplar | 23 | 411,000 - 800,000* | 380,000 | 30,000 |
| | (Grande Prairie) | | birch | 2 | (* full capacity) | | |
| | | | aspen | 75 | | | |
| | | | | | | | |
| 2 | West Fraser Mills Ltd. c/o | 100 | spruce | 60 | 887,000 | 405,000 | 110,000 |
| | Blue Ridge Lumber (1981) Ltd. | (primarily 40) | pine | 40 | | | |
| | (Blue Ridge) | | balsam | <1 | | | |
| | | | | | | | |
| 3 | Alberta Pacific Forest Industries Inc. | 47.7 | black poplar | 16 | 2,200,000 - | 600,000 | 0 |
| | (Athabasca) | | aspen | 73 | 2,800,00 | | |
| | | | balsam | 7 | | | |
| | | | tamarack, etc. | 4 | | | |
| | | | | | | | |
| 4 | Atlas Lumber (Alberta) Ltd. | 20 | spruce & pine | 75 | 100,000 - 125,000 | 35,000 | 0 |
| | (Sentinel) | | white bark pine | 10 | | | |
| | | | balsam fir | 10 | | | |
| | | | douglas fir | 5 | | | |
| 5 | Boucher Bros. Lumber Ltd. | 40 | spruce | 99 | 107,000 | 90,000 | 15,000 |
| | (Nampa) | | pine, tamarack | 1 | | | |
| | | | | | | | |
| | | | | | | | |
| 6 | Brewster Construction Ltd. | 47 | white spruce | 86 | 280,000 | 200,000 | 5,000 |
| | (a sub of Diashowa-Marubeni Intern'l Ltd.) | | apen | 13 | | | |
| | (Red Earth Creek) | | pine | 1 | | | |
| | | | | | | | |
| 7 | Buchanan Lumber | 80 | white spruce | 70 | 320,000 | 214,500 | 42,900 |
| | (High Prairie) | | jack pine | 30 | | | |
| | | | | | | | |
| | | | | | | | |
| 8 | Canadian Forest Products Ltd. | 60 | pine | 60 | 714,000 | 650,000 | 10,000 |
| | (Grande Prairie) | | spruce | 40 | | | |
| | | | | | | | |
| | | | | | | | |
| 9 | Canadian Forest Products Ltd. | 160 | spruce | 76 | 340,000 | 220,000 | 1,000 |
| | (Hines Creek) | | pine | 23 | | | |
| | | | balsam fir | 1 | | | |
| | | | | | | | |
| | | | | | | | |

Table A.2 Data Inventory of Log Yards - Log Yard Operation

| No | Company | Log Yard Area | Species | approximate | Approximate Annual | Max Log | Min Log |
|---|---|---|---|---|---|---|---|
| | | (acres) | | percent | Logs Stored ($m^3$) | ($m^3$) | ($m^3$) |
| | | | | | | | |
| 10 | Carrier Lumber | 8 - 10 | White spruce | 80 | 60,000 - 80,000 | 80,000 | 0 |
| | (Trout Lake) | | Balsam fir | 20 | | | |
| | | | | | | | |
| | | | | | | | |
| 11 | Cowley Forest Products Ltd. | 5 | pine | 45 | 90,000 | 15,000 | 0 |
| | (Cowley) | | spruce | 30 | | | |
| | | | douglas fir | 25 | | | |
| | | | | | | | |
| 12 | Daishowa-Marubeni International Limited | 309 | aspen | 100 | 1,300,000 | 900,000 | |
| | (Peace River) | | | | | | |
| | | | | | | | |
| | | | | | | | |
| 13 | High Level Forest Products Ltd. | 156 | White spruce | 98 | 1,000,000 | 1,000,000 | 74,000 |
| | (a sub of Daishowa -Marubeni Intern'l Ltd.) | | pine & fir | 2 | | | |
| | (High Level) | | | | | | |
| | | | | | | | |
| 14 | La Crete Sawmills Ltd. | 40 | White spruce | 100 | 200,000 | 26,000 | 0 |
| | (La Crete) | | | | | | |
| | | | | | | | |
| | | | | | | | |
| 15 | Manning Diversified Products Ltd. | 140 | spruce | 95 | 300,000 - 350,000 | 200,000 - 250,000 | 10,000 |
| | (Manning) | | pine | 5 | | | |
| | | | aspen | 200,000 $m^3$ | | | |
| | | | | | | | |
| 16 | Millar Western Industries Ltd. | 100 | spruce | 70 | 350,000 - 410,000 | 350,000 - 410,000 | 10,000 |
| | (Boyle) | | pine | 25 | | | |
| | | | jack oine, balsam fir | 5 | | | |
| | | | | | | | |
| 17 | Millar Western Industries Ltd. | 40 | aspen | 35 | 1,340,000 | 750,000 | 150,000 |
| | Millar Western Pulp Ltd. | | pine | 34 | | | |
| | (Whitecourt) | | spruce | 26 | | | |
| | | | black poplar | 4 | | | |
| | | | fir | 1 | | | |
| 18 | Mostowich Lumber Ltd. | 43 | spruce | 50 | 170,000 | 141,600 | 17,170 |
| | (Fox Creek) | | pine | 50 | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

