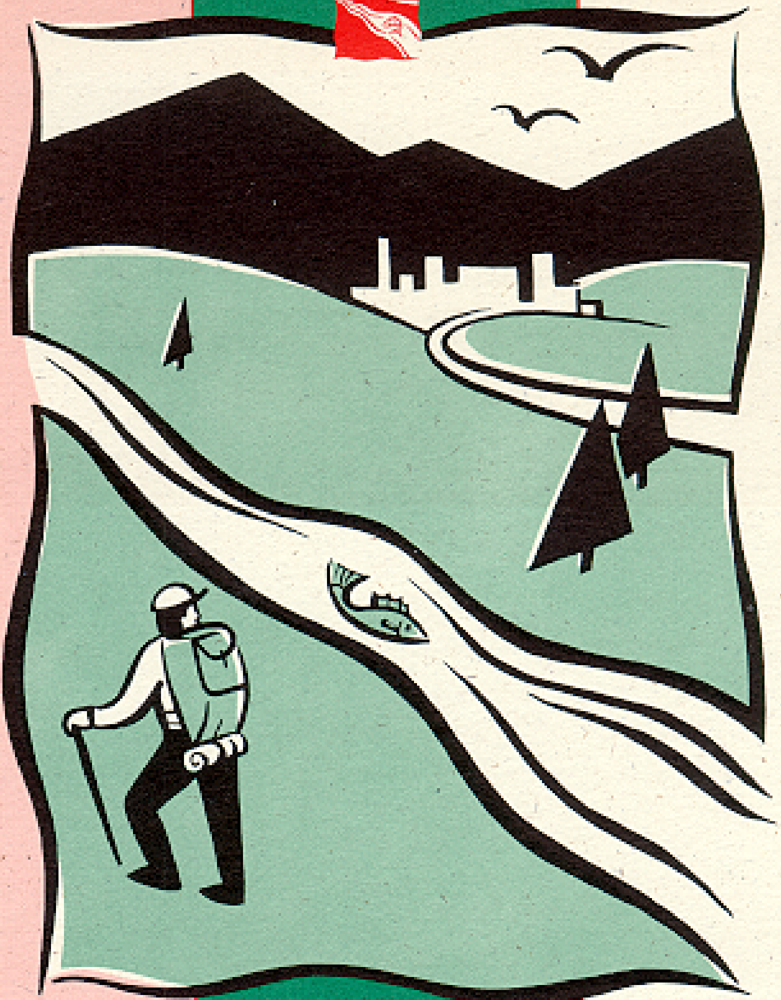
FRASER RIVER ACTION PLAN



Canada

Stormwater Best Management Practices (BMPs) for Selected Industrial Sectors in the Lower Fraser Basin

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Environment Canada
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Stormwater Best Management Practices (BMPs) for Selected Industrial Sectors in the Lower Fraser Basin

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Prepared for:

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Abstract

The objective of this study is to produce a document to serve as a reference and to provide guidance for the ongoing effort of Environment Canada to reduce pollution from stormwater in industrial operations in the Lower Fraser Basin.

This report sets out source control and runoff control/treatment Best Management Practices (BMPs) for 19 industrial sectors. A companion Baekground report is attached to this report to provide an analysis of the BMPs and some stormwater data of typical operations of:

Sand and Grave1 Pits
Meat and Meat Products Industries (Abattoir)
Fish Product Industry
Canned and Preserved Fruit and Vegetable Industry
Frozen Fruit and Vegetable Industry
Fluid Milk Industry
Cane and Beet Sugar Industry
Other Food Products Industry (Egg Processing)
Brewery Products Industry
Sawmill and Planing Mill Products Industry
Wire and Wire Products Industries
Hydraulic Cernent Industry
Ready Mixed Concrete Industry
Lime Industry
Refined Petroleum Products (Bulk Storage)
Other Petroleum and Coal Products Industries (Asphalt Preparation)
Industrial Inorganic Chemical Industry (Chlor-Alkali Manufacturing)
Marine Cargo Handling Industry (Dry Bulk Terminals)
Light Industry (Industrial Park)

Résumé

La présente étude a pour objectif de fournir un point de référence et une orientation aux efforts actuellement faits par Environnement Canada pour réduire la pollution due aux eaux pluviales dans les activités industrielles du bassin du bas Fraser.

Le rapport définit les meilleures pratiques de gestion (MPG) en vue de la réduction à la source et de la limitation et du traitement des eaux de ruissellement, pour 19 secteurs de l'industrie. Un rapport d'information y est joint, qui fournit une analyse des MPG et certaines données sur les eaux pluviales liées aux activités normales des secteurs suivants :

Carrières de sable et de gravier
Industries de la viande et des produits de la viande (abattoirs)
Industrie de la transformation du poisson
Industrie des fruits et légumes préservés
Industrie des fruits et légumes congelés
Industrie du lait de consommation
Industrie du sucre de canne et du sucre de betterave
Autres industries alimentaires (traitement des oeufs)
Industrie des produits de brasserie
Industrie des produits de sciage et de rabotage
Industrie du tréfilage et des produits de tréfilerie
Industrie du ciment hydraulique
Industrie du béton prêt à l'emploi
Industrie de la chaux
Produits pétroliers raffinés (stockage en vrac)
Autres industries de produits pétroliers et charbonniers (préparation de l'asphalte)
Industrie des produits chimiques inorganiques industriels (fabrique de chlore et de soude caustique)
Industrie de la manutention de cargaison maritime (ports pour vrac solide)
Industrie légère (parcs industriels)

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Glossary of Terms - Abbreviations

API	American Petroleum Institute
Basin	Lower Fraser Basin
BC	British Columbia
BMP	Best Management Practice
BOD_5	Biochemical Oxygen Demand (5-day)
CCA	Chromium-Copper-Arsenic
COD	Chemical Oxygen Demand
Comp	Composite samples
CPS	Coalescing Plate Separator
DEQ	Oregon Department of Environmental Quality
Ecology	Washington Department of Ecology
fpm	feet per minute
ft	feet
gm	grams
Grab	Grab samples
GVRD	Greater Vancouver Regional District
ICP	Inductively Coupled Argon Plasma Spectrometry
Kg	kilograms
l	litres
m	meters
m^2	square meters
m^3	cubic meters
mg	milligrams
mg/l	milligrams per litre
mm	millimeters
MOE	Ministry of Environment
N/A	Non Applicable
NO_{2+3}	Nitrite + Nitrate
NPDES	National Pollutant Discharge Elimination System
NURP	Nationwide Urban Runoff Program
PAH	Polynuclear Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
Plan	Fraser River Action Plan
ppm	parts per million
SIC	Standard Industrial Classification
SP	Soluble Phosphorus

SWPPP	Storm Water Pollution Plan
s.u.	standard units
TEH	Total Extractable Hydrocarbons
TKN	Total Kjeldahl Nitrogen
TOC	Total Organic Carbon
TP	Total Phosphorus
TPH	Total Petroleum Hydrocarbons
TSS	Total Suspended Solids
µg	micrograms
µS/cm	micromhos per centimetre
UN	United Nations
USEPA	United States Environmental Protection Agency
WWTP	waste water treatment plant

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This stormwater best management practices guide was developed based on documents from Environment Canada, United States Environmental Protection Agency, and Washington Department of Ecology. It contains information compiled from several publications including:

Envirochem Special Project Inc., *Ready Mix Concrete Industry, Environmental Code of Practice, 1993 Update*. Report Submitted to Conservation and Protection, Environment Canada, North Vancouver, British Columbia (1993).

United States, Federal Register, *Fact Sheet For the Multi-Sector Stormwater General Permit*, Vol. 58, No. 222, November 19, 1993, United States Government Printing Office, Washington, DC.

United States Environmental Protection Agency (USEPA), *Stormwater Management For Industrial Activities, Developing Pollution Prevention Plans and Best Management Practices*, EPA 832-R-92-006, September 1992. Washington, D.C.

Washington, Department of Ecology, *Stormwater Management Manual for the Puget Sound Basin*, Olympia, Washington (1992).

Washington, Department of Ecology, *Stormwater Program Guidance Manual*, Olympia, Washington, (July 1992).

o Introduction

In the ongoing effort to improve the water quality of the Fraser River, Environment Canada sponsored a project to develop best management practices to reduce stormwater pollution. This document contains recommended stormwater best management practices (BMPs) for nineteen (19) industrial sectors in the Lower Fraser Basin. It is intended to serve as a guide to industry for evaluating and implementing stormwater management programs. Implementation of these BMPs by the industry is recommended to effect stormwater pollution reduction.

The following information is listed for each of the 19 industrial sectors:

- Title of industrial sector;
- Standard Industrial Code (SIC);
- Description of industrial sector;
- Materials used and wastes generated;
- Potential sources of stormwater pollution; and,
- Prioritized recommended stormwater Best Management Practices.

For information on the stormwater characteristics, pollutant loading estimates and best management practice cost estimates, the reader should consult the companion document, *Background Report for Stormwater Best Management Practices for Selected Industrial Sectors in the Lower Fraser Basin*

What Are Stormwater BMPs?

Stormwater best management practices can be defined as schedules of activities; prohibitions of practices; maintenance operating and management procedures; source control; and treatment measures that, when used either singly or in combination, prevent or reduce the discharge of stormwater pollutants to the receiving water.

Stormwater BMPs can generally be categorized as:

- ***Source Control BMPs:*** BMPs designed to prevent pollutants from entering stormwater by eliminating the source of pollution or preventing contact of pollutants with rainfall and runoff.

- ***Runoff Control/Treatment BMPs:*** BMPs designed to either minimize the amount of pollutants in stormwater or to remove pollutants contained in stormwater runoff.

Source control BMPs are more desirable than runoff control/treatment BMPs because they prevent the formation of stormwater pollutants. Furthermore, they are relatively simple to implement and maintain, are often less expensive than runoff treatments and are applicable to a wide range of industries. Examples of source control BMPs include good housekeeping, preventive maintenance programs, spill prevention and emergency cleanup programs, covering waste piles, and providing bermed storage for oils and chemicals.

Runoff control/treatment BMPs are usually more costly to implement. They involved the collection of contaminated stormwater and the removal of contaminants before discharge. Examples of runoff control/treatment BMPs include site grading, curbing, oil/water separators and detention ponds.

Even though source control methods are the preferred BMPs, these measures alone may not eliminate the pollution of stormwater. For some industrial facilities, runoff control/treatment BMPs may be required and should not be excluded from a comprehensive stormwater pollution control program.

Implementation Strategy

In a comprehensive stormwater pollution control program, the environmental manager should first evaluate and implement source control BMPs followed by runoff control/treatment BMPs. All stormwater BMPs need to be evaluated on a case-by-case basis, taking into account site-specific conditions.

To illustrate the hierarchical structure of stormwater pollution management, listed below, in the order of preference, are selected stormwater BMPs that are commonly used by many of the industrial sectors evaluated in the preparation of this guide.

Good Housekeeping: This BMP is designed to maintain a clean and orderly work environment. It consists of ongoing maintenance and cleanup of areas that may contribute pollutants to stormwater discharges. A clean and orderly work area reduces the possibility of accidental spills caused by mishandling of chemicals and equipment and the mixing of stormwater with pollutants.

Preventive Maintenance: A comprehensive preventive maintenance program involves the regular inspection and testing of plant equipment and stormwater management devices. Timely inspection and maintenance of the stormwater drainage and treatment system should uncover conditions which could cause breakdowns that result in contamination of stormwater.

Spill Prevention and Emergency Cleanup: A spill prevention and emergency cleanup program establishes preventive and cleanup procedures to minimize spills and leaks and their impacts to the receiving environment. Spills and leaks, which together are one of the largest industrial sources of stormwater pollutants, are, in most cases, avoidable.

Secondary Containment System: Liquids (chemicals, solvents, lubricants, waste oil, etc.) in containers and tanks should be stored in designated locations. The storage area should be surrounded by curbs/dikes to provide secondary containment. The secondary containment system allows leaks to be detected more easily, holds the spill and keeps spill materials separated from the stormwater outside of the secondary containment area. It is an effective source control BMP for above-ground liquid storage tanks and rail car or tank truck loading/unloading areas.

Covering: This BMP provides rain protection for materials, equipment, process operations or other industrial activities. It prevents stormwater from coming into contact with potential pollutants and reduces material loss due to wind. Tarpaulins, plastic sheeting, roofs, buildings and other enclosures are examples of coverings that are effective in preventing stormwater contamination.

Site Grading: Site surfaces should be graded to direct uncontaminated stormwater away from industrial activity areas that may have pollutants. Grading should also be used to contain contaminated stormwater within industrial activity areas and divert them to treatment. This BMP is appropriate for any industrial site that has outdoor processing activities and outdoor material storage areas that may contaminate stormwater runoff. Grading is often used in conjunction with other control measures, such as paving and curbing, to direct and control stormwater flow.

Site Paving: Paved surfaces prevent contaminated stormwater from percolating into soil and polluting the groundwater. Site paving BMP is often implemented along with site grading and curbing to control the flow and to collect stormwater from polluted industrial areas. The paving material considered should not react with the contaminants. For potential spill sites and chemical storage areas, concrete should be used instead of asphalt. Asphalt absorbs organic pollutants and can be slowly dissolved by some fluids, thus contributing to stormwater pollution.

Curbing: Curbing can be used to contain small spills, leaks and contaminated stormwater from reaching the receiving environment. The common materials for curbing include earth, concrete, asphalt, synthetic materials, metal or other impenetrable materials. Curbing is often implemented with grading and paving BMPs.

Oil/Water Separators: Oil/water separators are specially constructed tanks that are installed between a drain and the pipe to the receiving water. These tanks prevent oil and sediments from being discharged into the environment. The tank design allows oil and grease to float to the surface where it can be recovered and recycled. Contaminated sediments settle to the bottom of the container.

Detention Ponds: Detention pond best management practice utilizes a variety of mechanisms to remove pollutants from stormwater. The primary mechanism is the removal of particulate pollutants by gravity settling. Gravity settling alone is effective only for larger size fractions and for the non-colloidal fraction.

Chemical Precipitation: For industrial operations that have high concentrations of metals in the stormwater, chemical precipitation may be required prior to stormwater discharge to the city sewer or to the receiving water.

Coagulation and Flocculation: Stormwater from outdoor material stockpiles may contain high levels of suspended solids. These particulates vary in size from less than 1 micron for colloids to a few hundred microns. The removal of large particles is usually accomplished by sedimentation. However, because many of the particles are too small for gravitational settling alone to be an effective removal process, coagulation/flocculation to form larger, more settleable aggregates is essential.

Public Wastewater Treatment Plant: Contaminated stormwater should not be discharged to the sanitary sewer system except under special conditions defined by the local sewer authority or regulatory agency and provided the local sewer treatment plant can effectively treat the stormwater pollutants of concern. For most localities, this BMP requires approval of the local sewer authority. The allowable flow rate and contaminant concentrations may vary with the particular sewer system and local sewer authority.

How to Implement Stormwater Best Management Practices

The following flowchart provides a step-by-step procedure to use this guide for developing and implementing a comprehensive stormwater management program.

STEP 1

Examine the Table of Contents and select the industrial sector that is most identifiable with your facility. Because many industrial operations have similar activities, the BMPs presented in this guide are also applicable for other industrial sectors that are not listed.

STEP 2

Review the potential sources of stormwater pollution for your industrial sector. Review the recommended stormwater BMPs. Keep in mind that not all of the recommended BMPs may be appropriate for your facility.

STEP 3

Conduct inspections of your facility to identify potential sources of stormwater pollution. Identify pollutants from these sources. You may need to collect and analyze stormwater samples to characterize the water quality.

STEP 4

Refer to the guide and identify the stormwater BMPs for the potential stormwater pollution sources. Organize the BMPs. Assign higher priorities to low-cost source control BMPs.

STEP 5

Evaluate the prioritized listing of BMPs to determine which measures are technically and economically feasible. Develop an implementation schedule.

STEP 6

Implement the stormwater BMPs. Develop a monitoring/maintenance program to ensure BMPs are implemented and properly maintained.

1º Sand and Gravel Pits

SIC 0821

Description of Industrial Sector

Establishments primarily engaged in the extraction, crushing, washing and screening of sand and gravel from pits or quarries. Such establishments may be secondarily engaged in trucking sand or gravel to job sites.

Materials Used and Wastes Generated

The raw and finished materials are sand and gravel. The principal operations consist of:

- Extraction - In the Lower Fraser Basin, sand and gravel are mined from open pits. Open pit mining begins by stripping off the soil and overburden to expose the deposit. Sand or gravel is then removed and is transported to a processing area.

- Crushing - After extraction, the material may undergo size reduction to produce proper size fractions.

- Washing - The material is washed to remove fines. Washwater is recycled and reused.

- Screening - After washing, the material is classified by screening to produce the various size fractions.

For this industrial sector, aside from the overburden, there is little solid waste material generated. Liquid waste consists of process wastewater from gravel washing, groundwater seepage and rainfall. Generally, sand and gravel operations result in physical pollution (sediment) rather than chemical pollution (acidity, dissolved metals).

Open pit mining often results in a large enclosed hole in the earth. These pits will sometimes fill with water, but seldom have a surface discharge. However, for open pit operations that have surface discharges, these pits may be significant sources of sediment to receiving waters.

Surface runoff and rainfall are generally collected in ponds. This collected water either evaporates or is infiltrated to the groundwater.

Potential Sources of Stormwater Pollution

Stormwater from this industrial sector may contain high suspended solids concentrations.

The potential sources of stormwater pollution are generally limited to the following industrial activities:

- Surface runoff;
- Gravel washing;
- Truck traffic;
- Vehicle/equipment maintenance and washing; and,
- Fuel and lubricant Storage.

Stormwater pollution potential is generally limited to open pit operations with surface discharges. For these operations, the major pollution problem is surface runoff. Surface runoffs can contribute significant suspended solids loadings to receiving waters.

The potential for stormwater pollution from the other sources is generally lower. Runoffs from the gravel washing operation and truck traffic may also contribute sediment to the receiving water. Vehicle/equipment maintenance/washing and fuel/lubricant storage may discharge oil and grease to stormwater.

Recommended Stormwater Best Management Practices

The following BMPs are designed to minimize runoff of contaminated stormwater to receiving waters. The facility personnel should first evaluate and implement source control BMPs, followed by runoff control/treatment BMPs.

For sand and gravel operations, stormwater pollution is primarily due to loss of erodible materials. Other recommended source control BMPs are designed to minimize the potential for stormwater contamination from spills or leaks of waste oil and fuel.

Even though the stormwater pollution potential from oil/fuel is small in relation to the other point sources, implementation of liquid storage source control BMPs is strongly recommended because of the high environmental liability associated with an unconfined spill.

To decrease the suspended solids loadings in the stormwater runoff, an infiltration pond is the lower cost runoff treatment BMP. If infiltration pond treatment is not possible or is ineffective, extended detention wet ponds may be used to remove suspended solids prior to discharge to lands or receiving waters. For stormwater containing small particle fractions, coagulants/polymers (coagulation/flocculation) may be added to the detention pond system to enhance gravity settling.

To ensure the proper selection of the runoff treatment BMP, the plant personnel should conduct stormwater sampling and analysis to determine stormwater characteristics. Plant personnel should also consult with the appropriate environmental regulatory agency prior to implementing the recommended treatment BMP.

1. Source Control BMPs

1.1 Good Housekeeping and Preventive Maintenance - *To minimize stormwater runoff of contaminants to receiving waters and to maintain a clean and orderly work environment which will lead to more organized and consistent handling of waste materials.*
• Implement a comprehensive preventive maintenance program for plant equipment and stormwater management devices. • Inspect and clean detention ponds frequently to remove accumulated solids to ensure proper operation.

1.2	**Surface Runoff** - *Minimize the erosion, transport and deposition of material by stormwater runoff.*

- Implement overburden segregation, regrading and revegetation to minimize contamination of stormwater. Stockpile soil along the high end of a pit or quarry and establish temporary vegetation to provide a dense ground cover.
- Place barriers on or around pollution-forming materials (waste/overburden), or establish a vegetative cover to prevent run-on and runoff of stormwater.
- Excavate ditches along the high end of a pit or wherever significant amounts of water will drain to the pit to collect and channel water before it reaches erodible materials.
- Use slope control or dikes to reduce the velocity of water flowing over erodible material.
- Construct dikes along the low end of the pit or areas to prevent runoff of contaminated stormwater to the receiving water.
- Maintain adequate vegetative barriers between the pit site and the receiving water.

1.3	**Gravel Washing** - *Minimize contaminated stormwater runoffs from the gravel washing operation.*

- Grade the perimeter of the gravel washing operation to collect and reuse washwater.

1.4	**Truck Traffic** - *Minimize fugitive dust from truck traffic.*
•	Use water sprays on road surfaces for dust control and coordinate water addition with weather forecasts to minimize the spray volume.

1.5	**Vehicle/Equipment Maintenance and Washing** - *Minimize stormwater from coming into contact with potential pollutants.*
•	Use drip-pans under all vehicles and equipment undergoing maintenance.
•	Pave with concrete and grade the maintenance area to prevent the run-on of uncontaminated stormwater from adjacent areas as well as runoff of contaminated stormwater.
•	Treat contaminated stormwater from the maintenance area in an oil/water separator prior to discharge to the receiving water.
•	Regularly clean the oil/water separator to remove accumulated oils and solids to maintain optimum performance.
•	Pave and grade truck wash areas to prevent the run-on of uncontaminated stormwater and the runoff of washwater and contaminated stormwater.
•	Collect and treat washwater/contaminated stormwater to remove suspended solids by gravity settling. Regularly clean the settling pond to remove accumulated solids to maintain optimum performance.

1.6 Liquid Storage in Above-Ground Tanks/Containers - *To reduce the potential for an unconfined spill.*

- Surround above-ground liquid (e.g., waste oil, fuel) storage tanks with curbs/dikes to provide secondary containment storage. The enclosed volume should be the greater of either 10% of the total tank volume or 110% of the volume contained in the largest tank. Additional volume may be needed depending on the quantity of rainfall reaching the site.

- The floor area enclosed by the curbing should be covered with an impervious surface and sealed to prevent spills from contaminating groundwater. The paved floor should be sloped to a lined sump for collection of small spills.

- During the wet season, accumulated stormwater should be released frequently. Ideally, a roof-type structure should also be provided to minimize the collection of stormwater inside the curbed/diked area.

- Provide treatment by oil/water separators for stormwater from oil/fuel containment areas.

- Provide special ventilation, temperature control and fire protection where chemical stability or freezing protection are of concern.

- Secure storage buildings to prevent unauthorized persons from accessing storage containers and causing spills.

- Segregate and store incompatible or reactive materials in separate containment areas to prevent the mixing of chemicals should spills occur.

- Use drip-pans when loading/unloading liquid materials. Place drip-pans at locations where spillage may occur, such as hose connections, hose reels, filler nozzles and opened tanks/drums.

- Regularly inspect all containers for deterioration and leakage. Check the lids of drums to ensure they are in place and properly secured. Immediately contain leaks and repair the source.

- Develop spill prevention and emergency cleanup plan and provide equipment and materials for cleanup.

2. Runoff Control/Treatment BMPs

2.1	**Stormwater Flow Segregation** - *To reduce the contaminated stormwater volume requiring treatment.*
•	Grade the site to prevent the runoff of contaminated stormwater. Collect and convey contaminated stormwater for treatment.

2.2	**Stormwater Treatment** - *To minimize the stormwater contaminant loadings to the receiving water.*
•	Conduct a stormwater sampling and analytical program to identify the volume and pollutant concentrations for the various sources of contaminated stormwater. For sand and gravel operations, the pollutant of concern is suspended solids.
•	Discharge contaminated stormwater to groundwater via infiltration ponds.
•	For discharges to land or receiving waters, treat contaminated stormwater in detention ponds to settle out suspended materials. Chemicals (coagulants) may be needed to enhance settling of smaller size fractions.
•	The wet pond volume should be designed to handle a 10-year, 24-hour storm. A maximum depth of 2 metres (6 feet) is recommended. A minimum depth of 1 metre (3 feet) is recommended so that resuspension of solids is inhibited.
•	The wet ponds should be multi-celled with at least two cells and easily accessible for maintenance purposes.
•	The length-to-width ratio for wet ponds should be at least 3:1 and preferably 5:1.
•	The ponds should be inspected and cleaned to remove sediment frequently to ensure proper operation.
•	*Note - Contaminated stormwater should not be discharged to the sanitary sewer system except under special conditions defined by the local sewer authority or regulatory agency and provided the local sewer treatment plant can effectively treat the stormwater pollutants of concern. For most localities, this BMP requires approval of the local sewer authority. The allowable flow rate and contaminant concentrations may vary with the particular sewer system and local sewer authority.*

2.0 Meat and Meat Products Industries (Abattoir)

SIC 1011

Description of Industrial Sector

Establishments primarily engaged in abattoir operations and/or in meat packing operations.

Materials Used and Wastes Generated

Raw materials for abattoir operations include both live and dead animals. The small operations located in the Fraser Valley primarily process dead cattle from the surrounding areas. Depending on the condition of the carcasses, they are usually processed as either pet food/animal feed, or are sent to reduction plants for rendering. Important by-products are processed carcasses, blood meal and hides. Pig carcasses are transported directly to reduction plants for rendering.

Both solid and liquid wastes are produced from this industrial category.

Liquid waste, which is mainly slaughterhouse washwater, contains high concentrations of organic materials. Treatment of the washwater is generally required prior to discharge to the city sewer or to the receiving environment. For slaughterhouses in the Fraser Valley, the washwater is usually discharged to septic tanks/drainfields for disposal. Biological treatment, such as aeration, is sometimes used to decrease the organic content of the washwater prior to discharge to drainfields.

Solids waste consists of processed carcasses and is usually stored outside in dumpsters awaiting transport to reduction plants.

Potential Sources of Stormwater Pollution

Stormwater from this industrial sector may contain elevated concentrations of suspended solids, organics, nutrients, oil and grease, and hydrocarbons.

The potential sources of stormwater pollution are generally limited to the following industrial activities:

- Washwater runoff;
- Processed carcasses storage;
- Truck traffic; and,
- Fuel storage.

The two primary potential sources are washwater runoff and processed carcasses storage. These two sources can contribute to elevated loadings of organics and nutrients in stormwater. Stormwater contamination from these two potential sources was identified from analysis of a stormwater sample from an abattoir operation in the Fraser Valley. The sample showed high concentrations of total Kjeldahl nitrogen, total phosphorus, and oil and grease.

The potential for stormwater pollution from the other two sources is generally lower. Truck traffic may contribute to increased suspended solids loadings in stormwater. Overfilling and leaks from fuel storage tanks may contribute oil and grease. The potential for stormwater contamination may increase substantially for facilities with larger fueling operations.

Recommended Stormwater Best Management Practices

The following BMPs are designed to minimize runoff of contaminated stormwater to receiving waters. The facility personnel should first evaluate and implement source control BMPs, followed by runoff control/treatment BMPs.

For slaughterhouse operations, stormwater pollution is due to defined point sources (washwater runoff and processed carcasses storage). Implementation of source control BMPs can effectively control stormwater pollution from these point sources at low costs.

Some facilities may store diesel or gasoline on-site. Even though the stormwater pollution potential from this activity is small in relation to the other point sources, implementation of fuel storage source control BMPs is strongly recommended because of the high environmental liability associated with an unconfined spill.

To minimize the volume that may require treatment, stormwater contaminated with raised levels of organic materials may require biological treatment prior to discharge to the receiving water.

To ensure the proper selection of the runoff treatment BMP, plant personnel should conduct stormwater sampling and analysis to determine stormwater characteristics. The appropriate environmental regulatory agency should also be consulted prior to implementation of the recommended treatment BMP.

1. Source Control BMPs

1.1 Good Housekeeping and Preventive Maintenance - *To minimize stormwater runoff of contaminants to receiving waters and to maintain a clean and orderly work environment which will lead to more organized and consistent handling of waste materials.*

- Sweep the site frequently to remove processed wastes that can contribute to stormwater pollutant loadings. Collect and dispose of sweepings to storage dumpsters for shipment to reduction plants.
- Implement a comprehensive preventive maintenance program for plant equipment and stormwater management devices.
- Inspect and clean catchbasins, drainage inlets, drainage ditches and grease traps frequently to ensure proper operation. A catchbasin should be cleaned if the depth of deposits is equal to or greater than 1/3 the depth from the basin to the invert of the lowest pipe into or out of the basin.

1.2 Washwater Runoff - *To minimize the contamination of stormwater.*

- Pave and curb the slaughterhouse processing area to prevent washwater runoff and the run-on of uncontaminated stormwater.
- Collect and treat washwater and contaminated stormwater in an on-site treatment system or discharge to city sewer according to permit or local sewer authority requirements.
- Close storm drains near high stormwater pollution potential areas to prevent discharges of contaminated stormwater to the receiving water.

1.3 **Processed Carcasses Storage** - *Prevent rainwater from coming into contact with potential pollutants.*
• Provide roof covers for processed carcasses storage areas to keep rainfall from reaching storage dumpsters. • For uncovered storage areas, grade and curb the perimeter to prevent the run-on of uncontaminated stormwater from adjacent areas as well as runoff of contaminated stormwater from the storage area. • Collect and discharge contaminated stormwater to an on-site wastewater treatment system or to the city sewer according to permit or local sewer authority requirements.

1.4 Fuel Storage in Above-Ground Tanks - *To reduce the potential for an unconfined spill.*

- Surround above-ground fuel storage tanks with curbs/dikes to provide secondary containment storage. The enclosed volume should be the greater of either 10% of the total tank volume or 110% of the volume contained in the largest tank. Additional volume may be needed depending on the quantity of rainfall reaching the site.

- The floor area enclosed by the curbing should be covered with an impervious surface and sealed to prevent spills from contaminating groundwater. The paved floor should be sloped to a lined sump for collection of small spills. The sump may need to be cleaned frequently to minimize stormwater contamination.

- Provide treatment by oil/water separators for stormwater from the containment area.

- During the wet season, accumulated stormwater should be released frequently. Ideally, a roof-type structure should also be provided to minimize the collection of stormwater inside the curbed/diked area.

- Double-wall tanks may be used in place of the secondary containment and roof structure.

- Regularly inspect fuel storage tanks for corrosion and leaks.

- Develop spill prevention and emergency cleanup plan and provide equipment and materials for cleanup.

2. Runoff Control/Treatment BMPs

2.1 Stormwater Flow Segregation - *To reduce the contaminated stormwater volume requiring treatment.*
• Grade and curb the site to prevent the runoff of contaminated stormwater and the run-on of uncontaminated stormwater from adjacent areas. Collect and convey contaminated stormwater for treatment. • Test and analyze rooftop runoff samples and non-process area stormwater samples to determine contaminant levels. Discharge uncontaminated stormwater to the storm drain below the treatment system or directly to the receiving water. Discharge contaminated stormwater to an on-site wastewater treatment system. • Pave and curb areas that may contribute to stormwater pollution to contain wastewater/contaminated stormwater from reaching storm drains. Collect and treat wastewater/contaminated stormwater for pollutants of concern.

2.2 Stormwater Treatment - *To minimize the stormwater contaminant loadings to the receiving water.*

- Conduct a stormwater sampling and analytical program to identify the volume and pollutant concentrations for the various sources of contaminated stormwater. For slaughterhouse operations, the major pollutants are organics and nutrients.

- Treat stormwater contaminated with oil and grease in oil/water separators prior to discharge to the receiving water.

- Collect and treat stormwater contaminated with organic matter in an on-site treatment system. Grease traps may be used to remove oil and grease from the effluent. For wastewaters and contaminated stormwater with high organic content, treatment in a biological system may also be required. Depending on the flow volume and waste characteristics, biological systems such as septic tank/drainfield or aerated lagoons may be used to degrade the effluent to an acceptable level. In addition to an on-site biological treatment system, the facility may also consider discharging the wastewater/contaminated stormwater to the local sewer for treatment. This treatment option may require approval from the local sewer authority.

- *Note - Contaminated stormwater should not be discharged to the sanitary sewer system except under special conditions defined by the local sewer authority or regulatory agency and provided the local sewer treatment plant can effectively treat the stormwater pollutants of concern. For most localities, this BMP requires approval of the local sewer authority. The allowable flow rate and contaminant concentrations may vary with the particular sewer system and local sewer authority.*

3.0 Fish Product Industry

SIC 1021

Description of Industrial Sector

Establishments primarily engaged in eviscerating, skinning, filleting, breading, pre-cooking and blanching of fish.

Materials Used And Wastes Generated

Typical fish processing operations in the Lower Fraser Basin process salmon, groundfish such as halibut and cod, and herring.

The major operations of a typical fish processing operation are:

- Vessel unloading - Fish are unloaded by either wet or dry pumps. Dry pumps, due to the rough handling of the fish, are generally used only for groundfish. After off-loading, the fish are transported by conveyors to grading stations and processing.
- Butchering - This operation can be done either manually or with semi-automatic dressing lines. It generally consists of head removal, slitting and removal of viscera, and final cleaning. After screening, the offal from dressing are transported to reduction plants for processing.
- Canning - The butchered fish are further cut into appropriate sizes and sealed inside cans. Following sealing, the cans are washed and pressure cooked in large retorts. After cooking, the cans are cooled with chlorinated water to ensure disinfection.
- Glazing - Frozen fish are either sprayed or dipped into water to form a coating of ice prior to final packing and shipping.
- Herring pocessing - After vessel unloading, the herring are sorted to separate male from female herring. The male herring are sent directly to reduction plants Female herring undergo washing to remove blood, slime and scales before being frozen. Roe are later removed from the defrosted fish and cured for shipment.

Both solid and liquid wastes are produced from this industrial category.

Process wastewaters, including washwater and offal flume water, contain high levels of solids and organic materials. Review of wastewater discharge permits for facilities in this industrial category showed these process wastewaters are screened (20-mesh) to remove solids prior to discharge to either the city sewer or to the receiving water.

Solid wastes, consisting mainly of fish offal, are transported to reduction plants for processing.

Potential Sources of Stormwater Pollution

Stormwater from this industrial sector may contain high concentrations of suspended solids, organics, nutrients, oil and grease, and hydrocarbons.

The potential sources of stormwater pollution are generally limited to the following industrial activities:

- Loading and unloading;
- Wastewater treatment;
- Offal storage;
- Truck traffic; and,
- Waste oil storage.

The three primary potential sources are unloading of fish, wastewater treatment and offal storage. These three sources can contribute to high loadings of solids, organics and nutrients in stormwater. There are no stormwater quality data from the fish product industry in the Lower Fraser Basin. It is likely the pollutants of concern in the stormwater would be similar to that found in process wastewaters. Wastewaters from this industrial sector can contain elevated biochemical oxygen demand, total suspended solids, chemical oxygen demand and ammonia. Metals are not of concern.

The potential for stormwater pollution from the other two sources is generally lower. Truck traffic may contribute to suspended solids loadings in stormwater. Overfilling and leaks from waste oil storage tanks may contribute to oil and grease.

Recommended Stormwater Best Management Practices

The following BMPs are designed to minimize runoff of contaminated stormwater to receiving waters. The facility personnel should first evaluate and implement source control BMPs, followed by runoff control/treatment BMPs.

For the fish product industry, stormwater pollution is due to defined point sources (unloading of fish, outside wastewater treatment, outside offal storage). Implementation of source control BMPs can effectively control stormwater pollution from these point sources at low costs.

The recommended runoff treatment BMPs are designed to minimize the volume of contaminated stormwater requiring treatment. Contaminated stormwater should be screened prior to discharge to the receiving water. Additional biological treatment may also be needed for stormwater contaminated with high levels of organic materials.

Even though the stormwater pollution potential from on-site fuel and/or waste oil storage activity is small in relation to the other point sources, implementation of source control BMPs is strongly recommended because of the high environmental liability associated with an unconfined spill.

To ensure the proper selection of the runoff treatment BMP, the plant personnel should conduct stormwater sampling and analysis to determine stormwater characteristics. Plant personnel should also consult with the appropriate environmental regulatory agency prior to implementing the recommended treatment BMP.

1. Source Control BMPs

1.1 Good Housekeeping and Preventive Maintenance - *To minimize stormwater runoff of contaminants to receiving waters and to maintain a clean and orderly work environment which will lead to more organized and consistent handling of waste materials.*

- Sweep the site frequently to remove spilled fish offal and other materials. Collect and return sweepings to offal storage tanks for shipment to reduction plants. Avoid washdown cleanup.

- Implement a comprehensive preventive maintenance program for plant equipment and stormwater management devices.

- Clean screens for the unloading dock drains after each fish unloading operation.

- Inspect and clean catchbasins around offal storage tanks and the wastewater treatment system frequently to ensure proper operation. A catchbasin should be cleaned if the depth of deposits are equal to or greater than 1/3 the depth from the basin to the invert of the lowest pipe into or out of the basin.

1.2	**Loading and Unloading** - *Prevent rainwater from coming into contact with potential pollutants.*

- Pave and curb unloading areas requiring washdown cleanup. Collect and convey contaminated stormwater to an on-site wastewater treatment plant or to the city sewer according to permit or local sewer authority requirements.

- Provide overhangs and site grading for loading/unloading areas with high stormwater pollution potential to prevent run-on of stormwater. Collect and convey contaminated stormwater from these areas to an on-site wastewater treatment plant or to the city sewer according to permit or local sewer authority requirements.

- Close storm drains near areas with high stormwater pollution potential to prevent discharges of contaminated stormwater to the receiving water.

- Pave chemical tank truck transfer areas with concrete. Design the transfer area to prevent the run-on of uncontaminated stormwater from adjacent areas and to contain spills. Direct spills to a dead-end for removal or to process treatment.

- Use drip-pans when loading/unloading liquid materials. Place drip-pans at locations where spillage may occur, such as hose connections, hose reels and filler nozzles.

- Develop spill prevention and emergency cleanup plan and provide equipment and materials for cleanup.

1.3	**Wastewater Treatment** - *Prevent rainwater from coming into contact with potential pollutants.*

- Provide a roof cover for the wastewater treatment plant to eliminate or minimize stormwater from coming into contact with contaminated areas.
- For an uncovered wastewater treatment plant, grade and curb the perimeter to prevent the run-on of uncontaminated stormwater from adjacent areas as well as runoff of contaminated stormwater from the treatment area.
- Collect and discharge contaminated stormwater back to the wastewater treatment plant.

1.4	**Fish Offal Storage** - *Prevent rainwater from coming into contact with potential pollutants.*

- Provide roof covers for fish offal storage areas.
- For uncovered storage areas, grade and curb the perimeter to prevent the run-on of uncontaminated stormwater from adjacent areas as well as runoff of contaminated stormwater from the storage area.
- Collect and discharge contaminated stormwater to an on-site wastewater treatment system or to the city sewer according to permit or local sewer authority requirements.

1.5 Liquid Storage in Above-Ground Tanks - *To reduce the potential for an unconfined spill.*

- Surround above-ground liquid (e.g., acids, caustics, ammonia, biocides, waste oil, chlorinated cooling water) storage tanks with curbs/dikes to provide secondary containment storage. The enclosed volume should be the greater of either 10% of the total tank volume or 110% of the volume contained in the largest tank. Additional volume may be needed depending on the quantity of rainfall reaching the site.

- The floor area enclosed by the curbing should be covered with an impervious surface and sealed to prevent spills from contaminating groundwater. The paved floor should be sloped to a lined sump for collection of small spills.

- During the wet season, accumulated stormwater should be released frequently. Ideally, a roof-type structure should also be provided to minimize the collection of stormwater inside the curbed/diked area.

- Provide treatment by oil/water separators for stormwater from oil/fuel containment areas.

- Provide special ventilation, temperature control and fire protection where chemical stability or freezing protection are of concern.

- Secure storage buildings to prevent unauthorized persons from accessing storage containers and causing spills.

- Segregate and store incompatible or reactive materials in separate containment areas to prevent the mixing of chemicals should spills occur.

- Use drip-pans when loading/unloading liquid materials. Place drip-pans at locations where spillage may occur, such as hose connections, hose reels, filler nozzles and opened tanks/drums.

- Regularly inspect all containers for deterioration and leakage. Check the lids of drums to ensure they are in place and properly secured. Immediately contain leaks and repair the source.

- Develop spill prevention and emergency cleanup plan and provide equipment and materials for cleanup.

2. Runoff Control/Treatment BMPs

2.1 Stormwater Flow Segregation - *To reduce the contaminated stormwater volume requiring treatment.*

- Grade and curb the site to prevent the runoff of contaminated stormwater and the run-on of uncontaminated stormwater from adjacent areas. Collect and convey contaminated stormwater for treatment.

- Test and analyze rooftop runoff samples and non-process area stormwater samples to determine contaminant levels. Discharge uncontaminated stormwater to the storm drain below the treatment system or directly to the receiving water. Discharge contaminated stormwater to an on-site wastewater treatment system.

- Pave and curb areas that may contribute to stormwater pollution to contain wastewater/contaminated stormwater from reaching storm drains. Collect and treat wastewater/contaminated stormwater for pollutants of concern.

2.2 Stormwater Treatment - *To minimize the stormwater contaminant loadings to the receiving water.*

- Conduct a stormwater sampling and analytical program to identify the volume and pollutant concentrations for the various sources of contaminated stormwater. For fish processing facilities, the major pollutants are suspended solids, organics and nutrients.

- Treat stormwater contaminated with oil and grease in oil/water separators prior to discharge to the receiving water.

- Collect and treat stormwater contaminated with organic matter in an on-site treatment system. Screening may be used to remove solids from the effluent. For wastewaters and contaminated stormwater with high organic content, treatment in a biological system may also be required. Depending on the flow volume and waste characteristics, biological systems such as septic tank/drainfield or aerated lagoons may be used to degrade the effluent to an acceptable level. In addition to an on-site biological treatment system, the facility may also consider discharging the wastewater/contaminated stormwater to the local sewer for treatment. This treatment option may require approval from the local sewer authority.

- *Note - Contaminated stormwater should not be discharged to the sanitary sewer system except under special conditions defined by the local sewer authority or regulatory agency and provided the local sewer treatment plant can effectively treat the stormwater pollutants of concern. For most localities, this BMP requires approval of the local sewer authority. The allowable flow rate and contaminant concentrations may vary with the particular sewer system and local sewer authority.*

4º Canned and Preserved Fruit and Vegetable Industry

SIC 1031

Description of Industrial Sector

Establishments primarily engaged in cleaning, canning, dehydrating, pickling, preserving, juice extracting or otherwise processing fruits and vegetables (except freezing).

Materials Used and Wastes Generated

With most food processors, all processing activities occur inside buildings. Exceptions are fruit and vegetable plants where the raw materials may be temporarily stored outside.

The major operations of a typical fruit washing plant are:

- Truck unloading - Fruit loaded in wooden containers is delivered to the plant by trucks. Forklifts are used to unload the containers from the trucks. After unloading, the fruit is dropped into hoppers.

- Fruit washing - From the hoppers, fruit is conveyed to washing stations for cleaning. Leaves and stems are removed to dumpsters. Washwater is discharged to the wastewater treatment plant.

- Packaging - After washing and air drying, the fruit is loaded into wooden containers for shipment to other plants for further processing.

Both solid and liquid wastes are produced from this industrial category.

The washwater contains high levels of solids and organic materials. Wastewater discharge permits for facilities in this industrial category require process wastewaters to be screened (20-mesh) to remove solids prior to discharge to either the city sewer or to the receiving water. Depending on the effluent acidity, pH neutralization may also be required.

Solid wastes, including leaves, stems and rejected fruit, are disposed of in landfills.

Potential Sources of Stormwater Pollution

Stormwater from this industrial sector may contain elevated concentrations of suspended solids, organics, nutrients and oil and grease.

The potential sources of stormwater pollution are generally limited to the following industrial activities:

- Loading and unloading;
- Solid waste storage;
- Truck traffic; and,
- Chemical storage.

Unloading of fruits and solid waste storage are the two primary potential sources. These sources can contribute to loadings of organics and nutrients in stormwater. Depending on the fruit being processed, pH of the stormwater may be affected. Stormwater contamination from these potential sources were identified from analysis of a stormwater sample from a fruit washing operation in the Lower Fraser basin. The sample showed high concentrations of chemical oxygen demand, total Kjeldahl nitrogen and total nitrogen. The pH of the same stormwater sample was below 4.

The potential for stormwater pollution from the other two sources is generally lower. Truck traffic may contribute to suspended solids loadings in stormwater. Spills from liquid chemical loading operations may affect the pH of the stormwater.

Recommended Stormwater Best Management Practices

The following BMPs are designed to minimize runoff of contaminated stormwater to receiving waters. The facility personnel should first evaluate and implement source control BMPs followed by runoff control/treatment BMPs.

For fruit and vegetable processing operations, stormwater pollution is due to defined point sources (unloading of fruit and solid waste storage). Source control BMPs can effectively control stormwater pollution from these point sources at low costs.

Some facilities may store chemicals on-site to neutralize the pH of the washwater/ stormwater. Even though the stormwater pollution potential from this activity is small in relation to the other point sources, implementation of chemical storage source control BMPs is strongly recommended because of the high environmental liability associated with an unconfined spill.

The recommended runoff control/treatment BMPs are designed to remove solids from the contaminated stormwater by screening. Additional biological treatment may be needed for contaminated stormwater with high organic content. Biological treatment may be accomplished by either an on-site treatment plant or the city biological sewage treatment plant. Discharge to the city sewer may require approval of the local sewer authority.

To ensure the proper selection of the runoff treatment BMP, plant personnel should conduct sampling and analysis to determine stormwater characteristics. Plant personnel should also consult with the appropriate environmental regulatory agency prior to implementation of the recommended treatment BMP.

1. Source Control BMPs

1.1 Good Housekeeping and Preventive Maintenance - *To minimize stormwater runoff of contaminants to receiving waters and to maintain a clean and orderly work environment which will lead to more organized and consistent handling of waste materials.*

- Sweep the site frequently, especially after each unloading operation, to remove spilled fruit and other materials that can contribute to the stormwater pollutant loadings. Washdown cleanup would contribute to higher pollutant loadings to the wastewater treatment plant and should be avoided.

- Collect and dispose of sweepings to storage dumpsters for disposal in approved landfills.

- Implement a comprehensive preventive maintenance program for plant equipment and stormwater management devices.

- Inspect and clean catchbasins, drainage inlets, drainage ditches around fruit unloading, the wastewater treatment system, and solid waste storage areas frequently to ensure proper operation. A catchbasin should be cleaned if the depth of deposits are equal to or greater than 1/3 the depth from the basin to the invert of the lowest pipe into or out of the basin.

1.2 Loading and Unloading - *Prevent rainwater from coming into contact with potential pollutants.*

- Pave and curb unloading areas requiring washdown cleanup. Collect and convey contaminated stormwater to an on-site wastewater treatment plant or to the city sewer according to permit or local sewer authority requirements.
- Provide overhangs and site grading for loading/unloading areas with high stormwater pollution potential to prevent run-on of stormwater. Collect and convey contaminated stormwater from these areas to an on-site wastewater treatment or to the city sewer according to permit or local sewer authority requirements.
- Close storm drains near areas with high stormwater pollution potential to prevent discharges of contaminated stormwater to the receiving water.
- Pave chemical tank truck transfer areas with concrete. Design the transfer area to prevent the run-on of uncontaminated stormwater from adjacent areas and to contain spills. Direct spills to a dead-end for removal or to process treatment.
- Use drip-pans when loading/unloading liquid materials. Place drip-pans at locations where spillage may occur, such as hose connections, hose reels and filler nozzles.
- Develop spill prevention and emergency cleanup plan and provide equipment and materials for cleanup.

1.3 Solid Waste Storage - *Prevent rainwater from coming into contact with potential pollutants.*

- Provide roof covers for solid waste storage areas.
- For uncovered solid waste storage areas, grade and curb the perimeter to prevent the run-on of uncontaminated stormwater from adjacent areas as well as runoff of contaminated stormwater from the storage area.
- Collect and discharge contaminated stormwater to an on-site wastewater treatment system or to the city sewer according to permit or local sewer authority requirements.

1.4 Liquid Storage in Above-Ground Tanks - *To reduce the potential for an unconfined spill.*

- Surround above-ground liquid (e.g., acids, caustics, ammonia, biocides, waste oil, chlorinated cooling water) storage tanks with curbs/dikes to provide secondary containment storage. The enclosed volume should be the greater of either 10% of the total tank volume or 110% of the volume contained in the largest tank. Additional volume may be needed depending on the quantity of rainfall reaching the site.

- The floor area enclosed by the curbing should be covered with an impervious surface and sealed to prevent spills from contaminating groundwater. The paved floor should be sloped to a lined sump for collection of small spills.

- During the wet season, accumulated stormwater should be released frequently. Ideally, a roof-type structure should also be provided to minimize the collection of stormwater inside the curbed/diked area.

- Provide treatment by oil/water separators for stormwater from oil/fuel containment areas.

- Provide special ventilation, temperature control and fire protection where chemical stability or freezing protection are of concern.

- Secure storage buildings to prevent unauthorized persons from accessing storage containers and causing spills.

- Segregate and store incompatible or reactive materials in separate containment areas to prevent the mixing of chemicals should spills occur.

- Use drip-pans when loading/unloading liquid materials. Place drip-pans at locations where spillage may occur such as hose connections, hose reels, filler nozzles and opened tanks/drums.

- Regularly inspect all containers for deterioration and leakage. Check the lids of drums to ensure they are in place and properly secured. Immediately contain leaks and repair the source.

- Develop spill prevention and emergency cleanup plan and provide equipment and materials for cleanup.

2. Runoff Control/Treatment BMPs

2.1 **Stormwater Flow Segregation** - *To reduce the contaminated stormwater volume requiring treatment.*
• Grade and curb the site to prevent the runoff of contaminated stormwater and the run-on of uncontaminated stormwater from adjacent areas. Collect and convey contaminated stormwater for treatment. • Test and analyze rooftop runoff samples and non-process area stormwater samples to determine contaminant levels. Discharge uncontaminated stormwater to the storm drain below the treatment system or directly to the receiving water. Discharge contaminated stormwater to an on-site wastewater treatment system. • Pave and curb areas that may contribute to stormwater pollution to contain wastewater/contaminated stormwater from reaching storm drains. Collect and treat wastewater/contaminated stormwater for pollutants of concern.

2.2 Stormwater Treatment - *To minimize the stormwater contaminant loadings to the receiving water.*

- Conduct a stormwater sampling and analytical program to identify the volume and pollutant concentrations for the various sources of contaminated stormwater. For fruit and vegetable processing operations, the major pollutants are acidity, suspended solids, organics and nutrients.

- Treat stormwater contaminated with oil and grease in oil/water separators prior to discharge to the receiving water.

- Collect and treat stormwater contaminated with organic matter in an on-site treatment system. Screening may be used to remove solids from the effluent. pH neutralization with caustic soda may also be needed. For wastewaters and contaminated stormwater with high organic content, treatment in a biological system may also be required. Depending on the flow volume and waste characteristics, biological systems such as septic tank/drainfield or aerated lagoons may be used to degrade the effluent to an acceptable level. In addition to an on-site biological treatment system, the facility may also consider discharging the wastewater/contaminated stormwater to the local sewer for treatment. This treatment option may require approval from the local sewer authority.

- *Note - Contaminated stormwater should not be discharged to the sanitary sewer system except under special conditions defined by the local sewer authority or regulatory agency and provided the local sewer treatment plant can effectively treat the stormwater pollutants of concern. For most localities, this BMP requires approval of the local sewer authority. The allowable flow rate and contaminant concentrations may vary with the particular sewer system and local sewer authority.*

5.0 Frozen Fruit and Vegetable Industry

SIC 1032

Description of Industrial Sector

Establishments primarily engaged in freezing fruits and vegetables.

Materials Used and Wastes Generated

With most food processors, all processing occurs inside buildings. For frozen fruit and vegetable plants, raw materials may be temporarily stored outside. Other outdoor operations include the unloading of vegetables into the plant.

The major operations for a typical frozen fruit and vegetable plant are:

- Truck unloading - Fruit and vegetables are delivered to the plant by trucks. Some vegetables (e.g., peas) are dumped into hoppers and conveyed into the plant. Other vegetables, such as corn, are unloaded directly onto a conveyor system for transfer into the plant.

- Washing - Fruit and vegetables are washed; washwater is discharged to the wastewater treatment plant.

- Processing - Depending on the plant, there are a wide variety of processing operations: juice making, jam making, freezing, canning, etc.

- Truck loading - Finished products are transported off-site using trucks.

Both solid and liquid wastes are produced from this industrial category.

Wastewater discharge permits require process wastewaters from this industrial category, including contaminated stormwater, to be screened (20-mesh) to remove large organic matter prior to discharge to the city sewer. For direct discharge to the receiving environment, such as landspreading, process wastewaters are required to be treated by a biological treatment system. Aerated lagoons are commonly used to decrease the organic content of the wastewater.

Uncontaminated cooling water from freezing and canning operations are usually permitted to be discharged directly to the receiving water.

Solid wastes, including vegetable wastes from the processing area and from the wastewater treatment plant, are disposed of in landfills.

Potential Sources of Stormwater Pollution

Stormwater from this industrial sector may contain high concentrations of suspended solids, organics, nutrients and oil and grease.

The potential sources of stormwater pollution are generally limited to the following industrial activities:

- Unloading of fruits and vegetables;
- Wastewater disposal practices;
- Solid waste storage;
- Truck traffic;
- Chemical storage; and,
- Waste oil storage.

Unloading of fruits and vegetables, wastewater disposal practices and solid waste storage are the three primary potential sources. These sources can contribute to loadings of suspended solids, organics and nutrients in stormwater. Analysis of a combined cooling water and stormwater sample from a frozen fruit and vegetable operation in the Fraser Valley showed high levels of chemical oxygen demand, totaKjeldahl nitrogen and total phosphorus.

The potential for stormwater pollution from the other three sources is generally lower. Truck traffic may contribute to suspended solids loadings in stormwater. Spills and leaks from chemical and waste oil storage tanks may contribute to oil and grease and chemical pollutants. Stormwater contamination potentials may increase substantially for facilities with larger chemical and/or waste oil storage facilities.

Recommended Stormwater Best Management Practices

The following BMPs are designed to minimize runoff of contaminated stormwater to receiving waters. The facility personnel should first evaluate and implement source control BMPs followed by runoff control/treatment BMPs.

For frozen fruit and vegetable processing operations, stormwater pollution is due to defined point sources (unloading of fruits and vegetables, wastewater disposal practices and solid waste storage). Source control BMPs can effectively control stormwater pollution from these point sources at low costs.

Waste oil and chemicals stored on-site for cleaning, disinfection and growth/corrosion inhibition may spill or leak, resulting in stormwater pollution. Even though the stormwater pollution potential from waste oil and chemical storage is small in relation to the other point sources, implementation of chemical and waste oil storage source control BMPs is strongly recommended because of the high environmental liability associated with an unconfined spill.

The recommended runoff control/treatment BMPs are designed to remove solids from the contaminated stormwater by screening. Additional biological treatment may be needed for stormwater with high organic content. Biological treatment may be accomplished by either an on-site treatment plant or the city biological sewage treatment plant. Discharge to the city sewer may require approval of the local sewer authority.

To ensure the proper selection of the runoff treatment BMP, the plant personnel should conduct sampling and analysis to determine stormwater characteristics. Plant personnel should also consult with the appropriate environmental regulatory agency prior to implementing the recommended treatment BMP.

1. Source Control BMPs

1.1 Good Housekeeping and Preventive Maintenance - *To minimize stormwater runoff of contaminants to receiving waters and to maintain a clean and orderly work environment which will lead to more organized and consistent handling of waste materials.*

- Sweep the site frequently, especially after unloading, to remove waste materials and vegetative matter that can contribute to the stormwater pollutant loadings. Washdown cleanup would contribute to higher pollutant loadings to the wastewater treatment plant and should be avoided.
- Collect and dispose of sweepings to storage dumpsters for disposal in approved landfills.
- Implement a comprehensive preventive maintenance program for plant equipment and stormwater management devices.
- Inspect and clean catchbasins, drainage inlets, drainage ditches around fruit unloading, the wastewater treatment system and solid waste storage areas frequently to ensure proper operation. A catchbasin should be cleaned if the depth of deposits are equal to or greater than 1/3 the depth from the basin to the invert of the lowest pipe into or out of the basin.

1.2 Loading and Unloading - *Prevent rainwater from coming into contact with potential pollutants.*

- Pave and curb unloading areas requiring washdown cleanup. Collect and convey contaminated stormwater to an on-site wastewater treatment plant or to the city sewer according to permit or local sewer authority requirements.

- Provide overhangs and site grading for loading/unloading areas with high stormwater pollution potential to prevent run-on of stormwater. Collect and convey contaminated stormwater from these areas to an on-site wastewater treatment or to the city sewer according to permit or local sewer authority requirements.

- Close storm drains near high stormwater pollution potential areas to prevent discharges of contaminated stormwater to the receiving water.

- Pave chemical tank truck transfer areas with concrete. Design the transfer areas to prevent the run-on of uncontaminated stormwater from adjacent areas and to contain spills. Direct spills to a dead-end for removal or to process treatment.

- Use drip-pans when loading/unloading liquid materials. Place drip-pans at locations where spillage may occur, such as hose connections, hose reels and filler nozzles.

- Develop spill prevention and emergency cleanup plan and provide equipment and materials for cleanup.

1.3 Wastewater Disposal Practices - *Minimize stormwater runoff from land disposal areas.*

- Grade waste disposal areas to minimize the runoff of contaminated stormwater to the receiving water.
- Avoid land disposal of wastewater when it is raining or when the ground is frozen or saturated with water.
- Maintain adequate barriers between the land application site and the receiving water.
- If feasible, discontinue land application practices. Alternatives to land application include biological treatment or discharge to the city sewer system according to permit or local sewer authority requirements.

1.4 Solid Waste Storage - *Prevent rainwater from coming into contact with potential pollutants.*

- Provide roof covers for solid waste storage areas.
- For uncovered solid waste storage areas, grade and curb the perimeter to prevent the run-on of uncontaminated stormwater from adjacent areas as well as runoff of contaminated stormwater from the storage area.
- Collect and discharge contaminated stormwater to an on-site wastewater treatment system or to the city sewer according to permit or local sewer authority requirements.

1.5 Liquid Storage in Above-Ground Tanks - *To reduce the potential for an unconfined spill.*

- Surround above-ground liquid (e.g., acids, caustics, ammonia, biocides, waste oil, chlorinated cooling water) storage tanks with curbs/dikes to provide secondary containment storage. The enclosed volume should be the greater of either 10% of the total tank volume or 110% of the volume contained in the largest tank. Additional volume may be needed depending on the quantity of rainfall reaching the site.

- The floor area enclosed by the curbing should be covered with an impervious surface and sealed to prevent spills from contaminating groundwater. The paved floor should be sloped to a lined sump for collection of small spills.

- During the wet season, accumulated stormwater should be released frequently. Ideally, a roof-type structure should also be provided to minimize the collection of stormwater inside the curbed/diked area.

- Provide treatment by oil/water separators for stormwater from oil/fuel containment areas.

- Provide special ventilation, temperature control and fire protection where chemical stability or freezing protection are of concern.

- Secure storage buildings to prevent unauthorized persons from accessing storage containers and causing spills.

- Segregate and store incompatible or reactive materials in separate containment areas to prevent the mixing of chemicals should spills occur.

- Use drip-pans when loading/unloading liquid materials. Place drip-pans at locations where spillage may occur, such as hose connections, hose reels, filler nozzles and opened tanks/drums.

- Regularly inspect all containers for deterioration and leakage. Check the lids of drums to ensure they are in place and properly secured. Immediately contain leaks and repair the source.

- Develop spill prevention and emergency cleanup plan and provide equipment and materials for cleanup.

2. Runoff Control/Treatment BMPs

2.1 Stormwater Flow Segregation - *To reduce the contaminated stormwater volume requiring treatment.*
• Grade and curb the site to prevent the runoff of contaminated stormwater and the run-on of uncontaminated stormwater from adjacent areas. Collect and convey contaminated stormwater for treatment. • Test and analyze rooftop runoff samples and non-process area stormwater samples to determine contaminant levels. Discharge uncontaminated stormwater to the storm drain below the treatment system or directly to the receiving water. Discharge contaminated stormwater to an on-site wastewater treatment system. • Pave and curb areas that may contribute to stormwater pollution to contain wastewater/contaminated stormwater from reaching storm drains. Collect and treat wastewater/contaminated stormwater for pollutants of concern.

2.2 Stormwater Treatment - *To minimize the stormwater contaminant loadings to the receiving water.*

- Conduct a stormwater sampling and analytical program to identify the volume and pollutant concentrations for the various sources of contaminated stormwater. For frozen fruit and vegetable processing facilities, the major pollutants are suspended solids, organics and nutrients.

- Treat stormwater contaminated with oil and grease in oil/water separators prior to discharge to the receiving water.

- Collect and treat stormwater contaminated with organic matter in an on-site treatment system. Screening may be used to remove solids from the effluent. pH neutralization with caustic soda may also be needed. For wastewaters and contaminated stormwater with high organic content, treatment in a biological system may also be required. Depending on the flow volume and waste characteristics, biological systems such as septic tank/drainfield or aerated lagoons may be used to degrade the effluent to an acceptable level. In addition to an on-site biological treatment system, the facility may also consider discharging the wastewater/contaminated stormwater to the local sewer for treatment. This treatment option may require approval from the local sewer authority.

- *Note - Contaminated stormwater should not be discharged to the sanitary sewer system except under special conditions defined by the local sewer authority or regulatory agency and provided the local sewer treatment plant can effectively treat the stormwater pollutants of concern. For most localities, this BMP requires approval of the local sewer authority. The allowable flow rate and contaminant concentrations may vary with the particular sewer system and local sewer authority.*

6º Fluid Milk Industry

SIC 1041

Description of Industrial Sector

Establishments primarily engaged in processing raw milk and cream.

Materials Used and Wastes Generated

Similar to other food processing facilities, all processing operations for the fluid milk industry are conducted indoors. Raw materials are raw milk, raw cream, fruit fillings, packaging materials, caustic, acid, chlorine and lubricants.

The major operations for a typical fluid milk plant are:

- Truck loading/unloading - Milk and cream are delivered to the milk plant in tanker trucks. In the receiving area, milk and cream are pumped from tankers to raw milk/cream storage tanks. Other raw materials and finished products are loaded and unloaded at truck docks.

- Processing - Depending on the plant, there are a wide variety of processing operations including milk/cream packaging, yogurt and cottage cheese production.

Both solid and liquid wastes are produced from this industrial category.

Process wastewaters contain high levels of oil and grease, suspended solids, organics and nutrients. Review of the wastewater discharge permits for facilities in this industrial category showed these highly contaminated wastewaters are permitted to be discharged to city sewers.

Solid wastes are disposed of in landfills.

Potential Sources of Stormwater Pollution

Stormwater from this industrial sector may contain high concentrations of suspended solids, organics, nutrients and oil and grease.

The potential sources of stormwater pollution are generally limited to the following industrial activities:

- Unloading of raw milk and cream;
- Vehicle washing;
- Solid waste storage;
- Truck traffic;
- Lubricant storage; and,
- Fuel storage.

Unloading of raw milk and cream, vehicle washing and solid waste storage are the three primary potential sources of contamination. These three sources can contribute to loadings of suspended solids, organics and nutrients in stormwater. Because most industrial operations are conducted indoors, stormwater contaminant levels are low. The low stormwater pollution potential from this industrial sector is confirmed by analysis of stormwater samples from a fluid milk operation in the LowerFraser Basin.

The potential for stormwater pollution from the other three sources is also low. Truck traffic may contribute to suspended solids loadings in stormwater. Overfilling and leaks from lubricant and fuel storage tanks may contribute to oil and grease and hydrocarbons. Stormwater contamination potentials may increase substantially for facilities with larger lubricant and fuel storage operations.

Recommended Stormwater Best Management Practices

The following BMPs are designed to minimize runoff of contaminated stormwater to receiving waters. The facility personnel should first evaluate and implement source control BMPs, followed by runoff control/treatmentBMPs.

For milk and cream processing facilities, stormwater pollution is due to defined point sources (unloading of raw milk and cream, truck washing and solid waste storage). Source control BMPs can effectively controlstormwater pollution from these point sources at low costs.

Waste oil, fuel and chemicals stored on-site for cleaning, disinfection and growth/corrosion inhibition may spill or leak, resulting in stormwater pollution. Even though the stormwater pollution potential from waste oil and chemical storage is small in relation to the other point sources, implementation of chemical, waste oil and fuel storage source control BMPs is strongly recommended because of the high environmental liability associated with an unconfined spill.

The recommended runoff control/treatment BMPs are designed to segregate contaminated stormwater from uncontaminated stormwater. Biological treatment may be needed for contaminated stormwater with high organic content. Biological treatment may be accomplished by either an on-site treatment plant or the city biological sewage treatment plant. Discharge to the city sewer may require approval of the local sewer authority.

To ensure the proper selection of the runoff treatment BMP, the plant personnel should conduct sampling and analysis to determine stormwater characteristics. Plant personnel should also consult with the appropriate environmental regulatory agency prior to implementation of the recommended treatment BMP.

1. Source Control BMPs

1.1 Good Housekeeping and Preventive Maintenance - *To minimize stormwater runoff of contaminants to receiving waters and to maintain a clean and orderly work environment which will lead to more organized and consistent handling of waste materials.*

- Sweep the site frequently to remove waste materials that can contribute to the stormwater pollutant loadings. Washdown cleanup would contribute to higher pollutant loadings that may require treatment and should be avoided.

- Collect and dispose of sweepings to storage dumpsters for disposal in approved landfills.

- Implement a comprehensive preventive maintenance program for plant equipment and stormwater management devices.

- Inspect and clean catchbasins around solid waste storage areas frequently to ensure proper operation. A catchbasin should be cleaned if the depth of deposits are equal to or greater than 1/3 the depth from the basin to the invert of the lowest pipe into or out of the basin.

1.2	**Loading and Unloading** - *Prevent rainwater from coming into contact with potential pollutants.*

- Enclose and pave the raw milk and cream unloading area to prevent run-on of uncontaminated stormwater from adjacent areas and to retain spills. Direct spills to the city sewer system according to the local sewer authority requirements.
- Provide overhangs and site grading for loading/unloading areas with high stormwater pollution potential to prevent run-on of stormwater. Collect and convey contaminated stormwater from these areas to an on-site wastewater treatment or to the city sewer according to permit or local sewer authority requirements.
- Close storm drains near areas with high stormwater pollution potential to prevent discharges of contaminated stormwater to the receiving water.
- Use drip-pans when loading/unloading liquid materials. Place drip-pans at locations where spillage may occur, such as hose connections, hose reels and filler nozzles.
- Develop spill prevention and emergency cleanup plan and provide equipment and materials for cleanup.

1.3	**Vehicle Washing** - *Minimize stormwater from coming into contact with potential pollutants.*

- Enclose the vehicle/equipment washing area with either walls and/or roof to prevent the entry of precipitation and to contain the washwater.
- Collect and treat washwater by an on-site wastewater treatment system or by the city wastewater treatment plant according to permit or local sewer authority requirements.
- Avoid the use of mobile wash services unless the washwater can be collected and treated.

1.4	**Solid Waste Storage** - *Prevent rainwater from coming into contact with potential pollutants.*

- Provide roof covers for solid waste storage areas.
- For uncovered solid waste storage areas, grade and curb the perimeter to prevent the run-on of uncontaminated stormwater from adjacent areas as well as runoff of contaminated stormwater from the storage area.
- Collect and discharge contaminated stormwater to an on-site wastewater treatment system or to the city sewer according to permit or local sewer authority requirements.

1.5 Liquid Storage in Above-Ground Tanks/Containers - *To reduce the potential for an unconfined spill.*

- Surround above-ground liquid (e.g., chemicals, waste oil) storage tanks with curbs/dikes to provide secondary containment storage. The enclosed volume should be the greater of either 10% of the total tank volume or 110% of the volume contained in the largest tank. Additional volume may be needed depending on the quantity of rainfall reaching the site.

- The floor area enclosed by the curbing should be covered with an impervious surface and sealed to prevent spills from contaminating groundwater. The paved floor should be sloped to a lined sump for collection of small spills.

- During the wet season, accumulated stormwater should be released frequently. Ideally, a roof-type structure should also be provided to minimize the collection of stormwater inside the curbed/diked area.

- Provide treatment by oil/water separators for stormwater from oil/fuel containment areas.

- Provide special ventilation, temperature control and fire protection where chemical stability or freezing protection are of concern.

- Secure storage buildings to prevent unauthorized persons from accessing storage containers and causing spills.

- Segregate and store incompatible or reactive materials in separate containment areas to prevent the mixing of chemicals should spills occur.

- Use drip-pans when loading/unloading liquid materials. Place drip-pans at locations where spillage may occur, such as hose connections, hose reels, filler nozzles and opened tanks/drums.

- Regularly inspect all containers for deterioration and leakage. Check the lids of drums to ensure they are in place and properly secured. Immediately contain leaks and repair the source.

- Develop spill prevention and emergency cleanup plan and provide equipment and materials for cleanup.

1.6 Underground Storage Tanks (USTs) - *To reduce the potential for an undetected leak.*

- Perform monthly inventory of stored liquid products to detect leakage.
- Perform leak testing every two years. All USTs older than 10 years are suspect and consideration should be given for removal. An above-ground double-wall storage system is highly recommended as a replacement for underground fuel storage tanks.
- Pave the fueling area using concrete, not asphalt. Construct and size the fueling area to contain spills and prevent run-on of uncontaminated stormwater from surrounding areas.
- Collect and treat contaminated stormwater by oil/water separators. Clean the oil/water separator frequently to maintain proper operation. A roof may be provided over the fueling area to minimize the collection of stormwater in the oil/water separator.
- Implement tank filling procedures to prevent spills and overfills.
- Develop spill prevention and emergency cleanup plan and provide equipment and materials for cleanup.

2. Runoff Control/Treatment BMPs

2.1 Stormwater Flow Segregation - *To reduce the contaminated stormwater volume requiring treatment.*
• Grade and curb the site to prevent the runoff of contaminated stormwater and the run-on of uncontaminated stormwater from adjacent areas. Collect and convey contaminated stormwater for treatment. • Test and analyze rooftop runoff samples and non-process area stormwater samples to determine contaminant levels. Discharge uncontaminated stormwater to the storm drain below the treatment system or directly to the receiving water. Discharge contaminated stormwater to an on-site wastewater treatment system. • Pave and curb areas that may contribute to stormwater pollution to contain wastewater/contaminated stormwater from reaching storm drains. Collect and treat wastewater/contaminated stormwater for pollutants of concern.

2.2 Stormwater Treatment - *To minimize the stormwater contaminant loadings to the receiving water.*
• Conduct a stormwater sampling and analytical program to identify the volume and pollutant concentrations for the various sources of contaminated stormwater. For fluid milk operations, the major pollutants are suspended solids, organics, and nutrients. • Treat stormwater contaminated with oil and grease in oil/water separators prior to discharge to the receiving water. • Treat stormwater contaminated with high concentrations of organic materials in an on-site wastewater treatment system or in a public wastewater treatment plant according to permit or local sewer authority requirements. • *Note - Contaminated stormwater should not be discharged to the sanitary sewer system except under special conditions defined by the local sewer authority or regulatory agency and provided the local sewer treatment plant can effectively treat the stormwater pollutants of concern. For most localities, this BMP requires approval of the local sewer authority. The allowable flow rate and contaminant concentrations may vary with the particular sewer system and local sewer authority.*

7.0 Cane and Beet Sugar Industry

SIC 1081

Description of Industrial Sector

Establishments primarily engaged in processing raw cane sugar, sugar beets or starches to finished sucrose, glucose or fructose.

Materials Used and Wastes Generated

Similar to other food processing facilities, all processing operations for the cane and beet sugar industry are conducted indoors. Primary raw material is unrefined cane or beet sugar.

The major operations for a typical cane sugar refinery are:

- Vessel unloading - Raw sugar is unloaded from ships by buckets onto a conveyor for transport to the raw sugar warehouse. The conveyor gallery is covered to prevent the loss of raw sugar.
- Processing - Raw sugar is processed by a series of operations including melting, clarification, filtration and evaporation to produce fine sugar, cube sugar, icing sugar, brown sugar and syrups.
- Truck loading/unloading - Trucks and tankers transport other raw materials and finished products to and away from the plant.

Process wastewaters from sugar refineries contain high concentrations of organic compounds measured as biochemical oxygen demand.

Potential Sources of Stormwater Pollution

Stormwater from this industrial sector may contain high concentrations of suspended solids, organics, nutrients, oil and grease, and hydrocarbons.

The potential sources of stormwater pollution are generally limited to the following industrial activities:

- Unloading and loading;
- Chemical storage;
- Solid waste storage;
- Truck traffic;
- Vehicle/equipment washing;
- Loading/unloading of liquid materials;
- Waste solvent storage;
- Waste oil storage; and,
- Fuel storage.

The three primary potential sources are raw sugar unloading, chemical storage and solid waste storage. These sources can contribute to loadings of suspended solids, organics and chemical pollutants in stormwater. Analysis of stormwater samples from a sugar refinery in the Lower Fraser Basin showed high concentrations of suspended solids, chemical oxygen demand, total Kjeldahl nitrogen and oil and grease.

The potential for stormwater pollution from the other sources is generally lower. Truck traffic may distribute pollutants to other sections of the plant. Vehicle/equipment washwater, if not collected, will contribute significantly to stormwater pollution. Spills from loading/unloading operations and overfilling and leaks from storage tanks may add chemical pollution to receiving waters.

Recommended Stormwater Best Management Practices

The following BMPs are designed to minimize runoff of contaminated stormwater to receiving waters. The facility personnel should first evaluate and implement source control BMPs, followed by runoff control/treatment BMPs.

For sugar refining facilities, stormwater pollution is due to defined point sources (unloading of raw sugar, chemicals storage and solid waste storage). Source control BMPs can effectively control stormwater pollution from these point sources at relatively low costs.

Waste oil, fuel and chemicals stored on-site for cleaning, disinfection and growth/corrosion inhibition may spill or leak resulting in stormwater pollution. Even though the stormwater pollution potential from waste oil and chemical storage is small in relation to the other point sources, implementation of chemical, waste oil and fuel storage source control BMPs is strongly recommended because of the high environmental liability associated with an unconfined spill.

The recommended runoff control/treatment BMPs are designed to prevent stormwater from coming into contact with contaminated areas. Biological treatment may be needed for stormwater contaminated with raw sugar. Biological treatment may be accomplished by either an on-site treatment plant or the city biological sewage treatment plant. Discharge to the city sewer may require approval of the local sewer authority.

To ensure the proper selection of the runoff treatment BMP, the plant personnel should conduct sampling and analysis to determine stormwater characteristics. Plant personnel should also consult with the appropriate environmental regulatory agency prior to implementing the recommended treatment BMP.

1. Source Control BMPs

1.1 **Good Housekeeping and Preventive Maintenance** - *To minimize stormwater runoff of contaminants to receiving waters and to maintain a clean and orderly work environment which will lead to more organized and consistent handling of waste materials.*
• Sweep the site frequently to remove waste materials that can contribute to stormwater pollutant loadings. Collect and dispose of sweepings to approved landfills. • Implement a comprehensive preventive maintenance program for plant equipment and stormwater management devices. • Inspect and clean catchbasins, drainage inlets around raw sugar storage, chemical storage and solid waste storage areas frequently to ensure proper operation. A catchbasin should be cleaned if the depth of deposits are equal to or greater than 1/3 the depth from the basin to the invert of the lowest pipe into or out of the basin.

1.2	**Loading and Unloading** - *Prevent rainwater from coming into contact with potential pollutants.*

- Sweep areas around raw sugar unloading docks after each unloading operation. Washdown cleanup would contribute to higher pollutant loadings that may require treatment and should be avoided. Collect and return raw sugar for processing.
- Provide overhangs and site grading for loading/unloading areas with high stormwater pollution potential to prevent run-on of stormwater. Collect and convey contaminated stormwater from these areas to an on-site wastewater treatment or to the city sewer according to permit or local sewer authority requirements.
- Close storm drains near areas with high stormwater pollution potential to prevent discharges of contaminated stormwater to the receiving water.
- Pave chemical tank truck transfer areas with concrete. Design the transfer areas to prevent the run-on of uncontaminated stormwater from adjacent areas and to contain spills. Direct spills to a dead-end for removal or to process treatment.
- Use drip-pans when loading/unloading liquid materials. Place drip-pans at locations where spillage may occur, such as hose connections, hose reels and filler nozzles.
- Develop spill prevention and emergency cleanup plan and provide equipment and materials for cleanup.

1.3 Liquid Storage in Above-Ground Tanks/Containers - *To reduce the potential for an unconfined spill.*

- Surround above-ground liquid (e.g., acids, caustics, ammonia, biocides, waste oil, solvents) storage tanks with curbs/dikes to provide secondary containment storage. The enclosed volume should be the greater of either 10% of the total tank volume or 110% of the volume contained in the largest tank. Additional volume may be needed depending on the quantity of rainfall reaching the site.

- The floor area enclosed by the curbing should be covered with an impervious surface and sealed to prevent spills from contaminating groundwater. The paved floor should be sloped to a lined sump for collection of small spills.

- During the wet season, accumulated stormwater should be released frequently. Ideally, a roof-type structure should also be provided to minimize the collection of stormwater inside the curbed/diked area.

- Provide treatment by oil/water separators for stormwater from oil/fuel containment areas.

- Provide special ventilation, temperature control and fire protection where chemical stability or freezing protection are of concern.

- Secure storage buildings to prevent unauthorized persons from accessing storage containers and causing spills.

- Segregate and store incompatible or reactive materials in separate containment areas to prevent the mixing of chemicals should spills occur.

- Use drip-pans when loading/unloading liquid materials. Place drip-pans at locations where spillage may occur, such as hose connections, hose reels, filler nozzles and opened tanks/drums.

- Regularly inspect all containers for deterioration and leakage. Check the lids of drums to ensure they are in place and properly secured. Immediately contain leaks and repair the source.

- Develop spill prevention and emergency cleanup plan and provide equipment and materials for cleanup.

1.4	**Solid Waste Storage** - *Prevent rainwater from coming into contact with potential pollutants.*

- Provide roof covers for solid waste storage areas.
- For uncovered solid waste storage areas, grade and curb the perimeter to prevent the run-on of uncontaminated stormwater from adjacent areas as well as runoff of contaminated stormwater from the storage area.
- Collect and discharge contaminated stormwater to an on-site wastewater treatment system or to the city sewer according to permit or local sewer authority requirements.

1.5	**Vehicle/Equipment Washing** - *Minimize stormwater from coming into contact with potential pollutants.*

- Enclose the vehicle/equipment washing area with either walls and/or roof to prevent the entry of precipitation and to contain the washwater.
- Collect and treat washwater by an on-site wastewater treatment system or by the city wastewater treatment plant according to permit or local sewer authority requirements.
- Avoid the use of mobile wash services unless the washwater can be collected and treated.

1.6 Underground Storage Tanks (USTs) - *To reduce the potential for an undetected leak.*

- Perform monthly inventory of stored liquid products to detect leakage.
- Perform leak testing every two years. All USTs older than 10 years are suspect and consideration should be given for removal. An above-ground double-wall storage system is highly recommended as a replacement for underground fuel storage tanks.
- Pave the fueling area using concrete, not asphalt. Construct and size the fueling area to contain spills and prevent run-on of uncontaminated stormwater from surrounding areas.
- Collect and treat contaminated stormwater by oil/water separators. Clean the oil/water separator frequently to maintain proper operation. A roof may be provided over the fueling area to minimize the collection of stormwater in the oil/water separator.
- Implement tank filling procedures to prevent spills and overfills.
- Develop spill prevention and emergency cleanup plan and provide equipment and materials for cleanup.

2. Runoff Control/Treatment BMPs

2.1 Stormwater Flow Segregation - *To reduce the contaminated stormwater volume requiring treatment.*
• Grade and curb the site to prevent the runoff of contaminated stormwater and the run-on of uncontaminated stormwater from adjacent areas. Collect and convey contaminated stormwater for treatment. • Test and analyze rooftop runoff samples and non-process area stormwater samples to determine contaminant levels. Discharge uncontaminated stormwater to the storm drain below the treatment system or directly to the receiving water. Discharge contaminated stormwater to an on-site wastewater treatment system. • Pave and curb areas that may contribute to stormwater pollution to contain wastewater/contaminated stormwater from reaching storm drains. Collect and treat wastewater/contaminated stormwater for pollutants of concern.

2.2 Stormwater Treatment - *To minimize the stormwater contaminant loadings to the receiving water.*
• Conduct a stormwater sampling and analytical program to identify the volume and pollutant concentrations for the various sources of contaminated stormwater. For sugar refining operations, the major pollutants are suspended solids, organics and nutrients. • Treat stormwater contaminated with oil and grease in oil/water separators prior to discharge to the receiving water. • Treat stormwater contaminated with high concentrations of organic materials in an on-site wastewater treatment system or in a public wastewater treatment plant according to permit or local sewer authority requirements. • *Note - Contaminated stormwater should not be discharged to the sanitary sewer system except under special conditions defined by the local sewer authority or regulatory agency and provided the local sewer treatment plant can effectively treat the stormwater pollutants of concern. For most localities, this BMP requires approval of the local sewer authority. The allowable flow rate and contaminant concentrations may vary with the particular sewer system and local sewer authority.*

8o Other Food Products Industries (Egg Processing)

SIC 1099

Description of Industrial Sector

Establishments primarily engaged in processing eggs.

Materials Used and Wastes Generated

Similar to other food production facilities, all processing operations for this industry are conducted indoors. Primary raw material is eggs.

The major operations for a typical egg processing plant in the Lower Fraser Basin are:

- Truck unloading/loading - Raw materials and finished products are transported to and from the plant by trucks.
- Processing - Eggs are processed to produce graded eggs, powdered eggs and frozen eggs.

Solid wastes and process wastewaters are produced from egg processing facilities.

Process wastewaters contain high concentrations of organic compounds. These highly contaminated biological wastes should be discharged to the city sewer or to process treatment. Biological treatment, such as aerated lagoons, is commonly used to reduce the organic loading of the wastewater. Depending on the water quality of the treated effluent, it may be discharged to receiving water, or to land or the city sewer for additional treatment.

The egg shells are stored in silos awaiting disposal on land.

Potential Sources of Stormwater Pollution

Stormwater from this industrial sector may contain high concentrations of organics and nutrients. The potential sources of stormwater pollution from this industrial sector are generally limited to the following industrial activities:

- Loading and unloading;
- Solid waste storage;
- Wastewater disposal;
- Truck traffic;
- Chemical storage;
- Waste oil storage; and,
- Fuel storage.

The primary potential pollution sources are loading and unloading, solid waste storage and wastewater disposal practices. These sources can contribute to higher loadings of organics, nutrients and chemical pollutants in stormwater. Analysis of stormwater samples from an egg processing facility in the Lower Fraser Basin showed the stormwater from this industrial sector can have elevated concentrations of organic nitrogen and phosphorus. Metals are not pollutants of concern for this industrial sector.

The potential for stormwater pollution from the other sources is generally lower. Truck traffic may contribute to high solids loadings in stormwater. Overfilling and leaks from liquid storage tanks may contribute to oil and grease and chemical pollutants. Stormwater contamination potentials may increase substantially for facilities with larger storage operations.

Recommended Stormwater Best Management Practices

The following BMPs are designed to minimize runoff of contaminated stormwater to receiving waters. The facility personnel should first evaluate and implement source control BMPs, followed by runoff control/treatmentBMPs.

For egg processing facilities, stormwater pollution is due to defined point sources (loading/unloading of eggs, solid waste storage and wastewater disposal). Source control BMPs can effectively control stormwater pollution from loading/unloading operations and solid waste storage at relatively low costs. Stormwater pollution from land disposal of wastewater can be minimized by proper land application practices. The source control measure for the land disposal of wastewater is either to improve effluent treatment or to discharge to the city sewer system for additional treatment. Either of these control measures may require large capital expenditures.

Waste oil, fuel and chemicals stored on-site for cleaning, disinfection and growth/corrosion inhibition may spill or leak, resulting in stormwater pollution. Even though the stormwater pollution potential from waste oil and chemical storage is small in relation to the other point sources, implementation of chemical, waste oil and fuel storage source control BMPs is strongly recommended because of the high environmental liability associated with an unconfined spill.

The recommended runoff control/treatment BMPs are designed to prevent stormwater from coming into contact with contaminated areas. Biological treatment may be needed for stormwater contaminated with high concentrations of organic materials. Biological treatment may be accomplished by either an on-site treatment plant or the city biological sewage treatment plant. Discharge to the city sewer may require approval of the local sewer authority.

To ensure the proper selection of the runoff treatment BMP, the plant personnel should conduct sampling and analysis to determine stormwater characteristics. Plant personnel should also consult with the appropriate environmental regulatory agency prior to implementing the recommended treatment BMP.

1. Source Control BMPs

1.1 **Good Housekeeping and Preventive Maintenance** - *To minimize stormwater runoff of contaminants to receiving waters and to maintain a clean and orderly work environment which will lead to more organized and consistent handling of waste materials.*
• Sweep loading docks and solid waste storage areas frequently to remove wastes that can contribute to stormwater pollution. Collect and dispose of sweepings to storage dumpsters for disposal in approved landfills. • Implement a comprehensive preventive maintenance program for plant equipment and stormwater management devices. • Inspect and clean catchbasins, drainage inlets around loading docks and solid waste storage areas frequently to ensure proper operation. A catchbasin should be cleaned if the depth of deposits are equal to or greater than 1/3 the depth from the basin to the invert of the lowest pipe into or out of the basin.

1.2	**Loading and Unloading** - *Prevent rainwater from coming into contact with potential pollutants.*

- Provide overhangs and site grading for loading/unloading areas with high stormwater pollution potential to prevent run-on of stormwater. Collect and convey contaminated stormwater from these areas to an on-site wastewater treatment or to the city sewer according to permit or local sewer authority requirements.
- Close storm drains near areas with high stormwater pollution potential to prevent discharges of contaminated stormwater to the receiving water.
- Pave chemical tank truck transfer areas with concrete. Design the transfer area to prevent the run-on of uncontaminated stormwater from adjacent areas and to contain spills. Direct spills to a dead-end for removal or to process treatment.
- Use drip-pans when loading/unloading liquid materials. Place drip-pans at locations where spillage may occur, such as hose connections, hose reels and filler nozzles.
- Develop spill prevention and emergency cleanup plan and provide equipment and materials for cleanup.

1.3	**Solid Waste Storage** - *Prevent rainwater from coming into contact with potential pollutants.*

- Provide roof covers for solid waste storage areas.
- For uncovered solid waste storage areas, grade and curb the perimeter to prevent the run-on of uncontaminated stormwater from adjacent areas as well as runoff of contaminated stormwater from the storage area.
- Collect and discharge contaminated stormwater to an on-site wastewater treatment system or to the city sewer according to permit or local sewer authority requirements.

1.4 **Wastewater Disposal** - *Minimize stormwater runoff from land disposal areas.*
• Grade the waste disposal areas to minimize the runoff of contaminated stormwater to the receiving water. • Avoid land disposal *of wastewater* when it is raining or when the ground is frozen or saturated with water. • Maintain adequate barriers between the land application site and the receiving water. • If feasible, discontinue land application practices. Alternatives to land application include biological treatment or discharge to the city sewer system according to permit or local sewer authority requirements.

1.5 Liquid Storage in Above-Ground Tanks/Containers - *To reduce the potential for an unconfined spill.*

- Surround above-ground liquid (e.g., chemicals, waste oil, fuel) storage tanks with curbs/dikes to provide secondary containment storage. The enclosed volume should be the greater of either 10% of the total tank volume or 110% of the volume contained in the largest tank. Additional volume may be needed depending on the quantity of rainfall reaching the site.

- The floor area enclosed by the curbing should be covered with an impervious surface and sealed to prevent spills from contaminating groundwater. The paved floor should be sloped to a lined sump for collection of small spills.

- During the wet season, accumulated stormwater should be released frequently. Ideally, a roof-type structure should also be provided to minimize the collection of stormwater inside the curbed/diked area.

- Provide treatment by oil/water separators for stormwater from oil/fuel containment areas.

- Provide special ventilation, temperature control and fire protection where chemical stability or freezing protection are of concern.

- Secure storage buildings to prevent unauthorized persons from accessing storage containers and causing spills.

- Segregate and store incompatible or reactive materials in separate containment areas to prevent the mixing of chemicals should spills occur.

- Use drip-pans when loading/unloading liquid materials. Place drip-pans at locations where spillage may occur, such as hose connections, hose reels, filler nozzles and opened tanks/drums.

- Regularly inspect all containers for deterioration and leakage. Check the lids of drums to ensure they are in place and properly secured. Immediately contain leaks and repair the source.

- Develop spill prevention and emergency cleanup plan and provide equipment and materials for cleanup.

1.6 Underground Storage Tanks (USTs) - *To reduce the potential for an undetected leak.*

- Perform monthly inventory of stored liquid products to detect leakage.
- Perform leak testing every two years. All USTs older than 10 years are suspect and consideration should be given for removal. An above-ground double-wall storage system is highly recommended as a replacement for underground fuel storage tanks.
- Pave the fueling area using concrete, not asphalt. Construct and size the fueling area to contain spills and prevent run-on of uncontaminated stormwater from surrounding areas.
- Collect and treat contaminated stormwater by oil/water separators. Clean the oil/water separator frequently to maintain proper operation. A roof may be provided over the fueling area to minimize the collection of stormwater in the oil/water separator.
- Implement tank filling procedures to prevent spills and overfills.
- Develop spill prevention and emergency cleanup plan and provide equipment and materials for cleanup.

2. Runoff Control/Treatment BMPs

2.1 **Stormwater Flow Segregation** - *To reduce the contaminated stormwater volume requiring treatment.*
• Grade and curb the site to prevent the runoff of contaminated stormwater and the run-on of uncontaminated stormwater from adjacent areas. Collect and convey contaminated stormwater for treatment. • Test and analyze rooftop runoff samples and non-process area stormwater samples to determine contaminant levels. Discharge uncontaminated stormwater to the storm drain below the treatment system or directly to the receiving water. Discharge contaminated stormwater to an on-site wastewater treatment system. • Pave and curb areas that may contribute to stormwater pollution to contain wastewater/contaminated stormwater from reaching storm drains. Collect and treat wastewater/contaminated stormwater for pollutants of concern.

2.2 **Stormwater Treatment** - *To minimize the stormwater contaminant loadings to the receiving water.*
• Conduct a stormwater sampling and analytical program to identify the volume and pollutant concentrations for the various sources of contaminated stormwater. For egg processing facilities, the major pollutants are suspended solids, organics and nutrients. • Treat stormwater contaminated with oil and grease in oil/water separators prior to discharge to the receiving water. • Treat stormwater contaminated with high concentrations of organic materials in an on-site biological wastewater treatment system or in a public wastewater treatment plant according to permit or local sewer authority requirements. • *Note - Contaminated stormwater should not be discharged to the sanitary sewer system except under special conditions defined by the local sewer authority or regulatory agency and provided the local sewer treatment plant can effectively treat the stormwater pollutants of concern. For most localities, this BMP requires approval of the local sewer authority. The allowable flow rate and contaminant concentrations may vary with the particular sewer system and local sewer authority.*

9.0 Brewery Products Industry

SIC 1131

Description of Industrial Sector

Establishments primarily engaged in steeping, boiling and fermenting malt and hops to manufacture malt beverages.

Materials Used and Wastes Generated

All processing activities are conducted indoors. The principal raw materials are corn, malt and barley. Other materials include carbon dioxide, caustic soda, hypochlorite and packaging materials. Commonly, raw materials and finished products are transported to and from the plant by trucks. For some facilities, rail cars may be used to bring in the bulk materials corn and malt.

The major operations for the brewery in the Lower Fraser Basin evaluated are:

- Truck/rail unloading/loading - Raw materials and finished products are transported to and from the plant by trucks and rail cars.
- Processing - The raw materials are boiled and fermented to manufacture malt beverages.
- Packaging - The malt beverages are packaged for shipment.

Both solid wastes and process wastewaters are produced from brewery operations.

Process wastewaters contain high concentrations of organic compounds and solids that contribute to high oxygen demand. These highly contaminated biological wastes should be discharged to process treatment or to the city sewer. Biological treatment, such as aerated lagoons, can be used to reduce the organic loading of the wastewater.

The organic residues after pressing are stored in a silo prior to disposal.

Potential Sources of Stormwater Pollution

Stormwater from this industrial sector may contain high concentrations of suspended solids, organics and nutrients.

The potential sources of stormwater pollution are generally limited to the following industrial activities:

- Loading and unloading;
- Solid waste storage;
- Vehicle washing;
- Truck traffic;
- Chemical storage; and,
- Waste oil storage.

Loading and unloading, solid waste storage and vehicle washing are the primary potential sources of contamination. These sources can contribute to high loadings of organics and nutrients in stormwater. Analysis of stormwater samples from a brewery products facility in the Lower Fraser Basin showed the stormwater from this industrial sector can have elevated concentrations of organic nitrogen.

The potential for stormwater pollution from the other sources is generally lower. Truck traffic may contribute to solids and oil and grease loadings in stormwater. Overfilling and leaks from waste oil and chemical storage tanks may contribute to oil and grease and chemical pollutant. Stormwater contamination potential may increase substantially for facilities with larger storage operations.

Recommended Stormwater Best Management Practices

The following BMPs are designed to minimize runoff of contaminated stormwater to receiving waters. The facility personnel should first evaluate and implement source control BMPs, followed by runoff control/treatmentBMPs.

For brewery operations, stormwater pollution is due to defined point sources (loading/unloading of raw materials, solid waste storage and truck washing). All other production processes are conducted indoors. Source control BMPs can effectively control stormwater pollution from these point sources at relatively low costs.

Waste oil and chemicals stored on-site for cleaning, disinfection and growth/corrosion inhibition may spill or leak, resulting in stormwater pollution. Even though the stormwater pollution potential from waste oil and chemical storage is small in relation to the other point sources, implementation of waste oil and chemical source control BMPs is strongly recommended because of the high environmental liability associated with an unconfined spill.

The recommended runoff control/treatment BMPs are designed to prevent stormwater from coming into contact with contaminated areas. Biological treatment may be needed for stormwater contaminated with high concentrations of organic materials. Biological treatment may be accomplished by either an on-site treatment plant or the city biological sewage treatment plant. Discharge to the city sewer may require approval of the local sewer authority.

To ensure the proper selection of the runoff treatment BMP, the plant personnel should conduct sampling and analysis to determine stormwater characteristics. Plant personnel should also consult with the appropriate environmental regulatory agency prior to implementation of the recommended treatment BMP.

1. Source Control BMPs

1.1 Good Housekeeping and Preventive Maintenance - *To minimize stormwater runoff of contaminants to receiving waters and to maintain a clean and orderly work environment which will lead to more organized and consistent handling of waste materials.*

- Sweep loading and solid waste storage areas frequently to remove wastes that can contribute to stormwater pollution. Collect and dispose of sweepings to storage dumpsters for disposal in approved landfills.

- Implement a comprehensive preventive maintenance program for plant equipment and stormwater management devices.

- Inspect and clean catchbasins, drainage inlets around loading docks and solid waste storage areas frequently to ensure proper operation. A catchbasin should be cleaned if the depth of deposits are equal to or greater than 1/3 the depth from the basin to the invert of the lowest pipe into or out of the basin.

1.2	**Loading and Unloading** - *Prevent rainwater from coming into contact with potential pollutants.*

- Sweep corn and malt unloading areas after each unloading operation to remove spilled materials.
- Pave chemical tank truck transfer areas with concrete. Design the transfer areas to prevent the run-on of uncontaminated stormwater from adjacent areas and to contain spills. Direct spills to a dead-end for removal or to process treatment.
- Use drip-pans when loading/unloading liquid materials. Place drip-pans at locations where spillage may occur, such as hose connections, hose reels and filler nozzles.
- Develop spill prevention and emergency cleanup plan and provide equipment and materials for cleanup.

1.3	**Solid Waste Storage** - *Prevent rainwater from coming into contact with potential pollutants.*

- Provide roof covers for solid waste storage areas.
- For uncovered solid waste storage areas, grade and curb the perimeter to prevent the run-on of uncontaminated stormwater from adjacent areas as well as runoff of contaminated stormwater from the storage area.
- Collect and discharge contaminated stormwater to an on-site wastewater treatment system or to the city sewer according to permit or local sewer authority requirements.

1.4	**Vehicle Washing** - *Minimize stormwater from coming into contact with potential pollutants.*

- Enclose the vehicle/equipment washing area with walls and/or roof to prevent the entry of precipitation and to contain the washwater.
- Collect and treat washwater by an on-site wastewater treatment system or by the city wastewater treatment plant according to permit or local sewer authority requirements.
- Avoid the use of mobile wash services unless the washwater can be collected and treated.

1.5 Liquid Storage in Above-Ground Tanks/Containers - *To reduce the potential for an unconfined spill.*

- Surround above-ground liquid (e.g., chemicals, waste oil) storage tanks with curbs/dikes to provide secondary containment storage. The enclosed volume should be the greater of either 10% of the total tank volume or 110% of the volume contained in the largest tank. Additional volume may be needed depending on the quantity of rainfall reaching the site.

- The floor area enclosed by the curbing should be covered with an impervious surface and sealed to prevent spills from contaminating groundwater. The paved floor should be sloped to a lined sump for collection of small spills.

- During the wet season, accumulated stormwater should be released frequently. Ideally, a roof-type structure should also be provided to minimize the collection of stormwater inside the curbed/diked area.

- Provide treatment by oil/water separators for stormwater from oil/fuel containment areas.

- Provide special ventilation, temperature control and fire protection where chemical stability or freezing protection are of concern.

- Secure storage buildings to prevent unauthorized persons from accessing storage containers and causing spills.

- Segregate and store incompatible or reactive materials in separate containment areas to prevent the mixing of chemicals should spills occur.

- Use drip-pans when loading/unloading liquid materials. Place drip-pans at locations where spillage may occur, such as hose connections, hose reels, filler nozzles and opened tanks/drums.

- Regularly inspect all containers for deterioration and leakage. Check the lids of drums to ensure they are in place and properly secured. Immediately contain leaks and repair the source.

- Develop spill prevention and emergency cleanup plan and provide equipment and materials for cleanup.

2. Runoff Control/Treatment BMPs

2.1 Stormwater Flow Segregation - *To reduce the contaminated stormwater volume requiring treatment.*
• Grade and curb the site to prevent the runoff of contaminated stormwater and the run-on of uncontaminated stormwater from adjacent areas. Collect and convey contaminated stormwater for treatment. • Test and analyze rooftop runoff samples and non-process area stormwater samples to determine contaminant levels. Discharge uncontaminated stormwater to the storm drain below the treatment system or directly to the receiving water. Discharge contaminated stormwater to an on-site wastewater treatment system. • Pave and curb areas that may contribute to stormwater pollution to contain wastewater/contaminated stormwater from reaching storm drains. Collect and treat wastewater/contaminated stormwater for pollutants of concern.

2.2 Stormwater Treatment - *To minimize the stormwater contaminant loadings to the receiving water.*
• Conduct a stormwater sampling and analytical program to identify the volume and pollutant concentrations for the various sources of contaminated stormwater. For breweries, the major pollutants are suspended solids, organics and nutrients. • Treat stormwater contaminated with oil and grease in oil/water separators prior to discharge to the receiving water. • Treat stormwater contaminated with high concentrations of organic materials in an on-site wastewater treatment system or in a public wastewater treatment plant according to permit or local sewer authority requirements. • *Note - Contaminated stormwater should not be discharged to the sanitary sewer system except under special conditions defined by the local sewer authority or regulatory agency and provided the local sewer treatment plant can effectively treat the stormwater pollutants of concern. For most localities, this BMP requires approval of the local sewer authority. The allowable flow rate and contaminant concentrations may vary with the particular sewer system and local sewer authority.*

10º Sawmill and Planing Mill Products Industry

SIC 2512

Description of Industrial Sector

Establishments primarily engaged in sawing and planing lumber from round woods. This industrial category includes sawmills, and all businesses that make wood products using cut wood, with the exception of wood treatment business.

Materials Used and Wastes Generated

Facilities classified under this industrial category use wood as their primary raw material. Byproducts are wood chips, hog fuel, sawdust, shavings and slabs. Although there is diversity among the types of final products that are produced, there are common industrial activities performed among them.

For the Lower Fraser Basin sawmill and planing mill that was evaluated, the major industrial activities include:

- Log storage and debarking - For many sawmill and planing facilities in the Lower Fraser Basin, wet storage or wet decking is often used to store logs. Water is often used to remove bark.
- Sawing and planing - Depending on the facilities, sawing operation may be conducted outside under cover. Planing is commonly conducted indoors.
- Wood surface protection - At many hardwood sawmills, wood surface protection is conducted to prevent sap stain caused by fungus. Surface protection is accomplished by either spraying, dipping or continuous immersion.
- Wood product storage - Finished products are stored outside. Most of the wood products are exposed to the weather; some wood products are wrapped to minimize impact of precipitation. For most wood product operations, the wood product storage area is paved.

Bark and other byproducts are usually stored temporarily on-site and subsequently delivered to other users or disposal.

Potential Sources of Stormwater Pollution

Stormwater from this industrial sector may contain high concentrations of suspended solids, organics, and oil and grease.

The potential sources of stormwater pollution are generally limited to the following industrial activities:

- Outdoor manufacturing;
- Lubricant and waste oil storage;
- Vehicle/equipment maintenance and washing;
- Truck traffic;
- Hydraulic system; and,
- Fuel storage.

The primary potential pollution sources are outdoor manufacturing, lubricant/waste oil storage and vehicle/equipment washing. These sources can contribute to loadings of suspended solids, organics, nutrients, and oil and grease in stormwater. Analysis of samples from a sawmill and planing mill in the Lower Fraser Basin showed the stormwater from this industrial sector can have high concentrations of total suspended solids, oil and grease and organic compounds.

The potential for contamination of stormwater from the other sources is generally lower. Truck traffic may contribute to suspended solids loadings in stormwater. Overfilling and leaks from fuel storage tanks may contribute to oil and grease. Stormwater contamination potentials may increase substantially for facilities with larger fueling and storage operations.

Recommended Stormwater Best Management Practices

The following BMPs are designed to minimize runoff of contaminated stormwater to receiving waters. The facility personnel should first evaluate and implement source control BMPs, followed by runoff control/treatment BMPs.

For sawmill and planing mill operations, stormwater pollution is due to defined point sources (outdoor manufacturing, lubricant/waste oil storage and vehicle/equipment washing). Source control BMPs can minimize stormwater pollution from these point sources.

Hydraulic fluid and fuel stored on-site may spill or leak, resulting in stormwater pollution. Even though the stormwater pollution potential from waste oil and chemical storage is small in relation to the other point sources, implementation of liquid storage source control BMPs is strongly recommended because of the high environmental liability associated with an unconfined spill.

The recommended runoff control/treatment BMPs are designed to prevent stormwater from coming into contact with contaminated areas. Stormwater contaminated with oil and grease may need to be treated in oil/water separators prior to discharge to the receiving water. Detention ponds can be used to reduce the solids in the stormwater.

To ensure the proper selection of the runoff treatment BMP, the plant personnel should conduct sampling and analysis to determine stormwater characteristics. Plant personnel should also consult with the appropriate environmental regulatory agency prior to implement the recommended treatment BMP.

1. Source Control BMPs

1.1 Good Housekeeping and Preventive Maintenance - *To minimize stormwater runoff of contaminants to receiving waters and to maintain a clean and orderly work environment which will lead to more organized and consistent handling of waste materials.*

- Sweep outdoor manufacturing and solids waste storage areas frequently to remove wastes that can contribute to stormwater pollution. Collect and dispose of sweepings to storage dumpsters for disposal in approved landfills.

- Implement a comprehensive preventive maintenance program for plant equipment and stormwater management devices.

- Inspect and clean catchbasins, drainage inlets around loading docks and solid waste storage areas frequently to ensure proper operation. A catchbasin should be cleaned if the depth of deposits are equal to or greater than 1/3 the depth from the basin to the invert of the lowest pipe into or out of the basin.

- Inspect and clean oil/water separators frequently to remove accumulated oil to ensure proper operation.

1.2	**Outdoor Manufacturing** - *Prevent rainwater from coming into contact with potential pollutants.*

- Enclose, cover or contain the outdoor manufacturing areas (debarking and sawing) to the maximum extent practical to prevent solid materials from reaching storm drains or receiving waters and to prevent precipitation from coming into contact with liquid and solid waste residues.
- Use sweepers regularly to clean up sawdust and woodwaste. Avoid washdown cleanup.
- Grade the outdoor process areas and woodchip storage areas to divert uncontaminated stormwater flow and to collect contaminated stormwater for treatment. Treat stormwater contaminated with oil in oil/water separators and stormwater containing high suspended solids by detention ponds.

1.3 Lubricant, Waste Oil, and Fuel Storage - *To reduce the potential for an unconfined spill and the discharge of contaminated stormwater..*

- Surround above-ground liquid (e.g., lubricants, waste oil, fuel) storage tanks with curbs/dikes to provide secondary containment storage. The enclosed volume should be the greater of either 10% of the total tank volume or 110% of the volume contained in the largest tank. Additional volume may be needed depending on the quantity of rainfall reaching the site.

- The floor area enclosed by the curbing should be covered with an impervious surface and sealed to prevent spills from contaminating groundwater. The paved floor should be sloped to a lined sump for collection of small spills.

- During the wet season, accumulated stormwater should be released frequently. Ideally, a roof-type structure should also be provided to minimize the collection of stormwater inside the curbed/diked area.

- Provide treatment by oil/water separators for stormwater from oil/fuel containment areas.

- Provide special ventilation, temperature control and fire protection where chemical stability or freezing protection are of concern.

- Secure storage buildings to prevent unauthorized persons from accessing storage containers and causing spills.

- Segregate and store incompatible or reactive materials in separate containment areas to prevent the mixing of chemicals should spills occur.

- Use drip-pans when loading/unloading liquid materials. Place drip-pans at locations where spillage may occur, such as hose connections, hose reels, filler nozzles and opened tanks/drums.

- Regularly inspect all containers for deterioration and leakage. Check the lids of drums to ensure they are in place and properly secured. Immediately contain leaks and repair the source.

- Develop spill prevention and emergency cleanup plan and provide equipment and materials for cleanup.

1.4	**Vehicle/Equipment Maintenance and Washing** - *Minimize stormwater from coming into contact with potential pollutants.*

- Use drip-pans under all vehicles and equipment undergoing maintenance.
- Pave with concrete and grade the maintenance area to prevent the run-on of uncontaminated stormwater from adjacent areas as well as runoff of contaminated stormwater.
- Treat contaminated stormwater from the maintenance area in an oil/water separator prior to discharge to the receiving water.
- Regularly clean the oil/water separator to remove accumulated oils and solids to maintain optimum performance.
- Enclose the vehicle/equipment washing area with either walls and/or roof to prevent the entry of precipitation and to contain the washwater.
- Collect and treat washwater to remove suspended solids by gravity settling. Regularly clean the settling pond to remove accumulated solids to maintain optimum performance.
- Avoid the use of mobile wash services.

1.5	**Hydraulic System** - *Prevent rainwater from coming into contact with potential pollutants and reduce the potential for an unconfined spill.*

- Regularly inspect the hydraulic system for deterioration and leaks. Immediately contain leaks and repair the source.
- Treat contaminated stormwater in an oil/water separator prior to discharge to the receiving water.
- Use drip-pans when loading/unloading liquid materials. Place drip-pans at locations where spillage may occur, such as hose connections, hose reels and filler nozzles.
- Implement a centralized hydraulic system to minimize sources of potential leaks. Enclose the hydraulic system to prevent run-on of uncontaminated stormwater. Pave and grade the floor of the enclosed structure with concrete to contain and direct spills to a dead-end sump.