Table A.2  Data Inventory of Log Yards - Log Yard Operation

| No | Company | Log Yard Area | Species | approximate | Approximate Annual | Max Log | Min Log |
|---|---|---|---|---|---|---|---|
| | | (acres) | | percent | Logs Stored ($m^3$) | ($m^3$) | ($m^3$) |
| | | | | | | | |
| 19 | Northlands Forest Products Ltd | 49 | spruce | 90 | 160,000 | 120,000 | 0 |
| | (Fort McMurray) | | pine | 10 | | | |
| | | | | | | | |
| | | | | | | | |
| 20 | Slave Lake Pulp Corporation | 40 | aspen | 80 | 373,000 - 479,000 | 200,000 | 75,000 |
| | (Slave Lake) | | balsam poplar | 20 | | | |
| | | | | | | | |
| | | | | | | | |
| 21 | Spray Lake Sawmills (1980) Ltd. | 50 | pine | 80 | 250,000 | 128,000 | 8,000 |
| | (Cochrane) | | white spruce | 20 | | | |
| | | | | | | | |
| | | | | | | | |
| 22 | Sundance Forest Industries Ltd. | 20 | pine | 100 | 465,000 | 131,000 | 12,000 |
| | (Edson) | (primarily | | | | | |
| | | use 15.8) | | | | | |
| | | | | | | | |
| 23 | Sunpine Forest Products Ltd. | 34 | pine | 80 | 210,000 | 120,000 | 10,000 |
| | (Strachan) | | white spruce | 20 | | | |
| | | | | | | | |
| | | | | | | | |
| 24 | Sunpine Forest Products Ltd. | 27 | pine | 80 | 270,000 | 140,000 | 30,000 |
| | (Sundre) | | white spruce | 15 | | | |
| | | | balsam fir | 5 | | | |
| | | | | | | | |
| 25 | Tolko Industries Ltd. | 40 | aspen | 88 | 650,000 - 750,000 | 380,000 | 0 |
| | (High Prairie) | | black poplar | 10 | | | |
| | | | white birch | 2 | | | |
| | | | | | | | |
| 26 | Vanderwell Contractors (1971) Ltd. | 60 | white spruce | 80 - 20 | 300,000 - 430,000 | 300,000 - 430,000 | 43,000 |
| | (Slave Lake) | | jack pine | 20 - 80 | | | |
| | | | lodgepole pine | | | | |
| | | | balsam fir & tamarack | | | | |
| 27 | Weldwood of Canada Limited | 230 | lodgepole pine | 55-60 | 2,000,000* | 350,000 - 400,000 | 90,000 |
| | HI-ATHA Sawmill Division c/o Weldwood | | blk&whte spruce | 35 | (* 50 % processed within a week) | | |
| | (HInton) | | alpine fir | 5 | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