2. Runoff Control/Treatment BMPs

2.1 **Stormwater Flow Segregation** - *To reduce the contaminated stormwater volume requiring treatment.*

- Grade and curb the site to prevent the runoff of contaminated stormwater and the run-on of uncontaminated stormwater from adjacent areas. Collect and convey contaminated stormwater for treatment.
- Test and analyze rooftop runoff samples and non-process area stormwater samples to determine contaminant levels. Discharge uncontaminated stormwater to the storm drain below the treatment system or directly to the receiving water. Discharge contaminated stormwater to an on-site wastewater treatment system.
- Pave and curb areas that may contribute to stormwater pollution to contain wastewater/contaminated stormwater from reaching storm drains. Collect and treat wastewater/contaminated stormwater for pollutants of concern.

2.2 **Stormwater Treatment** - *To minimize the stormwater contaminant loadings to the receiving water.*

- Conduct a sampling and analytical program to identify the volume and pollutant concentrations for the various sources of contaminated stormwater. For sawmill and planing mill operations, the major pollutants are suspended solids, and oil and grease.
- Treat stormwater contaminated with oil and grease in oil/water separators prior to discharge to the receiving water.
- Treat stormwater contaminated with suspended solids by using infiltration or detention ponds. For facilities with limited area, where detention pond is not possible, infiltration pond is the preferred option.
- *Note - Contaminated stormwater should not be discharged to the sanitary sewer system except under special conditions defined by the local sewer authority or regulatory agency and provided the local sewer treatment plant can effectively treat the stormwater pollutants of concern. For most localities, this BMP requires approval of the local sewer authority. The allowable flow rate and contaminant concentrations may vary with the particular sewer system and local sewer authority.*

11º Wire and Wire Products Industries

SIC 305

Description of Industrial Sector

Establishments primarily engaged in manufacturing wire and woven mesh; fasteners such as nails, nuts and bolts; and other wire products.

Materials Used and Wastes Generated

The primary raw material is steel rod; the principle wire production processes are:

- Rod cleaning - Steel rod is cleaned to remove rust, scale and dirt by dipping into tanks of hot diluted hydrochloric acid, followed by rinsing with city water, and further treatment in borax or lime solution. The cleaned rod is dried in hot air from a natural gas blower before storage. Acid is used in the cleaning operation. Spent acid is sold as a byproduct.

- Drawing - Rod is pulled through progressively smaller dies to produce wire of varying gauges.

- Galvanizing - Drawn wire is annealed and degreased by passing through molten lead, followed by rinsing. The degreased wire is passed through hot hydrochloric acid, followed by rinsing, immersion in ammonium chloride solution and drying. The prepared wire is galvanized in a zinc bath, followed by cooling and wax coating.

- Annealing - Coils of wire are annealed in a furnace in a nitrogen-enriched atmosphere.

Both solid and liquid wastes are produced from this industrial category.

Process wastewaters are collected for treatment in an on-site treatment plant. Caustic soda is added to neutralize the acidic wastewaters to precipitate dissolved metals as hydroxides. The treated wastewater is discharged to the city sewer or to the receiving water. The settled hydroxides are discharged toexfiltration lagoons or shipped off-site for disposal.

Solid wastes, baghouse dust, lead dross, zinc dross and scrap metal are sold for recycling.

Potential Sources of Stormwater Pollution

Stormwater from this industrial sector may contain high levels of suspended solids, chemical oxygen demand, organic nitrogen, phosphorus and metals.

The potential sources of stormwater pollution are generally limited to the following industrial activities:

- Loading and unloading;
- Dust emission;
- Solid waste storage;
- Vehicle/equipment maintenance;
- Truck traffic;
- Chemical storage; and,
- Fuel and lubricant storage.

Among the potential sources, the first five are the primary ones. Loading and unloading of raw and finished materials transfer contaminants from within the plant to outside areas, resulting in stormwater pollution. Dust emissions from production processes may also contribute to metals in stormwater runoff. Analysis of samples from facilities in the Lower Fraser Basin showed the stormwater from this industrial sector can have elevated pH (above 8) and high levels of total suspended solids, organic nitrogen, phosphorus, chemical oxygen demand and metals (lead and zinc).

The potential for stormwater pollution from chemical, fuel and lubricant storage is generally lower. Overfilling and leaks from storage tanks may contribute to chemical contaminants and oil and grease.

Recommended Stormwater Best Management Practices

The following BMPs are designed to minimize runoff of contaminated stormwater to receiving waters. The facility personnel should first evaluate and implement source control BMPs, followed by runoff control/treatment BMPs.

For wire and wire products facilities, stormwater pollution is due to defined point sources. Implementation of source control BMPs can minimize stormwater pollution. Other source control BMPs are designed to minimize the potential for stormwater contamination.

Even though the stormwater pollution potential is small from chemical or fuel spills and leaks in relation to the other point sources, implementation of liquid storage source control BMPs is strongly recommended because of the high environmental liability associated with an unconfined spill.

The recommended runoff control/treatment BMPs are designed to prevent stormwater from coming into contact with contaminated areas. For contaminated stormwater, treatment by an appropriate process may be needed prior to discharge to the receiving water. For this industrial sector, the appropriate treatment processes are oil/water separators for oil-contaminated stormwater and a physical/chemical system for stormwater with high concentrations of dissolved metals.

To ensure the proper selection of the runoff treatment BMP, the plant personnel should conduct sampling and analysis to determine stormwater characteristics. Plant personnel should also consult with the appropriate environmental regulatory agency prior to implementation of the recommended treatment BMP.

1. Source Control BMPs

1.1 Good Housekeeping and Preventive Maintenance - *To minimize stormwater runoff of contaminants to receiving waters and to maintain a clean and orderly work environment which will lead to more organized and consistent handling of waste materials.*

- Sweep the plant area frequently to remove wastes that can contribute to stormwater pollution. Collect and dispose of sweepings to storage dumpsters for disposal in approved landfills.

- Implement a comprehensive preventive maintenance program for plant equipment and stormwater management devices.

- Inspect and clean catchbasins, drainage inlets around loading docks and solid waste storage areas frequently to ensure proper operation. A catchbasin should be cleaned if the depth of deposits are equal to or greater than 1/3 the depth from the basin to the invert of the lowest pipe into or out of the basin.

- Inspect and clean oil/water separators frequently to remove accumulated oil to ensure proper operation.

1.2	**Loading and Unloading** - *Prevent rainwater from coming into contact with potential pollutants.*

- Provide overhangs and site grading for loading/unloading areas with high stormwater pollution potential to prevent run-on of stormwater. For wire products operations, these areas are plant entrances for the transfer of raw and finished products. Collect and convey contaminated stormwater from these areas to an on-site wastewater treatment plant.
- Close storm drains near areas of high stormwater pollution potential to prevent discharges of contaminated stormwater to the receiving water.
- Pave chemical tank truck transfer areas with concrete. Design the transfer areas to prevent the run-on of uncontaminated stormwater from adjacent areas and to contain spills. Direct spills to a dead-end for removal or to process treatment.
- Use drip-pans when loading/unloading liquid materials. Place drip-pans at locations where spillage may occur, such as hose connections, hose reels and filler nozzles.
- Develop spill prevention and emergency cleanup plan and provide equipment and materials for cleanup.

1.3	**Dust Emission** - *Minimize the discharge of contaminated stormwater to the receiving water.*

- Test and analyze rooftop runoff samples to determine metal contaminant levels.
- Discharge uncontaminated roof runoff to the receiving water or to the storm drain below the treatment system according to permit or local sewer authority requirements.
- Collect and discharge contaminated roof runoff to an on-site wastewater treatment system.

1.4	**Solid Waste Storage** - *Prevent rainwater from coming into contact with potential pollutants.*

- Provide roof covers for solid waste storage areas.
- For uncovered solid waste storage areas, grade and curb the perimeter to prevent the run-on of uncontaminated stormwater from adjacent areas as well as runoff of contaminated stormwater from the storage area.
- Grade open storage areas to minimize pooling of stormwater. A minimum slope of 1.5% is recommended.
- Collect and discharge contaminated stormwater to an on-site wastewater treatment system for the removal of dissolved metals.

1.5	**Vehicle/Equipment Maintenance** - *Minimize stormwater from coming into contact with potential pollutants.*

- Use drip-pans under all vehicles and equipment undergoing maintenance.
- Pave with concrete and grade the maintenance area to prevent the run-on of uncontaminated stormwater from adjacent areas as well as runoff of contaminated stormwater.
- Treat contaminated stormwater from the maintenance area in an oil/water separator prior to discharge to the receiving water.
- Regularly clean the oil/water separator to remove accumulated oils and solids to maintain optimum performance.

1.6 Liquid Storage in Above-Ground Tanks/Containers - *To reduce the potential for an unconfined spill.*

- Surround above-ground liquid (e.g., chemicals, fuel) storage tanks with curbs/dikes to provide secondary containment storage. The enclosed volume should be the greater of either 10% of the total tank volume or 110% of the volume contained in the largest tank. Additional volume may be needed depending on the quantity of rainfall reaching the site.

- The floor area enclosed by the curbing should be covered with an impervious surface and sealed to prevent spills from contaminating groundwater. The paved floor should be sloped to a lined sump for collection of small spills.

- During the wet season, accumulated stormwater should be released frequently. Ideally, a roof-type structure should also be provided to minimize the collection of stormwater inside the curbed/diked area.

- Provide treatment by oil/water separators for stormwater from oil/fuel containment areas.

- Provide special ventilation, temperature control and fire protection where chemical stability or freezing protection are of concern.

- Secure storage buildings to prevent unauthorized persons from accessing storage containers and causing spills.

- Segregate and store incompatible or reactive materials in separate containment areas to prevent the mixing of chemicals should spills occur.

- Use drip-pans when loading/unloading liquid materials. Place drip-pans at locations where spillage may occur such as hose connections, hose reels, filler nozzles and opened tanks/drums.

- Regularly inspect all containers for deterioration and leakage. Check the lids of drums to ensure they are in place and properly secured. Immediately contain leaks and repair the source.

- Develop spill prevention and emergency cleanup plan and provide equipment and materials for cleanup.

2. Runoff Control/Treatment BMPs

2.1 Stormwater Flow Segregation - *To reduce the contaminated stormwater volume requiring treatment.*
• Grade and curb the site to prevent the runoff of contaminated stormwater and the run-on of uncontaminated stormwater from adjacent areas. Collect and convey contaminated stormwater for treatment. • Test and analyze rooftop runoff samples and non-process area stormwater samples to determine contaminant levels. Discharge uncontaminated stormwater to the storm drain below the treatment system or directly to the receiving water. Discharge contaminated stormwater to an on-site wastewater treatment system. • Pave and curb areas that may contribute to stormwater pollution to contain wastewater/contaminated stormwater from reaching storm drains. Collect and treat wastewater/contaminated stormwater for pollutants of concern.

2.2 Stormwater Treatment - *To minimize the stormwater contaminant loadings to the receiving water.*
• Conduct a sampling and analytical program to identify the volume and pollutant concentrations for the various sources of contaminated stormwater. For wire products operations, the major pollutants are: high pH, suspended solids and dissolved metals. • Treat stormwater contaminated with oil and grease in oil/water separators prior to discharge to the receiving water. • Treat stormwater contaminated with dissolved metals by a physical/chemical process and dispose of the wastewater sludge according to regulatory requirements. • *Note - Contaminated stormwater should not be discharged to the sanitary sewer system except under special conditions defined by the local sewer authority or regulatory agency and provided the local sewer treatment plant can effectively treat the stormwater pollutants of concern. For most localities, this BMP requires approval of the local sewer authority. The allowable flow rate and contaminant concentrations may vary with the particular sewer system and local sewer authority.*

12º Hydraulic Cement Industry

SIC 3512

Description of Industrial Sector

These businesses produce Portland cement, the essential binder ingredient used in concrete. A paste of cement and water is the glue that binds sand and gravel together into a rock-like mass called concrete, the material of which buildings, bridges, roads, pipes and other structural products are made.

Materials Used and Wastes Generated

The raw materials vary with the plant but may be limestone, shale, conglomerate, iron oxide and gypsum. Waste materials from other industries are often used, such as iron slag, fly ash and spent blasting sand. Raw materials may be transported to the plant by either ships or rail cars. Finished products are commonly transported by trucks and/or rail cars.

The principal production processes are:

- Raw grinding - The crushed limestone (approximately 80% of the mix), shale, conglomerate, iron oxide and water are introduced into the raw grinding mill in carefully monitored proportions (wet process). The raw mix is ground into a slurry, creamy mixture. After grinding, the slurry is pumped into storage tanks.

- Pyro processing - Slurry is pumped from the storage tanks into the kiln. The kiln is a long steel tube in which the mixture is heated to transform the materials into red-hot marble-sized chunks called clinker.

- Finish grinding - From the kiln, the clinker is cooled by air. Once cooled, the clinker s fed into the mill for finish grinding. A small percentage of gypsum is added during grinding to control the setting time of cement.

Wastewaters from this industrial sector consist primarily of process cooling water and cement truck washwater. Cooling water and stormwater are discharged to the receiving water.

Potential Sources of Stormwater Pollution

Stormwater from this industrial sector may have high pH and elevated concentrations of suspended solids and metals.

The potential sources of stormwater pollution are generally limited to the following industrial activities:

- Dust emission;
- Raw material storage;
- Vehicle/equipment maintenance and washing;
- Truck traffic; and,
- Fuel and lubricant storage.

The major pollution problem for cement plants is the emission of dust during the manufacturing process. Dust emissions come from the kilns, clinker coolers, finish grinding, preparation of raw materials, and bagging and shipping operations. Analysis of stormwater samples collected from a cement manufacturing facility in the Lower Fraser Basin showed pH values above 10. Other parameters with elevated concentrations included total suspended solids, copper, lead and zinc.

The potential for stormwater pollution from the other sources is generally much lower. Raw material storage, vehicle/equipment washing and truck traffic may contribute to suspended solids loading; overfilling and leaks from fuel and lubricant storage tanks may add oil and grease.

Recommended Stormwater Best Management Practices

The following BMPs are designed to minimize runoff of contaminated stormwater to receiving waters. The facility personnel should first evaluate and implement source control BMPs, followed by runoff control/treatmentBMPs.

For cement manufacturing operations, stormwater pollution is primarily due to deposition of dust from many different operations. Implementation of source control BMPs can minimize this pollution. Other source control BMPs are designed to reduce the potential for stormwater contamination from the storage of chemicals, waste oil and fuel.

Even though the stormwater pollution potential is small from chemical and fuel spills and leaks in relation to the other point sources, implementation of liquid storage source control BMPs is strongly recommended because of the high environmental liability associated with an unconfined spill.

The recommended runoff control/treatment BMPs are designed to decrease the suspended solids loadings and the pH in the stormwater runoff. These parameters may be controlled by detention pond treatment and pH neutralization. An extended detention wet pond may be the most appropriate runoff treatment BMP for this industrial sector.

To ensure the proper selection of the runoff treatment BMP, the plant personnel should conduct sampling and analysis to determine stormwater characteristics. Plant personnel should also consult with the appropriate environmental regulatory agency prior to implementing the recommended treatment BMP.

1. Source Control BMPs

1.1 Good Housekeeping and Preventive Maintenance - *To minimize stormwater runoff of contaminants to receiving waters and to maintain a clean and orderly work environment which will lead to more organized and consistent handling of waste materials.*

- Sweep the plant area frequently to remove raw materials and finished products. Collect and dispose of sweepings to storage dumpsters for disposal in approved landfills. Washdown to remove debris should be avoided.
- Implement a comprehensive preventive maintenance program for plant equipment and stormwater management devices.
- Inspect and clean catchbasins and drainage inlets frequently to ensure proper operation. A catchbasin should be cleaned if the depth of deposits are equal to or greater than 1/3 the depth from the basin to the invert of the lowest pipe into or out of the basin.
- Inspect and clean detention ponds frequently to remove accumulated solids to ensure proper operation.

1.2 Dust Emission - *Minimize the accumulation of dust in stormwater drainage areas.*

- Install and maintain dust collection systems for airborne particles generated in the manufacturing process.
- Use sweepers regularly around the raw grinding, finish grinding and product storage areas to clean up fugitive dust. Avoid washdown cleanup.

1.3 Raw Material Storage - *Minimize the accumulation of stormwater in the storage area.*

- Grade the perimeter of the raw material storage area to direct stormwater and contaminated process wastewater away from the stockpile area.
- Grade the area to minimize pooling of stormwater and pollutants generated from the leaching of stockpiles. A minimum slope of 1.5% is recommended.
- Stormwater from the stockpile area may need to be treated by gravity settling to remove suspended solids.

1.4 Vehicle/Equipment Maintenance and Washing - *Minimize stormwater from coming into contact with potential pollutants.*

- Use drip-pans under all vehicles and equipment undergoing maintenance.
- Pave with concrete and grade the maintenance area to prevent the run-on of uncontaminated stormwater from adjacent areas as well as runoff of contaminated stormwater.
- Treat contaminated stormwater from the maintenance area in an oil/water separator prior to discharge to the receiving water.
- Regularly clean the oil/water separator to remove accumulated oils and solids to maintain optimum performance.
- Enclose the vehicle/equipment washing area with either walls and/or roof to prevent the entry of precipitation and to contain the washwater.
- Collect and treat washwater to remove suspended solids by gravity settling. Regularly clean the settling pond to remove accumulated solids to maintain optimum performance.
- Avoid the use of mobile wash services unless the washwater can be collected and treated.

1.5 Liquid Storage in Above-Ground Tanks/Containers - *To reduce the potential for an unconfined spill.*

- Surround above-ground liquid (e.g., chemicals, waste oil) storage tanks with curbs/dikes to provide secondary containment storage. The enclosed volume should be the greater of either 10% of the total tank volume or 110% of the volume contained in the largest tank. Additional volume may be needed depending on the quantity of rainfall reaching the site.

- The floor area enclosed by the curbing should be covered with an impervious surface and sealed to prevent spills from contaminating groundwater. The paved floor should be sloped to a lined sump for collection of small spills.

- During the wet season, accumulated stormwater should be released frequently. Ideally, a roof-type structure should also be provided to minimize the collection of stormwater inside the curbed/diked area.

- Provide treatment by oil/water separators for stormwater from oil/fuel containment areas.

- Provide special ventilation, temperature control and fire protection where chemical stability or freezing protection are of concern.

- Secure storage buildings to prevent unauthorized persons from accessing storage containers and causing spills.

- Segregate and store incompatible or reactive materials in separate containment areas to prevent the mixing of chemicals should spills occur.

- Use drip-pans when loading/unloading liquid materials. Place drip-pans at locations where spillage may occur, such as hose connections, hose reels, filler nozzles and opened tanks/drums.

- Regularly inspect all containers for deterioration and leakage. Check the lids of drums to ensure they are in place and properly secured. Immediately contain leaks and repair the source.

- Develop spill prevention and emergency cleanup plan and provide equipment and materials for cleanup.

1.6 Underground Storage Tanks (USTs) - *To reduce the potential for an undetected leak.*

- Perform monthly inventory of stored liquid products to detect leakage.
- Perform leak testing every two years. All USTs older than 10 years are suspect and consideration should be given for removal. An above-ground double-wall storage system is highly recommended as a replacement for underground fuel storage tanks.
- Pave the fueling area using concrete, not asphalt. Construct and size the fueling area to contain spills and prevent run-on of uncontaminated stormwater from surrounding areas.
- Collect and treat contaminated stormwater by oil/water separators. Clean the oil/water separator frequently to maintain proper operation. A roof may be provided over the fueling area to minimize the collection of stormwater in the oil/water separator.
- Implement tank filling procedures to prevent spills and overfills.
- Develop spill prevention and emergency cleanup plan and provide equipment and materials for cleanup.

2. Runoff Control/Treatment BMPs

2.1 Stormwater Flow Segregation - *To reduce the contaminated stormwater volume requiring treatment.*
• Grade and curb the site to prevent the runoff of contaminated stormwater and the run-on of uncontaminated stormwater from adjacent areas. Collect and convey contaminated stormwater for treatment. • Test and analyze rooftop runoff samples and non-process area stormwater samples to determine contaminant levels. Discharge uncontaminated stormwater to the storm drain below the treatment system or directly to the receiving water. If possible, recycle/reuse contaminated stormwater in process operations. Discharge contaminated stormwater to an on-site wastewater treatment system or to the city sewer system according to permit or local sewer authority requirements. • Pave and curb areas that may contribute to stormwater pollution to contain wastewater/contaminated stormwater from reaching storm drains. Collect and treat wastewater/contaminated stormwater for pollutants of concern.

2.2 Stormwater Treatment - *To minimize the stormwater contaminant loadings to the receiving water.*

- Conduct a sampling and analytical program to identify the volume and pollutant concentrations for the various sources of contaminated stormwater. For cement manufacturing operations, the major pollutants are high pH, suspended solids and oil and grease.
- Treat stormwater contaminated with oil and grease in oil/water separators prior to discharge to the receiving water.
- Treat stormwater contaminated with suspended solids by wet detention ponds. pH of the effluent may need to be neutralized by acids to the general range of 6.0 to 9.0 prior to discharge to the receiving water.
- The wet pond volume should be designed to handle a 10-year, 24-hour storm. A maximum depth of 2 metres (6 feet) is recommended. A minimum depth of 1 metre (3 feet) is recommended so that resuspension of trapped pollutants is inhibited.
- The wet ponds should be multi-celled with at least two cells and easily accessible for maintenance purposes.
- The length-to-width ratio for wet ponds should be at least 3:1 and preferably 5:1.
- The ponds should be inspected and cleaned frequently to ensure proper operation.
- *Note - Contaminated stormwater should not be discharged to the sanitary sewer system except under special conditions defined by the local sewer authority or regulatory agency and provided the local sewer treatment plant can effectively treat the stormwater pollutants of concern. For most localities, this BMP requires approval of the local sewer authority. The allowable flow rate and contaminant concentrations may vary with the particular sewer system and local sewer authority.*

13º Ready-Mix Concrete Industry

SIC 3551

Description of Industrial Sector

Establishments primarily engaged in manufacturing and delivering mixed concrete.

Materials Used and Wastes Generated

The basic ingredients of concrete are sand, gravel, Portland cement and admixtures. The principal operations consist of:

- Concrete mixing - The batching or mixing process is controlled by an operator from a central control room. Solid components are metered by weight and added to a truck from overhead silos. Water and chemical admixtures are metered by volume. Truck capacities typically range from 5-12 cubicmetres.

- Exterior truck washing - After loading, the truck moves to a wash area where an overhead spray or a hose is used to wash down the truck exterior. The truck then delivers the load to the job site. Weekly (or as required) exterior washing is carried out using a dilute muriatic acid solution to remove persistent concrete residues.

- Disposal of returned concrete - When incorporation in the next load is not possible, returned concrete must be discharged from the truck. Returned concrete is generally disposed of by production of concrete products, on-site paving, discharge to ground for drying and breaking for fill, or reclaimed for concrete mixing.

- Drum wash - At the end of the operating day, the truck drum must be washed out to avoid setting of concrete. Water is added to the drum and is discharged to a washwater collection basin. Settled process water is often used for drum washout.

Wastewaters from this industrial sector consist of process water and surface runoff from truck loading, truck washoff and drum washout. Treatment technologies used to reduce total suspended solids in washwater include lined settling basins, evaporation ponds, drag chain washers, sloped slab separation basins, filter ponds and clarifiers (commonly in conjunction with flocculation). Total recycling of washwater from lined settling ponds is an alternative to treatment, monitoring and discharge of high pH wastewater.

Potential Sources of Stormwater Pollution

Stormwater from this industrial sector may have high pH, and high concentrations of suspended solids, organics and nitrate.

The potential sources of stormwater pollution are generally limited to the following industrial activities:

- Concrete batching;
- Aggregate storage;
- Vehicle/equipment maintenance and washing;
- Sludge storage;
- Truck traffic;
- Chemical admixture storage; and,
- Fuel and lubricant storage.

The first four are the primary sources of pollution. These sources can contribute to high loadings of suspended solids in the stormwater runoff. The pH of the runoff is expected to be greater than 10 due to the presence of cement residues.

The potential for stormwater pollution from the other three sources is generally lower. Truck traffic may results in higher suspended solids and oil and grease in stormwater. Some admixtures commonly used in the concrete consist of organic-based compounds. Spills or leaks of admixtures may result in high biochemical oxygen demand or high nitrate concentrations in the discharge water. Fuel stored on-site may contribute to oil and grease in the runoff.

Recommended Stormwater Best Management Practices

The following BMPs are designed to minimize runoff of contaminated stormwater to receiving waters. The facility personnel should first evaluate and implement source control BMPs followed by runoff control/treatment BMPs.

For ready-mix operations, stormwater pollution is primarily due to loss of materials from many different operations. Source control BMPs can minimize stormwater pollution. Other recommended source control BMPs are designed to minimize the potential for stormwater contamination from the storage of chemicals, waste oil and fuel.

Admixtures and fuel stored on-site may spill or leak resulting in stormwater pollution. Even though the stormwater pollution potential is small in relation to the other point sources, implementation of liquid storage source control BMPs is strongly recommended because of the high environmental liability associated with an unconfined spill.

The recommended runoff control/treatment BMPs are designed to decrease suspended solids loadings and pH in the stormwater runoff. These parameters may be controlled by detention pond treatment and pH neutralization. An extended detention wet pond may be the most appropriate runoff treatment BMP for this industrial sector. Rooftop runoff may be contaminated with solids from dust deposition and should be disposed of through infiltration ponds.

To ensure the proper selection of the runoff treatment BMP, the plant personnel should conduct sampling and analysis to determine stormwater characteristics. Plant personnel should also consult with the appropriate environmental regulatory agency prior to implementation of the recommended treatment BMP.

1. Source Control BMPs

1.1 **Good Housekeeping and Preventive Maintenance** - *To minimize stormwater runoff of contaminants to receiving waters and to maintain a clean and orderly work environment which will lead to more organized and consistent handling of waste materials.*
• Sweep the plant area frequently to remove accumulated dust and raw materials. Collect and dispose of sweepings to storage dumpsters for disposal in approved landfills. Washdown generates washwater requiring treatment and should be avoided. • Implement a comprehensive preventive maintenance program for plant equipment and stormwater management devices. • Inspect and clean catchbasins, drainage inlets frequently to ensure proper operation. A catchbasin should be cleaned if the depth of deposits are equal to or greater than 1/3 the depth from the basin to the invert of the lowest pipe into or out of the basin. • Inspect and clean detention ponds frequently to remove accumulated solids to ensure proper operation.

1.2 **Concrete Batching** - *Minimize dust loss during loading that may contribute to stormwater contamination.*
• Install and maintain dust collection systems, such as a baghouse, on vents from pneumatic or mechanical transfer systems to collect airborne particles. • Use curtains or rubber socks to minimize dust loss during loading. • Use metered water sprays to suppress fugitive emissions during truck loading operations. Collect and treat water spray runoff in an on-site wastewater treatment system.

1.3	**Aggregate Storage** - *Minimize the accumulation of stormwater in the storage area.*
•	Locate or shelter the aggregate stockpiles from wind to minimize dust generation.
•	Use storage bins or provide covers for aggregate stockpiles.
•	Grade the perimeter of the raw material storage area to direct stormwater and contaminated process wastewater away from the stockpile area.
•	Grade the storage area to minimize pooling of stormwater and pollutants generated from the leaching of stockpiles. A minimum slope of 1.5% is recommended.
•	Collect and discharge stormwater from the stockpile area via infiltration ponds wherever possible. This disposal practice may require stormwater sampling and characterization to determine water quality and the approval of the local regulatory agency.

1.4 Vehicle/Equipment Maintenance and Washing - *Minimize stormwater from coming into contact with potential pollutants.*

- Use drip-pans under all vehicles and equipment undergoing maintenance.
- Pave with concrete and grade the maintenance area to prevent the run-on of uncontaminated stormwater from adjacent areas as well as runoff of contaminated stormwater.
- Treat contaminated stormwater from the maintenance area in an oil/water separator prior to discharge to the receiving water.
- Regularly clean the oil/water separator to remove accumulated oils and solids to maintain optimum performance.
- Pave and grade truck wash areas to prevent the run-on of uncontaminated stormwater and the runoff of washwater and contaminated stormwater.
- Collect and treat washwater/contaminated stormwater to remove suspended solids by gravity settling. pH neutralization may be required. Regularly clean the settling pond to remove accumulated solids to maintain optimum performance.

1.5 Sludge Storage - *Minimize contaminated stormwater runoffs from the sludge storage area.*

- Provide roofs or covers for sludge storage piles to prevent precipitation from coming into contact with contaminated materials.
- Enclose the sludge storage area with retaining walls or curb/grade the perimeter to prevent run-on of uncontaminated stormwater and runoff of contaminated stormwater.
- Grade the storage area to minimize pooling of stormwater and pollutants generated from the leaching of sludge stockpiles. A minimum slope of 1.5% is recommended.
- Collect and treat contaminated stormwater from the storage area in the on-site wastewater treatment system.
- Dispose of sludge regularly by approved methods.

1.6 Liquid Storage in Above-Ground Tanks/Containers - *To reduce the potential for an unconfined spill.*

- Surround above-ground liquid (e.g., admixtures, acids, waste oil, fuel) storage tanks with curbs/dikes to provide secondary containment storage. The enclosed volume should be the greater of either 10% of the total tank volume or 110% of the volume contained in the largest tank. Additional volume may be needed depending on the quantity of rainfall reaching the site.

- The floor area enclosed by the curbing should be covered with an impervious surface and sealed to prevent spills from contaminating groundwater. The paved floor should be sloped to a lined sump for collection of small spills.

- During the wet season, accumulated stormwater should be released frequently. Ideally, a roof-type structure should also be provided to minimize the collection of stormwater inside the curbed/diked area.

- Provide treatment by oil/water separators for stormwater from oil/fuel containment areas.

- Provide special ventilation, temperature control and fire protection where chemical stability or freezing protection are of concern.

- Secure storage buildings to prevent unauthorized persons from accessing storage containers and causing spills.

- Segregate and store incompatible or reactive materials in separate containment areas to prevent the mixing of chemicals should spills occur.

- Use drip-pans when loading/unloading liquid materials. Place drip-pans at locations where spillage may occur, such as hose connections, hose reels, filler nozzles and opened tanks/drums.

- Regularly inspect all containers for deterioration and leakage. Check the lids of drums to ensure they are in place and properly secured. Immediately contain leaks and repair the source.

- Develop spill prevention and emergency cleanup plan and provide equipment and materials for cleanup.

1.7 Underground Storage Tanks (USTs) - *To reduce the potential for an undetected leak.*

- Perform monthly inventory of stored liquid products to detect leakage.
- Perform leak testing every two years. All USTs older than 10 years are suspect and consideration should be given for removal. An above-ground double-wall storage system is highly recommended as a replacement for underground fuel storage tanks.
- Pave the fueling area using concrete, not asphalt. Construct and size the fueling area to contain spills and prevent run-on of uncontaminated stormwater from surrounding areas.
- Collect and treat contaminated stormwater by oil/water separators. Clean the oil/water separator frequently to maintain proper operation. A roof may be provided over the fueling area to minimize the collection of stormwater in the oil/water separator.
- Implement tank filling procedures to prevent spills and overfills.
- Develop spill prevention and emergency cleanup plan and provide equipment and materials for cleanup.

2. Runoff Control/Treatment BMPs

2.1 **Stormwater Flow Segregation** - *To reduce the contaminated stormwater volume requiring treatment.*
• Grade and curb the site to prevent the runoff of contaminated stormwater and the run-on of uncontaminated stormwater from adjacent areas. Collect and convey contaminated stormwater for treatment. • Test and analyze rooftop runoff samples and non-process area stormwater samples to determine contaminant levels. Discharge uncontaminated stormwater to infiltration ponds or to storm drains below the treatment system. If possible, recycle/reuse contaminated stormwater in process operations. Discharge contaminated stormwater to an on-site wastewater treatment system or to the city sewer system according to permit or local sewer authority requirements. • Pave and curb areas that may contribute to stormwater pollution to contain wastewater/contaminated stormwater from reaching storm drains. Collect and treat wastewater/contaminated stormwater for pollutants of concern.

2.2 Stormwater Treatment - *To minimize the stormwater contaminant loadings to the receiving water.*

- Conduct a sampling and analytical program to identify the volume and pollutant concentrations for the various sources of contaminated stormwater. For ready-mix concrete operations, the major pollutants are high pH, suspended solids and oil and grease.

- Treat stormwater contaminated with oil and grease in oil/water separators prior to discharge to the receiving water.

- Treat stormwater contaminated with suspended solids by wet detention ponds. pH of the effluent may need to be neutralized by acids to the general range of 6.0 to 9.0 prior to discharge to the receiving water. For discharges to groundwater via infiltration ponds, the allowable pH may be higher.

- The wet pond volume should be designed to handle a 10-year, 24-hour storm. A maximum depth of 2 metres (6 feet) is recommended. A minimum depth of 1 metre (3 feet) is recommended so that resuspension of trapped pollutants is inhibited.

- The wet ponds should be multi-celled with at least two cells and easily accessible for maintenance purposes.

- The length-to-width ratio for wet ponds should be at least 3:1 and preferably 5:1.

- The ponds should be inspected and cleaned to remove sludge frequently to ensure proper operation.

- *Note - Contaminated stormwater should not be discharged to the sanitary sewer system except under special conditions defined by the local sewer authority or regulatory agency and provided the local sewer treatment plant can effectively treat the stormwater pollutants of concern. For most localities, this BMP requires approval of the local sewer authority. The allowable flow rate and contaminant concentrations may vary with the particular sewer system and local sewer authority.*

14º Lime Industry

SIC 3581

Description of Industrial Sector

Establishments primarily engaged in manufacturing quicklime and hydrated lime. Secondary products include crushed limestone.

Materials Used and Wastes Generated

The raw material is limestone. The major operations of this industry include:

- Crushing/classification - After unloading, the limestone is crushed. Smaller size fractions are packaged and sold as agricultural limestone. The selected size fraction is conveyed to the quicklime process.
- Quicklime - The limestone is heated in a kiln and is transformed to quicklime.
- Hydrated lime - Water is added to quicklime to produce hydrated lime.

Process cooling water and contaminated stormwater are produced from this industrial sector.

Potential Sources of Stormwater Pollution

Stormwater from this industrial sector may have high pH and high suspended solids concentrations.

The potential sources of stormwater pollution are generally limited to the following industrial activities:

- Dust emission;
- Loading of finished products;
- Raw material storage;
- Vehicle/equipment maintenance;
- Truck traffic; and,
- Fuel and lubricant storage.

The major pollution problem for lime manufacturing operations is the emission of dust during the manufacturing process. Dust emissions come from the kilns, coolers, grinding, bagging and shipping operations. Analysis of stormwater samples collected from a lime manufacturing facility in the Lower Fraser Basin was found to have a pH above 12. Total suspended solids concentrations were also higher than typical industrial site runoffs.

The potential for stormwater pollution from the other sources is substantially lower. Raw material storage, vehicle/equipment washing and truck traffic may contribute to suspended solids; overfilling and leaks from fuel and lubricant storage tanks may add oil and grease.

Recommended Stormwater Best Management Practices

The following BMPs are designed to minimize runoff of contaminated stormwater to receiving waters. The facility personnel should first evaluate and implement source control BMPs, followed by runoff control/treatmentBMPs.

For lime manufacturing operations, stormwater pollution is primarily due to deposition of dust from many different operations. Implementation of source control BMPs can minimize stormwater pollution. Other source control BMPs are designed to minimize the potential for stormwater contamination.

Even though the stormwater pollution potential is small from chemical and fuel spills/leaks in relation to the other point sources, implementation of liquid storage source control BMPs is strongly recommended because of the high environmental liability associated with an unconfined spill.

The recommended runoff control/treatment BMPs are designed to decrease suspended solids loadings and pH in the stormwater runoff. The suspended solids and pH may be controlled by detention pond treatment and pH neutralization. An extended detention wet pond may be the most appropriate runoff treatment BMP for this industrial sector.

To ensure the proper selection of the runoff treatment BMP, the plant personnel should conduct sampling and analysis to determine stormwater characteristics. Plant personnel should also consult with the appropriate environmental regulatory agency prior to implementing the recommended treatment BMP.

1. Source Control BMPs

1.1 Good Housekeeping and Preventive Maintenance - *To minimize stormwater runoff of contaminants to receiving waters and to maintain a clean and orderly work environment which will lead to more organized and consistent handling of waste materials.*

- Sweep the plant area frequently to remove raw materials and finished products. Collect and dispose of sweepings to storage dumpsters for disposal in approved landfills. Washdown to remove debris should be avoided.
- Implement a comprehensive preventive maintenance program for plant equipment and stormwater management devices.
- Inspect and clean catchbasins and drainage inlets frequently to ensure proper operation. A catchbasin should be cleaned if the depth of deposits are equal to or greater than 1/3 the depth from the basin to the invert of the lowest pipe into or out of the basin.
- Inspect and clean detention ponds frequently to remove accumulated solids to ensure proper operation.

1.2 Dust Emission - *Minimize the accumulation of dust in stormwater drainage areas.*

- Install and maintain dust collection systems, such as baghouses, on vents from pneumatic or mechanical transfer systems to collect airborne particles generated in the manufacturing process.
- Use sweepers regularly around process and product storage areas to clean up fugitive dust. Avoid washdown cleanup.

1.3 Loading of Finished Products - *Minimize the accumulation of dust in stormwater drainage areas.*

- Use curtains or rubber socks to minimize dust loss during loading.
- Sweep or vacuum loading/shipping areas regularly or after each loading operation to remove accumulated dust. Washdown cleanup generates washwater which may require treatment and should be avoided. Collect and dispose of sweepings by an approved method.

1.4 Raw Material Storage - *Minimize the accumulation of stormwater in the storage area.*

- Grade the perimeter of the area to prevent the run-on of uncontaminated stormwater from adjacent areas as well as runoff of contaminated stormwater from the stockpile area.
- Grade the area to minimize pooling of stormwater and pollutants generated from the leaching of stockpiles. A minimum slope of 1.5% is recommended.
- Collect and discharge stormwater from the stockpile area via infiltration ponds wherever possible. This disposal practice may require stormwater sampling and characterization to determine water quality and the approval of the local regulatory agency.

1.5 Vehicle/Equipment Maintenance - *Minimize stormwater from coming into contact with potential pollutants.*

- Use drip-pans under all vehicles and equipment undergoing maintenance.
- Pave with concrete and grade the maintenance area to prevent the run-on of uncontaminated stormwater from adjacent areas as well as runoff of contaminated stormwater.
- Treat contaminated stormwater from the maintenance area in an oil/water separator prior to discharge to the receiving water.
- Regularly clean the oil/water separator to remove accumulated oils and solids to maintain optimum performance.

1.6 Liquid Storage in Above-Ground Tanks/Containers - *To reduce the potential for an unconfined spill.*

- Surround above-ground liquid (e.g., chemicals, waste oil) storage tanks with curbs/dikes to provide secondary containment storage. The enclosed volume should be the greater of either 10% of the total tank volume or 110% of the volume contained in the largest tank. Additional volume may be needed depending on the quantity of rainfall reaching the site.

- The floor area enclosed by the curbing should be covered with an impervious surface and sealed to prevent spills from contaminating groundwater. The paved floor should be sloped to a lined sump for collection of small spills.

- During the wet season, accumulated stormwater should be released frequently. Ideally, a roof-type structure should also be provided to minimize the collection of stormwater inside the curbed/diked area.

- Provide treatment by oil/water separators for stormwater from oil/fuel containment areas.

- Provide special ventilation, temperature control and fire protection where chemical stability or freezing protection are of concern.

- Secure storage buildings to prevent unauthorized persons from accessing storage containers and causing spills.

- Segregate and store incompatible or reactive materials in separate containment areas to prevent the mixing of chemicals should spills occur.

- Use drip-pans when loading/unloading liquid materials. Place drip-pans at locations where spillage may occur such as hose connections, hose reels, filler nozzles and opened tanks/drums.

- Regularly inspect all containers for deterioration and leakage. Check the lids of drums to ensure they are in place and properly secured. Immediately contain leaks and repair the source.

- Develop spill prevention and emergency cleanup plan and provide equipment and materials for cleanup.

2. Runoff Control/Treatment BMPs

2.1 Stormwater Flow Segregation - *To reduce the contaminated stormwater volume requiring treatment.*
• Grade and curb the site to prevent the runoff of contaminated stormwater and the run-on of uncontaminated stormwater from adjacent areas. Collect and convey contaminated stormwater for treatment. • Test and analyze rooftop runoff samples and non-process area stormwater samples to determine contaminant levels. Discharge uncontaminated stormwater to the storm drain below the treatment system or directly to the receiving water. If possible, recycle/reuse contaminated stormwater in process operations. Discharge excess contaminated stormwater to an on-site wastewater treatment system or to the city sewer system according to permit or local sewer authority requirements. • Pave and curb areas that may contribute to stormwater pollution to contain wastewater/contaminated stormwater from reaching storm drains. Collect and treat wastewater/contaminated stormwater for pollutants of concern.

2.2 Stormwater Treatment - *To minimize the stormwater contaminant loadings to the receiving water.*

- Conduct a sampling and analytical program to identify the volume and pollutant concentrations for the various sources of contaminated stormwater. For cement manufacturing operations, the major pollutants are high pH, suspended solids and oil and grease.

- Treat stormwater contaminated with oil and grease in oil/water separators prior to discharge to the receiving water.

- Treat stormwater contaminated with suspended solids by wet detention ponds. pH of the effluent may need to be neutralized by acids to the general range of 6.0 to 9.0 prior to discharge to the receiving water.

- The wet pond volume should be designed to handle a 10-year, 24-hour storm. A maximum depth of 2 metres (6 feet) is recommended. A minimum depth of 1 metre (3 feet) is recommended so that resuspension of trapped pollutants is inhibited.

- The wet ponds should be multi-celled with at least two cells and easily accessible for maintenance purposes.

- The length-to-width ratio for wet ponds should be at least 3:1 and preferably 5:1.

- The ponds should be inspected and cleaned frequently to ensure proper operation.

- *Note - Contaminated stormwater should not be discharged to the sanitary sewer system except under special conditions defined by the local sewer authority or regulatory agency and provided the local sewer treatment plant can effectively treat the stormwater pollutants of concern. For most localities, this BMP requires approval of the local sewer authority. The allowable flow rate and contaminant concentrations may vary with the particular sewer system and local sewer authority.*

15º Refined Petroleum Products Industry (Bulk Storage)

SIC 3611

Description of Industrial Sector

The petroleum refining industry manufactures gasoline, kerosene, distillate and residual oils, lubricants and other related products from crude petroleum.

Materials Used and Wastes Generated

Wastewaters generated from petroleum bulk storage plants include stormwater and process effluent from product blending, storage, shipping, ballast water, lube oil blending and packaging.

Potential Sources of Stormwater Pollution

Stormwater from this industrial sector may contain high concentrations of oil and grease and hydrocarbons.

The potential sources of stormwater pollution are generally limited to the following industrial activities:

- Fuel storage; and,
- Loading of liquid materials.

These are the major industrial activities conducted at petroleum bulk storage facilities and are the sources of stormwater pollution. These sources can contribute high loadings of oil and grease and hydrocarbons in stormwater. Analysis of a stormwater sample from a petroleum bulk storage plant in the Lower Fraser Basin showed the stormwater from this industrial sector, after treatment by oil/water separators, was relatively free of pollutants.

Recommended Stormwater Best Management Practices

The following BMPs are designed to minimize runoff of contaminated stormwater to receiving waters. The facility personnel should first evaluate and implement source control BMPs followed by runoff control/treatment BMPs.

For petroleum bulk storage facilities, stormwater pollution is primarily due to leaks or spills. Implementation of source control and runoff control/treatment BMPs can minimize stormwater pollution.

To ensure the proper selection of the runoff treatment BMP, the plant personnel should conduct sampling and analysis to determine stormwater characteristics. Plant personnel should also consult with the appropriate environmental regulatory agency prior to implementing the recommended treatment BMP.

1. Source Control BMPs

1.1 Good Housekeeping and Preventive Maintenance - *To minimize stormwater runoff of contaminants to receiving waters and to maintain a clean and orderly work environment which will lead to more organized and consistent handling of waste materials.*
• Implement a comprehensive preventive maintenance program for plant equipment and stormwater management devices. • Inspect and clean catchbasins and drainage inlets frequently to ensure proper operation. A catchbasin should be cleaned if the depth of deposits are equal to or greater than 1/3 the depth from the basin to the invert of the lowest pipe into or out of the basin. • Inspect and clean detention ponds and oil/water separators frequently to remove accumulated oils and solids to ensure proper operation.

1.2 Liquid Storage in Above-Ground Tanks/Containers - *To reduce the potential for an unconfined spill.*

- Surround above-ground liquid (e.g., chemicals, waste oil) storage tanks with curbs/dikes to provide secondary containment storage. The enclosed volume should be the greater of either 10% of the total tank volume or 110% of the volume contained in the largest tank. Additional volume may be needed depending on the quantity of rainfall reaching the site.

- The floor area enclosed by the curbing should be covered with an impervious surface and sealed to prevent spills from contaminating groundwater. The paved floor should be sloped to a lined sump for collection of small spills.

- During the wet season, accumulated stormwater should be released frequently. Ideally, a roof-type structure should also be provided to minimize the collection of stormwater inside the curbed/diked area.

- Provide treatment by oil/water separators for stormwater from oil/fuel containment areas.

- Provide special ventilation, temperature control and fire protection where chemical stability or freezing protection are of concern.

- Secure storage buildings to prevent unauthorized persons from accessing storage containers and causing spills.

- Segregate and store incompatible or reactive materials in separate containment areas to prevent the mixing of chemicals should spills occur.

- Use drip-pans when loading/unloading liquid materials. Place drip-pans at locations where spillage may occur such as hose connections, hose reels, filler nozzles and opened tanks/drums.

- Regularly inspect all containers for deterioration and leakage. Check the lids of drums to ensure they are in place and properly secured. Immediately contain leaks and repair the source.

- Develop spill prevention and emergency cleanup plan and provide equipment and materials for cleanup.

1.3	**Loading of Liquid Materials** - *Prevent rainwater from coming into contact with potential pollutants.*

- Provide overhangs and site grading for loading/unloading areas with high stormwater pollution potential to prevent run-on of stormwater. Collect and convey contaminated stormwater from these areas to an on-site wastewater treatment according to permit requirements.
- Close storm drains near areas with high stormwater pollution potential to prevent discharges of contaminated stormwater to the receiving water.
- Pave petroleum tank truck transfer area with concrete. Design the transfer area to prevent the run-on of uncontaminated stormwater from adjacent areas and to contain spills. Direct spills to a dead-end for removal or to process treatment.
- Use drip-pans when loading/unloading liquid materials. Place drip-pans at locations where spillage may occur, such as hose connections, hose reels and filler nozzles.
- Develop spill prevention and emergency cleanup plan and provide equipment and materials for cleanup.

2. Runoff Control/Treatment BMPs

2.1 Stormwater Flow Segregation - *To reduce the contaminated stormwater volume requiring treatment.*

- Grade and curb the site to prevent the runoff of contaminated stormwater and the run-on of uncontaminated stormwater from adjacent areas. Collect and convey contaminated stormwater for treatment.
- Test and analyze rooftop runoff samples and non-process area stormwater samples to determine contaminant levels. Discharge uncontaminated stormwater to the storm drain below the treatment system or directly to the receiving water. Discharge contaminated stormwater to an on-site wastewater treatment system according to permit requirements.
- Pave and curb areas that may contribute to stormwater pollution to contain wastewater/contaminated stormwater from reaching storm drains. Collect and treat wastewater/contaminated stormwater for pollutants of concern.

2.2 Stormwater Treatment - *To minimize the stormwater contaminant loadings to the receiving water.*

- Conduct a sampling and analytical program to identify the volume and pollutant concentrations for the various sources of contaminated stormwater. For petroleum bulk storage facilities, the major pollutants are hydrocarbons, and oil and grease.
- Treat stormwater contaminated with oil and grease in oil/water separators prior to discharge to the receiving water. The oil/water separator should be designed for a forty-five minute detention time for a 6-month, 24-hour storm event over the surface of the plant area with potential stormwater pollution.
- *Note - Contaminated stormwater should not be discharged to the sanitary sewer system except under special conditions defined by the local sewer authority or regulatory agency and provided the local sewer treatment plant can effectively treat the stormwater pollutants of concern. For most localities, this BMP requires approval of the local sewer authority. The allowable flow rate and contaminant concentrations may vary with the particular sewer system and local sewer authority.*

16º Other Petroleum and Coal Products Industries (Asphalt Manufacturing)

SIC 3699

Description of Industrial Sector

Establishments primarily engaged in manufacturing petroleum and coal products not elsewhere classified. Included in this industry category are establishments primarily engaged in manufacturing and delivering asphalt.

Materials Used and Wastes Generated

Primary raw materials for the asphalt manufacturing facilities are sand, gravel and petroleum-based asphalt that serves as the binder. The principal operations consist of:

- Asphalt mixing - Sand and gravel are heated and dried in a rotary drier and then placed in a mixing hopper and mixed with hot asphalt. The asphalt is then usually dumped into a truck for transport to the job site.

- Truck washing - Delivery truck washout may be performed with diesel fuel or other type of release agent at the site.

Wastewaters from this industrial sector consist of washwater and stormwater runoff. Treatment technologies available to hot-mix asphalt plants include the use of lined settling ponds for suspended solids removal and skimming of the pond surfaces or the use of oil/water separators for the removal of oil and settleable solids before discharging of water.

Potential Sources of Stormwater Pollution

Stormwater from this industrial sector may contain high concentrations of suspended solids, oil and grease, and polyaromatic hydrocarbons.

The potential sources of stormwater pollution are generally limited to the following industrial activities:

- Vehicle/equipment maintenance and washing;
- Asphalt manufacturing;
- Raw material storage;
- Truck traffic; and,
- Fuel and chemical storage.

The primary potential sources are vehicle/equipment maintenance and washing, asphalt manufacturing and raw material storage. These sources can contribute to high loadings of suspended solids and oil and grease in stormwater. Analysis of stormwater samples collected from an asphalt manufacturing plant in the Lower Fraser Basin had a pH above 8. Suspended solids and oil and grease concentrations, after treatment by oil/water separators, were similar to typical industrial stormwater levels. Polyaromatic hydrocarbons were found to be below detection or at low levels.

The potential for stormwater pollution from the other sources is generally lower. Truck traffic may contribute to suspended solids loadings; overfilling and leaks from fuel storage tanks may add to oil and grease. Stormwater contamination potentials may increase substantially for facilities with larger fueling operations.

Recommended Stormwater Best Management Practices

The following BMPs are designed to minimize runoff of contaminated stormwater to receiving waters. The facility personnel should first evaluate and implement source control BMPs, followed by runoff control/treatment BMPs.

For asphalt manufacturing operations, stormwater pollution is primarily due to contaminants generated from steam cleaning and washing operations, asphalt manufacturing and loss of materials from raw material stockpiles. Implementation of source control BMPs can minimize stormwater pollution from these sources. Other source control BMPs are designed to minimize the potential for stormwater contamination from chemical/fuel storage operations.

Even though the stormwater pollution potential is small from chemical and fuel spills or leaks in relation to the other point sources, implementation of liquid storage source control BMPs is strongly recommended because of the high environmental liability associated with an unconfined spill.

The recommended runoff control/treatment BMPs are designed to decrease suspended solids loadings and oil and grease in stormwater runoff. The suspended solids and oil and grease may be removed from the effluent by oil/water separators.

To ensure the proper selection of the runoff treatment BMP, the plant personnel should conduct sampling and analysis to determine stormwater characteristics. Plant personnel should also consult with the appropriate environmental regulatory agency prior to implementing the recommended treatment BMP.

1. Source Control BMPs

1.1 Good Housekeeping and Preventive Maintenance - *To minimize stormwater runoff of contaminants to receiving waters and to maintain a clean and orderly work environment which will lead to more organized and consistent handling of waste materials.*

- Sweep the site frequently to remove accumulated dust and other materials that can contribute to stormwater pollution. Collect and dispose of sweepings to storage dumpsters for disposal in approved landfills.

- Implement a comprehensive preventive maintenance program for plant equipment and stormwater management devices.

- Inspect and clean catchbasins and drainage inlets frequently to ensure proper operation. A catchbasin should be cleaned if the depth of deposits are equal to or greater than 1/3 the depth from the basin to the invert of the lowest pipe into or out of the basin.

- Inspect and clean detention ponds and oil/water separators frequently to remove accumulated oils and solids to ensure proper operation.

1.2	**Vehicle/Equipment Maintenance and Washing** - *Minimize stormwater from coming into contact with potential pollutants.*

- Use drip-pans under all vehicles and equipment undergoing maintenance.
- Pave with concrete and grade the maintenance area to prevent the run-on of uncontaminated stormwater from adjacent areas as well as runoff of contaminated stormwater.
- Treat contaminated stormwater from the maintenance area in an oil/water separator prior to discharge to the receiving water.
- Clean regularly the oil/water separator to remove accumulated oils and solids to maintain optimum performance.
- Pave and grade vehicle/equipment washing and steam-cleaning areas to prevent the run-on of uncontaminated stormwater and the runoff of washwater and contaminated stormwater. Where possible, enclose vehicle/equipment washing and steam-cleaning areas with either walls and/or roof to prevent the entry of precipitation and to contain the washwater.
- Collect and treat washwater/contaminated stormwater to remove suspended solids by gravity settling. Regularly clean settling ponds to remove accumulated solids to maintain optimum performance.
- Collect and treat steam-cleaning effluent and stormwater contaminated by oil in oil/water separators.

1.3 Asphalt Manufacturing - *Minimize stormwater contamination and runoff from the manufacturing area.*

- Grade the perimeter of the asphalt plant to prevent the run-on of uncontaminated stormwater from adjacent areas as well as runoff of contaminated stormwater from the stockpile area.
- Schedule regular cleanup of the asphalt plant to remove spilled material and accumulated dust.
- Collect and treat stormwater from the asphalt plant area in oil/water separators. Regularly clean oil/water separators to remove accumulated oils and solids to maintain optimum performance.

1.4 Raw Material Storage - *Minimize the accumulation of stormwater in the storage area.*

- Grade the perimeter of the area to prevent the run-on of uncontaminated stormwater from adjacent areas as well as runoff of contaminated stormwater from the stockpile area.
- Grade the area to minimize pooling of stormwater and pollutants generated from the leaching of stockpiles. A minimum slope of 1.5% is recommended.
- Collect and discharge stormwater from the stockpile area via infiltration ponds wherever possible. This disposal practice may require stormwater sampling and characterization to determine water quality and the approval of the local regulatory agency.

1.5 Liquid Storage in Above-Ground Tanks/Containers - *To reduce the potential for an unconfined spill.*

- Surround above-ground liquid (e.g., magnesium chloride, asphalt and fuel) storage tanks with curbs/dikes to provide secondary containment storage. The enclosed volume should be the greater of either 10% of the total tank volume or 110% of the volume contained in the largest tank. Additional volume may be needed depending on the quantity of rainfall reaching the site.

- The floor area enclosed by the curbing should be covered with an impervious surface and sealed to prevent spills from contaminating groundwater. The paved floor should be sloped to a lined sump for collection of small spills.

- During the wet season, accumulated stormwater should be released frequently. Ideally, a roof-type structure should also be provided to minimize the collection of stormwater inside the curbed/diked area.

- Provide treatment by oil/water separators for stormwater from oil/fuel containment areas.

- Provide special ventilation, temperature control and fire protection where chemical stability or freezing protection are of concern.

- Secure storage buildings to prevent unauthorized persons from accessing storage containers and causing spills.

- Segregate and store incompatible or reactive materials in separate containment areas to prevent the mixing of chemicals should spills occur.

- Use drip-pans when loading/unloading liquid materials. Place drip-pans at locations where spillage may occur, such as hose connections, hose reels, filler nozzles and opened tanks/drums.

- Regularly inspect all containers for deterioration and leakage. Check the lids of drums to ensure they are in place and properly secured. Immediately contain leaks and repair the source.

- Develop spill prevention and emergency cleanup plan and provide equipment and materials for cleanup.

2. Runoff Control/Treatment BMPs

2.1 **Stormwater Flow Segregation** - *To reduce the contaminated stormwater volume requiring treatment.*
• Grade and curb the site to prevent the runoff of contaminated stormwater and the run-on of uncontaminated stormwater from adjacent areas. Collect and convey contaminated stormwater for treatment. • Test and analyze rooftop runoff samples and non-process area stormwater samples to determine contaminant levels. Discharge uncontaminated stormwater to the storm drain below the treatment system or directly to the receiving water. Discharge contaminated stormwater to an on-site wastewater treatment system or to the city sewer system according to permit or local sewer authority requirements. • Pave and curb areas that may contribute to stormwater pollution to contain wastewater/contaminated stormwater from reaching storm drains. Collect and treat wastewater/contaminated stormwater for pollutants of concern.

2.2 Stormwater Treatment - *To minimize the stormwater contaminant loadings to the receiving water.*

- Conduct a sampling and analytical program to identify the volume and pollutant concentrations for the various sources of contaminated stormwater. For asphalt manufacturing operations, the major pollutants are suspended solids and oil and grease.

- Treat stormwater contaminated with suspended solids by wet detention ponds. pH of the effluent may need to be neutralized by acids to the general range of 6.0 to 9.0 prior to discharge to the receiving water.

- The wet pond volume should be designed to handle a 10-year, 24-hour storm. A maximum depth of 2 metres (6 feet) is recommended. A minimum depth of 1 metre (3 feet) is recommended so that resuspension of trapped pollutants is inhibited.

- The wet ponds should be multi-celled with at least two cells and easily accessible for maintenance purposes.

- The length-to-width ratio for wet ponds for wet ponds should be at least 3:1 and preferably 5:1.

- The ponds should be inspected and cleaned frequently to ensure proper operation.

- Treat stormwater contaminated with oil and grease in oil/water separators prior to discharge to the receiving water.

- Oil/water separators should be designed for a 45-minute detention time for a 6-month, 24-hour storm event over the surface of the plant area with potential stormwater pollution.

- *Note - Contaminated stormwater should not be discharged to the sanitary sewer system except under special conditions defined by the local sewer authority or regulatory agency and provided the local sewer treatment plant can effectively treat the stormwater pollutants of concern. For most localities, this BMP requires approval of the local sewer authority. The allowable flow rate and contaminant concentrations may vary with the particular sewer system and local sewer authority.*

17º Industrial Inorganic Chemical Industry (Chlor-Alkali Manufacturing)

SIC 3711

Description of Industrial Sector

Establishments primarily engaged in manufacturing basic industrial inorganic chemicals such as acids (except organic), alkalis, salts, radioactive chemical elements and other inorganic compounds, and compressed gases. Included in this industry category are establishments primarily engaged in manufacturing of chlorine gas, caustic soda and muriatic acid.

Materials Used and Wastes Generated

The chlor-alkali process uses three raw materials: salt, water and electrical energy. The major operations include:

- Vessel unloading - Sea salt is unloaded by conveyors to salt holding tanks and salt pad.
- Brine processing - Fresh and recycled process water is added to the salt to form a saturated salt solution (raw brine). The raw brine is purified by adding sodium carbonate and caustic soda, and filtered.
- Electrolytic processing - The purified brine solution is fed into an electrolytic cell. In the cell, an electrical current passes through the salt solution between electrodes, decomposing it into chlorine gas, hydrogen gas and caustic soda. About 50% of the brine is converted into caustic soda.
- Chlorine processing - The chorine gas is cooled by contact with water and dried by contact with surphuric acid. After purification, the chlorine gas is compressed, cooled and liquefied for storage and shipment.
- Hydrogen processing - The hot hydrogen gas from the electrolytic cells is cooled by contact with brine, then compressed and used either as auxiliary fuel, sold as gas or burned with chlorine to produce muriatic acid.

- Caustic processing - The 50% caustic soda is cooled, filtered, concentrated and stored for shipping.

- Muriatic acid processing - Hydrogen gas is burned in the presence of chlorine to produce hydrogen chloride gas. This gas is absorbed in water to form a solution of 35% muriatic acid and 65% water.

Wastewaters from this industrial sector consist of washwater, process effluent and cooling water.

Potential Sources of Stormwater Pollution

Stormwater from this industrial sector may contain high concentrations of dissolved solids.

The potential sources of stormwater pollution are generally limited to the following industrial activities:

- Raw material storage;
- Solid waste storage;
- Brine purification;
- Vehicle/equipment maintenance;
- Finished product storage;
- Fuel and lubricants storage; and,
- Truck traffic.

Raw material storage and solid waste storage are the two primary sources of stormwater pollution. The raw material, salt, can contribute to dissolved solids in stormwater. Analysis of stormwater samples collected from a chlor-alkali manufacturing plant in the Lower Fraser Basin showed high concentrations of dissolved solids. Other pollutants were lower than concentrations from typical industrialstormwater runoff.

The potential for stormwater pollution from the other sources is generally lower due to implementation of containment and spill control measures.

Recommended Stormwater Best Management Practices

The following BMPs are designed to minimize runoff of contaminated stormwater to receiving waters. The facility personnel should first evaluate and implement source control BMPs followed by runoff control/treatment BMPs.

For chlor-alkali manufacturing operations, stormwater pollution is primarily due to contaminants generated from salt stockpiles and from the brine purification operation. Implementation of source control BMPs can minimize stormwater pollution from these sources. Other source control BMPs are designed to minimize the potential for stormwater contamination from chemical/fuel storage operations.

Even though the stormwater pollution potential is small from chemical or fuel spills/leaks in relation to the other point sources, implementation of liquid storage source control BMPs is strongly recommended because of the high environmental liability associated with an unconfined spill.

The recommended runoff control/treatment BMPs are designed to minimize the potential of contaminated stormwater runoff.

1. Source Control BMPs

1.1 **Good Housekeeping and Preventive Maintenance** - *To minimize stormwater runoff of contaminants to receiving waters and to maintain a clean and orderly work environment which will lead to more organized and consistent handling of waste materials.*
• Sweep the site frequently to remove materials that can contribute to stormwater pollution. Collect and dispose of sweepings to storage dumpsters for disposal in approved landfills. • Implement a comprehensive preventive maintenance program for plant equipment and stormwater management devices. • Inspect and clean catchbasins and drainage inlets frequently to ensure proper operation. A catchbasin should be cleaned if the depth of deposits are equal to or greater than 1/3 the depth from the basin to the invert of the lowest pipe into or out of the basin. • Inspect and clean oil/water separators frequently to remove accumulated oils and solids to ensure proper operation.

1.2	**Raw Material Storage** - *Minimize the runoff of contaminated stormwater.*
•	Grade the perimeter of the area to prevent the run-on of uncontaminated stormwater from adjacent areas as well as runoff of contaminated stormwater from the salt stockpile area.
•	Collect and recycle stormwater from the salt stockpile area for brine processing.

1.3	**Brine Purification** - *Minimize the runoff of contaminated stormwater.*
•	Grade the perimeter of the area to prevent the run-on of uncontaminated stormwater from adjacent areas as well as runoff of contaminated stormwater from the brine purification area.
•	Collect and recycle spills and contaminated stormwater back to the purification process.

1.4	**Vehicle/Equipment Maintenance** - *Minimize stormwater from coming into contact with potential pollutants.*
•	Use drip-pans under all vehicles and equipment undergoing maintenance.
•	Pave with concrete and grade the maintenance area to prevent the run-on of uncontaminated stormwater from adjacent areas as well as runoff of contaminated stormwater.
•	Treat contaminated stormwater from the maintenance area in an oil/water separator prior to discharge to the receiving water.

1.5 Liquid Storage in Above-Ground Tanks/Containers - *To reduce the potential for an unconfined spill.*

- Surround above-ground liquid (e.g., magnesium chloride, asphalt and fuel) storage tanks with curbs/dikes to provide secondary containment storage. The enclosed volume should be the greater of either 10% of the total tank volume or 110% of the volume contained in the largest tank. Additional volume may be needed depending on the quantity of rainfall reaching the site.

- The floor area enclosed by the curbing should be covered with an impervious surface and sealed to prevent spills from contaminating groundwater. The paved floor should be sloped to a lined sump for collection of small spills.

- During the wet season, accumulated stormwater should be released frequently. Ideally, a roof-type structure should also be provided to minimize the collection of stormwater inside the curbed/diked area.

- Provide treatment by oil/water separators for stormwater from oil/fuel containment areas.

- Provide special ventilation, temperature control and fire protection where chemical stability or freezing protection are of concern.

- Secure storage buildings to prevent unauthorized persons from accessing storage containers and causing spills.

- Segregate and store incompatible or reactive materials in separate containment areas to prevent the mixing of chemicals should spills occur.

- Use drip-pans when loading/unloading liquid materials. Place drip-pans at locations where spillage may occur such as hose connections, hose reels, filler nozzles and opened tanks/drums.

- Regularly inspect all containers for deterioration and leakage. Check the lids of drums to ensure they are in place and properly secured. Immediately contain leaks and repair the source.

- Develop spill prevention and emergency cleanup plan and provide equipment and materials for cleanup.

2. Runoff Control/Treatment BMPs

2.1 Stormwater Flow Segregation - *To reduce the contaminated stormwater volume requiring treatment.*

- Grade and curb the site to prevent the runoff of contaminated stormwater and the run-on of uncontaminated stormwater from adjacent areas. Collect and convey contaminated stormwater for treatment.

- Test and analyze rooftop runoff samples and non-process area stormwater samples to determine contaminant levels. Discharge uncontaminated stormwater to the storm drain below the treatment system or directly to the receiving water. Collect and reuse contaminated stormwater in processes. Discharge excess contaminated stormwater to infiltration ponds or to the city sewer system according to permit or local sewer authority requirements.

- Pave and curb areas that may contribute to stormwater pollution to contain wastewater/contaminated stormwater from reaching storm drains. Collect and treat wastewater/contaminated stormwater for pollutants of concern.

2.2	**Stormwater Treatment** - *To minimize the stormwater contaminant loadings to the receiving water.*

- Conduct a sampling and analytical program to identify the volume and pollutant concentrations for the various sources of contaminated stormwater. For chlor-alkali manufacturing operations, the major pollutants are pH and dissolved solids.
- Treat stormwater contaminated with oil and grease in oil/water separators prior to discharge to the receiving water.
- Oil/water separators should be designed for a 45-minute detention time for a 6-month, 24-hour storm event over the surface of the plant area with potential stormwater pollution.
- Discharge high dissolved solids containing stormwater to infiltration ponds.
- *Note - Contaminated stormwater should not be discharged to the sanitary sewer system except under special conditions defined by the local sewer authority or regulatory agency and provided the local sewer treatment plant can effectively treat the stormwater pollutants of concern. For most localities, this BMP requires approval of the local sewer authority. The allowable flow rate and contaminant concentrations may vary with the particular sewer system and local sewer authority.*

18° Marine Cargo Handling Industry (Dry Bulk Terminals)

SIC 4491(US)

Description of Industrial Sector

Establishments primarily engaged in activities directly related to marine cargo handling from the time cargo arrives at shipside, dock, pier, terminal, staging area or in-transit area until cargo loading or unloading operations are completed. Included in this industry are establishments primarily engaged in the transfer of cargo between ships and barges, trucks, trains, pipelines and wharves. Dry bulk terminal operations are included in this industrial category.

Materials Used and Wastes Generated

Marine cargo handling terminals receive and tranship bulk commodities to local and international markets. The commodities handled by bulk terminals in the Lower Fraser Basin include urea, potash, fertilizer, alfalfa pellets, grains, wood chips, coal, sulphur, phosphate rock, metal concentrates, cement aggregates, salt, ethylene glycol and styrene monomer.

General operations of bulk terminals include:

- Unloading - Bulk commodities arrive at the terminal in rail cars, trucks, barges or ships. When possible, some commodities are loaded directly to waiting vessels.

- Open stockpiles/closed storage - After unloading, the commodities are stored in either closed or covered areas, storage tanks or in open stockpiles. The choice of storage type depends on the properties of the materials, requirements for weather protection, and environmental protection.

- Loading - From the storage area, the commodities are transferred to waiting vessels, barges, trucks or rail cars.

Process wastewaters (including wastewaters from washdown of transfer systems, transfer area, and from air emission control systems) and contaminated stormwater are generated by bulk terminal operations. Common technologies for treatment of process wastewaters and contaminated stormwater include gravity settling, flocculation and coagulation, chemical precipitation, and pH neutralization.

Potential Sources of Stormwater Pollution

Stormwater from this industrial sector may contain high concentrations of pollutants that are characteristics of the dry bulk commodities handled at the terminal. For dry bulk terminals in the Lower Fraser Basin, stormwater pollutants include suspended solids and organics from the handling of agricultural commodities, acidity and dissolved metals from mineral concentrates, and suspended solids from aggregates.

The potential sources of stormwater pollution are generally limited to the following industrial activities:

- Fugitive dust;
- Material handling;
- Commodity storage;
- Vehicle/equipment maintenance and washing;
- Truck traffic;
- Fuel and lubricants storage; and,
- Bulk chemical storage.

Fugitive dust from unloading/loading operations and open stockpiles is a major problem in some terminals. Settled dust, if not recovered, can contribute significantly to the stormwater pollution problem. Similar to fugitive dust emissions, spillage occurs throughout the material handling operation. An inherent problem of belt conveyors, large amounts of spillage occur at conveyor transfers and hoppers, and along the length of conveyor belts. Spilled materials on the ground can also contribute tostormwater pollution.

The potential for stormwater pollution from the other sources is generally lower. Truck traffic may distribute accumulated dust to other parts of the terminal. Overfilling and leaks during liquid transfer to and from storage tanks may contribute to oil and grease in stormwater runoff. Stormwater contamination potentials may increase substantially for facilities with larger bulk liquid storage operations.

Recommended Stormwater Best Management Practices

The following BMPs are designed to minimize runoff of contaminated stormwater to receiving waters. The facility personnel should first evaluate and implement source control BMPs, followed by runoff control/treatment BMPs.

For dry bulk terminal operations, stormwater pollution is primarily due to deposition of dust from many different operations. Source control BMPs can minimize stormwater pollution. Other source control BMPs are designed to minimize the potential for stormwater contamination from liquid storage operations.

Even though the stormwater pollution potential is small from chemical and fuel spills or leaks in relation to the other point sources, implementation of liquid storage source control BMPs is strongly recommended because of the high environmental liability associated with an unconfined spill.

The recommended runoff control/treatment BMPs are designed to decrease the suspended solids loadings and oil and grease in the stormwater runoff. These parameters may be removed from the effluent by oil/water separators.

To ensure the proper selection of the runoff control/treatment BMP, plant personnel should conduct sampling and analysis to determine stormwater characteristics. Plant personnel should also consult with the appropriate environmental regulatory agency prior to implementing the recommended treatment BMP.

1. Source Control BMPs

1.1 Good Housekeeping and Preventive Maintenance - *To minimize stormwater runoff of contaminants to receiving waters and to maintain a clean and orderly work environment which will lead to more organized and consistent handling of waste materials.*

- Sweep the site frequently to reclaim spilled commodities. Washdown cleanup generates washwater that may require treatment and should be avoided.
- Implement a comprehensive preventive maintenance program for plant equipment and stormwater management devices.
- Inspect and clean catchbasins and drainage inlets frequently to ensure proper operation. A catchbasin should be cleaned if the depth of deposits are equal to or greater than 1/3 the depth from the basin to the invert of the lowest pipe into or out of the basin.
- Inspect and clean detention ponds and oil/water separators frequently to remove accumulated oils and solids to ensure proper operation.

1.2 Material Handling - *Minimize the generation and the release of dust.*

- Provide flexible screens, drapes or curtains to minimize dust escaping.
- Regularly clean up spilled products to minimize dust creation.
- Pave and grade the conveyor corridor and transfer points to minimize dispersion and to improve sweeping and washdown.
- Use water or dust suppression agents at unloading areas and along conveyor transfer points to suppress dust.
- Install and maintain dust collection systems, such as baghouses, on vents from pneumatic or mechanical transfer systems, and at transfer points, to collect airborne particles.
- Use slower belt speeds for dusty materials. Higher belt speeds can cause higher dust emissions and spillage.
- Enclose the conveyor system or install dripping trays underneath the conveyor to catch spills and drips.
- Use telescoping chutes to load products to minimize spillage and reduce the free-fall height of the product to decrease dust emissions.

1.3	**Raw Material Storage** - *Minimize the accumulation of stormwater in the storage area and the runoff of contaminated stormwater.*

- Wherever possible, store commodities in enclosed structures.
- Use telescopic chutes or choke feeders to minimize free falling of products during stacking.
- Use water sprays for dust control and coordinate water addition with weather forecasts to minimize the spray volume.
- Use crusting agents to minimize wind-blown dust from open stockpiles during dry and windy weather.
- Grade the perimeter of the area to prevent the run-on of uncontaminated stormwater from adjacent areas as well as runoff of contaminated stormwater from the stockpile area.
- Grade the area to minimize pooling of stormwater and pollutants generated from the leaching of stockpiles. A minimum slope of 1.5% is recommended.
- Collect and treat contaminated stormwater from stockpile areas in an on-site wastewater treatment plant.

1.4	**Vehicle/Equipment Maintenance and Washing** - *Minimize stormwater from coming into contact with potential pollutants.*

- Use drip-pans under all vehicles and equipment undergoing maintenance.
- Pave with concrete and grade the maintenance area to prevent the run-on of uncontaminated stormwater from adjacent areas as well as runoff of contaminated stormwater.
- Treat contaminated stormwater from the maintenance area in an oil/water separator prior to discharge to the receiving water.
- Regularly clean the oil/water separator to remove accumulated oils and solids to maintain optimum performance.
- Pave and grade vehicle/equipment washing and steam-cleaning areas to prevent the run-on of uncontaminated stormwater and the runoff of washwater and contaminated stormwater. Where possible, enclose vehicle/equipment washing and steam-cleaning areas with either walls and/or roof to prevent the entry of precipitation and to contain the washwater.
- Collect and treat washwater/contaminated stormwater to remove suspended solids by gravity settling. Regularly clean settling ponds to remove accumulated solids to maintain optimum performance.
- Collect and treat steam-cleaning effluent and oil contaminated stormwater by oil/water separators.

1.5	**Loading/Unloading of Liquid Materials** - *Prevent rainwater from coming into contact with potential pollutants and to reduce the potential for an unconfined spill.*

- Provide overhangs and site grading for loading/unloading areas with high stormwater pollution potential to prevent run-on of stormwater. Collect and convey contaminated stormwater from these areas to an on-site wastewater treatment according to permit requirements.

- Close storm drains near areas with high stormwater pollution potential to prevent discharges of contaminated stormwater to the receiving water.

- Pave tank truck transfer area with concrete. Design the transfer area to prevent the run-on of uncontaminated stormwater from adjacent areas and to contain spills. Direct spills to a dead-end for removal or to process treatment.

- Use drip-pans when loading/unloading liquid materials. Place drip-pans at locations where spillage may occur, such as hose connections, hose reels and filler nozzles.

- Develop spill prevention and emergency cleanup plan and provide equipment and materials for cleanup.

1.6 Liquid Storage in Above-Ground Tanks/Containers - *To reduce the potential for an unconfined spill.*

- Surround above-ground liquid (e.g., vegetable oil, ethylene glycol and methanol) storage tanks with curbs/dikes to provide secondary containment storage. The enclosed volume should be the greater of either 10% of the total tank volume or 110% of the volume contained in the largest tank. Additional volume may be needed depending on the quantity of rainfall reaching the site.

- The floor area enclosed by the curbing should be covered with an impervious surface and sealed to prevent spills from contaminating groundwater. The paved floor should be sloped to a lined sump for collection of small spills.

- During the wet season, accumulated stormwater should be released frequently. Ideally, a roof-type structure should also be provided to minimize the collection of stormwater inside the curbed/diked area.

- Provide treatment by oil/water separators for stormwater from oil/fuel containment areas.

- Provide special ventilation, temperature control and fire protection where chemical stability or freezing protection are of concern.

- Secure storage buildings to prevent unauthorized persons from accessing storage containers and causing spills.

- Segregate and store incompatible or reactive materials in separate containment areas to prevent the mixing of chemicals should spills occur.

- Use drip-pans when loading/unloading liquid materials. Place drip-pans at locations where spillage may occurs, such as hose connections, hose reels, filler nozzles and opened tanks/drums.

- Regularly inspect all containers for deterioration and leakage. Check the lids of drums to ensure they are in place and properly secured. Immediately contain leaks and repair the source.

- Develop spill prevention and emergency cleanup plan and provide equipment and materials for cleanup.

2. Runoff Control/Treatment BMPs

2.1 Stormwater Flow Segregation - *To reduce the contaminated stormwater volume requiring treatment.*
• Grade and curb the site to prevent the runoff of contaminated stormwater and the run-on of uncontaminated stormwater from adjacent areas. Collect and convey contaminated stormwater for treatment. • Test and analyze rooftop runoff samples and non-process area stormwater samples to determine contaminant levels. Discharge uncontaminated stormwater to the storm drain below the treatment system or directly to the receiving water. Discharge contaminated stormwater to an on-site wastewater treatment system or to the city sewer system according to permit or local sewer authority requirements. • Pave and curb areas that may contribute to stormwater pollution to contain wastewater/contaminated stormwater from reaching storm drains. Collect and treat wastewater/contaminated stormwater for pollutants of concern.

2.2	**Stormwater Treatment** - *To minimize the stormwater contaminant loadings to the receiving water.*

- Conduct a sampling and analytical program to identify the volume and pollutant concentrations for the various sources of contaminated stormwater.

- Design and install a wastewater treatment system appropriate for the pollutants of concern. Treat stormwater contaminated with oil by oil/water separators; with dissolved metals by a physical/chemical treatment system; elevated or depressed pH by pH neutralization; with organics by a biological treatment system; and high suspended solids by gravity settling.

- Depending on the stormwater contaminants and volume, the facility may consider discharging the wastewater/contaminated stormwater to the local sewer for treatment. This disposal option may require approval from the local sewer authority.

- *Note - Contaminated stormwater should not be discharged to the sanitary sewer system except under special conditions defined by the local sewer authority or regulatory agency and provided the local sewer treatment plant can effectively treat the stormwater pollutants of concern. For most localities, this BMP requires approval of the local sewer authority. The allowable flow rate and contaminant concentrations may vary with the particular sewer system and local sewer authority.*

19º Light Industry (Industrial Park)

SIC 7599

Description of Industrial Sector

Establishments primarily engaged in owning and operating real estate not elsewhere classified. Included in this industry are industrial parks.

Materials Used and Wastes Generated

Generally, industrial parks house many types of businesses including offices, retail food establishments, small businesses, food distributors, food services, warehouses, automobile repair services and other light industries.

Depending on the types of businesses, there is a wide variety of raw materials used in an industrial park. The types of wastewater generated in industrial parks include process wastewaters, cooling water andstormwater runoff.

Potential Sources of Stormwater Pollution

Stormwater from this industrial sector, depending on the types of industrial operations present, may contain high concentrations of suspended solids, organics, nutrients, oil and grease, and dissolved metals.

The potential sources of stormwater pollution are generally limited to the following industrial activities:

- Loading and unloading;
- Outdoor manufacturing;
- Vehicle/equipment maintenance and washing;
- Solid waste storage;
- Fuel and lubricant storage;
- Chemical storage; and,
- Truck traffic.

Among the potential sources, unloading/loading, outdoor manufacturing, vehicle/ equipment maintenance and washing are primary. These activities can contribute to high loadings of suspended solids and oil and grease in stormwater. The potential for stormwater pollution from the other sources is generally lower.

Recommended Stormwater Best Management Practices

The following BMPs are designed to minimize runoff of contaminated stormwater to receiving waters. The facility personnel should first evaluate and implement source control BMPs, followed by runoff control/treatment BMPs.

For industrial parks, stormwater pollution is due to a variety of sources (loading/unloading, outdoor manufacturing, vehicle/equipment maintenance and washing). Source control BMPs can effectively control stormwater pollution from these point sources at relatively low costs.

Even though the stormwater pollution potential from waste oil and chemical storage is small in relation to the other point sources, implementation of appropriate source control BMPs is strongly recommended because of the high environmental liability associated with an unconfined spill.

The recommended runoff control/treatment BMPs are designed to prevent stormwater from coming into contact with contaminated areas.

1. Source Control BMPs

1.1 Good Housekeeping and Preventive Maintenance - *To minimize stormwater runoff of contaminants to receiving waters and to maintain a clean and orderly work environment which will lead to more organized and consistent handling of waste materials.*

- Sweep the plant area frequently, especially after each unloading operation, to remove raw materials and finished products that can contribute to stormwater pollution. Collect and dispose of sweepings to storage dumpsters for disposal in approved landfills.
- Implement a comprehensive preventive maintenance program for plant equipment and stormwater management devices.
- Inspect and clean catchbasins and drainage inlets around loading docks and solid waste storage areas frequently to ensure proper operation. A catchbasin should be cleaned if the depth of deposits are equal to or greater than 1/3 the depth from the basin to the invert of the lowest pipe into or out of the basin.
- Inspect and clean oil/water separators frequently to remove accumulated oils and solids to ensure proper operation.

1.2 Loading and Unloading - *Prevent rainwater from coming into contact with potential pollutants.*

- Pave chemical tank truck transfer areas with concrete. Design the transfer area to prevent the run-on of uncontaminated stormwater from adjacent areas and to contain spills. Direct spills to a dead-end for removal or to process treatment.
- Use drip-pans when loading/unloading liquid materials. Place drip-pans at locations where spillage may occurs, such as hose connections, hose reels and filler nozzles.
- Develop spill prevention and emergency cleanup plan and provide equipment and materials for cleanup.

1.3	**Outdoor Manufacturing** - *Prevent rainwater from coming into contact with potential pollutants.*

- Enclose, cover or contain the outdoor manufacturing areas to the maximum extent practical to prevent solid materials from reaching storm drains or receiving waters and to prevent precipitation from coming into contact with liquid and solid waste residues.
- Use sweepers regularly to clean up waste materials. Avoid washdown cleanup.
- Grade the outdoor manufacturing areas to divert uncontaminated stormwater flow and to collect contaminated stormwater for treatment. Treat stormwater contaminated with oil in oil/water separators.

1.4	**Solid Waste Storage** - *Prevent rainwater from coming into contact with potential pollutants.*

- Provide roof covers for solid waste storage areas.
- For uncovered solid waste storage areas, grade and curb the perimeter to prevent the run-on of uncontaminated stormwater from adjacent areas as well as runoff of contaminated stormwater from the storage area.
- Collect and discharge contaminated stormwater to an on-site wastewater treatment system or to the city sewer according to permit or local sewer authority requirements.

1.5 Vehicle/Equipment Maintenance and Washing - *Minimize stormwater from coming into contact with potential pollutants.*

- Use drip-pans under all vehicles and equipment undergoing maintenance.
- Pave with concrete and grade the maintenance area to prevent the run-on of uncontaminated stormwater from adjacent areas as well as runoff of contaminated stormwater.
- Treat contaminated stormwater from the maintenance area in an oil/water separator prior to discharge to the receiving water.
- Clean regularly the oil/water separator to remove accumulated oils and solids to maintain optimum performance.
- Pave and grade vehicle/equipment washing and steam-cleaning areas to prevent the run-on of uncontaminated stormwater and the runoff of washwater and contaminated stormwater. Where possible, enclose vehicle/equipment washing and steam-cleaning areas with either walls and/or roof to prevent the entry of precipitation and to contain the washwater.
- Collect and treat washwater/contaminated stormwater to remove suspended solids by gravity settling. Regularly clean settling ponds to remove accumulated solids to maintain optimum performance.
- Collect and treat steam-cleaning effluent and stormwater contaminated by oil in oil/water separators.

1.6 Liquid Storage in Above-Ground Tanks/Containers - *To reduce the potential for an unconfined spill.*

- Surround above-ground liquid (e.g., chemicals, waste oil) storage tanks with curbs/dikes to provide secondary containment storage. The enclosed volume should be the greater of either 10% of the total tank volume or 110% of the volume contained in the largest tank. Additional volume may be needed depending on the quantity of rainfall reaching the site.

- The floor area enclosed by the curbing should be covered with an impervious surface and sealed to prevent spills from contaminating groundwater. The paved floor should be sloped to a lined sump for collection of small spills.

- During the wet season, accumulated stormwater should be released frequently. Ideally, a roof-type structure should also be provided to minimize the collection of stormwater inside the curbed/diked area.

- Provide treatment by oil/water separators for stormwater from oil/fuel containment areas.

- Provide special ventilation, temperature control and fire protection where chemical stability or freezing protection are of concern.

- Secure storage buildings to prevent unauthorized persons from accessing storage containers and causing spills.

- Segregate and store incompatible or reactive materials in separate containment areas to prevent the mixing of chemicals should spills occur.

- Use drip-pans when loading/unloading liquid materials. Place drip-pans at locations where spillage may occur, such as hose connections, hose reels, filler nozzles and opened tanks/drums.

- Regularly inspect all containers for deterioration and leakage. Check the lids of drums to ensure they are in place and properly secured. Immediately contain leaks and repair the source.

- Develop spill prevention and emergency cleanup plan and provide equipment and materials for cleanup.

2. Runoff Control/Treatment BMPs

2.1 **Stormwater Flow Segregation** - *To reduce the contaminated stormwater volume requiring treatment.*

- Grade and curb the site to prevent the runoff of contaminated stormwater and the run-on of uncontaminated stormwater from adjacent areas. Collect and convey contaminated stormwater for treatment.

- Test and analyze rooftop runoff samples and non-process area stormwater samples to determine contaminant levels. Discharge uncontaminated stormwater to the storm drain below the treatment system or directly to the receiving water. Discharge contaminated stormwater to an on-site wastewater treatment system.

- Pave and curb areas that may contribute to stormwater pollution to contain wastewater/contaminated stormwater from reaching storm drains. Collect and treat wastewater/contaminated stormwater for pollutants of concern.

2.2 **Stormwater Treatment** - *To minimize the stormwater contaminant loadings to the receiving water.*

- Conduct a sampling and analytical program to identify the volume and pollutant concentrations for the various sources of contaminated stormwater. For industrial parks, the major pollutants are: organics and nutrients.

- Treat stormwater contaminated with oil and grease in oil/water separators prior to discharge to the receiving water.

- Treat stormwater contaminated with high concentrations of organic materials in an on-site wastewater treatment system or in a public wastewater treatment plant according to permit or local sewer authority requirements.

- *Note - Contaminated stormwater should not be discharged to the sanitary sewer system except under special conditions defined by the local sewer authority or regulatory agency and provided the local sewer treatment plant can effectively treat the stormwater pollutants of concern. For most localities, this BMP requires approval of the local sewer authority. The allowable flow rate and contaminant concentrations may vary with the particular sewer system and local sewer authority.*

Background Report for Stormwater Best Management Practices for Selected Industrial Sectors in the Lower Fraser Basin

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Glossary of Terms - Abbreviations

API	American Petroleum Institute
Asphalt	Asphalt concrete
Basin	Lower Fraser Basin
BC	British Columbia
BMP	Best Management Practice
BOD_5	Biochemical Oxygen Demand (5-day)
CCA	Chromated Copper Arsenic
COD	Chemical Oxygen Demand
Comp	Composite samples
concrete	Portland cement concrete
CPS	Coalescing Plate Separator
ODEQ	Oregon Department of Environmental Quality
Ecology	Washington Department of Ecology
fpm	feet per minute
ft	feet
FRAP	Fraser River Action Plan
gm	grams
Grab	Grab samples
GVRD	Greater Vanconver Regional District
GVSDD	Greater Vancouver Sewerage & Drainage District
ICP	Inductively Coupled Argon Plasma Spectrometry
kg	kilograms
l	litre
m	metres
m^2	square metres
m^3	cubic metres
mg	milligrams
mg/l	milligrams per litre
mm	millimetres
MOELP	Ministry of Environment, Lands and Parks
N/A	Non Applicable
NO_{2+3}	nitrite + nitrate
NPDES	National Pollutant Discharge Elimination System
NURP	Nationwide Urban Runoff program
PAH	Polynuclear Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
Plan	Fraser River Action Plan
ppm	parts per million
SIC	Standard Industrial Classification
SP	Soluble Phosphorus
SWPP	Stormwater Pollution Plan
s.u.	standard units
TEH	Total Extractable Hydrocarbons

TKN	Total Kjeldahl Nitrogen
TOC	Total Organic Carbon
TP	Total Phosphorus
TPH	Total Petroleum Hydrocarbons
TSS	Total Suspended Soilds
µg	micrograms
µS/cm	micromhos per centimeter
UN	United Nations
USEPA	United States Environmental Protection Agency
WWTP	wastewater treatment plant

1.0 Introduction

1.1 Background

Stormwater runoff is a major non-point discharge. The major pollutant effect from non-point sources is suspended solids, although this may vary depending on the geographical conditions of the regions. Runoff may also carry petroleum-based products (oil and gasoline), agricultural chemicals, nutrients, heavy metals, oxygen-demanding compounds, bacteria, viruses and other toxic substances to the receiving waters.

Research conducted in the United States revealed that non-point sources, such as agricultural runoff and urban surface runoff, comprise the major sources of water pollution, contributing 65 percent of the contamination in impaired rivers, 76% in impaired lakes, and 45% in impaired estuaries (USEPA, 1983).

In the Lower Fraser Basin, the major pollution sources are sewerage treatment plant discharges, agricultural runoff, urban runoff, industrial effluents and combined sewer overflows. Urban runoff and combined sewer overflows contribute about 34% of the contaminated flows to the Fraser River estuary (Environment Canada, 1992).

A substantial number of research and engineering studies on the characterization and management of urban runoff have been commissioned both in Canada and in the United States. Conclusions from the United States Environmental Protection Agency Nationwide Urban Runoff Program indicated that the characteristics of stormwater runoff depend on the following parameters:

- Climatic conditions;
- Geology and soil characteristics;
- Agricultural activity;
- Urbanization; and,
- Industrial activity.

In 1992, the federal government initiated the Fraser River Action Plan (FRAP) aiming to improve the water quality of the Fraser River in the province of British Columbia. A part of FRAP involved the delineation and development of control strategies for pollutants entering the Fraser River Basin from point and non-point sources. Prior to the introduction of FRAP, the primary focus of the regulatory agencies was on discharges from point sources, including the major industrial sectors and municipalities. Non-point sources, such as runoff from agricultural areas, storm runoff from urban centres or developments (municipal), industrial installations, mining, forestry and construction activities, had not been fully addressed.

In the United States, the Congress amended the Clean Water Act in 1987 requiring the United States Environmental Protection Agency (USEPA) to regulate stormwater discharges under the National Pollutant Discharge Elimination System (NPDES) program. The federal regulations currently require the affected facilities to implement operational and source control best management practices (BMPs). For facilities which discharge a significant amount of pollutants, implementation of treatment best management practices may also be required.

Climatic conditions and human-related activities, including industrial and agricultural developments in the Lower Fraser Basin, may be different from other parts of the country. Knowledge of actual stormwater characteristics and management practices in the region is limited. Recognizing the significant contribution of contaminants from non-point sources and to achieve the objectives of FRAP, Environment Canada, Pacific and Yukon Region, initiated a program to assess non-point discharges from various industrial sectors in the Lower Fraser Basin.

1.2 Objective and Scope of Background Report

The objective of the Background Report was to collect and analyze data from typical operations in the Lower Fraser Basin that represent the non-major industrial sectors. The findings of the study are presented in the following sections:

- Section2, “Stormwater Management Practices at Selected Industrial Sites in the Lower Fraser Basin”;
- Section 3, “Stormwater Sampling Analysis”;
- Section 4, “Stormwater Pollutant Loading Analysis”;
- Section 5, “Stormwater Best Management Practices”; and,
- Section 6, “Stormwater BMPs Cost Estimating Guide”.

This background material was used to develop BMPs to reduce stormwater pollution. These BMPs were integrated into the industry guide *Stormwater Best Management Practices (BMPs) for Selected Industrial Sectors in the Lower Fraser Basin*. This Background Report is a companion to the guide.

The Stormwater Best Management Practices report sets out source control and runoff control/treatment BMPs for 19 industrial sectors in the Lower Fraser Basin although 25 were surveyed. These industrial sectors and the respective Standard Industrial Classification (SIC) codes (Statistics Canada, 1980)are presented in Table 1.1.

Table 1.1 Listing of Industrial Sectors with Recommended Stormwater BMPs

Industrial Sector	SIC
Sand and Gravel Pits	0821
Meat and Meat Products Industries (Abattoir)	1011
Fish Product Industry	1021
Canned and Preserved Fruit and Vegetable Industry	1031
Frozen Fruit and Vegetable Industry	1032
Fluid Milk Industry	1041
Cane and Beet Sugar Industry	1081
Other Food Products Industries (Egg Processing)	1099
Brewery Products Industry	1131
Sawmill and Planing Mill Products Industry	2512
Wire and Wire Products Industries	0305
Hydraulic Cement Industry	3521
Ready-Mix Concrete Industry	3551
Lime Industry	3581
Refined Petroleum Products Industry (Bulk Storage)	3611
Other Petroleum and Coal Product Industries (Asphalt Manufacturing)	3699
Industrial Inorganic Chemical Industry (Chlor-Alkali Manufacturing)	3711
Marine Cargo Handling Industry (Dry Bulk Terminal, US SIC code)	4491
Light Industry (Industrial Park)	7599

This Background report and the companion Stormwater Best Management Practices report were developed in part based on documents from Environment Canada, United States Environmental Protection Agency, and Washington Department of Ecology.

2.0 Stormwater Management Practices at Selected Industrial Sites in the Lower Fraser Basin

2.1 Introduction

Based on information collected through a telephone survey, 25 industrial facilities representative of the various industrial sectors were selected for site inspection. The objectives of the site inspections were to:

- assess the current stormwater management practices;
- assess the stormwater sampling feasibility; and,
- develop a stormwater sampling plan.

Table 2.1 presents the 22 industrial sectors and the respective Standard Industrial Classification (SIC) codes represented by these 25 industrial sites.

Table 2.1 Summary of Selected Industrial Sectors

Industrial Sector	SIC
Sand and Gravel Pits	0821
Meat and Meat Products Industries (Abattoir)	1011
Fish Product Industry	1021
Canned and Preserved Fruit and Vegetable Industry	1031
Frozen Fruit and Vegetable Industry	1032
Fluid Milk Industry	1041
Cane and Beet Sugar Industry	1081
Other Food Products Industries (Egg Processing)	1099
Brewery Products Industry	1131
Sawmill and Planing Mill Products Industry	2512
Wire and Wire Products Industries	305
Hydraulic Cement Industry	3521
Ready-Mix Concrete Industry	3551
Lime Industry	3581
Refined Petroleum Products Industry (Bulk Storage)	3611
Other Petroleum and Coal Product Industries (Asphalt Manufacturing)	3699
Industrial Inorganic Chemical Industry (Chlor-Alkali Manufacturing)	3711
Other Chemical Products Industries	3799
Marine Cargo Handling Industry (Dry Bulk Terminal, US SIC code)	4491
Other Pipeline Transport Industries	4619
Automobile Salvage Yards	5911
Light Industry (Industrial Park)	7599

Site evaluation surveys for 24 industrial facilities were presented in the Draft Survey Results report (PCA). Site inspections conducted for automobile salvage yards have not been documented. Also, rather than a report on a single operation, the sand and gravel pits site evaluation report documented observations for several sand and gravel pit operations in the Matsqui area (PCA).

2.2 Industrial Facility Operating Schedule

Stormwater pollutants from industrial facilities are typically generated when stormwater comes into contact with contaminated areas at the site. Stormwater pollutants may also be generated as a result of the direct discharge of contaminants into the storm sewer system. Therefore, the potential for stormwater pollution is strongly dependent on the operational status of the industrial facility. In most cases, the potential for stormwater pollution from a non-operating facility is greatly reduced.

Presented in Table 2.2 is a summary of operating schedules for the 25 industrial sites.

Table 2.2 Facility Operating Schedule Summary

Industrial Sector	Plant Operating Period
Sand and Gravel Pits	Year-round
Meat and Meat Products (Abattoir)	Year-round
Fish Product	March - October
Fish Product	March - October
Canned and Preserved Fruit and Vegetable	October - November
Frozen Fruit and Vegetable	February - October
Frozen Fruit and Vegetable	Year-round
Fluid Milk	Year-round
Cane and Beet Sugar	Year-round
Other Food Products (Egg Processing)	Year-round
Brewery Products	Year-round
Sawmill and Planing Mill Products	Year-round
Wire and Wire Products	Year-round
Wire and Wire Products	Year-round
Hydraulic Cement	Year-round
Ready-Mix Concrete	Year-round
Lime	Year-round
Refined Petroleum Products (Bulk Storage)	Year-round
Asphalt Manufacturing	March - November
Industrial Inorganic Chemical (Chlor-Alkali)	Year-round
Other Chemical Products	Year-round
Marine Cargo Handling	Year-round
Other Pipeline Transport	Year-round
Automobile Salvage Yards	Year-round
Light Industry (Industrial Park)	Year-round

As indicated in the table, the majority of the facilities operate on a year-round basis. However, industrial sites representing the fish products and asphalt manufacturing industrial sectors are not operational during the winter wet season. Therefore, stormwater pollution from these facilities is expected to be lower than year-round facilities during the wet weather months.

2.3 Summary of Process Wastewater Information

Presented in Table 2.3 is a summary of the on-site process wastewater treatment system, regulated permit parameters, and the effluent receiving environment (discharge point) for 23 of the 25 industrial sites evaluated. The sand and gravel pits and automobile salvage yards industrial sectors were eliminated from further consideration because of the limited potential for the contamination of surface waters from stormwater runoff.

Current waste management practices require facilities with high organic content wastewater to implement biological treatment prior to discharge to receiving environments. The three food processing facilities pre-treat the wastewater biologically prior to land disposal. Facilities with heavy-metals-laden process wastewater are required to remove metals from the effluent. For the two sites within the wire and wire products industrial sector, the process wastewaters are treated by a physical/chemical process for metals removal. Depending on the pollutants of concern, other common waste treatment processes employed are screens/settling ponds for wastewater containing suspended solids, and oil/water separators for wastewater contaminated with oily materials.

Table 2.3 Process Wastewater Information Summary

Site No.	Industrial Sector	Process Wastewater Treatment	Regulated Permit Parameters	Discharge Point
1	Meat and Meat Products (Abattoir)	Aeration Basin	Flow Temperature Residual Chlorine pH	Land
2	Fish Product	Rotary Screen	Flow pH TSS Oil and Grease	Marine Water
3	Fish Product	Sidehill and Rotary Screens	Flow Temperature Residual Chlorine	Freshwater
4	Canned and Preserved Fruit and Vegetable	Sidehill Screen	Oil and Grease pH BOD_5	City Sewer
5	Frozen Fruit and Vegetable	Screening pH Adjustment	Flow BOD_5 pH	Land
6	Frozen Fruit and Vegetable	Screening	Oil and Grease pH BOD_5	City Sewer

Table 2.3 Process Wastewater Information Summary (Continued)

Site No.	Industrial Sector	Process Wastewater Treatment	Regulated Permit Parameters	Discharge Point
7	Fluid Milk	None	Flow pH Oil and Grease TSS BOD_5	City Sewer
8	Cane and Beet Sugar	None	pH TSS Temperature BOD_5	City Sewer
9	Other Food Products (Egg Processing)	Aerated Lagoons	Flow Chlorine	Land
10	Brewery Products	Settling pH Neutralization	Flow pH TSS BOD_5	City Sewer
11	Sawmill and Planing Mill Products	Extended Aeration (Sanitary Waste)	Flow BOD_5 TSS	Freshwater
12	Wire and Wire Products	Physical / Chemical	Flow pH TSS Dissolved Lead Dissolved Zinc Ammonia Toxicity 96h LC50	Land
13	Wire and Wire Products	Physical / Chemical	Flow Dissolved Zinc Toxicity 96h LC50	City Sewer
14	Hydraulic Cement	None	Flow Temperature Oil and Grease	Freshwater
15	Ready-Mix Concrete	Settling Ponds	Flow pH TSS	Land
16	Lime	None	Flow Temperature Residual Chlorine pH	Freshwater
17	Refined Petroleum Products (Bulk Storage)	Oil/Water Separators	Flow pH Oil and Grease TSS Phenols Toxicity 96h LC50	Marine Water
18	Asphalt Manufacturing	Oil/Water Separators	Flow pH TSS Oil/Grease	Freshwater

Table 2.3 Process Wastewater Information Summary (Continued)				
Site No.	**Industrial Sector**	**Process Wastewater Treatment**	**Regulated Permit Parameters**	**Discharge Point**
19	Industrial Inorganic Chemical Industry (Chlor - Alkali)	None	Flow pH TSS Residual Chlorine Copper Nickel Zinc Temperature Toxicity 96h LC50	Marine Water
20	Other Chemical Products	Cooling Towers	Temperature	Freshwater
21	Marine Cargo Handling	Settling pH Neutralization	Flow pH TSS	City Sewer
22	Other Pipeline Transport	Oil/Water Separators Physical/Chemical	Flow TEH PAH pH	Freshwater
23	Light Industry (Industrial Park)	Catch Basins	Non-applicable	Freshwater

2.4 Summary of Potential Stormwater Pollutant Sources

Presented in Table 2.4 is the summary of the potential stormwater pollutant sources for the 23 industrial sites evaluated. The potential pollutant sources are categorized in terms of the six common industrial activities that have been identified by USEPA (Federal Register, 1993) as major contributors to stormwater pollution. These common industrial activities are:

- loading and unloading operations;
- outdoor storage of raw materials and products;
- outdoor process activities;
- dust or particulate generating processes;
- illicit/cross connections or management practices; and,
- waste disposal practices.

Table 2.4 Summary of Potential Stormwater Pollutant Sources

Site No.	Industrial Sector	Potential Stormwater Pollutant Sources
1	Meat and Meat Product (Abattoir)	Truck traffic Processed carcass storage Fuel storage Washwater runoff
2	Fish Product	Unloading of fish Truck traffic Offal storage Waste oil storage Wastewater treatment - screening
3	Fish Product	Unloading of fish Truck traffic Offal storage Waste oil storage Wastewater treatment - screening
4	Canned and Preserved Fruit and Vegetable	Unloading of fruit Truck traffic Solid waste storage Chemical storage Wastewater treatment - screening
5	Frozen Fruit and Vegetable	Unloading of fruit and vegetables Truck traffic Solid waste storage Chemical storage Waste oil storage Land disposal of pre-treated wastewater
6	Frozen Fruit and Vegetable	Unloading of fruit and vegetables Truck traffic Outdoor storage of waste material Waste oil storage
7	Fluid Milk	Unloading of raw milk and cream Truck traffic Solid waste storage Lubricant storage Fuel storage Vehicle washing
8	Cane and Beet Sugar	Unloading of raw sugar Unloading of liquid materials Truck traffic Solid waste storage Waste solvent storage Waste oil storage Chemical storage Fuel Storage Vehicle/equipment washing

Table 2.4 Summary of Potential Stormwater Pollutant Sources (Continued)

Site No.	Industrial Sector	Potential Stormwater Pollutant Sources
9	Other Food Products (Egg Processing)	Loading/unloading of eggs Truck traffic Solid waste storage Waste oil storage Chemical storage Fuel storage Land disposal of pre-treated wastewater
10	Brewery Products	Unloading of corn, malt and barley Truck traffic Solid waste storage Waste oil storage Chemical storage Vehicle washing
11	Sawmill and Planing Mill Products	Waste oil storage Lubricant storage Fuel storage Hydraulic system Log debarking and sawing operations Vehicle/equipment maintenance and washing
12	Wire and Wire Products	Loading and unloading of raw and finished products Truck traffic Solid waste storage Chemical storage Fuel and lubricant storage Vehicle maintenance Baghouse emissions
13	Wire and Wire Products	Loading and unloading of raw and finished products Truck traffic Solid waste storage Chemical storage Fuel and lubricant storage Vehicle maintenance Baghouse emissions
14	Hydraulic Cement	Truck traffic Raw material storage Fuel and lubricant storage Vehicle/equipment maintenance and washing Dust emissions
15	Ready-Mix Concrete	Truck traffic Aggregate storage Sludge storage Chemical admixture storage Fuel and lubricant storage Concrete batching Vehicle/equipment maintenance and washing

Table 2.4 Summary of Potential Stormwater Pollutant Sources (Continued)		
Site No.	**Industrial Sector**	**Potential Stormwater Pollutant Sources**
16	Lime	Loading of finished lime products Truck traffic Limestone storage Fuel and lubricant storage Vehicle/equipment maintenance Dust emissions
17	Refined Petroleum Products (Bulk Storage)	Loading of petroleum products Truck traffic Petroleum product storage
18	Asphalt Manufacturing	Truck traffic Aggregate storage Chemical storage Fuel storage Asphalt manufacturing Equipment/vehicle maintenance and washing
19	Industrial Inorganic Chemical Industry (Chlor-Alkali)	Sea salt storage Truck traffic Caustic product storage Fuel and lubricant storage Brine purification Vehicle/equipment maintenance
20	Other Chemical Products	Unloading of tank cars Chemical storage Fuel storage
21	Marine Cargo Handling	Material handling of bulk materials Truck traffic Dry bulk commodity storage Bulk chemical storage Fuel and lubricant storage Vehicle/equipment maintenance and washing Fugitive dust
22	Other Pipeline Transport	Fuel storage
23	Light Industry (Industrial Park)	Loading and unloading Truck traffic Solid waste storage Chemical storage Fuel and lubricant storage Outdoor processing Vehicle/equipment maintenance and washing

2.5 Summary of Stormwater Management Practices

Of the 23 industrial sites, many have implemented some form of pollution prevention measures that can be classified as stormwater best management practices. These measures include:

- secondary containment structure for chemicals and fuel storage;
- oil/water separator for wastewater contaminated with oily materials; and,
- site grading to convey contaminated stormwater to treatment.

These control measures adequately address major potential stormwater pollution problems such as discharges from tank farms. However, smaller scale stormwater pollution sources are often overlooked by many industrial facilities. These potential source/problem areas are:

- secondary containment for storage of small quantity of liquid products;
- proper maintenance of existing treatment system;
- outdoor equipment/vehicle maintenance; and,
- outdoor equipment/vehicle cleaning.

Presented in Table 2.5 is a summary of the current stormwater management practices implemented at the 23 industrial sites. Problem areas are also identified and are preceded by an asterisk (*).

Table 2.5 Summary of Stormwater Management Practices

Site No.	Industrial Sector	Stormwater Management Practices
1	Meat and Meat Product (Abattoir)	None *The aboveground gasoline storage tank should be contained within a secondary containment structure.
2	Fish Product	Unloading dock - floor drains covered by coarse screens. Thawing container storage - graded pavement conveys flow to rotary screen then to city sewer. Offal storage area - graded pavement conveys flow to rotary screen then to city sewer. *The site drainage system has several overflows allowing the contaminated stormwater to bypass the treatment system and discharge directly to the receiving water.
3	Fish Product	Waste treatment area - graded pavement conveys flow to screens then to the receiving water. *The waste lubricant storage tank should be contained within a secondary containment structure.

Table 2.5 Summary of Stormwater Management Practices (Continued)		
Site No.	**Industrial Sector**	**Stormwater Management Practices**
4	Canned and Preserved Fruit and Vegetable	Placement of asphalt curbing around the property perimeters. Grading of pavement to collect contaminated stormwater for treatment. Treatment of contaminated stormwater by screening and pH neutralization. Discharge of treated process wastewater and stormwater to city sewer.
5	Frozen Fruit and Vegetable	None *The waste lubricant storage tank should be contained within a secondary containment structure.
6	Frozen Fruit and Vegetable	None *The waste lubricant storage tank should be contained within a secondary containment structure.
7	Fluid Milk	Routing of stormwater from truck dock areas to city sewer. Implemented spill collection system for the raw milk and cream receiving building. Weekly sweeping of areas around truck loading docks. Enclosed storage shed for lubricants (*Curbing should be placed around the storage shed to provide secondary containment).
8	Cane and Beet Sugar	Secondary containment for fuel oil and phosphoric acid above-ground storage tanks. Portable secondary containment for waste solvents. *Secondary containment should be provided for the waste oil storage tank and chemicals stored outdoors. *The storm drain located adjacent to the molasses storage tank pump house should be plugged.