## Table A.2 Data Inventory of Log Yards - Log Yard Operation

| No | Company | Log Yard Area | Species | approximate | Approximate Annual | Max Log | Min Log |
|---|---|---|---|---|---|---|---|
| | | (acres) | | percent | Logs Stored ($m^3$) | ($m^3$) | ($m^3$) |
| | | | | | | | |
| 28 | Weyerhaeuser Canada Ltd | 60 | aspen | 30 | 1,056,000 | 260,000 | 140,000 |
| | (Drayton Valley) | | softwood | 70 | | | |
| | | | (birch,black poplar, lodgepole pine, white spruce, alpine fir) | | | | |
| | | | | | | | |
| 29 | Weyerhaeuser Canada Ltd | 20 | aspen | 65 | 534,000 | 170,000 | 30,000 |
| | (Edson) | | black poplar | 25 | | | |
| | | | birch | 5 | | | |
| | | | | | | | |
| 30 | Weyerhaeuser Canada Ltd | 21 | pine | 60 | 440,000 | 214,200 | 20,000 |
| | (Grande Cache) | | spruce | 30 | | | |
| | | | balsam fir | 20 | | | |
| | | | aspen | ~20,000$m^3$ | | | |
| 31 | Weyerhaeuser Canada Ltd | 240 | spruce | 45 | 1,200,000* | 875,000 | 15,000 |
| | (Grande Prairie) | | pine | 55 | (* 25 % processed | | -20,000 |
| | | | fir | 5 | within a week) | | |
| | | | | | | | |
| 32 | Weyerhaeuser Canada Ltd | 63 | black & white poplar | 100 | 388,000 | 220,000 | 40,000 |
| | (Slave Lake) | | | | | | |
| | | | | | | | |
| | | | | | | | |
| 33 | Zeidler Forest Industries Ltd. | 80 | spruce | 88 | 393,000 | 393,000 | 80,000 |
| | (Slave Lake) | | pine | 7 | | | |
| | | | balsam fir | 5 | | | |

Table A.3 Data Inventory of Log Yards - Surface Runoff Control Measures

| No | Company | Basin | Proximity of Facility to Water Body | Current Runoff Control Practice: pond | treated | sewer | ditch | passive | Comments |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Ainsworth Lumber Co. Ltd. | Peace (7GE) | 6.5 km E of Big Mountain Cr. | X | | | | | - runoff directed to retention ponds |
| | (Grande Prairie) | | 5.6 km N of Wapiti R. | | | | | | - berm surrounds the site |
| | | | 4.0 km SW of Bridge Cr. | | | | | | |
| 2 | West Fraser Mills Ltd. c/o | Athabasca (7AH) | 2.5 km N. of Athabasca R. | X | | | | | - runoff directed to retention ponds |
| | Blue Ridge Lumber (1981) Ltd. | | 1 km E of creek discharging to | | | | | | |
| | (Blue Ridge) | | Athabasca R. | | | | | | |
| 3 | Alberta Pacific Forest Industries Inc. | Athabasca (7CB) | 5 km S of Athabasca R. | X | X | | | | - runoff directed to stormwater pond |
| | (Athabasca) | | | | | | | | - fed into effluent system and treated |
| 4 | Atlas Lumber (Alberta) Ltd. | Oldman (5AA) | 600 m. S of Crowsnest R. | | | | X | X | - runoff drains to Railway ditch, Allison Creek |
| | (Sentinel) | | Allison Creek in Property | | | | | | runs through the property |
| 5 | Boucher Bros. Lumber Ltd. | Peace (7HA) | 4.8 km N of Heart R. | | | | X | X | - majority of runoff directed to dugouts, some |
| | (Nampa) | | 0.5 km W of intermittent creek | | | | | | runoff goes to farmer's field |
| | | | which flows to Heart R. | | | | | | |
| 6 | Brewster Construction Ltd. | Peace R. (7JB) | 700 m W of Wabasca R. | | | | | X | - runoff infiltrates the ground, some runoff |
| | (a sub of Diashowa-Marubeni Intern'l Ltd.) | | 380 m N. of Loon R. | | | | | | may flow to Loon R. |
| | (Red Earth Creek) | | | | | | | | |
| 7 | Buchanan Lumber | Athabasca (7BF) | borders the West Prairie Canal | | | | X | X | -runoff flows via ditches to West Prairie |
| | (High Prairie) | | 4.5 km S of Iroquois Creek | | | | | | River (Canal), the town may discharge storm |
| | | | | | | | | | water to the Canal |
| 8 | Canadian Forest Products Ltd. | Smoky (7GE) | borders Bear Creek | | | | X | | -runoff is directed to city storm sewer ditch |
| | (Grande Prairie) | | | | | | | | which discharges to Bear Creek |
| 9 | Canadian Forest Products Ltd. | Peace (7FD) | Jack Creek - Intermittent? | X | | | X | | -some runoff directed to dugouts, some runoff |
| | (Hines Creek) | | | | | | | | goes into farmer's field |