Table 2.5 Summary of Stormwater Management Practices (Continued)		
Site No.	**Industrial Sector**	**Stormwater Management Practices**
9	Other Food Product (Egg Processing)	Tanker loading dock - under cover and stormwater collected is drained to a three-chamber settling tank then to aerated lagoons. Storm sewer system - an alarm system and a shut-off valve to control the flow to the receiving water in the event of spills. Fueling station - stormwater runoff to an oil/water separator. Lubricants storage - indoor storage with drip-trays. Chemical storage - indoor storage, floor drain directs spills to aerated lagoons. *The oil/water separator was found to contain visible hydrocarbon products in the first chamber. *At the time of the site inspection, flows from the two stormwater outfalls were substantial in relation to the amount of precipitation. The higher than anticipated flows may be due to cross connections.
10	Brewery Products	Solid Waste Storage - stormwater runoff to city sewer.
11	Sawmill and Planing Mill Products	Fueling station - double-wall tank with secondary containment (triple containment system) with an oil/water separator to treat stormwater collected inside the containment area. Chip storage - no leachate due to the high turnover of chips. Hydraulic system - enclosed centralized hydraulic system and a double-wall hydraulic fluid storage tank. Sawmill stormwater - proposed oil/water separator. Active lubricant tanks - drip-tray. Equipment washing - concrete wash pad, washwater drains to settling chamber and oil/water separator. *The lubricants storage area should be protected by a secondary containment structure. *Hydraulic system for the chip debarker is scheduled to be connected to the centralized system. *The debarker is located over water and may contribute to high suspended solids in stormwater.

Table 2.5 Summary of Stormwater Management Practices (Continued)		
Site No.	**Industrial Sector**	**Stormwater Management Practices**
12	Wire and Wire Products	Loading/unloading - oil/water separator. Fueling station - secondary containment, containment water is pumped out by a vendor. Vehicle maintenance - the area is graded to convey stormwater to an on-site treatment plant. Chemical storage - secondary containment structures. Baghouse - contaminated roof runoff is directed to the treatment plant. Waste storage - some waste piles are stored under cover, some wastes are stored in a designated area with stormwater collection and treatment. Stormwater collection - plant site is graded to segregate uncontaminated stormwater from contaminated stormwater. *The secondary containment volume for the fueling station is less than the 110% design requirement. *Due to the heavy truck traffic, stormwater pollutants may be carried to uncontaminated areas.
13	Wire and Wire Products	Chemical storage - secondary containment structure. Stormwater - treatment by an oil/water separator. Waste storage - site contained by a diking system. *The clarifier for the wastewater treatment plant should be contained within a secondary containment structure.
14	Hydraulic Cement	Constructed sedimentation basin to serve a section of the plant site. Twice monthly sweeping of the plant site. Portable secondary containment for waste lubricant and antifreeze. *Heavy accumulation of solids around some process areas.

Table 2.5 Summary of Stormwater Management Practices (Continued)		
Site No.	**Industrial Sector**	**Stormwater Management Practices**
15	Ready-Mix Concrete	Loading - water is used during concrete batching for dust suppression; the loading area is graded to direct flow to the settling ponds. Stormwater collection - the site is graded to direct flow from the active portion of the plant to the settling ponds. Water recycling - wastewater and stormwater are collected for reuse as washwater and as mixing water. Lock-blocks forming containment area - site is graded to prevent the run-on and runoff of stormwater; collected stormwater discharges to a gravel infiltration bed. *Admixtures, fuel and lubricants are not contained within secondary containment structures. *An oil trap should be installed to collect the form release oil used in the Lock-Blocks forming area. *The stormwater drain near the fueling station should be plugged to prevent spilled fuel flowing to the drainage ditch.
16	Lime	Fuel and waste oil storage - storage tanks placed inside a concrete containment structure. Chemical storage - tanks and containers are stored inside an enclosed locker. *The chemical storage locker needs to incorporate secondary containment. *Heavy accumulation of solids around process areas.
17	Refined Petroleum Products (Bulk Storage)	Fuel storage tanks - storage tanks are surrounded by a diking structure; collected stormwater is pumped to oil/water separator for treatment.

Table 2.5 Summary of Stormwater Management Practices (Continued)		
Site No.	**Industrial Sector**	**Stormwater Management Practices**
18	Asphalt Manufacturing	Fuel and chemical storage - storage tanks are surrounded by a diking structure; collected stormwater is pumped to an oil/water separator for treatment. Truck wash - washwater is collected in a lined storage pond where the solids are periodically removed for disposal. Steam-clean area - washwater is conveyed to an oil/water separator for treatment. Stormwater collection - the yard is graded to direct stormwater to two oil/water separators; weekly sweeping of the yard to minimize collection of solids in the separators. Oil/water separators - the separators' outlets are controlled by shut-off valves designed to contain major spills within the yard. *Traces of emulsified oil were seen collected around one outfall. The oil may be originating from the steam-cleaning area. *High oil and grease concentrations found in stormwater samples indicate overloaded oil/water separators. Oil and solids may need to be removed from the separators to improve treatment efficiency.
19	Industrial Inorganic Chemical (Chlor-Alkali)	Chemical storage - storage tanks are contained by dikes, uncontaminated stormwater is pumped to salt piles, contaminated stormwater is reused in the production process. Fuel storage - storage tanks are contained in secondary containment structure, underground pipeline is double-wall. Lubricants storage - lubricants in containers are stored outdoor under cover, drip-trays are used to collect minor spills and drips. *Caustic tank farms are not sized to contain 110% of the largest tank volume, but has incorporated alarm system to detect leaks.

Table 2.5 Summary of Stormwater Management Practices (Continued)		
Site No.	**Industrial Sector**	**Stormwater Management Practices**
20	Other Chemical Products	Loading dock - area is graded to direct stormwater towards collection sumps for reuse in production. Fuel and chemical storage - storage tanks are contained in secondary containment structures; collected stormwater is reused in production. Stormwater collection - the site is graded to prevent stormwater runoff and flow is directed to a sump collection system to be reused in production. Roof runoff collection - roof runoff is collected and discharged through below-ground piping to the receiving water. *Aside from the roof runoff, this is a zero-discharge facility.
21	Marine Cargo Handling	Plant drainage - stormwater from the entire plant is collected by collection sumps and treated by gravity settling and pH adjustment prior to discharge to the city sewer. Fuel Storage - diesel and gasoline are stored in an above-ground, dual-compartment, double-wall tank. Diking/curbing - curbing is used to prevent off-site migration of stormwater.
22	Other Pipeline Transport	Fuel storage - fuel tanks are surrounded by a dike; containment surface is lined with a geomembrane. Stormwater - collected stormwater is monitored for hydrocarbons by an Agar probe/control system followed by treatment with an oil/water separator or by a physical/chemical treatment system. *This is a newly retrofitted facility and has implemented several safeguard measures and the potential for stormwater pollution is minimal.
23	Light Industry (Industrial Park)	Chemical storage - storage tanks are located inside a secondary containment structure. Stormwater collection - this site is served by a stormwater sewer system; stormwater solids are removed by catch basins. *Fuel/lubricant tanks at one facility did not have secondary containment protection. *Stormwater characteristics should be similar to typical urban runoff.

3.0 Stormwater Sampling Analysis

3.1 Introduction

Stormwater samples from 18 industrial sites encompassing 17 industrial sectors were collected and analyzed in accordance with the sampling plans presented in the Draft Survey Results report (PCA). Due to factors such as plant closure, five industrial sites were eliminated from the stormwater sampling program. The sampled industrial sites and sectors with the respective Standard Industrial Classification (SIC) codes are presented in Table 3.1.

Table 3.1 Stormwater Sampling Sites

Site No.	Industrial Sector	SIC
1	Meat and Meat Products Industries (Abattoir)	1011
4	Canned and Preserved Fruit and Vegetable Industry	1031
5	Frozen Fruit and Vegetable Industry	1032
7	Fluid Milk Industry	1041
8	Cane and Beet Sugar Industry	1081
9	Other Food Products Industries (Egg Processing)	1099
10	Brewery Products Industry	1131
11	Sawmill and Planing Mill Products Industry	2512
12	Wire and Wire Products Industries	305
13	Wire and Wire Products Industries	305
14	Hydraulic Cement Industry	3521
15	Ready-Mix Concrete Industry	3551
16	Lime Industry	3581
17	Refined Petroleum Products Industry (Bulk Storage)	3611
18	Asphalt Manufacturing Industry	3699
19	Industrial Inorganic Chemical Industry (Chlor-Alkali)	3711
21	Marine Cargo Handling Industry (US SIC Code)	4491
23	Light Industry (Industrial Park)	7599

3.2 Stormwater Pollutants and Effects

The types of pollutants associated with industrial activity will depend on many factors, including the industrial activities occurring at the site. Typically, stormwater pollutants found in urban (residential/commercial) stormwater runoff include:

- acidity and alkalinity (pH);
- oxygen-demanding substances;
- solids;
- petroleum hydrocarbons;
- nutrients; and,
- heavy metals.

For some industrial facilities, pollutants in stormwater discharges will be similar to the types and concentrations of pollutants typically found in stormwater discharges from residential and commercial areas. However, stormwater discharges from other industrial facilities will have a significant potential for higher pollutant levels.

To better appreciate the need for best management practices to minimize the pollution of stormwater runoff, the following sections provide a summary of the potential environmental impacts from these stormwater pollutants.

3.2.1 Acidity and Alkalinity (pH)

pH is related to the acidity or alkalinity of stormwater streams. Highly acidic and highly alkaline water, and rapid changes in pH, can stress or kill aquatic organisms. Even moderate changes from "acceptable" criteria limits of pH are deleterious to some species. Because of this effect to aquatic life, it is a regulated pollutant parameter for many dischargers.

Normal pH values in the receiving waters of the Fraser River estuary range from 7 to 8. Normal coastal rainfall pH is about 5.3; the average pH in the region is in the mildly acidic range 4.5 - 5.0 (FREMP, 1990).

Discharges with pH lower than normal river levels are from sewage treatment plants, the forest and metal finishing industries, stormwater runoff, rural runoff from peat bogs and landfill leachates. Sources of alkaline effluents are concrete batch plants, forest industries, and metal finishing industries.

3.2.2 Oxygen-Demanding Substances (BOD & COD)

Many organic compounds are soluble in water. Most organic contaminants result from naturally decaying products as well as result of wastewater discharges or agricultural practices.

Natural organic compounds do not in themselves cause direct harm to receiving waters. However, when these compounds are consumed by bacteria in receiving waters, oxygen may be depressed in the process. Low oxygen levels in streams, lakes and marine waters can affect plant growth and can result in fish kills.

The main sources of oxygen demand loadings to the Fraser River estuary are sewage treatment plants, stormwater discharges, combined sewer overflows and industrial effluents, particularly from fish processing plants. Other sources include leachate from woodwaste discharges and other landfills, rural runoff from humus soils and agricultural waste discharges.

The organic content of water can be measured by the biochemical oxygen demand (BOD) test and the chemical oxygen demand (COD) test. These tests measure the organic content of a water sample that is susceptible to biological oxidation (BOD) or chemical oxidation (COD). Reported BOD values for surface waters in the Pacific Region range from 0 to 470 mg/l; COD values range from 10 to 105mg/l (CCREM, 1987).

3.2.3 Solids

The principal physical parameter of industrial pollutants is suspended solids which do not dissolve in water. This is an important parameter for measuring the quality of the wastewater influent, monitoring treatment processes, and measuring the quality of the effluent.

Solids from industrial facilities include both organic and inorganic materials. Inorganic compounds include sand, silt and clay. The organic fraction includes such materials as grease, oil, tar and animal and vegetable products. These solids may settle out rapidly and the bottom deposits are often a mixture of both organic and inorganic solids.

Solids may also be suspended in water for a long period of time and then settle to the bottom of receiving waters. Suspended solids impacts include reduction of light transmission; transportation of adhered contaminants; and clogging of respiratory, feeding, and digestive systems of aquatic organisms. Suspended solids are aesthetically displeasing and also reduce the recreational value of the water.

3.2.4 Petroleum Hydrocarbons

Oil and grease are a measure of hydrocarbon contamination. Principle constituents are vegetable oils, animal oils and fats, and petroleum- and mineral-based materials. Petroleum-based compounds are generally toxic, while non-petroleum oils are not.

Because of their widespread use, petroleum hydrocarbons often occur in stormwater streams. These oily wastes may be classified as light hydrocarbons, heavy hydrocarbons or lubricants. These compounds settle or float in water, and may exist as solids or liquids depending on factors such as methods of use, production process and the temperature of the stormwater.

Fish and waterfowl are adversely affected by oils in their habitat. Oil emulsions may adhere to fish gills causing suffocation. Deposition of oil in bottom sediments can serve to inhibit normal benthic growth. Oil and grease also exhibit an oxygen demand in the aquatic environment.

Levels of oil and grease which are toxic to aquatic organisms vary greatly depending on the type of oil and species' susceptibility. The light hydrocarbons, such as solvents, are known to be toxic to aquatic organisms.

3.2.5 Nutrients

The primary nutrients in water are phosphorus and nitrogen. While both of these elements are essential to the growth and reproduction of plants and animals, overabundance can yield undesirable consequences through the process known as eutrophication.

Phosphorus is not toxic, but can seriously affect water quality by overstimulating algae growth. Subsequent algal die-off can depress dissolved oxygen levels, impact aesthetic qualities and interfere with water use by man or other organisms. It is a natural constituent of soils and is used extensively in fertilizers on agricultural lands. Runoff from these agricultural areas is a major contributor to phosphate loadings in surface waters. Other major sources of phosphate include municipal wastewater containing detergents and industrial process wastewaters.

Excess nitrogen in drinking water (in the form of nitrate) can be toxic to infants. Sources of nitrogen in aquatic systems include animal wastes, chemical fertilizers and industrial wastewater discharges.

3.2.6 Heavy Metals

All metals are soluble to some extent in water. While excessive amounts of any metal may create health hazards, only those metals that are harmful in relatively small amounts are labeled "toxic".

Some metals are found in all forms of plant and animal life; some are essential trace elements required for nutrition and growth. Metals vary in concentration and toxicity and are of concern because they are persistent. Metal toxicity generally varies with the species, and the physical and chemical characteristics of the water including temperature, hardness and turbidity.

Concentrations of 0.02 to 0.03 mg/l of some metals have proven fatal to some fish species. Available technical data show that adverse effects on aquatic life occur at concentration as low as 7.5×10^{-4} mg/l. For zinc, lethal concentrations in the range of 0.1 mg/l have been reported (NRC).

Sources of metals are riverbed scour, sewage treatment plants, stormwater, combined sewer overflows, industrial effluents and leachates. Sewage treatment plants contribute major loadings of iron, lead, copper and zinc. Industry contributes a large proportion of zinc.

Heavy metals in urban runoff originate from the operation of motor vehicles. The most abundant metals in stormwater are lead, zinc and copper.

3.3 Sampling Requirements

Stormwater samples were collected for chemical analyses. Chemical parameters analyzed included the core monitoring parameters (excluding dissolved oxygen) proposed for the Fraser Basin Wastewater Characterization Program (Norecol, 1993) and pollutants identified in urban runoff, namely heavy metals, oil and grease, and nutrients. These analytes form the core stormwater parameters. All stormwater samples were analyzed for this core group along with the chemical parameter characteristic of the potential pollutant for the industrial sector under evaluation.

Core stormwater parameters were:

- temperature (field)
- pH (field/lab)
- conductivity (lab)
- total suspended solids (lab)
- alkalinity (lab)
- total Kjeldahl nitrogen (lab)
- total phosphorus (lab)
- total metals - ICP scan (lab)
- oil and grease - gravimetric (lab)
- chemical oxygen demand (lab)
- dissolved organic carbon (lab).

Polynuclear aromatic hydrocarbons (PAHs) were added to the core stormwater group for the asphalt manufacturing facility.

Stormwater samples were collected in three types of bottles. Oil and grease samples and PAH samples were collected in 1-l amber glass bottles. Total metals samples were collected in 250 ml polyethylene bottles with HNO_3 preservation. Samples for the remaining analytes were collected in 1-l polyethylene bottles. Pre-cleaned bottles supplied by the analytical laboratory were used in the sampling program.

Manual grab sampling was used to collect all of the stormwater samples. Grab samples were collected for 17 industrial sites. For the remaining industrial site, composite grab sampling was used where a series of grab samples was collected through a storm event. These grab samples were manually composited in the laboratory with the sample volume proportional to the flow rate.

3.4 Storm Event Criteria

The USEPA storm event criteria was adopted for this study (USEPA, July 1992). For the development and implementation of their national stormwater program, the USEPA has established specific storm event criteria for the type of storm event that should be sampled. These storm event criteria are:

- the depth of the rainfall must be greater than 2.5 mm (0.1 inch);
- the storm must be preceded by at least 72 hours of dry weather; and,
- where feasible, the depth of rain and duration of the event should not vary by more than 50 percent from the average depth and duration.

The storm event criteria were established to:

- ensure that adequate flow would be discharged;
- allow sufficient build-up of pollutants during the dry weather intervals; and,
- ensure that the storm would be representative in terms of intensity, depth and duration.

In the course of conducting Phase 1 of this study, the 72-hour dry weather criterion was found to be a major obstacle in implementing the stormwater sampling program. During the 1993 winter wet weather season, several sampling situations occurred where the day of suitable measurable precipitation following the 72-hour dry weather interval happened during a holiday and/or weekend where the evaluation sites were not accessible. With the exception of the light industry (Industrial Park), all other industrial facilities were fenced, limiting site access for stormwater sampling. This storm event sampling problem was further exacerbated by the less than normal precipitation rate and volume during the winter months of 1993.

Because of the frequency of storm events, the 72-hour dry weather criterion was changed to 48 hours for the Phase 2 study.

3.5 Chemical Analysis Methods

Stormwater samples were delivered to Analytical Service Laboratories, Ltd.. (ASL) for analysis. All analyses were carried out within the standard holding time and in accordance with procedures described in *Standard Methods for the Examination of Water and Wastewater, 18th Edition*.

3.6 Sampling Program Results

This section gives the results of the stormwater sampling program. The sampling sites are listed in accordance with the site numbering sequence used in Table 3.1.

Stormwater data from the sampling program area are compared to stormwater data from British Columbia (Gibb *et al.,* 1991) and the United States (Federal Register, 1993).

The stormwater database from the United States consists of stormwater sampling results submitted by participating industrial facilities in fulfillment of the Group Permit Application Part 2 of the 1990 USEPA stormwater regulations. Under this program, all of the representative industrial facilities sampled and analyzed their stormwater discharges for BOD_5, COD, oil & grease, total Kjeldahl nitrogen, nitrate-nitrite, pH and total phosphorus. In addition to these parameters, sampling facilities analyzed their discharges for any pollutant that they believed to be present. The data were categorized by industrial sector and were statistically analyzed and the mean, minimum, maximum, 95^{th} percentile and the 99^{th} percentile concentrations were calculated for each parameter.

In addition to the evaluation of stormwater data to reported stormwater runoff quality, stormwater data are also compared to the Canadian Water Quality Guidelines for freshwater aquatic life (CCREM, 1987).

3.6.1 Site No. 1 - Meat and Meat Product Industry (Abattoir)

This facility discharges biologically-treated slaughterhouse washwater to on-site drainfields. Precipitation falling on the site is either evaporated or percolated to the groundwater.

A stormwater sample was collected from standing water down-gradient from the slaughterhouse. A water sample from a groundwater supply line was also collected to determine the impact of slaughterhouse washwater and stormwater on the groundwater.

The analytical results are presented in the following table.

Site No. 1 - Meat and Meat Product Industry (Abattoir): Stormwater Samples			
Parameters	**Units**	**Groundwater Supply Grab Sample**	**Stormwater Grab Sample**
Temperature	^{0}C	-	9
pH	s.u.	7.45	7.52
Conductivity	µS/cm	306	72.8
Total Suspended Solids	mg/l	4	109
Total Alkalinity ($CaCO_3$)	mg/l as $CaCO_3$	119	33.9
Total Kjeldahl Nitrogen (N)	mg/l as N	0.08	9.05
Nitrite/Nitrate Nitrogen (N)	mg/l as N	3.19	-
Total Phosphorus (P)	mg/l as P	0.011	1.69
Aluminum	mg/l	<0.20	3.06
Antimony	mg/l	<0.20	<0.20
Arsenic	mg/l	<0.20	<0.20
Barium	mg/l	0.032	0.055
Beryllium	mg/l	<0.005	<0.005
Bismuth	mg/l	<0.100	<0.100
Boron	mg/l	<0.100	<0.100
Cadmium	mg/l	<0.010	<0.010
Calcium	mg/l	38.4	7.01
Chromium	mg/l	<0.015	<0.015
Cobalt	mg/l	<0.015	<0.015
Copper	mg/l	<0.010	0.014
Iron	mg/l	<0.030	3.22
Lead	mg/l	<0.050	<0.050
Lithium	mg/l	<0.015	<0.015
Magnesium	mg/l	10.3	1.83
Manganese	mg/l	<0.005	0.170
Molybdenum	mg/l	<0.030	<0.030
Nickel	mg/l	<0.020	<0.020
Phosphorus	mg/l	<0.30	0.98
Potassium	mg/l	2.0	2.8
Selenium	mg/l	<0.20	<0.20
Silicon	mg/l	9.15	4.73
Silver	mg/l	<0.015	<0.015
Sodium	mg/l	4.5	2.7
Strontium	mg/l	0.160	0.030
Thallium	mg/l	<0.10	<0.10
Tin	mg/l	<0.30	<0.30
Titanium	mg/l	<0.010	<0.110
Tungsten	mg/l	<0.10	<0.10
Vanadium	mg/l	<0.030	<0.030
Zinc	mg/l	0.023	0.128
Oil and Grease	mg/l	-	5
Chemical Oxygen Demand	mg/l	<20	53
Dissolved Organic Carbon	mg/l	0.50	4.92

The stormwater sample showed higher concentrations of total Kjeldahl nitrogen (9.05 mg/l) and total phosphorus (1.69 mg/l) than typical stormwater runoff from industrial facilities in the Lower Fraser Basin (Gibb *et al.,* 1991). The reported average concentration for total nitrogen is 1.31 mg/l and for total phosphorus is 0.09 mg/l for the Basin. Other stormwater parameters were within the reported ranges of values.

Total Kjeldahl nitrogen is a measure of the amount of ammonia nitrogen plus organic nitrogen in the water. Kjeldahl nitrogen is a good indicator of the crude protein in the water. The likely source of Kjeldahl nitrogen from the slaughterhouse operation was decomposing animal parts.

Total phosphorus is comprised of both dissolved and suspended phosphorus. The potential pollutant sources to stormwater runoff from the slaughterhouse operation were detergents and animal feces.

The groundwater supply sample showed a nitrate/nitrite concentration of 3.19 mg/l. Nitrates and nitrites are produced by the biological degradation of ammonia nitrogen and organic nitrogen. The likely source of the nitrate/nitrite wasthe slaughterhouse washwater.

Stormwater runoff from this facility was similar in quality to the runoff from the USEPA's Part 2 Group Permit Application from the Food and Kindred Products Processing Facilities industrial category. This industrial category includes the following types of operations:

- Meat Products;
- Dairy Products;
- Canned, Frozen and Preserved Fruit, Vegetables and Food Specialties;
- Grain Mill Products;
- Bakery Products;
- Sugar and Confectionery Products;
- Fats and Oils;
- Beverages;
- Miscellaneous Food Preparations and Kindred Products; and,
- Tobacco Products.

The slaughterhouse-related activities are included within the meat products subsector.

Presented in the following table is a summary of the common stormwater pollutant parameters for this slaughterhouse operation (Site No. 1) and the USEPA Part 2 group application stormwater data for the Food and Kindred Products industrial category.

Site No. 1 and USEPA Part 2 Food and Kindred Products Stormwater Summary				
Parameters (mg/l)	**Site No. 1 Groundwater Supply Grab Sample**	**Site No. 1 Stormwater Grab Sample**	**USEPA Part 2 Median Grab Sample**	**USEPA Part 2 95th Percentile Grab Sample**
Total Suspended Solids	4	109	72.5	1,320
Total Kjeldahl Nitrogen	0.08	9.05	2.35	18
Nitrate + Nitrite	3.19	-	0.56	3.7
Total Phosphorus	0.011	1.69	0.56	9.06
Copper	<0.010	0.014	0.04	0.27
Manganese	<0.005	0.170	0.16	1.49
Iron	<0.030	3.22	0.54	18
Zinc	0.023	0.128	0.21	2.1
Oil and Grease	-	5	1.1	21
Chemical Oxygen Demand	<20	53	77	745

Comparison of the two sets of data shows that stormwater pollutants from Site No. 1 are lower than the USEPA Part 2 95th percentile values for all pollutants. In comparison with the USEPA median values, the stormwater from Site No. 1 is higher in total suspended solids, total Kjeldahl nitrogen, total phosphorus, iron, and oil and grease.

Presented in the following table is a summary of the applicable stormwater pollutant parameters for this slaughterhouse operation (Site No. 1) and the Canadian Water Quality Guidelines for freshwater aquatic life.

Site No. 1 and Canadian Water Quality Guidelines for Freshwater Aquatic Life			
Parameters (mg/l)	**Site No. 1 Groundwater Supply Grab Sample**	**Site No. 1 Stormwater Grab Sample**	**Canadian Water Quality Guidelines for Freshwater Aquatic Life***
Aluminum	<0.20	3.06	0.1
Arsenic	<0.20	<0.20	0.05
Cadmium	<0.010	<0.010	0.0002
Chromium	<0.015	<0.015	0.02
Copper	<0.010	0.014	0.002
Iron	<0.030	3.22	0.3
Lead	<0.050	<0.050	0.001
Nickel	<0.020	<0.020	0.025
pH (s.u.)	7.45	7.52	6.5-9.0
Selenium	<0.20	<0.20	0.001
Silver	<0.015	<0.015	0.0001
Zinc	0.023	0.128	0.03

* Based on an assumed hardness of <60 mg/l as $CaCO_3$

As indicated by the table, aluminum, copper, iron and zinc in the stormwater sample are higher than the Canadian guidelines for aquatic life.

3.6.2 Site No. 4 - Canned and Preserved Fruit and Vegetable Industry

Process wastewater and stormwater from this fruit-washing facility are regulated by the Greater Vancouver Sewerage and Drainage District. Process wastewater and contaminated stormwater are screened and pH adjusted prior to discharge to the city sewer.

Stormwater samples were collected from this facility. Sample 001 was a stormwater sample collected from a stormwater catchbasin prior to mixing with the incoming process wastewater. Sample 003 was an effluent sample collected at the pH neutralization tank prior to discharge to the city sewer.

Presented in the following table are the results of the stormwater samples collected from this fruit washing facility.

Site No. 4 - Canned and Preserved Fruit and Vegetable Industry: Stormwater Samples			
Parameters	**Units**	**Sample 001 Grab Sample**	**Sample 003 Grab Sample**
Temperature	^0C	12	14
pH	s.u.	3.71	6.06
Conductivity	µS/cm	571	302
Total Suspended Solids	mg/l	342	236
Total Alkalinity ($CaCO_3$)	mg/l as $CaCO_3$	<1.0	75.8
Total Kjeldahl Nitrogen (N)	mg/l as N	7.10	5.46
Total Phosphorus (P)	mg/l as P	3.92	1.79
Aluminum	mg/l	15.8	1.77
Antimony	mg/l	<0.20	<0.20
Arsenic	mg/l	<0.20	<0.20
Barium	mg/l	0.352	0.07
Beryllium	mg/l	<0.005	<0.005
Bismuth	mg/l	<0.10	<0.10
Boron	mg/l	<0.10	<0.10
Cadmium	mg/l	<0.010	<0.010
Calcium	mg/l	72.8	17.2
Chromium	mg/l	0.066	<0.015
Cobalt	mg/l	0.019	<0.015
Copper	mg/l	0.307	0.155
Iron	mg/l	86.8	9.01
Lead	mg/l	0.054	<0.050
Lithium	mg/l	<0.015	<0.015
Magnesium	mg/l	10.4	3.90
Manganese	mg/l	1.73	0.595
Molybdenum	mg/l	<0.030	<0.030
Nickel	mg/l	0.059	<0.020
Phosphorus	mg/l	4.91	1.53
Potassium	mg/l	38.3	11.6
Selenium	mg/l	<0.20	<0.20
Silicon	mg/l	10.8	3.48
Silver	mg/l	<0.015	<0.015
Sodium	mg/l	5.2	54.7
Strontium	mg/l	0.239	0.062
Thallium	mg/l	<0.10	<0.10
Tin	mg/l	<0.30	<0.30
Titanium	mg/l	0.993	0.053
Tungsten	mg/l	<0.10	<0.10
Vanadium	mg/l	0.061	<0.030
Zinc	mg/l	1.68	0.422
Oil and Grease	mg/l	<5	10
Chemical Oxygen Demand	mg/l	3,460	1,000
Dissolved Organic Carbon	mg/l	778	71.0

The stormwater sample shows higher concentrations of total suspended solids (342 mg/l), total Kjeldahl nitrogen (7.10 mg/l), total phosphorus (3.92 mg/l), and chemical oxygen demand (3,460 mg/l) than typical stormwater runoff from industrial facilities in the Lower Fraser Basin (Gibb *et al.,* 1992). The reported average concentration for total suspended solids is 242 mg/l, total nitrogen is 1.31 mg/l, total phosphorus is 0.09 mg/l, and chemical oxygen demand is 292 mg/l for the Basin. Other stormwater parameters are within the reported ranges of values.

The low pH of 3.71 for Sample 001 is reflective of the acidic nature of the fruit being processed/washed at this facility. Similarly, the high total suspended solids and chemical oxygen demand values can be attributed to the fruit spilled during the unloading operation. Food items such as fruits are highly biodegradable, thus exerting a high oxygen demand on receiving waters.

The higher than average reported values of total Kjeldahl nitrogen and total phosphorus from this fruit washing facility may be attributed to disinfectants and detergents used in the equipment-cleaning operation.

Presented in the following table is a summary of the common stormwater pollutant parameters for this facility and the USEPA Part 2 group application stormwater data for the Food and Kindred Products industrial category.

Site No. 4 and USEPA Part 2 Food and Kindred Products Stormwater Summary				
Parameters (mg/l)	**Site No. 4 Sample 001 Grab Sample**	**Site No. 4 Sample 003 Grab Sample**	**USEPA Part 2 Median Grab Sample**	**USEPA Part 2 95th Percentile Grab Sample**
Total Suspended Solids	342	236	72.5	1,320
Total Kjeldahl Nitrogen	7.10	5.46	2.35	18
Total Phosphorus	3.92	1.79	0.56	9.06
Copper	0.307	0.155	0.04	0.27
Manganese	1.73	0.595	0.16	1.49
Iron	86.8	9.01	0.54	18
Zinc	1.68	0.422	0.21	2.1
Oil and Grease	<5	10	2.2	21
Chemical Oxygen Demand	3,460	1,000	131.0	745

Comparison of the two sets of data shows that stormwater pollutants from Sample 001 are greater than the USEPA Part 2 median values for the common pollutants. Because of the high organic content of the stormwater from this facility, the chemical oxygen demand of 3,460 mg/l for Sample 001 is substantially greater than the USEPA 95th percentile value of 745 mg/l. With the exception of iron, all other pollutants are less than or similar to the USEPA 95th percentile values.

Presented in the following table is a summary of the applicable stormwater pollutant parameters for this fruit-washing facility (Site No. 4) and the Canadian Water Quality Guidelines for freshwater aquatic life.

Site No. 4 and Canadian Water Quality Guidelines for Freshwater Aquatic Life			
Parameters (mg/l)	**Site No. 4 Sample 001 Grab Sample**	**Site No. 4 Sample 003 Grab Sample**	**Canadian Water Quality Guidelines for Freshwater Aquatic Life***
Aluminum	15.8	1.77	0.1
Arsenic	<0.20	<0.20	0.05
Cadmium	<0.010	<0.010	0.0002
Chromium	0.066	<0.015	0.02
Copper	0.307	0.155	0.002
Iron	86.8	9.01	0.3
Lead	0.054	<0.050	0.001
Nickel	0.059	<0.020	0.025
pH (s.u.)	3.71	6.06	6.5-9.0
Selenium	<0.20	<0.20	0.001
Silver	<0.015	<0.015	0.0001
Zinc	1.68	0.422	0.03

* Based on an assumed hardness of <60 mg/l as $CaCO_3$

As indicated by the table, aluminum, chromium, copper, iron, lead, nickel and zinc in the stormwater sample (Sample 001) are higher than the Canadian guidelines for aquatic life.

3.6.3 Site No. 5 - Frozen Fruit and Vegetable Industry

This facility processes a variety of fruits, vegetables and juice concentrates into frozen and canned products, juices and a small amount of jam. In addition to fruits and vegetables, herring are processed into frozen products during the early months of the year.

Process wastewaters from this fruit and vegetable processing facility are regulated by the Ministry of Environment, Lands and Parks. Wastewaters which are regulated include: cooling waters, defrost water and cannery process water. The cannery process water is treated biologically prior to discharge to grasslands. Other non-contaminated wastewaters are discharged directly to a creek flowing through the site property.

Stormwater/process water samples were collected from this facility. Sample 001 was an effluent sample collected at Outfall 01. Sample 002 was an effluent sample collected at Outfall 02. According to the plant engineer, Outfall 01 discharges both cooling water and stormwater, and Outfall 02 discharges only uncontaminated cooling water.

Presented in the following table are the results of the stormwater samples collected from this fruit and vegetable processing facility.

Site No. 5 - Frozen Fruit and Vegetable Industry: Stormwater Samples			
Parameters	**Units**	**Sample 001 Grab Sample**	**Sample 002 Grab Sample**
Temperature	^0C	-	-
pH	s.u.	6.91	7.51
Conductivity	µS/cm	1,420	526
Total Suspended Solids	mg/l	27	1
Total Alkalinity ($CaCO_3$)	mg/l as $CaCO_3$	169	86.8
Total Kjeldahl Nitrogen (N)	mg/l as N	2.31	0.10
Total Phosphorus (P)	mg/l as P	0.249	0.006
Aluminum	mg/l	<0.20	<0.20
Antimony	mg/l	<0.20	<0.20
Arsenic	mg/l	<0.20	<0.20
Barium	mg/l	0.041	0.028
Beryllium	mg/l	<0.005	<0.005
Bismuth	mg/l	<0.10	<0.10
Boron	mg/l	<0.10	<0.10
Cadmium	mg/l	<0.010	<0.010
Calcium	mg/l	86.2	44.9
Chromium	mg/l	<0.015	<0.015
Cobalt	mg/l	<0.015	<0.015
Copper	mg/l	0.011	<0.010
Iron	mg/l	2.32	0.037
Lead	mg/l	<0.050	<0.050
Lithium	mg/l	<0.015	<0.015
Magnesium	mg/l	12.9	5.40
Manganese	mg/l	0.157	<0.050
Molybdenum	mg/l	<0.030	<0.030
Nickel	mg/l	<0.020	<0.020
Phosphorus	mg/l	1.14	<0.30
Potassium	mg/l	11.2	<2.0
Selenium	mg/l	<0.20	<0.20
Silicon	mg/l	10.5	5.50
Silver	mg/l	<0.015	<0.015
Sodium	mg/l	163	48.5
Strontium	mg/l	0.510	0.245
Thallium	mg/l	<0.10	<0.10
Tin	mg/l	<0.30	<0.30
Titanium	mg/l	<0.010	<0.010
Tungsten	mg/l	<0.10	<0.10
Vanadium	mg/l	<0.030	<0.030
Zinc	mg/l	1.25	0.051
Oil and Grease	mg/l	<5	<5
Chemical Oxygen Demand	mg/l	174	<20
Dissolved Organic Carbon	mg/l	33.5	<0.50

Using the uncontaminated cooling water (Sample 002) as reference, the effluent results for Sample 001 show higher concentrations of:

- solids (dissolved solids, total suspended solids);
- organics (chemical oxygen demand, dissolved organic carbon);
- nutrients (total Kjeldahl nitrogen, total phosphorus); and,
- metals (iron, zinc).

With respect to the stormwater quality characteristics from industrial facilities compiled by Gibb *et al*., Sample 001 showed low concentration of total suspended solids and higher concentration of zinc. Although other parameters than those listed above were higher in Sample 001 than 002, they were either less than or within the range of the reported values for typical industrial facilities.

The high value of 33.5 mg/l for dissolved organic carbon in Sample 001 indicated the presence of dissolved organic compounds in the discharge. The source of this pollutant may be decomposing fruits and/or vegetables.

Presented in the following table is a summary of the common stormwater pollutant parameters for this facility and the USEPA Part 2 group application stormwater data for the Food and Kindred Products industrial category.

Site No. 5 and USEPA Part 2 Food and Kindred Products Stormwater Summary

Parameters (mg/l)	Site No. 5 Sample 001 Grab Sample	Site No. 5 Sample 002 Grab Sample	USEPA Part 2 Median Grab Sample	USEPA Part 2 95th Percentile Grab Sample
Total Suspended Solids	27	1	72.5	1,320
Total Kjeldahl Nitrogen	2.31	0.10	2.35	18
Total Phosphorus	0.249	0.006	0.56	9.06
Copper	0.011	<0.010	0.04	0.27
Manganese	0.157	<0.005	0.16	1.49
Iron	2.32	0.037	0.54	18
Zinc	1.25	0.051	0.21	2.1
Oil and Grease	<5	<5	1.1	21
Chemical Oxygen Demand	174	<20	77	745

Comparison of the two sets of stormwater data shows that pollutants from Sample 001 were greater than the USEPA Part 2 median values for iron, zinc and chemical oxygen demand but were less than the USEPA 95th percentile values.

Presented in the following table is a summary of the applicable stormwater pollutant parameters for this fruit and vegetable processing facility (Site No. 5) and the Canadian Water Quality Guidelines for freshwater aquatic life.

Site No. 5 and Canadian Water Quality Guidelines for Freshwater Aquatic Life			
Parameters (mg/l)	**Site No. 5 Sample 001 Grab Sample**	**Site No. 5 Sample 002 Grab Sample**	**Canadian Water Quality Guidelines for Freshwater Aquatic Life***
Aluminum	<0.20	<0.20	0.1
Arsenic	<0.20	<0.20	0.05
Cadmium	<0.010	<0.010	0.0002
Chromium	<0.015	<0.015	0.02
Copper	0.011	<0.010	0.002
Iron	2.32	0.037	0.3
Lead	<0.050	<0.050	0.001
Nickel	<0.020	<0.020	0.025
pH (s.u.)	6.91	7.51	6.5-9.0
Selenium	<0.20	<0.20	0.001
Silver	<0.015	<0.015	0.0001
Zinc	1.25	0.051	0.03

* Based on an assumed hardness of <60 mg/l as $CaCO_3$

As indicated by the table, copper, iron, and zinc in the stormwater sample (Sample 001) are higher than the Canadian guidelines for aquatic life.

3.6.4 Site No. 7 - Fluid Milk Industry

This plant packages milk and produces yogurt and cottage cheese. Process and domestic wastewaters, along with stormwater collected around the loading docks, are discharged to the Greater Vancouver Sewerage and Drainage District sewer system. Stormwater collected in the truck parking area is routed to the GVSDD stormwater collection system.

Presented in the following table are the results of the stormwater samples collected from this milk processing facility. Sample 001 was a stormwater sample collected from a catchbasin located behind the plant; Sample 002 was a stormwater sample collected from a catchbasin located south of a truck loading dock. Both of these catchbasins collect stormwater from the truck parking area.

Site No. 7 - Fluid Milk Industry: Stormwater Samples			
Parameters	**Units**	**Sample 001 (mg/l)**	**Sample 002 (mg/l)**
Temperature	^0C	5	5
pH	s.u.	6.50	6.77
Conductivity	µS/cm	53.3	59.2
Total Suspended Solids	mg/l	79	35
Total Alkalinity ($CaCO_3$)	mg/l as $CaCO_3$	13.5	18.3
Total Kjeldahl Nitrogen (N)	mg/l as N	0.34	0.27
Total Phosphorus (P)	mg/l as P	0.067	0.050
Aluminum	mg/l	0.57	0.70
Antimony	mg/l	<0.20	<0.20
Arsenic	mg/l	<0.20	<0.20
Barium	mg/l	0.023	0.020
Beryllium	mg/l	<0.005	<0.005
Bismuth	mg/l	<0.10	<0.10
Boron	mg/l	<0.10	<0.10
Cadmium	mg/l	<0.010	<0.010
Calcium	mg/l	5.70	6.78
Chromium	mg/l	<0.015	<0.015
Cobalt	mg/l	<0.015	<0.015
Copper	mg/l	<0.010	<0.010
Iron	mg/l	0.787	0.817
Lead	mg/l	<0.050	<0.050
Lithium	mg/l	<0.015	<0.015
Magnesium	mg/l	0.763	0.555
Manganese	mg/l	0.025	0.019
Molybdenum	mg/l	<0.030	<0.030
Nickel	mg/l	<0.020	<0.020
Phosphorus	mg/l	<0.30	<0.30
Potassium	mg/l	<2.0	<2.0
Selenium	mg/l	<0.20	<0.20
Silicon	mg/l	3.01	2.25
Silver	mg/l	<0.015	<0.015
Sodium	mg/l	2.9	4.4
Strontium	mg/l	0.056	0.066
Thallium	mg/l	<0.10	<0.10
Tin	mg/l	<0.30	<0.30
Titanium	mg/l	0.015	0.016
Tungsten	mg/l	<0.10	<0.10
Vanadium	mg/l	<0.030	<0.030
Zinc	mg/l	0.187	0.076
Oil and Grease	mg/l	<5	<5
Chemical Oxygen Demand	mg/l	34	26
Dissolved Organic Carbon	mg/l	2.71	1.57

The analytical results show stormwater from the truck parking and loading/unloading areas were relatively free of pollutants. Metals concentrations were at low or below detection levels. The average chemical oxygen demand value of 30 mg/l was less than the average value of 78 mg/l reported by Gibb *et al.* for light industrial facilities.

The following table is a summary of the common stormwater pollutants for this facility and the USEPA Part 2 group application stormwater data for the Food and Kindred Products industrial category. The dairy products subcategory is included within this industrial category.

This industrial category covers stormwater discharges from industrial plant yards; material handling sites; refuse sites; sites used for application or disposal of process wastewaters; sites used for storage and maintenance of material handling equipment; sites used for residuals treatment, storage or disposal; shipping and receiving areas; manufacturing buildings; storage areas for raw materials and intermediate and finished products.

Site No. 7 and USEPA Part 2 Food and Kindred Products Stormwater Summary

Parameters (mg/l)	Site No. 7 Sample 001 Grab Sample	Site No. 7 Sample 002 Grab Sample	USEPA Part 2 Median Grab Sample	USEPA Part 2 95th Percentile Grab Sample
Total Suspended Solids	79	35	72.5	1,320
Total Kjeldahl Nitrogen	0.34	0.27	2.35	18
Total Phosphorus	0.067	0.050	0.56	9.06
Copper	<0.010	<0.010	0.04	0.27
Manganese	0.025	0.019	0.16	1.49
Iron	0.787	0.817	0.54	18
Zinc	0.187	0.076	0.21	2.1
Oil and Grease	<5	<5	1.1	21
Chemical Oxygen Demand	34	26	77	745

Comparison of the two sets of stormwater data shows that stormwater pollutants from this facility were similar to the USEPA Part 2 median values and were substantially lower than the 95th percentile values for all pollutants.

Presented in the following table is a summary of the applicable stormwater pollutant parameters for this milk processing facility (Site No. 7) and the Canadian Water Quality Guidelines for freshwater aquatic life.

Site No. 7 and Canadian Water Quality Guidelines for Freshwater Aquatic Life			
Parameters (mg/l)	**Site No. 7 Sample 001 Grab Sample**	**Site No. 7 Sample 002 Grab Sample**	**Canadian Water Quality Guidelines for Freshwater Aquatic Life***
Aluminum	0.57	0.70	0.1
Arsenic	<0.20	<0.20	0.05
Cadmium	<0.010	<0.010	0.0002
Chromium	<0.015	<0.015	0.02
Copper	<0.010	<0.010	0.002
Iron	0.787	0.817	0.3
Lead	<0.050	<0.050	0.001
Nickel	<0.020	<0.020	0.025
pH (u.s.)	6.50	6.77	6.5-9.0
Selenium	<0.20	<0.20	0.001
Silver	<0.015	<0.015	0.0001
Zinc	0.187	0.076	0.03

* Based on an assumed hardness of <60 mg/l as $CaCO_3$

As indicated by the table, aluminum, iron and zinc in the stormwater samples were higher than the Canadian guidelines for aquatic life.

3.6.5 Site No. 8 - Cane and Beet Sugar Industry

This plant processes raw cane sugar to produce refined sugar. Process wastewaters are regulated by both the BC Ministry of Environment, Lands and Parks (BCMOELP) and the City of Vancouver. The discharge of cooling water and condensate to the receiving water is regulated by BCMOELP and the discharge of high organic wastewaters to the city sewer is regulated by the City of Vancouver. Stormwater from this facility is not regulated.

Stormwater samples were collected from this facility. Sample 001 was a stormwater sample collected from a catchbasin located adjacent to a chemical storage area. Sample 002 was an effluent sample collected at Outfall 01. Outfall 01 was a regulated discharge requiring compliance with flow, TSS, BOD_5, temperature and pH.

Presented in the following table are the results of the stormwater samples collected from this cane sugar refining facility.

Site No. 8 - Cane and Beet Sugar Industry: Stormwater Samples			
Parameters	**Units**	**Sample 001 (mg/l)**	**Sample 002 (mg/l)**
Temperature	^0C	14	13
pH	s.u.	5.83	9.10
Conductivity	µS/cm	62.0	80.7
Total Suspended Solids	mg/l	570	39
Total Alkalinity ($CaCO_3$)	mg/l as $CaCO_3$	11.7	27.2
Total Kjeldahl Nitrogen (N)	mg/l as N	8.10	1.05
Total Phosphorus (P)	mg/l as P	5.13	0.300
Aluminum	mg/l	1.00	0.64
Antimony	mg/l	<0.20	<0.20
Arsenic	mg/l	<0.20	<0.20
Barium	mg/l	0.028	0.016
Beryllium	mg/l	<0.005	<0.005
Bismuth	mg/l	<0.10	<0.10
Boron	mg/l	<0.10	<0.10
Cadmium	mg/l	<0.010	<0.010
Calcium	mg/l	6.44	2.94
Chromium	mg/l	<0.015	<0.015
Cobalt	mg/l	<0.015	<0.015
Copper	mg/l	0.075	0.059
Iron	mg/l	1.93	0.977
Lead	mg/l	0.065	0.051
Lithium	mg/l	<0.015	<0.015
Magnesium	mg/l	0.768	0.434
Manganese	mg/l	0.038	0.022
Molybdenum	mg/l	<0.030	<0.030
Nickel	mg/l	<0.020	<0.020
Phosphorus	mg/l	1.14	0.46
Potassium	mg/l	<2.0	<2.0
Selenium	mg/l	<0.20	<0.20
Silicon	mg/l	1.38	2.24
Silver	mg/l	<0.015	<0.015
Sodium	mg/l	<2.0	15.3
Strontium	mg/l	0.016	0.008
Thallium	mg/l	<0.10	<0.10
Tin	mg/l	<0.30	<0.30
Titanium	mg/l	0.047	0.026
Tungsten	mg/l	<0.10	<0.10
Vanadium	mg/l	<0.030	<0.030
Zinc	mg/l	0.241	0.104
Oil and Grease	mg/l	17	<5
Chemical Oxygen Demand	mg/l	401	90
Dissolved Organic Carbon	mg/l	4.36	4.57

The concentrations of metals for both of the stormwater samples were low or below detection levels. In comparison with Sample 002, Sample 001 (catchbasin sample) contained higher concentrations of total suspended solids, total Kjeldahl nitrogen, total phosphorus, oil and grease, and chemical oxygen demand.

The total suspended solids, total Kjeldahl nitrogen, total phosphorus, oil and grease, and chemical oxygen demand values for Sample 001 were also higher than the reported values for stormwater runoff from Lower Fraser Basin industrial facilities. Gibb *et al.* reported average values of 242 mg/l for total suspended solids, 1.31 mg/l for total nitrogen, 0.09 mg/l for total phosphorus, 7.8 mg/l for oil and grease, and 292mg/l for chemical oxygen demand.

The likely source of the high total suspended solids and oil and grease values in Sample 001 was general truck traffic. The presence of organic nitrogen and phosphorus may be due to ammonia disinfectants, detergents or contaminants from surrounding chemical stockpiles.

The pH value of 9.10, for Sample 002, exceeded the permit pH range of 6.5 to 8.5 specified for Outfall 01. This high pH may have been due to the presence of alkaline materials contained in the cooling water, condenser or contaminants from chemical stockpiles.

The following table is a summary of the common stormwater pollutants for this facility and the USEPA Part 2 group application stormwater data for the Food and Kindred Products industrial category. The industrial category includes the cane sugar refining subcategory.

This industrial category covers stormwater discharges from industrial plant yards; material handling sites; refuse sites; sites used for application or disposal of process wastewaters; sites used for storage and maintenance of material handling equipment; sites used for residuals treatment, storage or disposal; shipping and receiving areas; manufacturing buildings; storage areas for raw materials and intermediate and finished products.

Site No. 8 and USEPA Part 2 Food and Kindred Products Stormwater Summary				
Parameters (mg/l)	**Site No. 8 Sample 001 Grab Sample**	**Site No. 8 Sample 002 Grab Sample**	**USEPA Part 2 Median Grab Sample**	**USEPA Part 2 95^{th} Percentile Grab Sample**
Total Suspended Solids	570	39	72.5	1,320
Total Kjeldahl Nitrogen	8.10	1.05	2.35	18
Total Phosphorus	5.13	0.300	0.56	9.06
Copper	0.075	0.059	0.04	0.27
Manganese	0.768	0.434	0.16	1.49
Iron	1.93	0.977	0.54	18
Zinc	0.241	0.104	0.21	2.1
Oil and Grease	17	<5	1.1	21
Chemical Oxygen Demand	401	90	77	745

Comparison of the two sets of stormwater data shows that stormwater pollutants from Sample 001 were greater than the USEPA Part 2 median values. Sample 001, the catchbasin sample, measured substantially higher for concentrations of total suspended solids, total Kjeldahl nitrogen, total phosphorus, oil and grease, and chemical oxygen demand. Manganese and iron concentrations were higher than the USEPA Part 2 median values but were lower than the USEPA Part 2 95^{th} percentile values.

The Sample 001 results were lower than the USEPA Part 2 95^{th} percentile values for all of the common pollutants.

Presented in the following table is a summary of the applicable stormwater pollutant parameters for this sugar refining facility (Site No. 8) and the Canadian Water Quality Guidelines for freshwater aquatic life.

Site No. 8 and Canadian Water Quality Guidelines for Freshwater Aquatic Life			
Parameters (mg/l)	**Site No. 8 Sample 001 Grab Sample**	**Site No. 8 Sample 002 Grab Sample**	**Canadian Water Quality Guidelines for Freshwater Aquatic Life***
Aluminum	1.00	0.64	0.1
Arsenic	<0.20	<0.20	0.05
Cadmium	<0.010	<0.010	0.0002
Chromium	<0.015	<0.015	0.02
Copper	0.075	0.059	0.002
Iron	1.93	0.977	0.3
Lead	0.065	0.051	0.001
Nickel	<0.020	<0.020	0.025
pH (s.u.)	5.83	9.10	6.5-9.0
Selenium	<0.20	<0.20	0.001
Silver	<0.015	<0.015	0.0001
Zinc	0.241	0.104	0.03

* Based on an assumed hardness of <60 mg/l as $CaCO_3$

As indicated by the table, aluminum, copper, iron and zinc in the stormwater samples were higher than the Canadian guidelines for aquatic life. The pH readings of the stormwater samples were outside the range of the guidelines.

3.6.6 Site No. 9 - Other Food Products Industry (Egg Processing)

This egg processing facility produces a variety of products ranging from graded eggs to powdered and frozen egg products. Process wastewaters from the facility are biologically treated in aerated lagoons prior to disposal on grasslands. This effluent is regulated by a wastewater permit issued by the Ministry of Environment, Lands and Parks.

Stormwater from this facility is discharged to an adjacent creek. The discharge of stormwater is not regulated.

Stormwater samples were collected; Sample 001 and Sample 002 were effluent samples collected from stormwater outfalls discharging to the creek.

Presented in the following table is the summary of the stormwater results from this egg processing facility.

Site No. 9 - Other Food Products Industry (Egg Processing) : Stormwater Samples			
Parameters	**Units**	**Sample 001 Grab Sample**	**Sample 002 Grab Sample**
Temperature	^0C	-	-
pH	s.u.	7.14	7.11
Conductivity	µS/cm	3,430	750
Total Suspended Solids	mg/l	197	20
Total Alkalinity ($CaCO_3$)	mg/l as $CaCO_3$	13.7	26.1
Total Kjeldahl Nitrogen (N)	mg/l as N	2.05	1.79
Total Phosphorus (P)	mg/l as P	0.389	0.152
Aluminum	mg/l	2.44	0.57
Antimony	mg/l	<0.20	<0.20
Arsenic	mg/l	<0.20	<0.20
Barium	mg/l	0.112	0.041
Beryllium	mg/l	<0.005	<0.005
Bismuth	mg/l	0.26	<0.10
Boron	mg/l	2.40	0.33
Cadmium	mg/l	<0.010	<0.010
Calcium	mg/l	53.3	36.5
Chromium	mg/l	<0.015	<0.015
Cobalt	mg/l	<0.015	<0.015
Copper	mg/l	0.021	0.013
Iron	mg/l	2.61	0.521
Lead	mg/l	<0.050	<0.050
Lithium	mg/l	0.035	<0.015
Magnesium	mg/l	344	50.0
Manganese	mg/l	0.448	0.181
Molybdenum	mg/l	<0.030	<0.030
Nickel	mg/l	<0.020	<0.020
Phosphorus	mg/l	0.41	<0.30
Potassium	mg/l	28.5	6.9
Selenium	mg/l	<0.20	<0.20
Silicon	mg/l	3.12	2.64
Silver	mg/l	<0.015	<0.015
Sodium	mg/l	29.2	12.0
Strontium	mg/l	0.272	0.190
Thallium	mg/l	<0.10	<0.10
Tin	mg/l	<0.30	<0.30
Titanium	mg/l	0.093	0.025
Tungsten	mg/l	<0.10	<0.10
Vanadium	mg/l	<0.030	<0.030
Zinc	mg/l	0.099	0.037
Oil and Grease	mg/l	<5	<5
Chemical Oxygen Demand	mg/l	91	23
Dissolved Organic Carbon	mg/l	7.15	5.13

The stormwater Sample 001 showed higher concentrations of total Kjeldahl nitrogen (2.05 mg/l) and total phosphorus (0.389 mg/l) than typical stormwater runoff from industrial facilities in the Lower Fraser Basin (Gibb *et al*., 1991). Gibb *et al*., reported an average total nitrogen concentration of 1.31 mg/l and an average total phosphorus concentration of 0.09 mg/l. Other stormwater parameters were within the reported ranges of values.

The results of stormwater Sample 002 also showed higher concentrations of total Kjeldahl nitrogen (1.79 mg/l) and total phosphorus (0.152 mg/l) than the reported values for typical industrial facilities in the Lower Fraser Basin. Other stormwater parameters were within the reported ranges of values.

The stormwater results showed Sample 001 contained notably higher concentrations of dissolved solids, total suspended solids, aluminum, boron, iron, magnesium and potassium in relation to Sample 002. According to the plant operator, these higher levels may be due to residues remaining on-site after a recent fire.

The USEPA Part 2 stormwater data for the Food and Kindred Products industrial category do not contain data for the egg processing subcategory.

Presented in the following table is a summary of the applicable stormwater pollutant parameters for this egg processing facility (Site No. 9) and the Canadian Water Quality Guidelines for freshwater aquatic life.

Site No. 9 and Canadian Water Quality Guidelines for Freshwater Aquatic Life			
Parameters (mg/l)	**Site No. 9 Sample 001 Grab Sample**	**Site No. 9 Sample 002 Grab Sample**	**Canadian Water Quality Guidelines for Freshwater Aquatic Life***
Aluminum	2.44	0.57	0.1
Arsenic	<0.20	<0.20	0.05
Cadmium	<0.010	<0.010	0.0002
Chromium	<0.015	<0.015	0.02
Copper	0.021	0.013	0.002
Iron	2.61	0.521	0.3
Lead	<0.050	<0.050	0.001
Nickel	<0.020	<0.020	0.025
pH (s.u.)	7.14	7.11	6.5-9.0
Selenium	<0.20	<0.20	0.001
Silver	<0.015	<0.015	0.0001
Zinc	0.099	0.037	0.03

* Based on an assumed hardness of <60 mg/l as $CaCO_3$

As indicated by the table, aluminum, copper, iron and zinc in the stormwater samples were higher than the Canadian guidelines for aquatic life.

3.6.7 Site No. 10 - Brewery Products

Process wastewater from this brewery is pH adjusted prior to discharge to the Greater Vancouver Sewerage and Drainage District (GVSDD) sewer system. This process wastewater is regulated by a waste permit issued by GVSDD.

Precipitation falling on roofs and paved areas is collected by a stormwater sewer system and is routed to the wastewater treatment plant prior to discharge to the city sewer.

Presented in the following table are the results of the stormwater samples collected from this brewery. Both of the stormwater samples were surface water samples collected down-gradient of the industrial activity areas.

Site No. 10 - Brewery Products Industry: Stormwater Samples			
Parameters	**Units**	**Sample 001 (mg/l)**	**Sample 002 (mg/l)**
Temperature	^{0}C	13	13
pH	s.u.	6.40	6.31
Conductivity	µS/cm	11.8	25.6
Total Suspended Solids	mg/l	79	99
Total Alkalinity ($CaCO_3$)	mg/l as $CaCO_3$	<1.0	4.0
Total Kjeldahl Nitrogen (N)	mg/l as N	6.65	1.41
Total Phosphorus (P)	mg/l as P	0.056	0.086
Aluminum	mg/l	2.00	1.68
Antimony	mg/l	<0.20	<0.20
Arsenic	mg/l	<0.20	<0.20
Barium	mg/l	0.052	0.046
Beryllium	mg/l	<0.005	<0.005
Bismuth	mg/l	<0.10	<0.10
Boron	mg/l	<0.10	<0.10
Cadmium	mg/l	<0.010	<0.010
Calcium	mg/l	2.51	4.06
Chromium	mg/l	<0.015	<0.015
Cobalt	mg/l	<0.015	<0.015
Copper	mg/l	0.023	0.023
Iron	mg/l	2.33	2.07
Lead	mg/l	0.057	<0.050
Lithium	mg/l	<0.015	<0.015
Magnesium	mg/l	0.692	0.639
Manganese	mg/l	0.053	0.050
Molybdenum	mg/l	<0.030	<0.030
Nickel	mg/l	<0.020	<0.020
Phosphorus	mg/l	<0.30	<0.30
Potassium	mg/l	<2.0	<2.0
Selenium	mg/l	<0.20	<0.20
Silicon	mg/l	1.83	1.80
Silver	mg/l	<0.015	<0.015
Sodium	mg/l	<2.0	<2.0
Strontium	mg/l	0.035	0.026
Thallium	mg/l	<0.10	<0.10
Tin	mg/l	<0.30	<0.30
Titanium	mg/l	0.075	0.068
Tungsten	mg/l	<0.10	<0.10
Vanadium	mg/l	<0.030	<0.030
Zinc	mg/l	0.379	0.377
Oil and Grease	mg/l	<5	6
Chemical Oxygen Demand	mg/l	87	127
Dissolved Organic Carbon	mg/l	0.80	1.61

The stormwater samples showed that the discharges were relatively free of pollutants. With the exception of iron and zinc, most of the metals were either low orbelow detection.

In comparison with the stormwater data compiled by Gibb *et al*., Sample 001 was higher in organic nitrogen than the typical runoff from industrial facilities in the Lower Fraser Basin. Other pollutants in both Sample 001 and Sample 002 were similar to the reported values.

The following table is a summary of the common stormwater pollutants for this facility and the USEPA Part 2 group application stormwater data from the Food and Kindred Products industrial category. The beverages subcategory is included within this industrial category.

This industrial category covers stormwater discharges from industrial plant yards; material handling sites; refuse sites; sites used for application or disposal of process wastewaters; sites used for storage and maintenance of material handling equipment; sites used for residual treatment, storage, or disposal; shipping and receiving areas; manufacturing buildings; storage areas for raw materials and intermediate and finished products.

Site No. 10 and USEPA Part 2 Food and Kindred Products Stormwater Summary

Parameters (mg/l)	Site No. 10 Sample 001 Grab Sample	Site No. 10 Sample 002 Grab Sample	USEPA Part 2 Median Grab Sample	USEPA Part 2 95th Percentile Grab Sample
Total Suspended Solids	79	99	72.5	1,320
Total Kjeldahl Nitrogen	6.65	1.41	2.35	18
Total Phosphorus	0.056	0.086	0.56	9.06
Copper	0.023	0.023	0.04	0.27
Manganese	0.053	0.050	0.16	1.49
Iron	2.33	2.07	0.54	18
Zinc	0.379	0.377	0.21	2.1
Oil and Grease	<5	6	1.1	21
Chemical Oxygen Demand	87	127	77	745

Comparison of the two sets of stormwater data shows that stormwater pollutants from this facility were similar to the USEPA Part 2 median values and substantially lower than the 95th percentile values for all pollutants.

Presented in the following table is a summary of the applicable stormwater pollutant parameters for this brewery products facility (Site No. 10) and the Canadian Water Quality Guidelines for freshwater aquatic life.

Site No. 10 and Canadian Water Quality Guidelines for Freshwater Aquatic Life			
Parameters (mg/l)	**Site No. 10 Sample 001 Grab Sample**	**Site No. 10 Sample 002 Grab Sample**	**Canadian Water Quality Guidelines for Freshwater Aquatic Life***
Aluminum	2.00	1.68	0.1
Arsenic	<0.20	<0.20	0.05
Cadmium	<0.010	<0.010	0.0002
Chromium	<0.015	<0.015	0.02
Copper	0.023	0.023	0.002
Iron	2.33	2.07	0.3
Lead	0.057	<0.050	0.001
Nickel	<0.020	<0.020	0.025
pH (s.u.)	6.4	6.31	6.5-9.0
Selenium	<0.20	<0.20	0.001
Silver	<0.015	<0.015	0.0001
Zinc	0.379	0.377	0.03

* Based on an assumed hardness of <60 mg/l as $CaCO_3$

As indicated by the table, aluminum, copper, iron, lead and zinc in the stormwater samples were higher than the Canadian guidelines for aquatic life. The pH of the stormwater samples were below the guidelines.

3.6.8 Site No. 11 - Sawmill and Planing Mill Products Industry

This plant produces over 500 different finished cedar wood products. Domestic wastewater from this facility is treated in an extended aeration plant before discharging to the Fraser River. This discharge is permitted by the Ministry of Environment, Lands and Parks. Stormwater runoff from this facility is not regulated.

Presented in the following table are the results of the stormwater samples collected from this wood processing facility. Sample 001 was a surface water sample collected down-gradient from the lubricants storage area and Sample 002 was a surface water sample collected from the finished wood products storage area.

Site No. 11 - Sawmill and Planing Mill Products Industry: Stormwater Samples			
Parameters	**Units**	**Sample 001 (mg/l)**	**Sample 002 (mg/l)**
Temperature	^0C	5	5
pH	s.u.	7.31	7.47
Conductivity	µS/cm	60.5	231
Total Suspended Solids	mg/l	95	694
Total Alkalinity ($CaCO_3$)	mg/l as $CaCO_3$	25.7	100
Total Kjeldahl Nitrogen (N)	mg/l as N	0.52	0.95
Total Phosphorus (P)	mg/l as P	0.071	1.20
Aluminum	mg/l	0.92	5.65
Antimony	mg/l	<0.20	<0.20
Arsenic	mg/l	<0.20	<0.20
Barium	mg/l	0.015	0.070
Beryllium	mg/l	<0.005	<0.005
Bismuth	mg/l	<0.10	<0.10
Boron	mg/l	<0.10	<0.10
Cadmium	mg/l	<0.010	<0.010
Calcium	mg/l	12.9	90.5
Chromium	mg/l	<0.015	<0.015
Cobalt	mg/l	<0.015	<0.015
Copper	mg/l	0.049	0.026
Iron	mg/l	1.70	7.03
Lead	mg/l	0.054	<0.050
Lithium	mg/l	<0.015	<0.015
Magnesium	mg/l	0.441	4.34
Manganese	mg/l	0.067	0.492
Molybdenum	mg/l	<0.030	<0.030
Nickel	mg/l	<0.020	<0.020
Phosphorus	mg/l	<0.30	0.43
Potassium	mg/l	<2.0	6.0
Selenium	mg/l	<0.20	<0.20
Silicon	mg/l	1.05	8.17
Silver	mg/l	<0.015	<0.015
Sodium	mg/l	<2.0	7.8
Strontium	mg/l	0.042	0.263
Thallium	mg/l	<0.10	<0.10
Tin	mg/l	<0.30	<0.30
Titanium	mg/l	0.031	0.163
Tungsten	mg/l	<0.10	<0.10
Vanadium	mg/l	<0.030	<0.030
Zinc	mg/l	0.104	0.587
Oil and Grease	mg/l	12	33
Chemical Oxygen Demand	mg/l	146	551
Dissolved Organic Carbon	mg/l	4.44	60.0

In comparison with the stormwater data compiled by Gibb *et al*., Sample 002 was higher in total suspended solids, total phosphorus and chemical oxygen demand than the typical runoff from industrial facilities in the Lower Fraser Basin. Other pollutants in both Sample 001 and Sample 002 were similar to the reported values.

Stormwater from this facility is not regulated. With the exception of oil and grease and chemical oxygen demand, Sample 001 was relatively low in stormwater pollutants. In relation to Sample 001, Sample 002 contained higher concentrations of total suspended solids; total phosphorus; metals including aluminum, barium, calcium, iron, magnesium, manganese, potassium, silicon, sodium, strontium, titanium, zinc; oil and grease; chemical oxygen demand; and dissolved organic carbon.

The higher stormwater pollutant levels in Sample 002 are reflective of the higher levels of truck traffic for this drainage area. Leachate from the finished wood products storage area contributed to the high chemical oxygen demand and dissolved organic carbon found in Sample 002.

A summary of the common stormwater pollutant parameters for this facility and the USEPA Part 2 group application for the All Timber Product industrial category is presented in the following table.

Site No. 11 and USEPA Part 2 All Timber Product Stormwater Summary

Parameters (mg/l)	Site No. 11 Sample 001 Grab Sample	Site No. 11 Sample 002 Grab Sample	USEPA Part 2 Median Grab Sample	USEPA Part 2 95th Percentile Grab Sample
pH (s.u.)	7.31	7.47	3.6 (minimum)	-
Total Suspended Solids	95	694	242	4,800
Total Kjeldahl Nitrogen	0.52	0.95	1.620	9.26
Total Phosphorus	0.071	1.20	0.287	2.66
Arsenic	<0.20	<0.20	0.009	0.13
Copper	0.049	0.026	0.026	0.16
Oil and Grease	12	33	2.2	55.0
Chemical Oxygen Demand	146	551	131	1,500

As shown by the stormwater data summary, the stormwater pollutant concentrations from this facility were higher in total suspended solids, oil and grease, and chemical oxygen demand than the USEPA Part 2 median values for the All Timber Product industrial category. Both Sample 001 and Sample 002 were lower than the 95th percentile values for all of the common pollutants.

Presented in the following table is a summary of the applicable stormwater pollutant parameters for this saw and planing mill (Site No. 11) and the Canadian Water Quality Guidelines for freshwater aquatic life.

Site No. 11 and Canadian Water Quality Guidelines for Freshwater Aquatic Life			
Parameters (mg/l)	**Site No. 11 Sample 001 Grab Sample**	**Site No. 11 Sample 002 Grab Sample**	**Canadian Water Quality Guidelines for Freshwater Aquatic Life***
Aluminum	0.92	5.65	0.1
Arsenic	<0.20	<0.20	0.05
Cadmium	<0.010	<0.010	0.0002
Chromium	<0.015	<0.015	0.02
Copper	0.049	0.026	0.002
Iron	1.70	7.03	0.3
Lead	0.054	<0.050	0.001
Nickel	<0.020	<0.020	0.025
pH (s.u.)	7.31	7.47	6.5-9.0
Selenium	<0.20	<0.20	0.001
Silver	<0.015	<0.015	0.0001
Zinc	0.104	0.587	0.03

* Based on an assumed hardness of <60 mg/l as $CaCO_3$

As indicated by the table, aluminum, copper, iron, lead and zinc in the stormwater samples were higher than the Canadian guidelines for aquatic life.

3.6.9 Site No. 12 - Wire and Wire Products Industries

This wire products plant produces nails, wire mesh and coated wire products. The plant discharges both treated and untreated stormwater to the receiving water. Contaminated stormwater is treated along with process wastewaters via a physical/chemical process to remove dissolved metal contaminants prior to discharge to the receiving water. Uncontaminated stormwater is discharged directly to the receiving water.

Influent and effluent samples were collected from the wastewater treatment plant (WWTP) during a dry weather period. The wastewater treatment plant samples were used to determine treatment efficiencies. Stormwater samples were collected from catchbasins located in areas of heavy industrial activities.

Presented in the following table are the results of the dry weather WWTP influent/effluent samples.

Site No. 12 - Wire and Wire Products Industry: WWTP Samples				
Parameters	**Units**	**Influent - 1 Grab Sample**	**Influent - 2 Grab Sample**	**WWTP Effluent Grab Sample**
Temperature	^0C	-	-	-
pH	s.u.	-	-	9.09
Conductivity	µS/cm	-	-	5,430
Total Suspended Solids	mg/l	-	-	6
Total Alkalinity ($CaCO_3$)	mg/l as $CaCO_3$	-	-	66.8
Total Kjeldahl Nitrogen (N)	mg/l as N	2.15	15.0	11.0
Total Phosphorus (P)	mg/l as P	1.44	13.8	0.010
Aluminum	mg/l	0.63	1.35	<0.20
Antimony	mg/l	<0.20	<0.20	<0.20
Arsenic	mg/l	<0.20	<0.20	<0.20
Barium	mg/l	<0.010	<0.010	<0.010
Beryllium	mg/l	<0.005	<0.005	<0.005
Bismuth	mg/l	<0.10	0.12	<0.10
Boron	mg/l	-	-	-
Cadmium	mg/l	<0.010	<0.010	<0.010
Calcium	mg/l	50.4	8.80	9.84
Chromium	mg/l	0.155	2.44	<0.015
Cobalt	mg/l	<0.015	0.015	<0.015
Copper	mg/l	0.552	0.312	<0.010
Iron	mg/l	319	293	0.998
Lead	mg/l	0.473	44.4	0.079
Lithium	mg/l	<0.015	<0.015	<0.015
Magnesium	mg/l	0.550	0.546	0.419
Manganese	mg/l	1.90	2.12	0.087
Molybdenum	mg/l	<0.030	<0.030	<0.030
Nickel	mg/l	0.159	0.171	<0.020
Phosphorus	mg/l	1.24	14.4	<0.30
Potassium	mg/l	10.0	306	101
Selenium	mg/l	<0.20	<0.20	<0.20
Silicon	mg/l	-	-	-
Silver	mg/l	<0.015	<0.015	<0.015
Sodium	mg/l	431	711	993
Strontium	mg/l	0.134	0.018	0.033
Thallium	mg/l	<0.10	<0.10	<0.10
Tin	mg/l	<0.30	<0.30	<0.30
Titanium	mg/l	<0.030	0.080	<0.010
Tungsten	mg/l	<0.10	0.79	<0.10
Vanadium	mg/l	<0.030	<0.030	<0.030
Zinc	mg/l	8.14	384	0.804
Oil and Grease	mg/l	-	-	-
Chemical Oxygen Demand	mg/l	247	372	105
Dissolved Organic Carbon	mg/l	3.40	18.4	4.10

The post-treatment pollutant loading and removal efficiencies are shown in the following table.

Site No. 12 - Dry Weather WWTP Pollutant Loading					
Parameters	**Units**	**Influent-1 Grab Sample**	**Influent-2 Grab Sample**	**Effluent Grab Sample**	**% Removal**
Flow	m^3/day	240	1,830	2,070	N/A
Total Suspended Solids	kg/day	-	-	12	
Total Kjeldahl Nitrogen	kg/day as N	0.5	28	23	0
Total Phosphorus	kg/day as P	0.3	25	0.02	>99
Chemical Oxygen Demand	kg/day	59	680	217	71
Total Organic Carbon	kg/day	0.8	34	8	77
Total Aluminum	kg/day	0.2	2.5	<0.4	93
Total Chromium	kg/day	0.04	4.5	<0.03	>99
Total Copper	kg/day	0.1	0.6	<0.02	99
Total Iron	kg/day	77	540	2.1	>99
Total Lead	kg/day	0.1	81	0.2	>99
Total Magnesium	kg/day	0.1	1	0.9	18
Total Manganese	kg/day	0.5	3.9	0.2	95
Total Nickel	kg/day	0.04	0.3	<0.04	94
Total Zinc	kg/day	2	703	1.7	>99

As indicated by the data, the WWTP achieved high removal rates (>90%) for most metals. High removals were also found for phosphorus and organic compounds measured as chemical oxygen demand and total organic carbon. Organic nitrogen passed through the plant un-treated.

Presented in the following table are the results of the stormwater samples collected from this wire and wire products industry. Sample 001 was a catchbasin sample from the wire storage area and Sample 002 was a catchbasin sample from the repair shop area.

Site No. 12 - Wire and Wire Products Industry: Stormwater Samples			
Parameters	**Units**	**Sample 001 (mg/l)**	**Sample 002 (mg/l)**
Temperature	^0C	9	9
pH	s.u.	8.26	8.74
Conductivity	µS/cm	192	207
Total Suspended Solids	mg/l	1,950	275
Total Alkalinity ($CaCO_3$)	mg/l as $CaCO_3$	111	101
Total Kjeldahl Nitrogen (N)	mg/l as N	2.02	2.39
Total Phosphorus (P)	mg/l as P	1.38	0.506
Aluminum	mg/l	6.37	2.67
Antimony	mg/l	<0.20	<0.20
Arsenic	mg/l	<0.20	<0.20
Barium	mg/l	0.118	0.056
Beryllium	mg/l	<0.005	<0.005
Bismuth	mg/l	<0.10	<0.10
Boron	mg/l	8.80	22.3
Cadmium	mg/l	<0.010	<0.010
Calcium	mg/l	447	101
Chromium	mg/l	0.080	0.022
Cobalt	mg/l	0.016	<0.015
Copper	mg/l	0.225	0.084
Iron	mg/l	37.4	12.3
Lead	mg/l	7.64	1.53
Lithium	mg/l	<0.015	0.030
Magnesium	mg/l	4.35	1.54
Manganese	mg/l	0.553	0.202
Molybdenum	mg/l	<0.030	<0.030
Nickel	mg/l	0.044	<0.020
Phosphorus	mg/l	0.83	0.43
Potassium	mg/l	2.2	<2.0
Selenium	mg/l	<0.20	<0.20
Silicon	mg/l	8.77	4.67
Silver	mg/l	<0.015	<0.015
Sodium	mg/l	17.0	29.7
Strontium	mg/l	0.866	0.205
Thallium	mg/l	<0.10	<0.10
Tin	mg/l	<0.30	<0.30
Titanium	mg/l	0.240	0.120
Tungsten	mg/l	<0.10	<0.10
Vanadium	mg/l	<0.030	<0.030
Zinc	mg/l	26.6	5.73
Oil and Grease	mg/l	11	<5
Chemical Oxygen Demand	mg/l	485	127
Dissolved Organic Carbon	mg/l	4.60	7.50

In relation to the average quality characteristics of runoff from industries in the Lower Fraser Basin (Gibb *et al*., 1991), the stormwater samples showed elevated concentrations of total suspended solids, total Kjeldahl nitrogen, total phosphate, lead, zinc, oil and grease and chemical oxygen demand. The pH of the two stormwater samples were at the upper range of reported values. Other elevated parameters, not reported in the runoff quality characteristics by Gibb *et al.* included aluminum, boron and calcium.

A review of the production processes indicated the following likely sources for the stormwater pollutants:

- Total suspended solids, oil and grease - general traffic;
- pH, boron, calcium - rod cleaning operation;
- Total Kjeldahl nitrogen, aluminum, lead, zinc - galvanizing operation ; and,
- Total phosphorus, iron, zinc - phosphating operation.

The following table presents a summary of the common stormwater pollutant parameters for this facility and the USEPA Part 2 group application data from the Fabricated Metal Products industrial category.

Site No. 12 and USEPA Part 2 Fabricated Metal Products Stormwater Summary				
Parameters (mg/l)	**Site No. 12 Discharge 01 Grab Sample**	**Site No. 12 Discharge 02 Grab Sample**	**USEPA Part 2 Median Grab Sample**	**USEPA Part 2 95th Percentile Grab Sample**
pH (s.u.)	8.26	8.74	3.3 (minimum)	9.0 (maximum)
Total Suspended Solids	1,950	275	76	758
Total Kjeldahl Nitrogen	2.02	2.39	1.37	7.2
Total Phosphorus	1.38	0.506	0.22	9.8
Aluminum	6.37	2.67	1.2	-
Copper	0.225	0.084	0.03	-
Iron	37.4	12.3	1.42	-
Manganese	0.553	0.202	0.06	-
Zinc	26.6	5.73	0.36	-
Oil and Grease	11	<5	2.0	21.0
Chemical Oxygen Demand	485	127	56.0	440.0

Comparison of the two sets of stormwater data indicates that stormwater pollutants from this facility were substantially higher than the USEPA Part 2 median values.

Presented in the following table is a summary of the applicable stormwater pollutant parameters for this wire and wire products facility (Site No. 12) and the Canadian Water Quality Guidelines for freshwater aquatic life.

Site No. 12 and Canadian Water Quality Guidelines for Freshwater Aquatic Life			
Parameters (mg/l)	**Site No. 12 Sample 001 Grab Sample**	**Site No. 12 Sample 002 Grab Sample**	**Canadian Water Quality Guidelines for Freshwater Aquatic Life***
Aluminum	6.37	2.67	0.1
Arsenic	<0.20	<0.20	0.05
Cadmium	<0.010	<0.010	0.0002
Chromium	0.080	0.022	0.02
Copper	0.225	0.084	0.002
Iron	37.4	12.3	0.3
Lead	7.64	1.53	0.001
Nickel	0.044	<0.020	0.025
pH	6.50	6.77	6.5-9.0
Selenium	<0.20	<0.20	0.001
Silver	<0.015	<0.015	0.0001
Zinc	26.6	5.73	0.03

* Based on an assumed hardness of <60 mg/l as $CaCO_3$

As indicated by the table, aluminum, chromium, copper, iron, lead, nickel and zinc in the stormwater samples were higher than the Canadian guidelines for aquatic life.

3.6.10 Site No. 13 - Wire and Wire Products Industries

This wire products plant produces nails, wire mesh and coated wire products. The facility has two wastewater discharges. Metals-laden wastewater is treated by a physical/chemical system to remove the dissolved metals as metal hydroxides. The treated wastewater is discharged to the city sewer system and the metal hydroxide precipitates are dewatered and stored on-site in a containment pond. The second wastewater discharge consists of uncontaminated cooling water and is discharged to a drainage ditch leading to the receiving water. The majority of the stormwater from this property is also discharged to the receiving water via this drainage ditch. The cooling water and the stormwater are treated by an oil/water separator to minimize the discharge of oils and soap scum.

Drainage ditch water samples, upstream of the oil/water separator, were collected over an entire storm event. Grab samples were collected in a 30-minute interval over a span of 3.5 hours. The grab samples were composited in the laboratory based on the "Constant Time - Volume Proportional to Flow Increment" method.

Concurrent with the stormwater sampling, rainfall data and the water velocity and depth in the ditch were also measured. Flow rate was approximated by measuring the velocity of the water and the cross-sectional area of the flow in the ditch.

Presented in the following table are the rainfall data and the calculated stormwater runoff volumes for the stormwater sampling period.

Site No. 13 - Wire and Wire Products Industry: Rainfall and Runoff Data

Time of Sampling	Rainfall Depth (mm)	Time of Travel[1] (seconds)	Channel Water Depth (m)	Calculated Flow Rate (m^3/s, ft^3/s)	Cumulated Flow Volume (m^3, $feet^3$)
16:35	0	0	0.25	0	0
16:50	0	35	0.25	0.09 (3.3)	0
17:15	0.1				
17:35		32	0.25	0.11 (3.8)	290 (10,340)
18:00	0.3				
18:05		32	0.27	0.11 (3.8)	490 (17,230)
18:30	0.8				
18:35		25	0.28	0.14 (5.1)	750 (26,470)
18:40	1.3				
18:50	1.5				
19:05	1.9	24	0.30	0.16 (5.8)	1,040 (36,860)
19:25	1.9				
19:30	1.9	25	0.29	0.15 (5.4)	1,270 (44,910)
20:00	1.9	32	0.28	0.11 (4.0)	1,480 (52,130)

[1]Length of the sampling channel = 6.1 metres, width of the sampling channel = 2.1 metres

The rainfall and runoff data showed:

- rainfall duration of approximately 2 hours from 17:00 to 19:00;
- channel flow started to increase at 17:35;
- channel flow peaked at 19:05;
- channel flow decreased to within 20% of the base flow by 20:00, the end of the monitoring period; and,
- a base flow of 0.09 m^3/sec in the channel (cooling water from this facility is approximately 50% of this base flow).

For the duration of the storm event, the cumulative flow volume in the sampling channel was approximately 1,480 m^3. After subtracting the base flow rate of 0.09 m^3/second in the channel, the increase in flow due to stormwater runoff was approximately 400 m^3. This cumulative flow volume constituted the bulk of the total stormwater runoff since the flow in the channel decreased to within 20% of the base flow rate at the conclusion of stormwater monitoring.

Based on a drainage area of 40,000 m^2 for this site, the rainfall depth of 1.9 mm collected during the stormwater monitoring period would produce a runoff volume of 80 m^3. Given that a total runoff volume of over 400 m^3 was found in the channel during the monitoring period, the channel therefore collected stormwater runoff from a drainage basin that included other facilities in addition to this facility.

The following table presents analytical results for:

- baseline grab sample;
- mid-storm grab sample; and,
- composited grab sample for the storm event.

Site No. 13 - Wire and Wire Products Industry: Stormwater Samples				
Parameters	**Units**	**16:50 Grab Sample**	**18:35 Grab Sample**	**17:35 - 20:00 Calculated Composite Sample**
pH	s.u.	7.40	7.42	7.43 (grab)
Conductivity	µS/cm	209	192	197
Total Suspended Solids	mg/l	<1	2	2.8
Total Alkalinity ($CaCO_3$)	mg/l as $CaCO_3$	85.3	70.5	72.3
Total Kjeldahl Nitrogen (N)	mg/l as N	0.12	0.21	0.35
Total Phosphorus (P)	mg/l as P	0.264	0.269	0.320
Aluminum	mg/l	<0.20	<0.20	0.22
Barium	mg/l	<0.010	<0.010	0.012
Calcium	mg/l	9.59	8.89	9.40
Copper	mg/l	<0.010	<0.010	0.021
Iron	mg/l	0.051	0.126	0.382
Magnesium	mg/l	2.33	2.07	2.17
Manganese	mg/l	0.023	0.029	0.036
Molybdenum	mg/l	<0.030	<0.030	<0.030
Phosphorus	mg/l	<0.30	<0.30	0.32
Potassium	mg/l	2.7	2.1	2.3
Sodium	mg/l	34.2	30.1	31.5
Strontium	mg/l	0.052	0.050	0.050
Zinc	mg/l	0.014	0.0176	0.312
Chemical Oxygen Demand	mg/l	<20	<20	<20
Total Organic Carbon	mg/l	2.22	2.37	2.49

The results of the 16:50 baseline sample, representative of the cooling water and site drainage water, show the zinc concentration was within the permit limit. Other metals are not regulated by the discharge permit.

For the 18:35 mid-storm sample, the zinc concentration of 0.176 mg/l (total) may have exceeded the permitted limit of 0.15 mg/l (dissolved).

For the calculated composite sample, the zinc concentration of 0.312 mg/l (total) may have exceeded the permitted limit of 0.15 mg/l (dissolved).

In comparison to the 16:50 baseline sample, the calculated composite sample contained higher concentrations of:

- total suspended solids;
- total Kjeldahl nitrogen;
- total phosphorus;
- total copper;
- total iron; and,
- total zinc.

As determined earlier, this channel conveys stormwater from other sites in addition to this wire products plant. Therefore, increases in pollutant levels cannot be totally attributed to this facility. However, with the possible exception of copper, all of the above pollutants can be attributed to materials and chemicals used on-site. An adjacent wood preservation plant was a likely source of the copper in the stormwater runoff.

Stormwater runoff from this facility is similar in quality to the runoff from the USEPA's Part 2 group application submittal from the Fabricated Metal Products Industry. Comparison of the two stormwater data sets indicated that stormwater from this facility was lower in suspended solids and chemical oxygen demand. These decreases could be attributed to the presence of a large oil/water separator which functions both as an oil/water separator and as a settling basin.

The following table presents a summary of the common stormwater pollutant parameters for this facility and the USEPA Part 2 group application data from the Fabricated Metal Products industrial category.

Site No. 13 and USEPA Part 2 Fabricated Metal Products Stormwater Summary			
Parameters (mg/l)	**Site No. 13 17:35 To 20:00 Composite Sample**	**USEPA Part 2 Median Composite Sample**	**USEPA Part 2 95th Percentile Composite Sample**
pH (s.u.)	7.43	3.3 (minimum)	9.0 (maximum)
Total Suspended Solids	2.8	32	423
Total Kjeldahl Nitrogen	0.35	1.2	5.75
Total Phosphorus	0.32	0.205	4.8
Aluminum	0.22	1.0	-
Copper	0.021	0.02	-
Iron	0.382	0.57	-
Manganese	0.036	0.02	-
Zinc	0.312	0.21	-
Oil and Grease	<5 (grab)	2.0 (grab)	-
Chemical Oxygen Demand	<20	47.5	249.0

Presented in the following table is a summary of the applicable stormwater pollutant parameters for this wire and wire products facility (Site No. 13) and the Canadian Water Quality Guidelines for freshwater aquatic life.

Site No. 13 and Canadian Water Quality Guidelines for Freshwater Aquatic Life		
Parameters (mg/l)	**Site No. 13 17:35 To 20:00 Composite Sample**	**Canadian Water Quality Guidelines for Freshwater Aquatic Life***
Aluminum	0.22	0.1
Arsenic	-	0.05
Cadmium	-	0.0002
Chromium	-	0.02
Copper	0.021	0.002
Iron	0.382	0.3
Lead	-	0.001
Nickel	-	0.025
pH (s.u.)	7.43 (grab)	6.5-9.0
Selenium	-	0.001
Silver	-	0.0001
Zinc	2.49	0.03

* Based on an assumed hardness of <60 mg/l as $CaCO_3$

As indicated by the table, aluminum, copper, iron and zinc in the composite stormwater sample are higher than the Canadian guidelines for aquatic life.

3.6.11 Site No. 14 - Hydraulic Cement Industry

This cement manufacturing plant has two effluent discharge outfalls (Discharge 01 and Discharge 02). Discharge 01 collects cooling water from kiln bearings, process cooling and stormwater from the eastern section of the plant. Raw materials stored within the drainage area of Discharge 01 include:

- crushed limestone;
- shale;
- conglomerate;
- silica slag;
- gypsum;
- coal tailing; and,
- iron oxide.

Discharge 02 collects cooling water from water jackets, cement coolers, compressor water jackets and stormwater from the western section of the plant. The majority of the industrial activities are located within the drainage area of Discharge 02. These industrial activities include:

- raw grinding;
- pyro processing;
- finish grinding; and,
- storage and distribution.

Stormwater grab samples were collected during a storm event; the analytical results are presented in the following table.

Site No. 14 - Hydraulic Cement Industry: Stormwater Samples			
Parameters	**Units**	**Discharge 01 Grab Sample**	**Discharge 02 Grab Sample**
Temperature	^{0}C	6	6
pH	s.u.	9.57	10.7
Conductivity	µS/cm	12,100	2,010
Total Suspended Solids	mg/l	72	1,030
Total Alkalinity ($CaCO_3$)	mg/l as $CaCO_3$	78.4	62.0
Total Kjeldahl Nitrogen (N)	mg/l as N	0.22	0.39
Total Phosphorus (P)	mg/l as P	0.015	0.022
Aluminum	mg/l	0.61	5.93
Antimony	mg/l	<0.40	<0.20
Arsenic	mg/l	<0.40	<0.20
Barium	mg/l	0.020	0.117
Beryllium	mg/l	<0.01	<0.005
Bismuth	mg/l	<0.24	<0.10
Boron	mg/l	0.78	0.14
Cadmium	mg/l	<0.020	<0.010
Calcium	mg/l	138	259
Chromium	mg/l	0.098	0.037
Cobalt	mg/l	<0.030	<0.015
Copper	mg/l	0.020	0.109
Iron	mg/l	0.798	8.48
Lead	mg/l	<0.10	0.114
Lithium	mg/l	0.038	0.022
Magnesium	mg/l	230	31.2
Manganese	mg/l	0.05	0.210
Molybdenum	mg/l	<0.060	<0.030
Nickel	mg/l	<0.040	<0.020
Phosphorus	mg/l	<0.60	<0.30
Potassium	mg/l	104	36.4
Selenium	mg/l	<0.40	<0.20
Silicon	mg/l	4.04	19.3
Silver	mg/l	<0.030	<0.015
Sodium	mg/l	1,790	249
Strontium	mg/l	1.88	1.23
Thallium	mg/l	<0.20	<0.10
Tin	mg/l	<0.60	<0.30
Titanium	mg/l	<0.020	0.278
Tungsten	mg/l	<0.20	<0.10
Vanadium	mg/l	<0.060	<0.030
Zinc	mg/l	0.15	0.446
Oil and Grease	mg/l	<5	<5
Chemical Oxygen Demand	mg/l	138	60
Dissolved Organic Carbon	mg/l	<1	2.40

The stormwater samples showed that the discharges were within the permit limitations for temperature and oil and grease. The major difference between these two discharges was the type of solids found in the stormwater. Discharge 01 had a higher concentration of dissolved solids while Discharge 02 had a higher concentration of total suspended solids.

The high dissolved solids concentration in Discharge 01 was due to the dissolved salt in the river water. River water is used to cool kiln bearings and other processes in the plant. After picking up the waste heat, the river water is returned to the river via Discharge 01.

The higher total suspended solids concentration in Discharge 02 was due to fines entrained in the stormwater.

In comparison to the industrial runoff water quality for facilities in the Lower Fraser Basin, with the exception of total suspended solids, all pollutants were either similar to or below values reported by Gibb *et al.* for the industrial land use category.

Stormwater runoff from this facility was similar in quality to the runoff from the USEPA's Part 2 Group Permit Application from the Glass, Clay, Cement, Concrete and Gypsum Product Manufacturing industrial category. Specifically, stormwater discharges from hydraulic cement manufacturing operations are included within this industrial category. Stormwater data submitted included discharges from industrial plant yards; access areas; raw material storage areas; and areas used for bagging and packaging operations.

The following table presents a summary of the common stormwater pollutant parameters for this facility and the USEPA Part 2 group application data from this industrial category.

Site No. 14 and USEPA Part 2 Glass, Clay, Cement, Concrete and Gypsum Product Manufacturing Stormwater Summary

Parameters (mg/l)	Site No. 14 Discharge 01 Grab Sample	Site No. 14 Discharge 02 Grab Sample	USEPA Part 2 Median Grab Sample	USEPA Part 2 95th Percentile Grab Sample
pH (s.u.)	9.57	10.7	2.0 (minimum)	12.3 (maximum)
Total Suspended Solids	72	1,030	200	2,620
Total Kjeldahl Nitrogen	0.22	0.39	1.15	7.0
Total Phosphorus	0.015	0.022	0.28	4.96
Aluminum	0.61	5.93	3.1	900
Copper	<0.020	0.109	0.019	0.4
Iron	0.798	8.48	3.48	29
Zinc	0.15	0.446	0.137	1.17
Oil and Grease	<5	<5	1.4	17.1
Chemical Oxygen Demand	138	60	51.3	317.0

Comparison of the two sets of stormwater data shows stormwater pollutants from Discharge 01 were lower than the USEPA Part 2 median values for all pollutants with the exception of chemical oxygen demand. Discharge 02 stormwater pollutants were generally higher than the median values but lower than the 95th percentile values.

Presented in the following table is a summary of the applicable stormwater pollutant parameters for this hydraulic cement plant (Site No. 14) and the Canadian Water Quality Guidelines for freshwater aquatic life.

Site No. 14 and Canadian Water Quality Guidelines for Freshwater Aquatic Life

Parameters (mg/l)	Site No. 14 Sample 01 Grab Sample	Site No. 14 Sample 02 Grab Sample	Canadian Water Quality Guidelines for Freshwater Aquatic Life*
Aluminum	0.61	5.93	0.1
Arsenic	<0.40	<0.20	0.05
Cadmium	<0.020	<0.010	0.0002
Chromium	0.098	0.037	0.02
Copper	0.020	0.109	0.002
Iron	0.798	8.48	0.3
Lead	<0.10	0.114	0.001
Nickel	<0.040	<0.020	0.025
pH (s.u.)	9.57	10.7	6.5-9.0
Selenium	<0.40	<0.20	0.001
Silver	<0.030	<0.015	0.0001
Zinc	0.15	0.446	0.03

* Based on an assumed hardness of <60 mg/l as $CaCO_3$

As indicated by the table, aluminum, chromium, copper, iron, lead and zinc in the stormwater samples were higher than the Canadian guidelines for aquatic life. The pH of the stormwater samples were above the upper range of 9.0.

3.6.12 Site No. 15 - Ready-Mix Concrete Industry

This ready-mix concrete plant manufactures and delivers mixed concrete. This facility discharges both process wastewater, contaminated stormwater from the process area, and uncontaminated stormwater to the receiving environment. The process wastewater and contaminated stormwater are treated by a series of settling ponds to remove settleable solids prior to discharge to an infiltration bed. The uncontaminated stormwater flows to the site perimeter ditch.

An effluent sample of process and stormwater was collected from the final sedimentation pond.

Presented in the following table are the analytical results of Sample 001.

Site No. 15 - Ready-Mix Concrete Industry: Stormwater Samples		
Parameters	**Units**	**Sample 001 Grab Sample**
Temperature	^0C	0
pH	s.u.	14.0
Conductivity	µS/cm	1,710
Total Suspended Solids	mg/l	189
Total Alkalinity ($CaCO_3$)	mg/l as $CaCO_3$	315
Total Kjeldahl Nitrogen (N)	mg/l as N	0.46
Total Phosphorus (P)	mg/l as P	0.345
Aluminum	mg/l	6.00
Antimony	mg/l	<0.20
Arsenic	mg/l	<0.20
Barium	mg/l	0.255
Beryllium	mg/l	<0.005
Bismuth	mg/l	<0.10
Boron	mg/l	<0.10
Cadmium	mg/l	<0.010
Calcium	mg/l	175
Chromium	mg/l	0.035
Cobalt	mg/l	<0.015
Copper	mg/l	0.035
Iron	mg/l	4.32
Lead	mg/l	<0.050
Lithium	mg/l	<0.015
Magnesium	mg/l	3.01
Manganese	mg/l	0.096
Molybdenum	mg/l	<0.030
Nickel	mg/l	<0.020
Phosphorus	mg/l	<0.30
Potassium	mg/l	7.1
Selenium	mg/l	<0.20
Silicon	mg/l	28.2
Silver	mg/l	<0.015
Sodium	mg/l	101
Strontium	mg/l	1.25
Thallium	mg/l	<0.10
Tin	mg/l	<0.30
Titanium	mg/l	0.634
Tungsten	mg/l	<0.10
Vanadium	mg/l	<0.030
Zinc	mg/l	0.076
Oil and Grease	mg/l	6
Chemical Oxygen Demand	mg/l	<20
Total Organic Carbon	mg/l	4.60

In comparison to stormwater data compiled by Gibb *et al*., with the exception of pH, Sample 001 analytical results were lower than the reported values for typical industrial facilities in the Lower Fraser Basin.

The wastewater/stormwater sample had an alkaline pH of 14. This is due to the alkaline nature of cement fines in the water sample. This pH is outside the range of 6.2 to 8.7 for stormwater discharges from typical industrial facilities and is acutely lethal to fish.

Presented in the following table is a summary of the common stormwater pollutants for this ready-mix facility and the USEPA's Part 2 Group Permit Application from the Glass, Clay, Cement, Concrete and Gypsum Product Manufacturing industrial category. This industrial category includes the ready-mix concrete manufacturing operations. The USEPA stormwater data submitted included discharges from industrial plant yards; access areas; raw material storage areas; and areas used for bagging and packaging operations.

Site No. 15 and USEPA Part 2 Glass, CLAY, Cement, Concrete and Gypsum Product Manufacturing Stormwater Summary

Parameters (mg/l)	Site No. 15 Sample 001 Grab Sample	USEPA Part 2 Median Grab Sample	USEPA Part 2 95th Percentile Grab Sample
pH (s.u.)	14	2.0 (minimum)	12.3 (maximum)
Total Suspended Solids	189	200	2,620
Total Kjeldahl Nitrogen	0.46	1.15	7.0
Total Phosphorus	0.345	0.28	4.96
Aluminum	6.00	3.1	900
Copper	0.035	0.019	0.4
Iron	4.32	3.48	29
Zinc	0.076	0.137	1.17
Oil and Grease	6	1.4	17.1
Chemical Oxygen Demand	<20	51.3	317.0

Comparison of the two sets of stormwater data shows that Sample 001 was higher in total phosphorus, aluminum, copper, iron, and oil and grease than the USEPA Part 2 median values. The pollutant values for Sample 001 were substantially lower than the 95^{th} percentile values.

Presented in the following table is a summary of the applicable stormwater pollutant parameters for this ready-mix facility (Site No. 15) and the Canadian Water Quality Guidelines for freshwater aquatic life.

Site No. 15 and Canadian Water Quality Guidelines for Freshwater Aquatic Life		
Parameters (mg/l)	**Site No. 15 Sample 001 Grab Sample**	**Canadian Water Quality Guidelines for Freshwater Aquatic Life***
Aluminum	6.00	0.1
Arsenic	<0.20	0.05
Cadmium	<0.010	0.0002
Chromium	0.035	0.02
Copper	0.035	0.002
Iron	4.32	0.3
Lead	<0.050	0.001
Nickel	<0.020	0.025
pH (s.u.)	14.0	6.5-9.0
Selenium	<0.20	0.001
Silver	<0.015	0.0001
Zinc	0.076	0.03

* Based on an assumed hardness of <60 mg/l as $CaCO_3$

As indicated by the table, aluminum, chromium, copper, iron and zinc in the stormwater sample were higher than the Canadian guidelines for aquatic life. The pH was outside the upper range of 9.0 in the guidelines.

3.6.13 Site No. 16 - Lime Industry

This plant processes limestone into quicklime, hydrated lime and agricultural lime. This facility discharges air compressor and air conditioner cooling water to the receiving water under a Ministry of Environment, Lands and Parks discharge permit. Stormwater from the facility flows to a drainage ditch adjacent to the eastern boundary of the plant property. The stormwater discharge is not regulated.

Three stormwater samples were collected from this facility. Sample 001 was collected from the drainage ditch down-gradient from the hydrated lime and the quicklime production areas. Sample 002 was a stormwater runoff sample from the hydrated lime production area. Sample 003 was a stormwater runoff sample from the warehouse and the Agri-stone pile facilities.

Presented in the following table are the analytical results of the stormwater samples

Site No. 16 - Lime Industry: Stormwater Samples				
Parameters	**Units**	**Sample 001 Grab Sample**	**Sample 002 Grab Sample**	**Sample 003 Grab Sample**
Temperature	^0C	8	8	8
pH	s.u.	12.4	12.2	10.4
Conductivity	µS/cm	7,660	4,140	93.5
Total Suspended Solids	mg/l	121	782	570
Total Alkalinity ($CaCO_3$)	mg/l as $CaCO_3$	1,920	1,010	19.4
Total Kjeldahl Nitrogen (N)	mg/l as N	0.96	0.70	0.15
Total Phosphorus (P)	mg/l as P	0.038	0.211	0.158
Aluminum	mg/l	<0.20	1.01	0.73
Antimony	mg/l	<0.20	<0.20	<0.20
Arsenic	mg/l	<0.20	<0.20	<0.20
Barium	mg/l	0.011	0.015	0.015
Beryllium	mg/l	<0.005	<0.005	<0.005
Bismuth	mg/l	<0.10	<0.10	<0.10
Boron	mg/l	<0.10	<0.10	<0.10
Cadmium	mg/l	<0.010	<0.010	<0.010
Calcium	mg/l	712	746	256
Chromium	mg/l	<0.015	<0.015	<0.015
Cobalt	mg/l	<0.015	<0.015	<0.015
Copper	mg/l	<0.010	<0.010	<0.010
Iron	mg/l	0.062	0.919	0.801
Lead	mg/l	<0.050	<0.050	<0.050
Lithium	mg/l	<0.015	<0.015	<0.015
Magnesium	mg/l	0.321	2.61	1.64
Manganese	mg/l	0.009	0.101	0.051
Molybdenum	mg/l	<0.030	<0.030	<0.030
Nickel	mg/l	<0.020	<0.020	<0.020
Phosphorus	mg/l	<0.30	<0.30	<0.30
Potassium	mg/l	<2.0	<2.0	<2.0
Selenium	mg/l	<0.20	<0.20	<0.20
Silicon	mg/l	0.620	1.91	1.42
Silver	mg/l	<0.015	<0.015	<0.015
Sodium	mg/l	2.6	<2.0	<2.0
Strontium	mg/l	3.57	2.25	0.671
Thallium	mg/l	<0.10	<0.10	<0.10
Tin	mg/l	<0.30	<0.30	<0.30
Titanium	mg/l	<0.010	0.026	0.029
Tungsten	mg/l	<0.10	<0.10	<0.10
Vanadium	mg/l	<0.030	<0.030	<0.030
Zinc	mg/l	<0.005	0.038	0.037
Oil and Grease	mg/l	<5	<5	<5
Chemical Oxygen Demand	mg/l	30	26	26
Dissolved Organic Carbon	mg/l	4.70	3.20	1.00

The major pollutants of concern from this facility were pH and total suspended solids. Due to the nature of the products (quicklime and hydrated lime) and the low alkalinity of the rain water, stormwater from this facility after coming into contact with either quicklime or hydrated lime would be high in pH. Spilled products from the manufacturing and loading operations contributed to the high total suspended solids concentrations in the three stormwater samples.

In comparison to the stormwater data compiled by Gibb *et al*., Sample 001 and Sample 002 were higher in pH, alkalinity and total suspended solids than the reported values for typical industrial facilities in the Lower Fraser Basin. All other pollutants were less than the reported average values. Sample 003 washigher in pH and total suspended solids.

Discharges from lime manufacturing facilities were not included in the USEPA Part 2 Group 2 Permit Application from the Glass, Clay, Cement, Concrete and Gypsum Product Manufacturing industrial category.

Presented in the following table is a summary of the applicable stormwater pollutant parameters for this lime processing facility (Site No. 16) and the Canadian Water Quality Guidelines for freshwater aquatic life.

Site No. 16 and Canadian Water Quality Guidelines for Freshwater Aquatic Life				
Parameters (mg/l)	**Site No. 16 Sample 001 Grab Sample**	**Site No. 16 Sample 002 Grab Sample**	**Site No. 16 Sample 003 Grab Sample**	**Canadian Water Quality Guidelines for Freshwater Aquatic Life***
Aluminum	<0.20	1.01	0.73	0.1
Arsenic	<0.20	<0.20	<0.20	0.05
Cadmium	<0.010	<0.010	<0.010	0.0002
Chromium	<0.015	<0.015	<0.015	0.02
Copper	<0.010	<0.010	<0.010	0.002
Iron	0.062	0.919	0.801	0.3
Lead	<0.050	<0.050	<0.050	0.001
Nickel	<0.020	<0.020	<0.020	0.025
pH (s.u.)	12.4	12.2	10.4	6.5-9.0
Selenium	<0.20	<0.20	<0.20	0.001
Silver	<0.015	<0.015	<0.015	0.0001
Zinc	<0.005	0.038	0.037	0.03

* Based on an assumed hardness of <60 mg/l as $CaCO_3$

As indicated by the table, aluminum, iron and zinc in the stormwater samples (Sample 002 and Sample 003) were higher than the Canadian guidelines for aquatic life. The pH for all three stormwater samples was higher than the upper range of 9.0 in the guidelines.

3.6.14 Site No. 17 - Refined Petroleum Products Industry

Stormwater runoff from this petroleum bulk storage plant (Outfall 01) is regulated by the Ministry of Environment, Lands and Parks. Stormwater is first treated in a baffled sump with skimmer prior to discharging to the receiving water.

A stormwater sample was collected from the tank farm area. Sample 001 was an effluent sample collected at Outfall 01.

Presented in the following table are the results of the stormwater sample collected from this bulk storage plant.

Site No. 17 - Refined Petroleum Products Industry: Stormwater Samples		
Parameters	**Units**	**Sample 001 Grab Sample**
Temperature	^0C	-
pH	s.u.	6.96
Conductivity	µS/cm	87.3
Total Suspended Solids	mg/l	6
Total Alkalinity ($CaCO_3$)	mg/l as $CaCO_3$	23.2
Total Kjeldahl Nitrogen (N)	mg/l as N	0.72
Total Phosphorus (P)	mg/l as P	0.026
Aluminum	mg/l	<0.20
Antimony	mg/l	<0.20
Arsenic	mg/l	<0.20
Barium	mg/l	0.011
Beryllium	mg/l	<0.005
Bismuth	mg/l	<0.10
Boron	mg/l	<0.10
Cadmium	mg/l	<0.010
Calcium	mg/l	8.67
Chromium	mg/l	<0.015
Cobalt	mg/l	<0.015
Copper	mg/l	<0.010
Iron	mg/l	1.28
Lead	mg/l	<0.050
Lithium	mg/l	<0.015
Magnesium	mg/l	1.15
Manganese	mg/l	0.140
Molybdenum	mg/l	<0.030
Nickel	mg/l	<0.020
Phosphorus	mg/l	<0.30
Potassium	mg/l	<2.0
Selenium	mg/l	<0.20
Silicon	mg/l	2.50
Silver	mg/l	<0.015
Sodium	mg/l	5.9
Strontium	mg/l	0.049
Thallium	mg/l	<0.10
Tin	mg/l	<0.30
Titanium	mg/l	<0.010
Tungsten	mg/l	<0.10
Vanadium	mg/l	<0.030
Zinc	mg/l	0.026
Oil and Grease	mg/l	<5
Chemical Oxygen Demand	mg/l	52
Dissolved Organic Carbon	mg/l	5.11

After treatment by an oil/water separator, the stormwater sample from the sump effluent was relatively free of pollutants. The oil and grease concentration was below the detection limit of 5 mg/l and was in compliance with the permit limit of 5 mg/l. The total suspended solids concentration of the stormwater sample was below the permit limit of 20 mg/l.

Compared to the stormwater data compiled by Gibb *et al*., Sample 001 analytical results were lower than the reported values for typical industrial facilities in the Lower Fraser Basin.