## Table A.3  Data Inventory of Log Yards - Surface Runoff Control Measures

| No | Company | Basin | Proximity of Facility to Water Body | Current Runoff Control Practice: pond | treated | sewer | ditch | passive | Comments |
|---|---|---|---|---|---|---|---|---|---|
| 10 | Carrier Lumber | Peace (7JB) | 1 km E of Maria Lake Inlet | | | | X | | -runoff directed via ditches, discharges to |
| | (Trout Lake) | | | | | | | | muskeg, slough approx. 1 km from Maria |
| | | | | | | | | | Lake inlet |
| 11 | Cowley Forest Products Ltd. | Oldman (5AA) | 5 km S of Crowsnest R | | | | | X | - small log storage, runoff directed to ditch |
| | (Cowley) | | 4 km W of Castle R. | | | | | | along highway #3. |
| 12 | Daishowa-Marubeni International Limited | Peace (7HA) | 50 - 350 m W of Peace R. | | | | | X | -vegetative buffer between log yard and river |
| | (Peace River) | | | | | | | | |
| 13 | High Level Forest Products Ltd. | Peace (7JF) | 1.6 km S of Bushe R. | | | | X | | - runoff controlled and in series of ditches |
| | (a sub of Daishowa -Marubeni Intern'l Ltd.) | | | | | | | | |
| | (High Level) | | | | | | | | |
| 14 | La Crete Sawmills Ltd. | Peace (7HF) | 1 km E of Linton Lake | | | | X | | - runoff flows to a drainage ditch SE of log |
| | (La Crete) | | 6.5 km N of Bear R. tributary | | | | | | yard, then to a dugout |
| | | | 9.5 km E of Peace River | | | | | | |
| 15 | Manning Diversified Products Ltd. | Peace (7HC) | intermittent creek at E edge of | | | | | X | - some runoff directed to fire retention pond, |
| | (Manning) | | property discharges to Meikle | | | | | | some runoff likely flows to an intermittent |
| | | | 6 km S of Meikle River | | | | | | creek east of site, hog fuel stored at yard. |
| | | | 9 km W of Notikewin River | | | | | | |
| 16 | Millar Western Industries Ltd. | Athabasca (7CA) | 7 km NE (via creek) of Flat Lake | | | | X | | - containment via ditches, fire retention |
| | (Boyle) | | | | | | | | pond, overflow to Flat Lake |
| 17 | Millar Western Industries Ltd. | Athabasca (7AH) | 100 m S of Athabasca R. | | | | | X | - runoff flows to surrounding environment and |
| | Millar Western Pulp Ltd. | | 100 m E of MacLeod R. | | | | | | the Athabasca River |
| | (Whitecourt) | | | | | | | | |
| 18 | Mostowich Lumber Ltd. | Peace (7GG) | 1 km W of Iosegun Lake tributary | | | | X | | - runoff directed via ditches discharges to |
| | (Fox Creek) | | 50 m N of intermittent creek | | | | | | surrounding environment |