Presented in the following table is a summary of the common stormwater pollutant parameters for this facility and the USEPA Part 2 group application for the Petroleum Bulk Oil Stations and Terminals Facilities industrial category.

Site No. 17 and USEPA Part 2 Petroleum Bulk Oil Stations and Terminals Stormwater Summary			
Parameters (mg/l)	**Site No. 17 Sample 001 Grab Sample**	**USEPA Part 2 Median Grab Sample**	**USEPA Part 2 95th Percentile Grab Sample**
pH (s.u.)	6.96	6.0 (minimum)	9.3 (maximum)
Total Suspended Solids	6	106	1,090
Total Kjeldahl Nitrogen	0.72	2.80	5.80
Total Phosphorus	0.026	0.12	4.60
Oil and Grease	<5	5.4	28.0
Chemical Oxygen Demand	52	94.0	390.0

Comparison of the stormwater data shows pollutants in the treated stormwater sample from this facility were substantially less than the USEPA Part 2 median and the 95th percentile values.

Presented in the following table is a summary of the applicable stormwater pollutant parameters for this petroleum bulk storage facility (Site No. 17) and the Canadian Water Quality Guidelines for freshwater aquatic life.

Site No. 17 and Canadian Water Quality Guidelines for Freshwater Aquatic Life		
Parameters (mg/l)	**Site No. 17 Sample 001 Grab Sample**	**Canadian Water Quality Guidelines for Freshwater Aquatic Life***
Aluminum	<0.20	0.1
Arsenic	<0.20	0.05
Cadmium	<0.010	0.0002
Chromium	<0.015	0.02
Copper	<0.010	0.002
Iron	1.28	0.3
Lead	<0.050	0.001
Nickel	<0.020	0.025
pH (s.u.)	6.96	6.5-9.0
Selenium	<0.20	0.001
Silver	<0.015	0.0001
Zinc	0.026	0.03

* Based on an assumed hardness of <60 mg/l as $CaCO_3$

As indicated by the table, iron concentration in the stormwater sample was higher than the Canadian guidelines for aquatic life.

3.6.15 Site No. 18 - Asphalt Manufacturing Industry

This facility has two stormwater discharge outfalls (Discharge 01 and Discharge 02). Discharge 01 collects stormwater from the northern section of the plant. This area contains the tank farm, equipment storage and recycled asphalt storage. Discharge 02 collects washwater and stormwater from the southern section of the plant. This area contains the asphalt plant, the truck wash area, the steam cleaning area, aggregate stockpiles and salt stockpiles. The site is graded to direct all contaminated water to one of the two on-site oil/water separators for treatment prior to discharging to an adjacent drainage ditch.

Stormwater grab samples were collected during a storm event; the results are presented in the following table.

Site No. 18 - Asphalt Manufacturing Industry: Stormwater Samples			
Parameters	**Units**	**Discharge 01 Grab Sample**	**Discharge 02 Grab Sample**
Temperature	^0C	-	-
pH	s.u.	7.84	8.20
Conductivity	µS/cm	722	7,160
Total Suspended Solids	mg/l	139	150
Total Alkalinity ($CaCO_3$)	mg/l as $CaCO_3$	33.7	40.7
Total Kjeldahl Nitrogen (N)	mg/l as N	0.57	0.37
Total Phosphorus (P)	mg/l as P	0.197	0.235
Aluminum	mg/l	4.07	13.0
Antimony	mg/l	<0.20	<2.0
Arsenic	mg/l	<0.20	<2.0
Barium	mg/l	0.058	<0.10
Beryllium	mg/l	<0.005	<0.05
Bismuth	mg/l	<0.10	<1.0
Boron	mg/l	-	-
Cadmium	mg/l	<0.010	<0.10
Calcium	mg/l	18.4	36.5
Chromium	mg/l	<0.015	<0.15
Cobalt	mg/l	<0.015	<0.15
Copper	mg/l	0.014	<0.10
Iron	mg/l	4.39	11.8
Lead	mg/l	<0.050	<0.50
Lithium	mg/l	<0.015	<0.15
Magnesium	mg/l	21.3	21.5
Manganese	mg/l	0.145	1.51
Molybdenum	mg/l	<0.030	<0.30
Nickel	mg/l	<0.020	<0.20
Phosphorus	mg/l	<0.30	<3.0
Potassium	mg/l	2.3	<20
Selenium	mg/l	<0.20	<2.0
Silicon	mg/l	-	-
Silver	mg/l	<0.015	<0.15
Sodium	mg/l	83.4	1600
Strontium	mg/l	0.085	0.18
Thallium	mg/l	<0.10	<1.0
Tin	mg/l	<0.30	<3.0
Titanium	mg/l	0.177	0.30
Tungsten	mg/l	<0.10	<1.0
Vanadium	mg/l	<0.030	<0.30
Zinc	mg/l	0.085	10.4
Oil and Grease	mg/l	8	7
Chemical Oxygen Demand	mg/l	65	129
Dissolved Organic Carbon	mg/l	5.77	<1.0

Site No. 18 - Asphalt Manufacturing Industry: Stormwater Samples (Continued)			
Polyaromatic Hydrocarbons	**Units**	**Discharge 01 Grab Sample**	**Discharge 02 Grab Sample**
Acenaphthene	mg/l	<0.0005	<0.0005
Acenaphthylene	mg/l	<0.0005	<0.0005
Anthracene	mg/l	0.0003	<0.0002
Benzo (a) anthracene	mg/l	0.00012	0.00001
Benzo (a) pyrene	mg/l	0.00011	0.00001
Benzo (b) fluoranthene	mg/l	0.00015	0.00002
Benzo (ghi) perylene	mg/l	0.0001	<0.0001
Benzo (k) fluoranthene	mg/l	0.00008	<0.00001
Chrysene	mg/l	0.0002	<0.0001
Dibenzo (a,h) anthracene	mg/l	0.00004	<0.00001
7,12-Dimethyl-1,2-benzanthracene	mg/l	<0.0001	<0.0001
Fluoranthene	mg/l	0.0002	<0.0001
Fluorene	mg/l	0.0008	0.0007
Indeno (1,2,3-cd) pyrene	mg/l	0.00008	0.00002
3-Methylcholanthrene	mg/l	<0.0001	<0.0001
Naphthalene	mg/l	<0.0002	0.0025
Phenanthrene	mg/l	0.0010	0.0007
Pyrene	mg/l	0.0005	<0.0002

The stormwater samples showed that the discharges were within the permit limitations for pH, and oil and grease. The total suspended solids concentrations of 139 mg/l (Discharge 01) and 150 mg/l (Discharge 02) were greater than the permit limit of 50 mg/l. The higher than permitted values may have been due to accumulated solids in the oil/water separators (i.e., poor maintenance resulting in lower removal efficiencies).

As indicated above, the northern section of the plant houses the majority of the industrial activities that can contribute to stormwater pollution. This difference in the stormwater pollution potential between the north and south section of the plant is evidenced by the sampling results. The Discharge 02 stormwater sample was higher in:

- conductivity;
- total aluminum;
- total calcium;
- total magnesium;
- total sodium;
- total zinc; and,
- naphthalene

The high metal and conductivity levels were due to leachate from the road salt stockpiles. The hydrocarbon, naphthalene, is from kerosene which is used as a lubricant for coating truck beds prior to loading asphalt. Truck washing releases the contaminants, including naphthalene, to the collection system and eventually to the receiving water.

Stormwater runoff from this facility was similar in quality to the runoffs from the USEPA's Asphalt Paving and Roofing Materials Manufacturers and Lubricants Manufacturers industrial category. The following table presents a summary of the common stormwater pollutant parameters for this facility and the USEPA Part 2 group application data from the Asphalt Paving and Roofing Materials Manufacturing and Lubricants Manufacturers category.

Site No. 18 and USEPA Part 2 Asphalt Paving and Roofing Materials Manufacturing Stormwater Summary				
Parameters (mg/l)	**Site No. 18 Discharge 01 Grab Sample**	**Site No. 18 Discharge 02 Grab Sample**	**USEPA Part 2 Median Grab Sample**	**USEPA Part 2 95th Percentile Grab Sample**
pH (s.u.)	7.8	8.2	N/A	N/A
Total Suspended Solids	139	150	93	1,330
Total Kjeldahl Nitrogen	0.57	0.37	1.1	7.2
Total Phosphorus	0.197	0.235	0.1	1.7
Oil and Grease	8	7	1.3	28.0
Chemical Oxygen Demand	65	129	48.0	485.0

Comparison of the two sets of stormwater data shows that stormwater pollutants from this facility were higher than the USEPA Part 2 median and lower than the 95^{th} percentile values for most pollutants.

Presented in the following table is a summary of the applicable stormwater pollutant parameters for this asphalt manufacturing plant (Site No. 18) and the Canadian Water Quality Guidelines for freshwater aquatic life.

Site No. 18 and Canadian Water Quality Guidelines for Freshwater Aquatic Life			
Parameters (mg/l)	**Site No. 18 Discharge 01 Grab Sample**	**Site No. 18 Discharge 02 Grab Sample**	**Canadian Water Quality Guidelines for Freshwater Aquatic Life***
Aluminum	4.07	13.0	0.1
Arsenic	<0.20	<2.0	0.05
Cadmium	<0.010	<0.10	0.0002
Chromium	<0.015	<0.15	0.02
Copper	0.014	<0.10	0.002
Iron	4.39	11.8	0.3
Lead	<0.050	<0.50	0.001
Nickel	<0.020	<0.20	0.025
pH (s.u.)	7.84	8.20	6.5-9.0
Selenium	<0.20	<2.0	0.001
Silver	<0.015	<0.15	0.0001
Zinc	0.085	10.4	0.03

* Based on an assumed hardness of <60 mg/l as $CaCO_3$

As indicated by the table, aluminum, copper, iron and zinc in the stormwater samples were higher than the Canadian guidelines for aquatic life.

3.6.16 Site No. 19 - Industrial Inorganic Chemical Industry (Chlor-Alkali)

This facility produces chlorine and caustic soda using salt as the raw material. Effluents from the facility are discharged through two outfalls regulated by the BC Ministry of Environment, Lands and Parks. Outfall 1 discharges process water, cooling water and domestic wastewater to the marine environment. Outfall 2 discharges wastewater to groundwater via an infiltration pond.

Precipitation falling onto the plant site is either routed to process or is percolated to the groundwater. The potential for stormwater runoff to the receiving water is limited.

Presented in the following table are the results of the stormwater samples collected from this facility. Sample 001 was a standing water sample west of a raw salt tank and Sample 002 was a standing water sample near a caustic operation area.

Site No. 19 - Industrial Inorganic Chemical Industry (Chlor-Alkali): Stormwater Samples			
Parameters	**Units**	**Sample 001 Grab Sample**	**Sample 002 Grab Sample**
Temperature	^0C	7	7
pH	s.u.	7.18	7.38
Conductivity	µS/cm	7,220	137
Total Suspended Solids	mg/l	18	4
Total Alkalinity ($CaCO_3$)	mg/l as $CaCO_3$	13.3	21.0
Total Kjeldahl Nitrogen (N)	mg/l as N	0.17	0.12
Total Phosphorus (P)	mg/l as P	0.014	0.033
Aluminum	mg/l	0.31	<0.20
Antimony	mg/l	<0.20	<0.20
Arsenic	mg/l	<0.20	<0.20
Barium	mg/l	0.013	<0.010
Beryllium	mg/l	<0.005	<0.005
Bismuth	mg/l	<0.10	<0.10
Boron	mg/l	<0.10	<0.10
Cadmium	mg/l	<0.010	<0.010
Calcium	mg/l	3.48	2.84
Chromium	mg/l	<0.015	<0.015
Cobalt	mg/l	<0.015	<0.015
Copper	mg/l	0.016	0.013
Iron	mg/l	0.437	0.186
Lead	mg/l	<0.050	<0.050
Lithium	mg/l	<0.015	<0.015
Magnesium	mg/l	0.277	0.138
Manganese	mg/l	0.012	0.006
Molybdenum	mg/l	<0.030	<0.030
Nickel	mg/l	<0.020	<0.020
Phosphorus	mg/l	<0.30	<0.30
Potassium	mg/l	<2.0	<2.0
Selenium	mg/l	<0.20	<0.20
Silicon	mg/l	0.408	0.348
Silver	mg/l	<0.015	<0.015
Sodium	mg/l	839	25.7
Strontium	mg/l	0.036	0.014
Thallium	mg/l	<0.10	<0.10
Tin	mg/l	<0.30	<0.30
Titanium	mg/l	0.012	<0.010
Tungsten	mg/l	<0.10	<0.10
Vanadium	mg/l	<0.030	<0.030
Zinc	mg/l	0.048	0.051
Oil and Grease	mg/l	<5	<5
Chemical Oxygen Demand	mg/l	78	<20
Dissolved Organic Carbon	mg/l	1.83	0.78

The stormwater from this facility is not regulated. Using the Outfall 1 pollutant limits as a comparison, the stormwater samples were within the permit limits for pH, total suspended solids, total copper and total nickel. The zinc concentrations of 0.048 mg/l and 0.051 mg/l were greater than the permit limit of 0.02 mg/l. However, these zinc concentrations were substantially less than the median zinc concentrations of 0.14 mg/l for residential and 0.23 for commercial areas identified in the USEPA's Nationwide Urban Runoff Program.

Presented in the following table is a summary of the common stormwater pollutants for this facility and the USEPA Part 2 group application stormwater data from this industrial category.

Site No. 19 and USEPA Part 2 Industrial Inorganic Chemical Industry (Chlor-Alkali) Stormwater Summary				
Parameters (mg/l)	**Site No. 19 Sample 001 Grab Sample**	**Site No. 19 Sample 002 Grab Sample**	**USEPA Part 2 Median Grab Sample**	**USEPA Part 2 95th Percentile Grab Sample**
pH (s.u.)	7.18	7.38	5.4 (minimum)	10.4 (maximum)
Total Suspended Solids	18	4	99	790
Total Kjeldahl Nitrogen	0.17	0.12	4.1	132.0
Total Phosphorus	0.014	0.033	0.3	6.6
Oil and Grease	<5	<5	0.1	18.0
Chemical Oxygen Demand	78	<20	80.0	350.0

Comparison of the two sets of stormwater data shows that stormwater pollutants from this facility were substantially lower than the USEPA Part 2 median and the 95th percentile values for all pollutants.

Presented in the following table is a summary of the applicable stormwater pollutant parameters for this chlor-alkali plant (Site No. 19) and the Canadian Water Quality Guidelines for freshwater aquatic life.

Site No. 19 and Canadian Water Quality Guidelines for Freshwater Aquatic Life			
Parameters (mg/l)	**Site No. 19 Sample 001 Grab Sample**	**Site No. 19 Sample 002 Grab Sample**	**Canadian Water Quality Guidelines for Freshwater Aquatic Life***
Aluminum	0.31	<0.20	0.1
Arsenic	<0.20	<0.20	0.05
Cadmium	<0.010	<0.010	0.0002
Chromium	<0.015	<0.015	0.02
Copper	0.016	0.013	0.002
Iron	0.437	0.186	0.3
Lead	<0.050	<0.050	0.001
Nickel	<0.020	<0.020	0.025
pH (s.u.)	7.18	7.38	6.5-9.0
Selenium	<0.20	<0.20	0.001
Silver	<0.015	<0.015	0.0001
Zinc	0.048	0.051	0.03

* Based on an assumed hardness of <60 mg/l as $CaCO_3$

As indicated by the table, aluminum, copper, iron (Sample 001), and zinc in the stormwater samples were higher than the Canadian guidelines for aquatic life.

3.6.17 Site No. 21 - Marine Cargo Handling Industry

This bulk commodity handling facility collects and treats process washwater and stormwater from the open stockpile area. The combined flow is treated by gravity settling and pH neutralization. Treated effluent is discharged to the city sewer system. The site is graded and curbed to prevent off-site migration of contaminated stormwater from the facility.

Because of the stormwater/washwater collection system, samples containing both stormwater and washwater were collected. Water samples were collected from the primary and secondary ponds. Sample 001 was collected from the influent area of the primary pond; Sample 002 was collected from the influent area of the secondary pond; and Sample 003 was collected from the wet well after pH neutralization.

Presented in the following table are the results of the pond treatment system effluent samples.

Site No. 21 - Marine Cargo Handling Industry: Stormwater Samples				
Parameters	**Units**	**Sample 001 Grab Sample**	**Sample 002 Grab Sample**	**Sample 003 Grab Sample**
Temperature	^0C	10	10	10
pH	s.u.	2.24	2.25	5.87
Conductivity	µS/cm	2,530	2,260	977
Total Suspended Solids	mg/l	2	6	39
Total Alkalinity ($CaCO_3$)	mg/l as $CaCO_3$	<1.0	<1.0	8.4
Total Kjeldahl Nitrogen (N)	mg/l as N	0.61	0.49	0.39
Total Phosphorus (P)	mg/l as P	0.113	0.185	0.328
Aluminum	mg/l	3.39	6.94	8.50
Antimony	mg/l	<0.20	<0.20	<0.20
Arsenic	mg/l	<0.20	<0.20	<0.20
Barium	mg/l	<0.010	<0.010	<0.010
Beryllium	mg/l	<0.005	<0.005	<0.005
Bismuth	mg/l	<0.10	<0.10	<0.10
Boron	mg/l	<0.10	<0.10	<0.10
Cadmium	mg/l	<0.010	<0.010	<0.010
Calcium	mg/l	35.1	30.5	30.4
Chromium	mg/l	<0.015	<0.015	<0.015
Cobalt	mg/l	<0.015	<0.015	<0.015
Copper	mg/l	<0.010	0.015	0.014
Iron	mg/l	6.58	10.3	12.7
Lead	mg/l	<0.050	<0.050	<0.050
Lithium	mg/l	<0.015	<0.015	<0.015
Magnesium	mg/l	9.64	6.92	7.00
Manganese	mg/l	0.180	0.246	0.286
Molybdenum	mg/l	<0.030	<0.030	<0.030
Nickel	mg/l	<0.020	<0.020	<0.020
Phosphorus	mg/l	<0.30	<0.30	<0.30
Potassium	mg/l	3.4	2.5	2.2
Selenium	mg/l	<0.20	<0.20	<0.20
Silicon	mg/l	3.14	3.40	3.59
Silver	mg/l	<0.015	<0.015	<0.015
Sodium	mg/l	38.6	14.5	166
Strontium	mg/l	0.199	0.148	0.671
Thallium	mg/l	<0.10	<0.10	<0.10
Tin	mg/l	<0.30	<0.30	<0.30
Titanium	mg/l	0.030	0.043	0.050
Tungsten	mg/l	<0.10	<0.10	<0.10
Vanadium	mg/l	<0.030	<0.030	<0.030
Zinc	mg/l	0.234	0.205	0.207
Oil and Grease	mg/l	40	<5	<5
Chemical Oxygen Demand	mg/l	40	32	28
Dissolved Organic Carbon	mg/l	5.00	4.20	2.60

The water quality characteristics were similar for all three pond samples. The metals concentrations were either low or below detection. The major differences between final effluent (Sample 003) and the other two samples (Sample 001 and Sample 002) were the higher concentrations of total suspended solids and sodium in Sample 003. Caustic soda is used to neutralize the pH prior to discharge to the city sewer. The difference in sampling location accounted for the difference in total suspended solids concentrations. Sample 001 and Sample 002 were surface pond samples whereas Sample 003 was a well-mixed wet well sample.

Due to similarity of the water quality characteristics for the three pond samples, it was not possible to determine the removal efficiencies of the settling ponds.

Comparing these data with the stormwater data compiled by Gibb *et al.,* analytical results for the three samples were lower than the values reported for typical industrial facilities in the Lower Fraser Basin.

There is no USEPA Part 2 stormwater data submittal from the Marine Cargo Handling Industry.

Presented in the following table is a summary of the applicable stormwater pollutant parameters for this marine cargo handling facility (Site No. 21) and the Canadian Water Quality Guidelines for freshwater aquatic life.

Site No. 21 and Canadian Water Quality Guidelines for Freshwater Aquatic Life

Parameters (mg/l)	Site No. 21 Sample 003 Grab Sample	Canadian Water Quality Guidelines for Freshwater Aquatic Life*
Aluminum	8.50	0.1
Arsenic	<0.20	0.05
Cadmium	<0.010	0.0002
Chromium	<0.015	0.02
Copper	0.014	0.002
Iron	12.7	0.3
Lead	<0.050	0.001
Nickel	<0.020	0.025
pH (s.u.)	5.87	6.5-9.0
Selenium	<0.20	0.001
Silver	<0.015	0.0001
Zinc	0.207	0.03

* Based on an assumed hardness of <60 mg/l as $CaCO_3$

As indicated by the table, aluminum, copper, iron and zinc in the stormwater samples were higher than the Canadian guidelines for aquatic life. The pH of the effluent was below the lower range of 6.5 in the guidelines.

3.6.18 Site No. 23 - Light Industry (Industrial Park)

This is a multi-use industrial park with the following types of businesses:

- Offices;
- Retail food establishments;
- Small business;
- Food distributors;
- Food services;
- Warehouses; and,
- Light industries

Stormwater from this site is collected by a stormwater sewer system and is discharged to a slough leading to the Fraser River.

To monitor pollutant levels from this site, stormwater samples were collected from the slough at two different locations. The first location was upstream of the industrial site and represented the background condition of the stormwater prior to commingling with the stormwater from the industrial site. The second location was downstream of the stormwater sewer discharge culvert. Two sets of grab samples were collected for each site, one set was collected at a dry weather flow condition and a second set was collected during a storm event.

The following tables present the analytical results of the dry weather samples and the storm event samples.

Site No. 23 - Industrial Park: Dry Weather Samples			
Parameters	**Units**	**Background Grab Sample**	**Industrial Outfall Grab Sample**
Temperature	^{0}C	8	8
pH	s.u.	6.96	6.93
Conductivity	µS/cm	465	865
Total Suspended Solids	mg/l	49	31
Total Alkalinity ($CaCO_3$)	mg/l as $CaCO_3$	179	153
Total Kjeldahl Nitrogen (N)	mg/l as N	1.98	1.69
Total Phosphorus (P)	mg/l as P	0.372	0.244
Aluminum	mg/l	0.28	<0.20
Antimony	mg/l	<0.20	<0.20
Arsenic	mg/l	<0.20	<0.20
Barium	mg/l	0.044	0.057
Beryllium	mg/l	<0.005	<0.005
Bismuth	mg/l	<0.10	<0.10
Boron	mg/l	-	-
Cadmium	mg/l	<0.010	<0.010
Calcium	mg/l	43.5	43.6
Chromium	mg/l	<0.015	<0.015
Cobalt	mg/l	<0.015	<0.015
Copper	mg/l	<0.010	<0.010
Iron	mg/l	13.6	15.3
Lead	mg/l	<0.050	<0.050
Lithium	mg/l	<0.015	<0.015
Magnesium	mg/l	23.6	29.9
Manganese	mg/l	1.44	1.25
Molybdenum	mg/l	<0.030	<0.030
Nickel	mg/l	<0.020	<0.020
Phosphorus	mg/l	0.39	<0.30
Potassium	mg/l	6.5	6.3
Selenium	mg/l	<0.20	<0.20
Silicon	mg/l	-	-
Silver	mg/l	<0.015	<0.015
Sodium	mg/l	25.2	98.1
Strontium	mg/l	0.184	0.258
Thallium	mg/l	<0.10	<0.10
Tin	mg/l	<0.30	<0.30
Titanium	mg/l	0.019	<0.010
Tungsten	mg/l	<0.10	<0.10
Vanadium	mg/l	<0.030	<0.030
Zinc	mg/l	0.020	0.016
Oil and Grease	mg/l	<5	<5
Chemical Oxygen Demand	mg/l	36	43
Dissolved Organic Carbon	mg/l	14.8	11.0

Site No. 23 - Industrial Park: Wet Weather Samples			
Parameters	**Units**	**Background Grab Sample**	**Industrial Outfall Grab Sample**
Temperature	^{0}C	-	6
pH	s.u.	6.85	6.75
Conductivity	µS/cm	436	139
Total Suspended Solids	mg/l	29	12
Total Alkalinity ($CaCO_3$)	mg/l as $CaCO_3$	175	30
Total Kjeldahl Nitrogen (N)	mg/l as N	1.74	0.73
Total Phosphorus (P)	mg/l as P	0.292	0.109
Aluminum	mg/l	0.34	<0.20
Antimony	mg/l	<0.20	<0.20
Arsenic	mg/l	<0.20	<0.20
Barium	mg/l	0.030	<0.010
Beryllium	mg/l	<0.005	<0.005
Bismuth	mg/l	<0.10	<0.10
Boron	mg/l	-	-
Cadmium	mg/l	<0.010	<0.010
Calcium	mg/l	34.0	3.54
Chromium	mg/l	<0.015	<0.015
Cobalt	mg/l	<0.015	<0.015
Copper	mg/l	0.018	<0.010
Iron	mg/l	10.9	0.752
Lead	mg/l	<0.050	<0.050
Lithium	mg/l	<0.015	<0.015
Magnesium	mg/l	18.4	1.31
Manganese	mg/l	0.854	0.076
Molybdenum	mg/l	<0.030	<0.030
Nickel	mg/l	<0.020	<0.020
Phosphorus	mg/l	0.32	<0.30
Potassium	mg/l	4.8	<2.0
Selenium	mg/l	<0.20	<0.20
Silicon	mg/l	-	-
Silver	mg/l	<0.015	<0.015
Sodium	mg/l	26.4	8.5
Strontium	mg/l	0.143	0.014
Thallium	mg/l	<0.10	<0.10
Tin	mg/l	<0.30	<0.30
Titanium	mg/l	0.014	<0.010
Tungsten	mg/l	<0.10	<0.10
Vanadium	mg/l	<0.030	<0.030
Zinc	mg/l	0.030	0.036
Oil and Grease	mg/l	<5	<5
Chemical Oxygen Demand	mg/l	24	<20
Dissolved Organic Carbon	mg/l	11.7	5.70

For the dry weather samples, both the background sample and the industrial park outfall sample were similar in the stormwater quality. The major differences were the higher sodium concentration and higher conductivity level in the stormwater downstream of the industrial park outfall.

For the wet weather samples, the industrial park outfall sample was generally lower in pollutant concentrations than the background stormwater sample. This was due primarily to dilution effect. The flow rate in the drainage ditch at the background sampling location should always be less than the flow rate in the vicinity of the industrial park outfall.

For both sampling locations, the stormwater quality was in the same range or better than urban runoff data in either the British Columbia or the United States stormwater database.

Presented in the following table is a summary of the applicable stormwater pollutant parameters for this industrial park (Site No. 23) and the Canadian Water Quality Guidelines for freshwater aquatic life.

Site No. 23 and Canadian Water Quality Guidelines for Freshwater Aquatic Life			
Parameters (mg/l)	**Site No. 23 Background Grab Sample**	**Site No. 23 Industrial Outfall Grab Sample**	**Canadian Water Quality Guidelines for Freshwater Aquatic Life***
Aluminum	0.34	<0.20	0.1
Arsenic	<0.20	<0.20	0.05
Cadmium	<0.010	<0.010	0.0002
Chromium	<0.015	<0.015	0.02
Copper	0.018	<0.010	0.002
Iron	10.9	0.752	0.3
Lead	<0.050	<0.050	0.001
Nickel	<0.020	<0.020	0.025
pH (s.u.)	6.85	6.75	6.5-9.0
Selenium	<0.20	<0.20	0.001
Silver	<0.015	<0.015	0.0001
Zinc	0.030	0.036	0.03

* Based on an assumed hardness of <60 mg/l as $CaCO_3$

As indicated by the table, aluminum, copper, iron and zinc in the background ditch sample were higher than the Canadian guidelines for aquatic life. For the industrial outfall sample, iron was higher than the recommended value.

4º Stormwater Pollutant Loading Analysis

4.1 Introduction

Presented in this section is a planning-level assessment of stormwater pollutant loadings from selected industrial sites. Stormwater data, presented in Section 3, were used for this loading determination. The information may be used to project stormwater pollutants from similar industrial facilities.

Quantification of stormwater loadings is difficult. Pollutant loadings for a storm event can be determined only if representative composite stormwater samples can be collected, and acceptable storm flow measurements and/or estimations can be obtained. Furthermore, contaminant levels of surface runoff samples collected from the same locations can vary significantly within a storm event, between different storm events, and between different rainfall years.

For this study, 18 industrial sites representing 17 industrial sectors were sampled for stormwater runoff. Grab samples were collected for 17 industrial sites with composite grab samples collected from one site. Due to the non-point nature of runoff for many of these sites, these samples represented only a limited portion of the stormwater runoff. Among the 17 industrial sectors, pollutant loadings for the Light Industry Section were not developed because of the lack ofcritical technical information to conduct the necessary calculations.

Given the constraints of the stormwater sampling program, the surface runoff data should be interpreted with caution. Since pollutant loading values were based on very limited data, extrapolations of data from grab samples from one storm event to annual loading would be highly speculative and subject to large statistical error.

In addition to the stormwater sampling problems associated with quantifying annual or seasonal contaminant loadings, site-specific factors would also affect stormwater loadings to receiving waters. These site-specific factors that will influence stormwater quality from industrial facilities include:

- geographic features;
- hydrologic data;
- degree of surface imperviousness;
- industrial activities occurring at the facility;
- size of the facility;
- age of the facility;

- types and amounts of materials stored or used at the site; and,
- current waste and stormwater management practices.

Sources of pollutants other than stormwater, such as illicit connections, spills and improperly dumped materials, may increase pollutant loadings from an industrial facility.

Given the site-specific factors, the uncertainty would be magnified further if loading data for one industrial site were used to estimate stormwater loadings for the whole industrial sector.

4.2 Stormwater Runoff Projection

Annual stormwater runoff was estimated for each of the 17 selected industrial facilities using the "rational method". This method considers the annual precipitation, stormwater drainage area and the runoff coefficients for a particular site using the formula :

$$Q = CiA,$$

where

Q = the rate of runoff from an area;
C = runoff coefficient;
i = rainfall intensity; and,
A = the area of the drainage basin.

4.2.1 Hydrologic Data

The *Canadian Climate Normals, 1961-1990, British Columbia*, published by Environment Canada Atmospheric Environment Service, was used as the source of the annual precipitation data. These normals are based on a 30-year period of record; current published data are for the period 1961 to 1990. The precipitation data are averages for the 1961-90 period, or for a portion of that period no shorter than 20 years. These data, averaged over a long period of record, should eliminate the year-to-year variations.

For each industrial site, precipitation data were selected from a nearby gauging station. Precipitation is defined as the water equivalent of all types of precipitation. Annual precipitation data were used for industrial facilities that operate year-round. For industrial facilities that operate only at certain months of the year, the mean monthly precipitation data for the operating months were used to derive the average annual precipitation data used for the annual pollutant loading estimates.

4.2.2 Stormwater Drainage Area

Overall site area for each facility was determined by using either the site map provided by the participating facility or the site plan presented in the wastewater discharge permit.

The stormwater drainage area was derived from the overall plant area after considering:

- current stormwater management practices; and,
- stormwater sampling locations.

Stormwater drainage area for this loading analysis included only areas where stormwater pollution were of concern. Areas excluded from the stormwater drainage area included:

- roof and site areas where the stormwater runoff was uncontaminated and was diverted from the contaminated stormwater discharge; and,
- areas where stormwater was diverted to process treatment or the city sewer.

For many facilities, the stormwater drainage area was not known with any accuracy. Stormwater drainage area determination was constrained by inaccuracies in site maps and limited information on the drainage pattern. This inaccuracy in the stormwater drainage area greatly affects the total flow calculation and thereby, the pollutant loading values.

4.2.3 Surface Runoff Coefficient

The surface runoff coefficient is the partial amount of the total rainfall which will become runoff. Presented in Table 4.1 are typical runoff coefficients for a variety of land uses.

Table 4.1 Typical Runoff Coefficients

Description of Areas	Runoff Coefficients
Business	
• Downtown Areas	0.70 - 0.95
• Neighborhood Areas	0.50 - 0.70
Residential	
• Single-family Areas	0.30 - 0.50
• Multi-units, Detached	0.40 - 0.60
• Multi-units, Attached	0.60 - 0.75
Industrial	
• Light Areas	0.50 - 0.80
• Heavy Areas	0.60 - 0.90
Streets	
• Asphalt	0.70 - 0.95
• Concrete	0.80 - 0.95
• Brick	0.70 - 0.85
Drives and Walks	0.75 - 0.95
Roofs	0.75 - 0.95

A runoff coefficient of 0.9 was used for all industrial sites for the stormwater pollutant loading analysis. This value was based on the upper range of runoff coefficient for the Industrial: Heavy Areas land use category.

4.2.4 Annual Stormwater Runoff

Annual stormwater runoff was estimated for 17 selected industrial facilities using the "rational method". The results are presented in Table 4.2.

Table 4.2 Selected Industrial Sites - Precipitation Runoff

Site No.	Industrial Sector	Total Plant Area (m^2)	Drainage Area (m^2)	Annual Precipitation (mm/y)	Annual Runoff (m^3/y)
1	Meat and Meat Products (Abattoir)	3,600	1,000	1,850.5	$1.7x10^3$
4	Canned and Preserved Fruit and Vegetable	11,000	8,000	157.8	$1.2x10^3$
5	Frozen Fruit and Vegetable	50,000	50,000	881.6	$40x10^3$
7	Fluid Milk	23,000	10,000	1,514.6	$14x10^3$
8	Cane and Beet Sugar	49,000	19,000	1,854.2	$32x10^3$
9	Other food Products (Egg Processing)	30,000	8,000	1,701.4	$12x10^3$
10	Brewery Products	37,000	9,000	1,574.6	$13x10^3$
11	Sawmill and Planing Mill Products	8,000	8,000	1,574.6	$11x10^3$
12	Wire and Wire Products	150,000	6,000	1,574.6	$9x10^3$
13	Wire and Wire Products	46,000	40,000	1,574.6	$57x10^3$
14	Hydraulic Cement	107,000	107,000	1,574.6	$150x10^3$
15	Ready-Mix Concrete	22,000	11,000	1,482.2	$15x10^3$
16	Lime	45,000	45,000	1,995.5	$81x10^3$
17	Refined Petroleum Products (Bulk Storage)	220,000	220,000	1,908.9	$380x10^3$
18	Asphalt Manufacturing	17,000	17,000	1,574.6	$24x10^3$
19	Industrial Inorganic Chemical (Chlor-Alkali)	91,000	91,000	1,355.9	$110x10^3$
21	Marine Cargo Handling	470,000	470,000	1,908.9	$810x10^3$

4.3 Stormwater Pollutant Loading Projection

Stormwater runoff pollutant loadings were estimated by considering annual precipitation, stormwater drainage area, runoff coefficients and site-specific contaminant concentrations. This projection method assumes no seasonal variation in stormwater pollutant concentrations.

The annual pollutant loading values were normalized on the basis of the total plant area for each industrial site. This normalization method assumes:

- site area requirement is proportional to the production rate; and,
- stormwater pollutant loading is proportional to the site area.

The normalized loading values may be used to assess potential pollutant loadings for the respective industrial sector.

The use of site-specific loading data for the extrapolation of industrial sector-wide loading values should be limited only to planning purposes since loading values are greatly influenced by many site-specific factors (Section 4.1).

Presented in the following tables are site-specific estimates of stormwater pollutant loadings and area-normalized stormwater pollutant loadings for the 17 industrial sectors under consideration in this study.

The pollutant parameters evaluated were:

- total suspended solids;
- total Kjeldahl nitrogen;
- total phosphorus ;
- chemical oxygen demand
- oil and grease;
- copper;
- lead; and,
- zinc.

Table 4.2 Stormwater Pollutant Loading Projection

Site No.	Industrial Sector/Parameter	Stormwater Sample (mg/l)	Pollutant Loading (kg/y)	Pollutant Loading (kg/y/ha)
1	**Meat and Meat Products (Abattoir)**			
	• Total Suspended Solids	109	190	510
	• Total Kjeldahl Nitrogen	9.05	15	40
	• Total Phosphorus	1.69	3	8
	• Chemical Oxygen Demand	53	90	250
	• Oil and Grease	5	9	20
	• Copper	0.014	0.02	0.07
	• Lead	<0.05	<0.09	<0.2
	• Zinc	0.128	0.2	0.6)

Table 4.3 Stormwater Pollutant Loading Projection				
Site No.	**Industrial Sector/Parameter**	**Stormwater Sample (mg/l)**	**Pollutant Loading (kg/y)**	**Pollutant Loading (kg/y/ha)**
4	**Canned and Preserved Fruit and Vegetables**			
	• Total Suspended Solids	342	410	370
	• Total Kjeldahl Nitrogen	7.10	9	8
	• Total Phosphorus	3.92	5	4
	• Chemical Oxygen Demand	3,460	4,200	3,800
	• Oil and Grease	<5	<6	<5
	• Copper	0.307	0.4	0.3
	• Lead	0.054	0.06	0.06
	• Zinc	1.68	2	2

Table 4.4 Stormwater Pollutant Loading Projection				
Site No.	**Industrial Sector/Parameter**	**Stormwater Sample (mg/l)**	**Pollutant Loading (kg/y)**	**Pollutant Loading (kg/y/ha)**
5	**Frozen Fruit and Vegetables**			
	• Total Suspended Solids	27	1,100	220
	• Total Kjeldahl Nitrogen	2.31	90	20
	• Total Phosphorus	0.249	10	2
	• Chemical Oxygen Demand	174	7,000	1,400
	• Oil and Grease	<5	<200	<40
	• Copper	0.011	0.4	0.09
	• Lead	<0.050	<2	<0.4
	• Zinc	1.25	50	10

Table 4.5 Stormwater Pollutant Loading Projection				
Site No.	**Industrial Sector/Parameter**	**Stormwater Sample (mg/l)**	**Pollutant Loading (kg/y)**	**Pollutant Loading (kg/y/ha)**
7	**Fluid Milk**			
	• Total Suspended Solids	57	800	340
	• Total Kjeldahl Nitrogen	0.31	4	2
	• Total Phosphorus	0.059	0.8	0.4
	• Chemical Oxygen Demand	30	420	180
	• Oil and Grease	<5	<70	<30
	• Copper	<0.010	<0.1	<0.06
	• Lead	<0.050	<0.7	<0.3
	• Zinc	0.132	2	0.8

Table 4.6 Stormwater Pollutant Loading Projection

Site No.	Industrial Sector/Parameter	Stormwater Sample (mg/l)	Pollutant Loading (kg/y)	Pollutant Loading (kg/y/ha)
8	**Cane and Beet Sugar**			
	• Total Suspended Solids	304.5	9,700	2,000
	• Total Kjeldahl Nitrogen	4.58	150	30
	• Total Phosphorus	2.72	90	20
	• Chemical Oxygen Demand	245.5	7,900	1,600
	• Oil and Grease	11	350	70
	• Copper	0.067	2	0.4
	• Lead	0.058	2	0.4
	• Zinc	0.173	6	1

Table 4.7 Stormwater Pollutant Loading Projection

Site No.	Industrial Sector/Parameter	Stormwater Sample (mg/l)	Pollutant Loading (kg/y)	Pollutant Loading (kg/y/ha)
9	**Other Food Products (Egg Processing)**			
	• Total Suspended Solids	108.5	1,300	430
	• Total Kjeldahl Nitrogen	1.92	20	8
	• Total Phosphorus	0.271	3	1
	• Chemical Oxygen Demand	57	680	230
	• Oil and Grease	<5	<60	<20
	• Copper	0.017	0.2	0.7
	• Lead	<0.050	<0.6	<0.2
	• Zinc	0.068	0.8	0.3

Table 4.8 Stormwater Pollutant Loading Projection

Site No.	Industrial Sector/Parameter	Stormwater Sample (mg/l)	Pollutant Loading (kg/y)	Pollutant Loading (kg/y/ha)
10	**Brewery Products**			
	• Total Suspended Solids	89	1,200	310
	• Total Kjeldahl Nitrogen	4.03	50	10
	• Total Phosphorus	0.071	0.9	0.2
	• Chemical Oxygen Demand	107	1,400	380
	• Oil and Grease	5.5	70	20
	• Copper	0.023	0.3	0.08
	• Lead	0.054	0.7	0.2
	• Zinc	0.378	5	1

Table 4.9 Stormwater Pollutant Loading Projection

Site No.	Industrial Sector/Parameter	Stormwater Sample (mg/l)	Pollutant Loading (kg/y)	Pollutant Loading (kg/y/ha)
11	**Sawmill and Planing Mill Products**			
	• Total Suspended Solids	95	1,000	1,300
	• Total Kjeldahl Nitrogen	0.52	6	7
	• Total Phosphorus	0.071	0.8	1
	• Chemical Oxygen Demand	146	1,600	2,000
	• Oil and Grease	12	130	170
	• Copper	0.049	0.5	0.7
	• Lead	0.054	0.6	0.7
	• Zinc	0.104	1	1

Table 4.10 Stormwater Pollutant Loading Projection

Site No.	Industrial Sector/Parameter	Stormwater Sample (mg/l)	Pollutant Loading (kg/y)	Pollutant Loading (kg/y/ha)
12	**Wire and Wire Products**			
	• Total Suspended Solids	1,112.5	10,000	670
	• Total Kjeldahl Nitrogen	2.21	20	1
	• Total Phosphorus	0.94	8	1
	• Chemical Oxygen Demand	306	2,800	180
	• Oil and Grease	8.0	70	5
	• Copper	0.155	1	0.09
	• Lead	4.59	40	3
	• Zinc	16.2	150	10

Table 4.11 Stormwater Pollutant Loading Projection

Site No.	Industrial Sector/Parameter	Stormwater Sample (mg/l)	Pollutant Loading (kg/y)	Pollutant Loading (kg/y/ha)
13	**Wire and Wire Products**			
	• Total Suspended Solids	2.8	160	30
	• Total Kjeldahl Nitrogen	0.35	20	4
	• Total Phosphorus	0.32	20	4
	• Chemical Oxygen Demand	<20	<1,100	<240
	• Oil and Grease	<5	<290	<60
	• Copper	0.021	1	0.3
	• Lead	<0.050	<3	<0.6
	• Zinc	0.312	20	4

Table 4.12 Stormwater Pollutant Loading Projection

Site No.	Industrial Sector/Parameter	Stormwater Sample (mg/l)	Pollutant Loading (kg/y)	Pollutant Loading (kg/y/ha)
14	**Hydraulic Cement**			
	• Total Suspended Solids	551	83,000	7,700
	• Total Kjeldahl Nitrogen	0.31	50	4
	• Total Phosphorus	0.019	3	0.3
	• Chemical Oxygen Demand	99	14,900	1,400
	• Oil and Grease	<5	<750	<160
	• Copper	0.065	10	0.9
	• Lead	0.107	20	2
	• Zinc	0.30	40	4

Table 4.13 Stormwater Pollutant Loading Projection

Site No.	Industrial Sector/Parameter	Stormwater Sample (mg/l)	Pollutant Loading (kg/y)	Pollutant Loading (kg/y/ha)
15	**Ready-Mix Concrete**			
	• Total Suspended Solids	189	2,800	1,300
	• Total Kjeldahl Nitrogen	0.46	7	3
	• Total Phosphorus	0.345	5	2
	• Chemical Oxygen Demand	<20	<300	<140
	• Oil and Grease	6	90	40
	• Copper	0.035	0.5	0.2
	• Lead	<0.050	<8	<0.4
	• Zinc	0.076	1	0.5

Table 4.14 Stormwater Pollutant Loading Projection

Site No.	Industrial Sector/Parameter	Stormwater Sample (mg/l)	Pollutant Loading (kg/y)	Pollutant Loading (kg/y/ha)
16	**Lime**			
	• Total Suspended Solids	121	9,800	2,200
	• Total Kjeldahl Nitrogen	0.96	80	20
	• Total Phosphorus	0.038	3	0.7
	• Chemical Oxygen Demand	30	2,400	540
	• Oil and Grease	<5	<400	<90
	• Copper	<0.010	<0.8	<0.2
	• Lead	<0.050	<4	<0.9
	• Zinc	<0.005	<0.4	<0.09

Table 4.15 Stormwater Pollutant Loading Projection

Site No.	Industrial Sector/Parameter	Stormwater Sample (mg/l)	Pollutant Loading (kg/y)	Pollutant Loading (kg/y/ha)
17	**Refined Petroleum Products (Bulk Storage)**			
	• Total Suspended Solids	6	2,300	100
	• Total Kjeldahl Nitrogen	0.72	270	10
	• Total Phosphorus	0.026	10	4
	• Chemical Oxygen Demand	52	19,800	900
	• Oil and Grease	<5	<1,900	<90
	• Copper	<0.010	<4	<0.2
	• Lead	<0.050	<20	<0.9
	• Zinc	0.026	10	0.4

Table 4.16 Stormwater Pollutant Loading Projection

Site No.	Industrial Sector/Parameter	Stormwater Sample (mg/l)	Pollutant Loading (kg/y)	Pollutant Loading (kg/y/ha)
18	**Asphalt Manufacturing**			
	• Total Suspended Solids	144.5	3,500	2,000
	• Total Kjeldahl Nitrogen	0.47	10	7
	• Total Phosphorus	0.216	5	3
	• Chemical Oxygen Demand	97	2,300	1,400
	• Oil and Grease	7.5	180	110
	• Copper	0.014	0.3	0.2
	• Lead	<0.050	<1	<0.7
	• Zinc	0.085	2	1

Table 4.17 Stormwater Pollutant Loading Projection

Site No.	Industrial Sector/Parameter	Stormwater Sample (mg/l)	Pollutant Loading (kg/y)	Pollutant Loading (kg/y/ha)
19	**Industrial Inorganic Chemical (Chlor-Alkali)**			
	• Total Suspended Solids	11	1,200	130
	• Total Kjeldahl Nitrogen	0.15	20	2
	• Total Phosphorus	0.024	3	0.3
	• Chemical Oxygen Demand	49	5,400	600
	• Oil and Grease	<5	<550	<60
	• Copper	0.015	2	0.2
	• Lead	<0.050	<6	<0.6
	• Zinc	0.05	6	0.6

Table 4.18 Selected Industrial Sites - Stormwater Pollutant Loadings				
Site No.	**Industrial Sector**	**Stormwater Sample (mg/l)**	**Pollutant Loading (kg/y)**	**Pollutant Loading (kg/y/ha)**
21	**Marine Cargo Handling**			
	• Total Suspended Solids	39	32,000	670
	• Total Kjeldahl Nitrogen	0.39	320	7
	• Total Phosphorus	0.328	270	7
	• Chemical Oxygen Demand	28	23,000	480
	• Oil and Grease	<5	<4,100	<90
	• Copper	0.014	10	0.2
	• Lead	<0.050	<40	<0.9
	• Zinc	0.207	170	4

4.4 Stormwater Pollutant Loading Summary

Comparisons of normalized pollutant loadings for each stormwater pollutant parameter are presented in the following tables. The industrial sites/sectors are arranged in decreasing order of pollutant loading estimates.

To project the stormwater pollutants for an industrial sector, the plant areas (drainage areas) for all industrial sites within the industrial sector need to be quantified. Given the total plant area for a given industrial sector, the stormwater pollutant loadings can then be generated using the area-normalized pollutant loading data presented in Section 4.3. The resultant industrial sector stormwater pollutant estimates should only be used for planning purposes as discussed in Section 4.1.

The < “value”, as shown in the following tables, is calculated using the chemical parameter’s reported detection limit and represents the upper range of the stormwater pollutant loading to the receiving water.

4.4.1 Total Suspended Solids

The total suspended solids (TSS) loading data presented in Table 4.19 show a large range of values depending on the nature of the industrial activities and the site-specific stormwater/wastewater management practices.

The industrial sites/sectors with high TSS discharge potentials generally included industries with:

- outside storage of raw materials, by-products or finished products; and,
- outside manufacturing.

The industrial sites/sectors with similar activities that contributed to high suspended solids loadings in stormwater included:

- Hydraulic cement;
- Lime;
- Asphalt manufacturing;
- Sawmill and planing mill products; and,
- Ready-mix cement.

Due to the large volume of settled dust generated from the manufacturing, bagging and shipping operations, the hydraulic cement industry had the highest potential to discharge suspended solids to receiving waters.

Unlike the above listing of industries, the Cane and Beet Sugar industrial site/sector does not have outside storage of raw materials nor outside manufacturing. The high TSS loading for this industrial site may have been due to solids carried in from outside the plant area from the trucking activity.

The Marine Cargo Handling industrial sector normally would be considered as a major contributor to solids loadings to receiving waters. However, due to end-of-pipe stormwater treatment (gravity settling) implemented at Site No. 21, the TSS pollutant loading was substantially below other industrial sites/sectors with similar industrial activities. The TSS data from this site reinforced the importance of site-specific factors, including stormwater/wastewater management practices, in interpreting stormwater data.

Table 4.19 Stormwater Pollutant Loading - Total Suspended Solids

Site No.	Industrial Sector	Pollutant Loading (kg/y/ha)
14	Hydraulic Cement	7,700
16	Lime	2,200
8	Cane and Beet Sugar	2,000
18	Asphalt Manufacturing	2,000
11	Sawmill and Planing Mill Products	1,300
15	Ready-Mix Concrete	1,300
12	Wire and Wire Products	670
21	Marine Cargo Handling	670
1	Meat and Meat Products (Abattoir)	510
9	Other Food Products (Egg Processing)	430
4	Canned and Preserved Fruit and Vegetable	370
7	Fluid Milk	340
10	Brewery Products	310
5	Frozen Fruit and Vegetable	220
19	Industrial Inorganic Chemical (Chlor-Alkali)	130
17	Refined Petroleum Products (Bulk Storage)	100
13	Wire and Wire Products	30

4.4.2 Total Kjeldahl Nitrogen

The total Kjeldahl nitrogen loading data presented in Table 4.20 show a smaller range of values compared to TSS. The likely sources of Kjeldahl nitrogen were animal wastes for the Meat and Meat Products (Abattoir) industrial site/sector and ammonia disinfectants and detergents used in the Cane and Beet Sugar industrial site/sector.

In general, the food processing industry has the higher potential for discharging stormwater contaminated with organic nitrogen compounds. The sources of these nitrogenous compounds are either the raw materials or the chemicals used in process operations.

Table 4.20 Stormwater Pollutant Loading - Total Kjeldahl Nitrogen

Site No.	Industrial Sector	Pollutant Loading (kg/y/ha)
1	Meat and Meat Products (Abattoir)	40
8	Cane and Beet Sugar	30
5	Frozen Fruit and Vegetable	20
16	Lime	20
10	Brewery Products	10
17	Refined Petroleum Products (Bulk Storage)	10
4	Canned and Preserved Fruit and Vegetable	8
9	Other Food Products (Egg Processing)	8
11	Sawmill and Planing Mill Products	7
18	Asphalt Manufacturing	7
21	Marine Cargo Handling	7
13	Wire and Wire Products	4
14	Hydraulic Cement	4
13	Ready-Mix Concrete	3
7	Fluid Milk	2
19	Industrial Inorganic Chemical (Chlor-Alkali)	2
12	Wire and Wire Products	1

4.4.3 Total Phosphorus

The total phosphorus loading data presented in Table 4.21 are similar to the data set for total Kjeldahl nitrogen. Again, the food processing industry has the higher potential for discharging stormwater contaminated with organic phosphorus compounds. The sources of these phosphorus compounds are either the raw materials or the chemicals used in the process operations.

Table 4.21 Stormwater Pollutant Loading - Total Phosphorus

Site No.	Industrial Sector	Pollutant Loading (kg/y/ha)
8	Cane and Beet Sugar	20
1	Meat and Meat Products (Abattoir)	8
21	Marine Cargo Handling	7
4	Canned and Preserved Fruit and Vegetable	4
13	Wire and Wire Products	4
17	Refined Petroleum Products (Bulk Storage)	4
18	Asphalt Manufacturing	3
5	Frozen Fruit and Vegetable	2
15	Ready-Mix Concrete	2
9	Other Food Products (Egg Processing)	1
11	Sawmill and Planing Mill Products	1
12	Wire and Wire Products	1
16	Lime	0.7
7	Fluid Milk	0.4
14	Hydraulic Cement	0.3
19	Industrial Inorganic Chemical (Chlor-Alkali)	0.3
10	Brewery Products	0.2

4.4.4 Chemical Oxygen Demand

The chemical oxygen demand loading data presented in Table 4.22 show a large range of values depending on the nature of the industrial activities and the site-specific stormwater/wastewater management practices. The values range from a low of 180 kg/y/ha for the Wire and Wire Products industrial site/sector to a high of 3,800 kg/y/ha for the Canned and Preserved Fruit and Vegetable industrial site/sector.

Given that chemical oxygen demand is a measure of the oxygen equivalent of the organic matter content, the industrial sites/sectors with high discharge potentials generally included industries that use organic materials in process operations. With the exception of the Lime industrial site/sector, the organic compound-based industries comprised the major potential dischargers of organic compounds in the stormwater.

The source of the high chemical oxygen demand in the Lime manufacturing facility was not readily apparent.

Table 4.22 Stormwater Pollutant Loading - Chemical Oxygen Demand

Site No.	Industrial Sector	Pollutant Loading (kg/y/ha)
4	Canned and Preserved Fruit and Vegetable	3,800
11	Sawmill and Planing Mill Products	2,000
8	Cane and Beet Sugar	1,600
5	Frozen Fruit and Vegetable	1,400
14	Hydraulic Cement	1,400
18	Asphalt Manufacturing	1,400
17	Refined Petroleum Products (Bulk Storage)	900
19	Industrial Inorganic Chemical (Chlor-Alkali)	600
16	Lime	540
21	Marine Cargo Handling	480
10	Brewery Products	380
1	Meat and Meat Products (Abattoir)	250
9	Other Food Products (Egg Processing)	230
12	Wire and Wire Products	180
13	Wire and Wire Products	<240
14	Hydraulic Cement	<160
15	Ready-Mix Concrete	<140

4.4.5 Oil and Grease

As shown in the oil and grease loading estimates presented in Table 4.23, oil and grease in industrial stormwater was limited to facilities that use petroleum-based products extensively in the manufacturing process. For most industrial facilities, the oil and grease concentration in the stormwater was below detection.