## Table A.3  Data Inventory of Log Yards - Surface Runoff Control Measures

| No | Company | Basin | Proximity of Facility to Water Body | Current Runoff Control Practice: pond | treated | sewer | ditch | passive | Comments |
|---|---|---|---|---|---|---|---|---|---|
| 19 | Northlands Forest Products Ltd (Fort McMurray) | Athabasca (7DA) | 90-200m W of Athabasca R. | | | | | X | - runoff flows to surrounding environment (muskeg) and to Athabasca River |
| 20 | Slave Lake Pulp Corporation (Slave Lake) | Athabasca (7BK) | 4 km S of Lesser Slave R. | X | | | | | -runoff collected in chip/log holding pond |
| 21 | Spray Lake Sawmills (1980) Ltd. (Cochrane) | Bow (5BH) | 1 km N of Bow R. | | | | | X | - no specific runoff control measures, runoff appears to infiltrate ground |
| 22 | Sundance Forest Industries Ltd. (Edson) | Athabasca (7AG) | 1.5 km E of Sundance Creek<br>1 km N of MacLeod River | | | | X | | - runoff directed via ditches then into forest |
| 23 | Sunpine Forest Products Ltd. (Strachan) | North Sask (5DB) | 2.5 km S of Prairie Cr. | | | | X | X | - runoff directed via ditches then into forest, recent upgrades to the log yard include grading, gravelling & erosion control berms |
| 24 | Sunpine Forest Products Ltd. (Sundre) | Red Deer (5CA) | 3.3 km S of Red Deer R.<br>2 km N of Bearberry Cr. | | | | | X | - runoff may infiltrate ground, remaining runoff directed to low lying areas on site or to neighbouring farmer's field |
| 25 | Tolko Industries Ltd. (High Prairie) | Athabasca (7BF) | 1.5 km S of Iroquois Lakes<br>1km N of Intermittent creek | X | | | X | | - directed via ditches to retention ponds, berm surrounding site |
| 26 | Vanderwell Contractors (1971) Ltd. (Slave Lake) | Athabasca (7BK) | 0.5 km NE of Mitsue Lake<br>3 km S of Lesser Slave R.<br>1.5 km S of creek | | | | X | X | - runoff directed via ditches to Weyerhaeuser's property, and to surrounding environment, swamp. |
| 27 | Weldwood of Canada Limited<br>HI-ATHA Sawmill Division c/o Weldwood<br>(HInton) | Athabasca (7AD) | 250-400 m S of Athabasca R.<br>Hardisty Creek on E edge of site | | | | | X | - runoff infiltrates soil and flows to low-lying areas, some runoff may flow to Athabasca R. |

## Table A.3 Data Inventory of Log Yards - Surface Runoff Control Measures

| No | Company | Basin | Proximity of Facility to Water Body | Current Runoff Control Practice: pond | treated | sewer | ditch | passive | Comments |
|---|---|---|---|---|---|---|---|---|---|
| 28 | Weyerhaeuser Canada Ltd (Drayton Valley) | N. Sask. (5DE) | 11 km NW of N Sask borders West Park Creek | | | | X | | - runoff is directed to West Park Creek then to a "Beaver Pond". (Drayton Valley discharges storm sewer to the Creek) |
| 29 | Weyerhaeuser Canada Ltd (Edson) | Athabasca (7AG) | 1.5 km N of MacLeod R. | X | | | X | | - runoff directed to retention pond |
| 30 | Weyerhaeuser Canada Ltd (Grande Cache) | Smoky (7GA) | Findley Creek @ SE edge of site | | | | X | | - runoff directed via ditches, discharges to Findley Creek |
| 31 | Weyerhaeuser Canada Ltd (Grande Prairie) | Peace (7GE) | 0.5 km N of Wapiti R. | | | | X | X | - runoff flows east to low-lying swampy area |
| 32 | Weyerhaeuser Canada Ltd (Slave Lake) | Athabasca (7BK) | 2.5 km S of Lesser Slave R. | | | | X | X | -runoff flows north to a very swampy area, weeping tile installed in logyard G |
| 33 | Zeidler Forest Industries Ltd. (Slave Lake) | Athabasca (7BK) | 2 km S of Lesser Slave R. 1 km N of Mitsue Lake | | | | X | X | -runoff flows N of site either via ditches through 3 km of bush to Lesser Slave R. or to the surrounding muskeg |