Table 4.23 Stormwater Pollutant Loading - Oil and Grease

Site No.	Industrial Sector	Pollutant Loading (kg/y/ha)
11	Sawmill and Planing Mill Products	170
18	Asphalt Manufacturing	110
8	Cane and Beet Sugar	70
15	Ready-Mix Concrete	40
1	Meat and Meat Products (Abattoir)	20
10	Brewery Products	20
12	Wire and Wire Products	5
14	Hydraulic Cement	<160
16	Lime	<90
17	Refined Petroleum Products (Bulk Storage)	<90
21	Marine Cargo Handling	<90
13	Wire and Wire Products	<60
19	Industrial Inorganic Chemical (Chlor-Alkali)	<60
5	Frozen Fruit and Vegetable	<40
7	Fluid Milk	<30
9	Other Food Products (Egg Processing)	<20
4	Canned and Preserved Fruit and Vegetable	<5

4.4.6 Copper

Table 4.24 presents the stormwater loading estimates for copper. As shown in the table, the copper loadings for the industrial sites/sectors evaluated were relatively low. There was no one industrial site/sector that had a substantially higher discharge potential as compared to the remaining industrial sites/sectors.

Table 4.24 Stormwater Pollutant Loading - Copper

Site No.	Industrial Sector	Pollutant Loading (kg/y/ha)
14	Hydraulic Cement	0.9
9	Other Food Products (Egg Processing)	0.7
11	Sawmill and Planing Mill Products	0.7
8	Cane and Beet Sugar	0.4
4	Canned and Preserved Fruit and Vegetable	0.3
13	Wire and Wire Products	0.3
15	Ready-Mix Concrete	0.2
18	Asphalt Manufacturing	0.2
19	Industrial Inorganic Chemical (Chlor-Alkali)	0.2
21	Marine Cargo Handling	0.2
5	Frozen Fruit and Vegetable	0.09
12	Wire and Wire Products	0.09
10	Brewery Products	0.08
1	Meat and Meat Products (Abattoir)	0.07
16	Lime	<0.2
17	Refined Petroleum Products (Bulk Storage)	<0.2
7	Fluid Milk	<0.06

4.4.7 Lead

Table 4.25 presents the stormwater loading estimates for lead. With the exception of the discharge estimate from one Wire and Wire Products industrial facility (Site No. 12), the stormwater loading estimates were relatively low and are similar to the copper loading estimates presented in Table 4.24.

Site No. 12 manufactures wire products from purchased steel rod. Molten lead is used in the galvanizing process and was likelythe source of lead in the stormwater.

Table 4.25 Stormwater Pollutant Loading - Lead

Site No.	Industrial Sector	Pollutant Loading (kg/y/ha)
12	Wire and Wire Products	3
14	Hydraulic Cement	2
11	Sawmill and Planing Mill Products	0.7
8	Cane and Beet Sugar	0.4
10	Brewery Products	0.2
4	Canned and Preserved Fruit and Vegetable	0.06
16	Lime	<0.9
17	Refined Petroleum Products (Bulk Storage)	<0.9
21	Marine Cargo Handling	<0.9
18	Asphalt Manufacturing	<0.7
13	Wire and Wire Products	<0.6
19	Industrial Inorganic Chemical (Chlor-Alkali)	<0.6
5	Frozen Fruit and Vegetable	<0.4
15	Ready-Mix Concrete	<0.4
7	Fluid Milk	<0.3
1	Meat and Meat Products (Abattoir)	<0.2
9	Other Food Products (Egg Processing)	<0.2

4.4.8 Zinc

Table 4.26 presents the stormwater loading estimates for zinc.

Based on the average zinc concentration from two stormwater samples, the zinc loading for the Asphalt Manufacturing industrial site was 70 kg/y/ha. This high zinc loading estimate may have been attributed to zinc contaminated stormwater from the on-site road salt stockpiles. After eliminating the contribution from the road salt stockpiles, the zinc loading was reduced to 1 kg/y/ha. This value better reflects the industrial activities related to asphalt manufacturing. This normalized zinc loading estimate is reported in Table 4.16 and Table 4.26.

The table shows the Frozen Fruit and Vegetable industrial site had a high potential to discharge zinc in the stormwater. The high zinc loading estimate was contrary to the results obtained from other food processing facilities which had lower estimates. Since the sample from this industrial site contained both process cooling water and stormwater, the high zinc concentration may have been due to the contamination of the cooling water by process equipment.

A likely source of zinc in the stormwater from the Wire and Wire Products facilities was the galvanizing process.

Table 4.26 Stormwater Pollutant Loading - Zinc

Site No.	Industrial Sector	Pollutant Loading (kg/y/ha)
5	Frozen Fruit and Vegetable	10
12	Wire and Wire Products	10
13	Wire and Wire Products	4
14	Hydraulic Cement	4
21	Marine Cargo Handling	4
4	Canned and Preserved Fruit and Vegetable	2
8	Cane and Beet Sugar	1
10	Brewery Products	1
11	Sawmill and Planing Mill Products	1
18	Asphalt Manufacturing	1
7	Fluid Milk	0.8
1	Meat and Meat Products (Abattoir)	0.6
19	Industrial Inorganic Chemical (Chlor-Alkali)	0.6
15	Ready-Mix Concrete	0.5
17	Refined Petroleum Products (Bulk Storage)	0.4
9	Other Food Products (Egg Processing)	0.3
16	Lime	<0.09

5º Stormwater Best Management Practices

5.1 Introduction

Stormwater best management practices can be defined as schedules of activities, prohibitions of practices, maintenance procedures, operating procedures, management procedures, source control measures and treatment requirements that, when used either singly or in combination, prevent or reduce the discharge of stormwater pollutants to the receiving water.

In general, this broad class of BMP measures can be classified into two groups:

- Source control BMPs; and,
- Runoff control/treatment BMPs.

Source control BMPs are designed to prevent pollutants from entering stormwater by eliminating the source of pollution or preventing contact of pollutants with rainfall and runoff.

Runoff control/treatment BMPs are designed to either minimize the amount of pollutants in the stormwater or to remove pollutants contained in the stormwater runoff.

Source control BMPs are more desirable than runoff treatment BMPs because they prevent the formation of stormwater pollutants. Furthermore, source controls are often relatively simple to implement and maintain, are often less expensive than runoff treatments, and are applicable to a wide range of industries. Examples of source control BMPs include good housekeeping, preventive maintenance programs, spill prevention and emergency cleanup programs, covering waste piles, and bermed storage for oils and chemicals.

Runoff control/treatment BMPs are usually more costly to implement. They involve the collection of contaminated stormwater and the removal of contaminants from it before discharge. Examples of runoff control/treatment BMPs include site grading, curbing, oil/water separators and detention ponds.

Notwithstanding the many benefits inherent in source control BMPs, these measures alone will not eliminate the pollution of stormwater. Runoff treatment BMPs are still needed and should not be excluded from a comprehensive stormwater pollution control program. For some industrial facilities where source control BMPs are insufficient, runoff treatment, such as oil/water separators, may need to be considered as the next option.

5.2 Source Control Best Management Practices

Source control best management practices can be divided into two major categories. The first category, management BMPs, consists of schedule of activities, prohibition of practices, maintenance procedures, employee training, good housekeeping and other management practices that may be implemented at low costs. Frequently they are very effective in eliminating the source of pollution prior to its entry into stormwater runoff. The second category consists of best management practices that may require changes or additions to physical facilities or construction of pollution control devices (capital improvements). These capital improvement best management practices are generally more costly than procedural changes.

Presented in the following sections are descriptions of management and capital improvement BMPs and implementation methods/requirements applicable to the selected industrial sectors in the Lower Fraser Basin.

5.2.1 Management Best Management Practices

1. Good Housekeeping

Good housekeeping practices are designed to maintain a clean and orderly work environment. They consists of ongoing maintenance and cleanup of areas that may contribute pollutants to stormwater discharges. A clean and orderly work area reduces the possibility of accidental spills caused by mishandling of chemicals and equipment and the mixing of stormwater with pollutants. Some of the housekeeping practices are:

Operation and Maintenance

- Maintain dry and clean ground surfaces using brooms, shovels and vacuum cleaners.
- Regularly pick up and dispose of garbage and waste material.
- Ensure equipment is working properly.
- Conduct regular inspection of equipment for leaks.
- Conduct regular inspection of containers for deterioration and leaks.
- Clear clogged pipes or drainage inlets, or remove excessive growth from drainage ditches on-site to maintain proper operation.

Material Storage Practices

- Provide adequate aisle space to facilitate material transfer and access for inspections.
- Store containers in such a way as to allow for visual inspection for corrosion and leaks.
- Stack containers in a way to minimize the chance of tipping, puncturing or breaking.
- Store containers and drums away from traffic routes to prevent accidental spills.
- Provide containment structures for potentially toxic substances.

Material Inventory Procedures

- Identify all chemical substances present in the workplace.
- Label all containers; unlabeled chemicals are often disposed of improperly.

2. Preventive Maintenance

A comprehensive preventive maintenance program involves the regular inspection and testing of plant equipment and stormwater management devices. Timely inspection and maintenance of the stormwater drainage and treatment system should uncover conditions which could cause breakdowns that result in contamination of stormwater.

An effective preventive maintenance program should include the following elements:

- Identification of process equipment and stormwater facilities to inspect and conduct preventive maintenance.
- Schedule routine preventive maintenance inspections by trained personnel.
- Maintain equipment history cards on equipment location, characteristics and maintenance.
- Maintain a master preventive maintenance schedule.
- Ensure the availability of vendor maintenance manuals.
- Conduct timely adjustment, repair or replacement of equipment and systems.
- Maintain complete maintenance/repair history records.
- Maintain Material Safety Data Sheets for all substances/material on-site.

3. Spill Prevention and Emergency Cleanup

A spill prevention and emergency cleanup plan establishes preventive and cleanup procedures to minimize spills and leaks and their impact to the receiving environment. Spills and leaks, which together are one of the largest industrial sources of stormwater pollutants, are, in most cases, avoidable.

To reduce accidental releases, the facility needs to:

- identify areas (site plan) where potential spills can contribute pollutants to stormwater discharges;
- specify material handling procedures and storage requirements;
- provide notification procedures to be used in the event of a spill;
- provide detailed instructions on cleanup procedures; and,
- provide information on cleanup equipment and materials located at the site. The cleanup equipment and materials should be appropriate for the type and quantities of chemicals stored at the facility.

4. Employee Training/Awareness Building Programs

Employee training/awareness building programs should be designed to provide training for:

- proper materials handling, loading/unloading and transfer operations, to reduce waste and spills;
- emphasizing the importance of stormwater best management practices to the company's profitability and to the environment;
- use of properly designed tanks and vessels for storage of chemicals;
- detecting and minimizing material loss to air, land or water; and,
- emergency procedures to minimize lost materials during accidents.

5. Inspection and Record Keeping

Visual inspections should be conducted to confirm stormwater pollution control measures chosen are in place and working properly. A follow-up procedure should be implemented to ensure that appropriate action has been taken in response to the inspection. The facility should establish inspection reporting and record keeping procedures.

5.2.2 Capital Improvement Best Management Practices

1. Secondary Containment

Liquids (chemicals, solvents, lubricants or waste oil) in containers and tanks should be stored in designated locations. The storage area should be surrounded by curbs/dikes to provide secondary containment. The secondary containment system allows leaks to be detected more easily and holds the spill, keeping spill materials separated from the stormwater outside of the secondary containment area. It is an effective source control best management practice for above-ground liquid storage tanks and rail car or tank truck loading and unloading areas.

Containment Diking

Containment diking is a common type of secondary containment. The design considerations and operating requirements include:

- The enclosed volume should be the greater of either 10% of the total tank volume or 110% of the volume contained in the largest tank. Additional volume may be needed depending on the quantity of rainfall reaching the site. For rail car and tank truck loading and unloading operations, the enclosed area should be capable of holding an amount equal to any single tank truck compartment.
- Materials for the containment dike should be strong enough to safely hold spilled materials. The enclosed floor area needs to be covered with an impervious surface and sealed to prevent spills from contaminating groundwater. The paved floor should be sloped to a lined sump for collection of small spills.
- The sump may need to be cleaned frequently to minimize the contamination of stormwater. The materials for the dike and the floor should be compatible with the substance to be contained.
- Ideally, a roof-type structure should be placed over the secondary containment structure to minimize the collection of stormwater.
- During the wet season, accumulated uncontaminated stormwater should be released frequently.

Double-Wall Tanks

A double-wall tank is made up of two tanks, an inner tank (the primary containment) and an outer tank (the secondary containment). The secondary tank is 10% larger than the primary fluid-holding tank and is designed to retain any fluids should the primary tank leak.

Double-wall tanks are available from many manufacturers for many applications. Many double-wall tanks are equipped with overfill protection and leak detection systems. Common applications are for the storage of flammable liquids, used oil, used antifreeze and used solvents.

The British Columbia Ministry of Municipal Affairs, Recreation and Culture, Office of the Fire Commissioner, ruled that double-wall tanks and contained tank assemblies may be installed without the need for a conventional dike provided that:

- the interstitial space is vacuum monitored and emergency vented, or the interstitial space is accessible by means of a leak detection or monitoring tube for manual or continuous hydrocarbon sensor monitoring;
- monitoring is done on a regular basis and recorded; and,
- the tank is protected from vehicular impact by barriers.

These requirements are applicable for flammable liquids, including waste oil.

2. Hazardous Materials/Chemicals Storage Buildings

This best management practice should be followed for storing liquid feedstock, chemicals, used oil or accumulated wastes in containers outside a building, provided this practice is not in conflict with the Uniform Fire Code requirements.

The design considerations and operating requirements for chemical storage include:

- The storage building should incorporate curbing and a sealed floor to serve as secondary containment.
- The curbed volume should be the greater of either 10% of the total tank volume or 110% of the volume contained in the largest tank.
- The floor should be sloped to a sump for the collection of minor spills.
- The storage building should be secure to prevent unauthorized persons from accessing storage containers and causing spills.
- Special ventilation, temperature, and fire protection requirements should be provided where chemical stability or freezing protection are of concern.
- Incompatible or reactive materials should be separated and stored in separate containment areas to prevent the mixing of chemicals should spills occur.

Prefabricated storage buildings are available from many manufacturers. Commonly, these storage buildings are constructed of steel and coated for chemical and weather resistance. Secondary containment and other special requirements can be incorporated into these storage buildings for compliance with applicable fire codes and spill containment requirements.

3. Covering

This best management practice provides rain protection for materials, equipment, process operations or other industrial activities. It prevents stormwater from coming into contact with potential pollutants and reduces material loss due to wind. Tarpaulins, plastic sheeting, roofs, buildings and other enclosures are examples of coverings that are effective in preventing stormwater contamination.

Covering is appropriate for:

- outdoor material stock piles, especially for highly reachable materials (e.g. road salt);
- chemical/fuel storage areas;
- loading and unloading areas;
- waste management and storage areas; and,
- equipment and vehicle maintenance areas.

4. Drip-Pans

Drip-pans are used to contain very small leaks, drips and spills. This best management practice should be used:

- for open tanks/drums to contain minor spills and drips during transfer;
- at locations where spillage may occur, such as hose connections, hose reels, filler nozzles, valves and pipes; and,
- when making and breaking connections.

Drip-pans can be made of metals, plastic, depressions in concrete, asphalt or other material that does not react with the dripped chemicals. They are inexpensive and easily installed. Because drip-pans are designed to contain only small volumes, they require frequent inspection and cleaning. Inspections should also be conducted before forecasted rainfall events to remove accumulated materials, and immediately after storm events to empty stormwater accumulations.

5. Collection Basins/Sumps

Collection basins/sumps are permanent structures where large spills or contaminated stormwater are contained before cleanup/recycling or treatment. This source control best management practice is designed to receive and contain spills and prevent the release of these materials to the environment.

The collection basins/sumps should be sized to contain a certain amount of spill or a certain size storm, or both. The basins/sumps should be constructed of materials that are compatible with the spilled material(s).

6. Sweeping

This best management practice removes small quantities of dry solids from areas that are exposed to precipitation or stormwater runoff. The collected materials can be returned to the manufacturing process or properly disposed of. The removal of dry solids prevents the contamination of stormwater. To be effective, the contaminated areas should be swept regularly and before forecasted rainfall events to remove accumulated materials.

Sweeping can be done using brooms, mechanical sweepers or vacuum trucks. Site cleanup via washdown should be minimized because the washwater requires treatment prior to disposal.

Sweeping BMP is applicable for many industrial sites/sectors. It is generally inexpensive, requiring very little capital investment. Depending on the size of the site, sweeping may be labor intensive.

5.3 Runoff Control/Treatment Best Management Practices

Where source control best management practices to prevent stormwater pollution are insufficient, runoff control/treatment best management practices may also be required. Runoff control best management practices are designed to minimize the amount of pollutants in the stormwater or the volume of contaminated stormwater; runoff treatment best management practices are designed to remove the pollutants contained in the stormwater runoff.

Runoff control BMPs, depending on the size of the facility, are generally less expensive than runoff treatments. Examples of runoff controls include grading, curbing, paved surfaces and catch basins.

After implementation of runoff control BMPs, the contaminated stormwater may either be treated on-site, or off-site in a public wastewater treatment plant, prior to discharge to the receiving environment. On-site treatment systems encompass a wide range of technologies depending on the nature of the stormwater contaminants. They range from low cost systems, such as gravity settling, to higher cost systems, such as flocculation/coagulation. Off-site treatment of stormwater in a public wastewater treatment plant may be a low cost option provided approval is given by the local sewer authority.

Presented in the following sections are descriptions of the runoff control/treatment best management practices and implementation methods/requirements applicable to the selected industrial sectors in the Lower Fraser Basin.

5.3.1 Runoff Control Best Management Practices

1. Site Grading

The site surfaces should be graded to direct uncontaminated stormwater away from industrial activity areas that may contain pollutants. Grading should also be used to contain contaminated stormwater within industrial activity areas and divert them to treatment. This best management practice is appropriate for any industrial site that has outdoor processing activities and outdoor material storage areas that may contaminate stormwater runoff. Grading is often used in conjunction with other control measures, such as paving and curbing to direct and control stormwater flow.

Pooling of the stormwater in outdoor material storage areas may promote the leaching or dissolution of stockpiled materials, resulting in increased pollutant loadings of stormwater. To minimize the pooling of stormwater, open stockpile areas should be graded with a minimum slope of 1.5 percent.

Grading is an effective best management practice in limiting stormwater contact with contaminants. Depending on the size of the site, grading is relatively inexpensive and is easily implemented.

2. Site Paving

Paved surfaces prevent contaminated stormwater from percolating into soil and polluting the groundwater. Site paving BMP is often implemented along with site grading and curbing to control the flow and to collect stormwater from polluted industrial areas.

For paving an industrial area, the paving material considered should not react with the contaminants. For potential spill sites and chemical storage areas, concrete should be used instead of asphalt. Asphalt absorbs organic pollutants and can be slowly dissolved by some fluids, contributing to stormwater pollution. Depending on the size of the plant area, site paving BMP may be costly to implement.

3. Curbing

Curbing can be used to contain small spills, leaks and contaminated stormwater from reaching the receiving environment. Common materials for curbing include earth, asphalt, concrete, synthetic materials, metal or other impenetrable materials. Curbing is often implemented with grading and paving BMP.

Curbing can be placed around the chemical storage area to contain spilled materials and to prevent stormwater run-on. The curbed area may be graded toward a sump to allow for easier cleanup.

Curbing can be used at all industrial facilities. The following are examples of curbing applications at industrial facilities:

- To minimize off-site migration of contaminated stormwater, curbing should be placed along plant property boundaries.
- Curbing should be placed along the perimeter of the contaminated area to prevent the run-on of uncontaminated stormwater from adjacent areas and the runoff of stormwater from the contaminated areas.
- Curbing should be placed along the perimeter of the truck/equipment maintenance area to prevent the run-on of stormwater from outside the designated area. The stormwater within the designated area should be treated by an oil/water separator prior to discharge to the receiving water.

5.3.2 Runoff Treatment Best Management Practices

1. Public Wastewater Treatment Plant

Contaminated stormwater should not be discharged to the sanitary sewer system except under special condition defined by the local sewer authority or regulatory agency. An example special condition may be defined as the condition under which treatment by best available technology will not meet regulatory standards for discharging to receiving waters or will cause unreasonable financial burden.

For most localities, discharging stormwater to a public sanitary sewer requires approval of the local sewer authority. The allowable flow rate and contaminant concentrations may vary with the particular sewer system and local sewer authority. To give some indication of typical discharge limitations for contaminated stormwater, relevant sections of the Greater Vancouver Sewerage and Drainage District Sewer Use Bylaw No. 164 are summarized below.

- ♦ The discharge of Prohibited Waste into a sewer or sewage facility is disallowed. The following are designated as Prohibited Wastes:
    - Flammable or explosive waste
    - Waste causing obstruction or interference
    - Odorous waste
    - High temperature creating waste
    - Corrosive waste
    - Pathogenic waste.

- Subject to the Special Waste Regulation, the discharge of Special Waste into a sewer or sewage facility is disallowed. The following are designated as Special Waste:
    - PCB wastes
    - Wastes containing dioxin
    - Waste oil
    - Waste asbestos
    - Wastes containing pest control products
    - Leachable toxic waste
    - Waste containing tetrachloroethylene
    - Waste containing polycyclic aromatic hydrocarbon.

- The discharge of contaminated stormwater or cooling waste into a sanitary sewer requires prior authorization.

- The discharge of Restricted Waste into a sewer or sewage facility requires a valid waste discharge permit and is subject to discharge limits. The following are designated as Restricted Wastes:
    - Food waste
    - Radioactive waste
    - pH waste
    - Oil and grease waste
    - Suspended solid waste
    - Specified waste.

2. Catchbasins

Catchbasins can be used to link the stormwater conveyance system to the runoff treatment best management practice. For example, by installing large basins at various locations along the drainage way to allow the bulk of the sediments/solids to settle in these basins, the solids loadings to the treatment system can be decreased substantially. This will decrease overall treatment cost and will improve treatment performance.

A catchbasin should be cleaned if the depth of deposits are equal to or greater than 1/3 the depth from the basin to the invert of the lowest pipe into or out of the basin.

3. Oil/water Separators

Oil/water separators are specially constructed tanks that are installed between a drain and the pipe to the receiving water. These tanks prevent oil and sediments from being discharged into the environment. The tank design allows oil and grease to float to the surface where it can be recovered and recycled. Contaminated sediments settle to the bottom of the container.

The oil/water separator should be designed for a six-month, 24-hour storm and have a minimum separator surface area of 20 m^2/10,000 m^2 of the drainage area. One rule-of-thumb design criterion is the tank should be able to hold liquid for 45 minutes or have a 2.3 m^3 (600-gallon) treatment capacity, whichever is larger.

An oil/water separator should be cleaned before 8 cm (3 in.) of oil accumulates in the entry chamber.

4. Flow Equalization Basins

Flow equalization is used to balance the quantity and quality of the stormwater before treatment. Contaminated stormwater from diverse areas can be treated more effectively if the stormwater treatment system is operated at or near uniform hydraulic, organic and solids loading rates. Some runoff treatment processes are very sensitive to fluctuation of operating conditions.

Equalization basins can be manufactured from steel or concrete or may be excavated and lined or unlined. The basins should be designed to hold peak flows and be capable of discharging at a constant rate. Normally, equalization basins are designed based on the 10-year 24-hour storm event.

5. Detention Ponds

Detention pond best management practice utilizes a variety of mechanisms to remove pollutants from stormwater. The primary mechanism is the removal of particulate pollutants by gravity settling. Gravity settling alone is effective only for larger size fractions and for the non-colloidal fraction.

Detention ponds BMP which utilize a permanent pool of water are known as “wet” ponds. Wet ponds design considerations include:

- Pond volume equals the runoff volume from the design storm. The normal design storm for drainage systems is a 24-hour storm event with a return period of one in ten years.

- The maximum permanent pool depth should not exceed 1.8 m (6 feet) to maximize effectiveness and to prevent anaerobic conditions from developing. Under anaerobic conditions, pollutants which are normally bound in the sediment may be resolubilized and released back to the water. A minimum depth of 1 m (3 feet) is recommended so that resuspension of trapped pollutants is inhibited.
- Wet ponds should be multi-celled with at least two cells, and preferably three. To minimize short-circuiting, the ponds should be designed with a length-to-width ratio of at least 3:1 and preferably 5:1. The inlet and outlet should be at opposite ends of the pond, where feasible. If this is not possible, then baffles should be installed to increase the flow path and stormwater residence time.

The wet pond improves the removal efficiency of particulate pollutants by:

- dissipating the inflow energy of the stormwater as it enters the basin;
- preventing scour of material settled to the bottom; and,
- allowing exchange of incoming stormwater with previously-captured water, thus providing additional detention time between storms to settle pollutants.

6. Screening

Screening is a simple process to operate and maintain. It generally consists of simple mechanical equipment. Screening is commonly used by industries for removal of suspended solids from process wastewater and stormwater. For stormwater application, screening is limited to larger particle sizes, generally greater than 20-mesh.

7. Neutralization/pH Adjustment

Many industrial stormwaters are acidic or alkaline. Stormwater from fruit processing facilities is acidic due to the acidic nature of the fruit. Stormwater from cement, ready-mix concrete and lime facilities is alkaline.

Highly acidic or highly alkaline stormwater may need to be neutralized with either caustic or acidic chemical agents to minimize impacts to aquatic organisms.

The selection of acid to lower the pH of an alkaline stormwater is generally between sulphuric acid and hydrochloric acid. Sulphuric acid is the more common neutralizing agent because of its lower cost. Hydrochloric acid has the advantage of soluble reaction end products thus avoiding sludge handling problems.

To raise the pH of an acidic stormwater, several caustic agents may be used. The selection is usually limited to sodium hydroxide (caustic soda), sodium carbonate (soda ash) and lime compounds.

8. Chemical Precipitation

For industrial operations that have high concentrations of metals in the stormwater, chemical precipitation may be required to treat the stormwater prior to discharge to the city sewer or to the receiving water.

Chemical precipitation is a mechanism for removing dissolved metal ions and certain anions from wastewater. It is a complex process of at least two steps:

- Precipitation of the unwanted metals
- Removal of the relatively insoluble precipitate.

To minimize treatment cost, the facility should implement flow segregation and direct only the contaminated stormwater to treatment.

9. Coagulation and Flocculation

Stormwater from outdoor material stockpiles may contain high levels of suspended solids. These particulates vary in size, from less than 1 micron for colloids, to a few hundred microns for larger particles. Large particles can generally be removed from stormwater by gravity settling. However, gravity settling is not effective for the smaller size fractions and colloidal particles. For these cases, coagulation/flocculation to form larger aggregates is usually incorporated into the treatment system to enhance settling.

10. Biological Treatment

Stormwater from food processing facilities may contain high concentrations of organic materials. These organic materials may need to be reduced biologically prior to discharge to the city sewer or to the receiving water. In addition to the removal of organic materials, biological treatment can also significantly reduce toxic pollutants in the wastestream.

The most common types of biological treatment used in treating industrial wastewater and stormwater include:

- oxidation basins;
- aerated stabilization basins; and,
- activated sludge process.

Biological treatment is expensive to construct and operate. Unless the facility has the capacity to treat contaminated stormwater in an existing biological treatment system, it would be more cost effective to collect and discharge high organic content stormwater to the city sewer system. This option generally requires approval of the local sewer authority.

5.4 Best Management Practice Implementation Strategy Hierarchy

There are many BMP implementation strategies. The recommended hierarchical approach emphasizes implementation of source control BMPs. Lower in priority are runoff control/treatment BMPs

Table 5.1 presents the recommended hierarchical approach for the implementation of stormwater best management practices.

Table 5.1 Hierarchical Structure of Stormwater Management

Implementation Priority	Stormwater Management Method	Example General BMP Strategies
Highest	Source Control	**Elimination of Pollution Sources:** The elimination of a pollution source may be the most cost-effective way to control stormwater pollution. Example options for eliminating pollution sources include reducing on-site air emissions affecting runoff quality, changing chemicals used at the facility and recycling used oil.
	Source Control	**Elimination of Illicit Connections:** Illicit or unintentional connection of indoor drains to the storm drain, rather than to the sanitary or process sewer, is a significant source of stormwater pollution.
	Source Control	**Conduct Regular Maintenance of Loading/Unloading Areas:** Airborne dust and spillage are major sources of contaminants in the stormwater. Spilled materials should be reclaimed. Wet cleanup of spilled materials should be kept at a minimum. This is an example of good housekeeping BMP that should be incorporated as proper management practices.
	Source Control	**Enclosed or Covered Pollution Sources:** Enclosure or cover eliminates or minimizes the potential for the stormwater coming into contact with the pollutants.
	Runoff Control	**Segregate Contaminated Stormwater:** Segregating contaminated stormwater from uncontaminated stormwater may lower the treatment cost. Flow segregation may be accomplished by grading and/or curbing.
	Runoff Treatment	**Discharge Stormwater to Process Treatment System:** With the approval of regulatory agency, discharge contaminated stormwater to on-site process wastewater treatment system for treatment prior to discharge to the receiving water.
	Runoff Treatment	**Discharge Stormwater to Public Sanitary Sewer:** With the approval of the local sewer authority, discharge contaminated stormwater to a public treatment plant for treatment.
Lowest	Runoff Treatment	**Treat the Stormwater with a Stormwater Treatment BMP:** The treatment of stormwater with stormwater treatment devices (e.g., detention ponds) is the least preferred option due to low treatment efficiency. In addition, inadequate maintenance can reduce a system's expected efficiency.

5.5 Industrial Activities Best Management Practices

Although there are wide diversities in the types of production processes and the types of final products that are produced at the many industrial facilities located in the Lower Fraser River Basin, there are common industrial activities that can contribute to the stormwater pollution problem.

The USEPA, after evaluating the site and stormwater information submitted by industrial facilities in fulfillment of stormwater regulations, identified six common industrial activities as potential sources of stormwater pollution (Federal Register, 1993). These common industrial activities are:

- loading and unloading operations;
- outdoor storage of raw materials and products;
- outdoor process activities;
- dust or particulate generating processes;
- illicit/cross connections or management practices; and,
- waste disposal practices.

Presented in the following are recommended BMPs for these common industrial activities.

5.5.1 Loading and Unloading Operations

Materials enter and leave facilities via a number of different modes of transport, the most common being trucks, rail cars, barges and ships. Some loading and unloading operations are carried out inside the facility's operations building, but most often outdoors along facility access roads, railways and at truck docks and barge/ship terminals.

Typical loading and unloading operations include:

- pumping of chemicals or petroleum products from barges, trucks or rail cars to or from storage facilities;
- the transfer of bags, boxes, drums and pallets, by forklifts from trucks or rail cars; and,
- loading and unloading of dry bulk materials such as coal, grains, aggregates or mineral concentrates by trucks, dumpers and by continuous unloading equipment.

The risk to the stormwater quality from loading/unloading operations generally is dependent on several factors. These factors include:

- types of materials;
- types and conditions of the loading/unloading equipment ;
- extent of the loading/unloading areas exposed to rainfall;
- extent of the loading/unloading areas subjected to stormwater run-on; and,
- managerial practices.

Of the five factors identified, the most important factor is loading/unloading areas exposed to rainfall. For operations performed outdoors, spills and residual materials may be carried off-site by stormwater runoff to the receiving water. In addition to the materials themselves being sources of stormwater pollutants, the material-handling equipment also constitutes a major source of stormwater pollutants. The equipment may leak oil, fuel or other fluids and contribute to the pollutant loading in the stormwater.

The following tables present potential source control and runoff control/treatment best management practices for the loading and unloading activities at industrial facilities.

BMPs to Minimize the Impacts from Precipitation		
BMPs	**Advantages**	**Disadvantages**
Cover loading and unloading areas	Effective source control to prevent losses to wind and precipitation	Applicable only to truck and rail operations May be costly to install
Enclose material handling systems	Effective source control for spillage of materials and fluids/oil from equipment	May be costly to install and maintain
Cover materials entering and leaving the areas	Inexpensive source control to prevent losses to wind and precipitation	A labor-intensive practice
Install dust collection (e.g., bag house) for the material handling operations.	Effective source control for airborne particles Minimizes yard cleaning	May be costly to install and maintain May need to treat wastewater from wet dust collection systems

BMPs to Minimize the Impacts from Stormwater Run-on		
BMPs	**Advantages**	**Disadvantages**
Provide curbs or berms in the loading and unloading areas	Controls stormwater run-on/runoff Inexpensive and easily implemented Can recycle spilled materials within the curbed areas	Not effective to control losses to wind from curbed areas Requires timely removal of spilled materials, i.e., before rainfall or washdown May collect incompatible materials
Provide paved surfaces in the loading and unloading areas. The paving material needs to be suitable for the type of material that is transferred	Allows for easy cleanup and/or the collection of spilled materials	May be costly to re-grade and resurface large areas
Install dead-end sumps where spilled materials could be directed and collected	Prevents off-site migration of spilled liquid materials Inexpensive and easily implemented Can recycle spilled materials within the sumps	No applicable for dry materials Requires timely removal of spilled materials, i.e., before rainfall or washdown Requires covers or maintenance to prevent the collection of rain water
Confine loading and unloading activities to a designated area	Allows for quick and proper cleanup of spills	Not effective for large loading/ unloading operations
Use catch buckets, drip pans, drop cloths, and other spill prevention measures for the transfer of liquid products	Inexpensive and easily implemented Can recycle spilled materials	Applicable for small volumes only Requires maintenance and proper disposal practices

Managerial practices		
BMPs	**Advantages**	**Disadvantages**
Avoid loading and unloading materials in the rain if possible	Inexpensive alternative to covering the loading area	Not applicable to many industrial facilities
Schedule regular cleanup of the facility to remove spilled material and settled dust	Inexpensive and easily implemented	A labor-intensive practice Limited to dry materials
Periodically clean material handling equipment and vehicles to remove accumulated dust and residue	Inexpensive capital cost and easily implemented	A labor-intensive practice May generate wastewater requiring treatment
Schedule frequent inspections of material handling equipment for spills or leakage of fluids, oil, or fuel	Inexpensive capital cost and easily implemented	A labor-intensive practice
Close storm drains during loading/unloading activities in surrounding areas	Inexpensive and excellent pollution prevention measure	A site-specific measure
Develop and implement spill plans	Allows for quick and proper cleanup of spills	Requires proper plan development and updating
Inspect containers for leaks or damage prior to loading	Inexpensive capital cost and easily implemented	A labor-intensive practice

5.5.2 Outdoor Storage of Raw Materials and Products

For many facilities, raw and/or finished materials are frequently stockpiled outdoors and exposed to precipitation and stormwater runoff. These materials can contribute pollutants to stormwater when solids wash off or dissolve into the stormwater.

For the selected industrial sectors considered in this study, materials frequently stockpiled outdoors included coal, gravel, salt, sulfur, asphalt, wood chips, lumber and building products, metal products, junked vehicles, chemicals and petroleum products.

The risk to the stormwater quality from the outdoor storage of raw materials and products is generally related to:

- types of raw materials and/or finished products;
- extent of the materials subjected to stormwater run-on;
- types of treatment available for the stormwater runoff; and,
- managerial practices.

The most important parameter is the type of stockpiled material that is subjected to the physical and chemical actions of rain. Relatively benign materials, such as gravel and recycled asphalt, may only contribute to higher suspended solids concentrations in the stormwater. The impact to the receiving waters from these materials may be limited. However, stormwater runoff from more leachable or toxic materials will have greater adverse impacts to the receiving water.

Presented below are the potential source control and runoff control/treatment best management practices that can be applied for the control of stormwater contamination from the outdoor storage of raw materials and/or finished products.

BMPs to Minimize the Impacts from Precipitation		
BMPs	**Advantages**	**Disadvantages**
Store significant materials that may seriously contaminate stormwater in covered structures or inside covered areas	Effective source control measure to segregate stored materials from rainfall and stormwater run-on Prevents losses to wind and precipitation Eliminates the treatment of contaminated stormwater runoff	Costly to implement for large stockpiles
Place a temporary plastic sheeting over the material, such as salt stockpiles	Less costly than permanent structures and easily implemented	Depending on the durability of the covering material, this measure may require frequent inspection
Locate stored materials, away from drainage pathways	Reduces stockpiles exposure to stormwater	Does not eliminate the impacts of rainfall on the stockpiles
Pave the area where the materials will be stored and install curbing around the perimeter of the area	Effective source control measure to segregate the stored materials from stormwater run-on Effective for controlling stormwater runoff Inexpensive for small sites	Costly to implement for large industrial facilities Does not eliminate the impacts of rainfall on the stockpiles May need drainage system to remove accumulated stormwater from within curbed areas May need to treat stormwater Not applicable for liquid storage sites
Grade the storage area <u>Design Criteria:</u> A minimum slope of 1.5 percent	Minimum slope requirement is effective for controlling pooling of water and pollutants generated from the leaching of stockpiles	May be costly to regrade and resurface large areas

BMPs to Minimize the Impacts from Stormwater Run-on		
BMPs	**Advantages**	**Disadvantages**
Use double-wall tanks or provide secondary containment for permanent tanks for materials such as oils, solvents, chemicals and fuel Design Criteria: The secondary structure should provide sufficient containment for the larger of either 10 percent of the volume of all containers or 110 percent of the volume of the largest tank The floor within the containment needs to be covered with an impervious surface	Effective for containing spills, leaks from stormwater run-on and runoff Permits materials collected in dikes to be recycled Currently used/required for certain chemicals and liquid products	May be costly to implement Requires timely removal of spilled materials, i.e., before rainfall or washdown Requires covers or maintenance to prevent the collection of rain water inside the containment area Stormwater collected inside the containment area may need treatment
Install collection basin or storage basin for storage of large spills or contaminated stormwater prior to cleanup or treatment Design Criteria: Size the basin either to hold a certain amount of spill or a certain size storm, or both The normal design storm is the 24-hour storm event with a return period of one in ten years	Appropriate for areas with high spill potential Allows for quick and proper cleanup of spills Permits materials collected in the catchbasin to be recycled Can be used to equalize the contaminated stormwater flow to the treatment plant	Limited to industrial sites where space allows Requires timely removal of spilled materials, i.e., before rainfall or washdown Requires covers or maintenance to prevent the collection of rain water inside the containment area Stormwater collected inside the containment area may need treatment

BMPs to Minimize the Impacts from Stormwater Run-on (Continued)		
BMPs	**Advantages**	**Disadvantages**
Install oil/water separators for treating petroleum tank farm runoff Design Criteria: 6-month, 24-hour design storm, use flow restriction device to control larger storms Minimum separator surface area: 20 m^2/10,000 m^2 of the drainage area API-Separator Sizing Criteria: Horizontal velocity: 0.15 m/s Depth: 1 to 2.5 m Depth to width ratio: 0.3 to 0.5 Width: 2 to 5 m CPS-Separator Sizing Criteria: Rise rate: 0.01 m/min	Applicable for high oil and grease loadings API separator is suitable for oil droplets 150 microns in diameter or greater The Coalescing plate separator (CPS) is effective for oil droplets 60 microns in diameter or greater For same size oil droplets, the CPS separator requires 1/5 to 1/2 the space needed by the API separator	Requires frequent cleaning to remove accumulated oil and settled solids Requires frequent sweeping of the drainage area to remove sediments Not appropriate for spill control Not appropriate for drainage areas with sources of sediments
Install catchbasin or sedimentation basin for contaminated stormwater	Inexpensive control measure to reduce solids in the stormwater	Limited to industrial sites where space allows Requires regular maintenance to remove accumulated settled solids Requires frequent sweeping of the drainage area to remove sediments
Store incompatible materials in separate containment areas	Prevents the mixing of chemicals in the event of spills Facilitates cleanup	May be costly for some industrial sites

Managerial practices		
BMPs	**Advantages**	**Disadvantages**
Confine material storage to designated areas	Allows for better response to spills and facilitates cleanup	May be labor intensive
Label and secure all containers	Inexpensive and easily implemented Allows for quick identification and correct response to spills	Requires frequent updating to ensure the labels are legible
Schedule regular cleanup of the storage areas to remove spilled materials and settled dusts	Inexpensive to implement Allows recycling of spilled materials	Labor-intensive practice Applicable only to small releases of dry materials
Release accumulated stormwater inside the secondary containment periodically	Maintains containment volume for future spills	Requires frequent inspection
Install overfill protection on storage tanks	Minimizes the risk of spills during transfer and loading	May be costly for some industrial sites
Tag and label valves to reduce human error	Inexpensive to implement	May require maintenance to ensure that labels are legible
Inspect all containers and piping system on a regular basis for deterioration to ensure leakage is not occurring	Inexpensive capital cost and easy to implement	Labor-intensive practice
Implement regular inventory of fluids	May be used to identify below-ground leaks	Requires frequent updating
Establish regular disposal schedule to minimize quantities of waste materials stored on-site	Minimizes sources of stormwater pollutants	May increase disposal cost for some industrial sites
Maintain an emergency spill response and cleanup plan	Allows for better response to spills and facilitates cleanup	Requires updating

5.5.3 Outdoor Process Activities

Many industrial facilities conduct manufacturing activities in areas exposed to precipitation. Outdoor manufacturing activities can result in losses of raw/finished materials, chemicals or fuel to the surrounding areas. For the industrial sectors under consideration in this study, outdoor industrial activities included asphalt manufacturing, concrete mixing, sand and gravel operations and dry bulk terminal operations. These operations may contribute to higher concentrations of suspended solids, dissolved solids, and oil and grease in the stormwater runoff. The pH of stormwaters from these operations may also be affected. Common to many industrial facilities, outdoor maintenance of equipment and vehicles may also contribute to the lowering of stormwater quality.

Similar to the outdoor stockpiling of raw/finished materials, the extent an outdoor manufacturing activity is impacting the stormwater quality and the receiving water is highly influenced by the types of materials produced at the site. To reduce the pollution potential of the stormwater coming into contact with the raw/finished materials, the facility should first evaluate changing the manufacturing process to curtail pollutant formation and/or discharge. If the preferred process modification option is not possible or is cost prohibitive, alternate options, such as covering the manufacturing area, should be considered.

Presented below are the potential source control best management practices that can be applied for the control of contamination of stormwater from outdoor activities at industrial facilities.

BMPs to Minimize the Impacts of Precipitation		
BMPs	**Advantages**	**Disadvantages**
Alter or change the activity so that pollutants are not discharged	May effect overall cost saving by eliminating or reducing the treatment of contaminated stormwater	Option may not be available or costly to implement for some industrial sites
Enclose, cover or contain industrial activities to the maximum extent practical to prevent solid materials from reaching storm sewers or receiving water	Eliminates or minimizes the potential for the stormwater coming into contact with the pollutants	Costly to implement for large industrial process areas
Segregate the operations or processes that will generate the most significant sources of stormwater pollution at the site	Decreases the volume of contaminated stormwater that may require treatment	Option may not be available or costly to implement for some industrial sites
Grade the outdoor process activities areas to divert stormwater flow	Minimizes stormwater run-on	May be costly to regrade and resurface large areas Does not eliminate the impact of rainfall on the process areas

BMPs to Minimize the Impacts of Outdoor Activities		
BMPs	**Advantages**	**Disadvantages**
Use drip-pans under all vehicles and equipment undergoing maintenance	Inexpensive and easily implemented Can recycle spilled materials	Applicable for small volumes only Requires maintenance and proper disposal
For vehicle and equipment washing, berm the designated cleaning area	A low-cost source control measure if the washwater can be discharged to a treatment plant	May be costly to construct a vehicle washing facility to recycle washwater May need to treat washwater

Managerial practices		
BMPs	**Advantages**	**Disadvantages**
Avoid some high stormwater pollution potential activities in adverse weather conditions	If it is possible, a no-cost source control measure	May not be possible for many industrial sites
Avoid solvent washing of parts outside	Low cost and easily implemented	Need to provide parts-washing container
Have cleanup materials nearby	Allows for easy cleanup of spilled materials	Requires knowledge to choose the best cleanup material
Schedule regular cleanup of the manufacturing areas to remove spilled material and settled dust	Common industrial practice Easily implemented	Labor-intensive practice

5.5.4 Dust or Particulate Generating Processes

Dust controls may be needed on industrial sites to minimize the contamination of stormwater by stack emissions, process dusts or fugitive emissions from commodity stockpiles that settle on plant surfaces. Stormwater from primary and secondary metals manufacturing facilities, such as wire and wire products facilities, may contain elevated concentrations of metals due to air emission deposition. Other industrial sites, such as cement manufacturing and sand and gravel operations, may generate significant levels of dust, resulting in higher concentrations of suspended solids in the stormwater discharges.

BMPs for dust control, in the order of preference, can be categorized as measures that:

- eliminate the emission of dust;
- minimize the accumulation of dust in the stormwater drainage areas; and,
- remove the pollutants from the dust-contaminated stormwater.

Presented below are potential BMPs for controlling dust from material handling, process and transfer areas.

BMPs to Minimize the Impacts of Airborne Particles		
BMPs	**Advantages**	**Disadvantages**
Install and maintain dust collection systems, such as vacuum systems, or baghouse and cyclone, or filter systems, to collect airborne particles generated in the manufacturing processes	May already be required by air regulations Effective for decreasing stormwater pollution from deposition of airborne particles	Expensive to install and maintain
Clean around vents and stacks from process and storage areas	Inexpensive capital cost to implement Decreases stormwater pollution from deposition of airborne particles	Labor-intensive practice
Install water sprays on open stockpiled commodities for dust control	Common industrial practice Reduces the air transport of dust	Dust-contaminated waters may require treatment prior to discharge to the receiving water
Route overflow/condensates from process vents to on-site treatment system or to the sanitary sewer	May already be required by waste water regulations	Requires retrofitting plant piping system
Use sweepers regularly around the site to clean up fugitive dust; vacuum sweepers are more effective on dry paved areas	Common industrial practice May allow for recycling of collected materials	Labor and equipment intensive May not be effective for all pollutants
Route contaminated stormwater from stack and baghouse areas to wastewater treatment plant for treatment	Provides end-of-pipe treatment for only the contaminated flows Reduces treatment requirement	May need site grading to segregate uncontaminated flow from contaminated flow May require flow equalization to offset the increased flow to the treatment plant Increases wastewater treatment cost

5.5.5 Illicit/Cross Connections or Management Practices

Illicit connections or inappropriate management practices may result in non-stormwater discharges, such as liquid waste, to stormwater sewer systems. Non-stormwater liquid waste materials discharged to the stormwater sewer system are likely due to improper or cross connections between the wastewater system and the stormwater sewer system; improper disposal practices; and spills or leakage from storage tanks and transfer areas.

The potential for stormwater contamination due to illicit/cross connections generally can be related to the age of the facility, and to the types and numbers of liquid waste streams discharged from the facility. Plant records for older industrial facilities are often not available or are incomplete. As such, the likelihood of improper connections for these facilities increases with each plant modification. Similarly, due to the complexity of the piping network, illicit connections are more common at facilities with many types of liquid waste streams, such as process wastewaters, cooling waters and rinse waters.

Presented below are BMPs designed to identify the illicit/cross connections and to minimize the occurrence of illicit/cross connections at industrial sites.

BMPs to Identity and Eliminate Illicit/Cross Connections or Improper Management Practices		
BMPs	**Advantages**	**Disadvantages**
Evaluate site drainage maps to identify sources of improper discharges	Low-cost preliminary study	May not be able to identify illicit connections from maps
Visual inspection of all discharge points during dry weather for odors, discolorations, abnormal flows or conditions	Low-cost preliminary study	Cannot distinguish improper plant discharges from groundwater flows
Perform smoke or dye testing to determine if interconnections exist between the wastewater collection system and the stormwater collection system	Commonly used to identify plumbing connections Can be used to identify plant flows from groundwater flows	Costly to implement for large industrial sites
Plug floor drains where it is unknown whether the connection is to the stormwater sewer or to wastewater sewer systems	Inexpensive source control measure	Applicable only if the floor drains are not needed
Update and correct facility piping schematics to accurately reflect all plumbing connections based on information found during inspections	Information is available for other plant applications	Costly to implement for large industrial sites
Do not pour liquid waste down floor drains, or outdoor drains connected to the stormwater sewer system	Required to comply with environmental regulations for certain chemicals	Requires strict compliance by employees to be effective Needs to provide proper disposal options
Install a safeguard against plant washdown water and vehicle washwater entering the stormwater sewer	A low-cost source control measure if the washwater can be discharged to the treatment plant	May be costly to construct a vehicle washing facility Washwater may require treatment
Maintain and inspect the integrity of all underground storage tanks	Prevents the loss of materials to the groundwater and to the sewer system	May be costly to implement for large industrial sites

5.5.6 Waste Disposal Practices

Many industrial facilities conduct some waste management activities on-site. Commonly, these activities are conducted outdoors. For the selected industrial sectors under consideration in this Guide, these activities included:

- treatment of process wastewater;
- land disposal of treated effluent;
- on-site storage of solid wastes; and,
- on-site storage of liquid wastes.

These waste management activities are similar in nature to the outdoor storage of raw material and product and outdoor process activities discussed in Section 5.5.2 and Section 5.5.3, respectively. Therefore, the risk to the stormwater quality associated with the waste management activities is also similar. Namely, the risk factors are:

- the types of materials stored on-site; and,
- the extent to which these materials are exposed to the physical and chemical actions of the stormwater.

The preferred stormwater BMP is to change the manufacturing process so that pollutants are not created and discharged, thus eliminating the need for waste treatment. If this option is not possible or is cost prohibitive, other alternate management practices, including measures that minimize the exposure to precipitation and stormwater runoff, should be considered.

The following BMPs are recommended to prevent the contamination of stormwater from the industrial waste disposal activity.

BMPs to Minimize Pollution from Waste Disposal Practices		
BMPs	**Advantages**	**Disadvantages**
Institute industrial waste source reduction and recycling	May effect overall cost saving by reducing or eliminating waste treatment cost	Some industrial processes may not be amenable or would be costly to change
Move waste management activities indoors and cover waste piles to prevent stormwater run-on	Eliminates or minimizes stormwater contact with the waste materials	May be costly to implement for large industrial sites
Grade or curb the waste management areas	Minimizes the stormwater run-on	May be costly to regrade and curb large areas Does not eliminate the impacts of rainfall on the waste management areas Accumulated stormwater in the curbed areas may require treatment
Inspect waste management areas for leaking containers, uncovered waste piles	Inexpensive and easily implemented	Labor-intensive practice
Grade the land disposal sites	Minimizes the runoff of contaminated stormwater to the receiving waters	May be costly to regrade the disposal sites
Avoid land disposal when it is raining or when the ground is frozen or saturated with water	Commonly practiced per waste water discharge permits	May need to increase the size of the wastewater storage system
Maintain adequate barriers between the site for land application and the receiving waters	May offset the grading requirement	May not be possible for some disposal sites

6.0 Stormwater BMPs Cost Estimating Guide

6.1 Introduction

The objective of this section is to provide basic cost information to enable the plant personnel to derive a budget for implementing various best management practices. For the purposes of estimating alternatives, an approximate estimate is usually sufficient. For construction or bid purposes, the plant personnel will need to prepare detailed estimates.

Detailed estimating information is beyond the scope of this report as there are many variables that influence cost estimating including:

- costs of construction materials;
- equipment;
- labor rate from one locality to another; and,
- time of construction.

6.2 Site-Specific Conditions

The costs of implementing stormwater best management practices are influenced significantly by many factors. In general, many of the source control measures that do not require physical changes (capital improvements) are relatively low in cost when compared with runoff treatment systems. For example, in the case of management process/procedure BMPs, implementation usually involves only changes in management practices with minor increase in cost. For other BMPs, including capital improvement BMPs, the implementation costs cannot be easily determined and are dependent on many site-specific conditions. These site-specific conditions include:

- location of the facility;
- size of the facility;
- age of equipment and facility;
- types and amount of materials stored or used;
- types of waste materials generated;
- types of contaminants and levels;
- types of industrial activities; and,
- current waste and stormwater management practices.

Presented in the following are examples illustrating the effects of site-specific conditions on the selection of stormwater BMPs and the implementation costs.

Good Housekeeping - Ground Maintenance

Ground maintenance to remove small quantities of dry chemicals and dry solids from areas that are exposed to precipitation or stormwater is an effective source control measure. Cleanup can be accomplished by manual sweeping, sweeping with mechanical devices or water washdown. Generally, manual sweeping is the recommended control measure and is the least expensive option. Higher in cost are mechanical sweeping and washdown cleanup. Washdown cleanup, in many cases, is the most expensive option since the washwater may require treatment. Treatment may be accomplished by an on-site system or by discharging the contaminated washwater to the city wastewater treatment plant. The discharge of washwater to a public sanitary sewer may require prior authorization of the local sewer authority or regulatory agency.

For a small site, manual sweeping is the recommended and least costly option. The next higher cost option is mechanical sweeping. Depending on the size of the site and the travel distance, mechanical sweeping services generally cost between $200 to $300 per visit. Further up the cost scale is washdown cleanup. For washwater treatment, discharging to the city sewer is the lower cost option than on-site treatment.

For a larger site, mechanical sweeping is the recommended and least costly option. The manual sweeping option may require employing full time staff whereas mechanical sweeping can accomplish the same task in a few hours.

Even though dry cleanup is the recommended control measure, it may not be the appropriate ground maintenance option for facilities limited by the characteristics of the spilled materials or on-site process equipment. For these facilities, washdown may be the only viable and, thereby the more costly, ground maintenance option.

Preventive Maintenance Program

The cost of implementing a preventive maintenance program depends on many site-specific conditions. These conditions are: the size of the facility, the age of equipment and facility and the nature of the plant operations. Preventive maintenance programs for larger facilities will cost more than for smaller facilities. Similarly, older facilities/equipment will require more frequent maintenance than newer facilities/equipment.

Structural Stormwater Controls - Stormwater Flow Segregation

Stormwater flow segregation can eliminate or minimize the contamination of stormwater. Flow segregation can be accomplished via surface pavement and berming. These costs, in general, are substantially smaller than runoff or end-of-pipe treatment.

Stormwater flow segregation can be integrated into the design of new facilities and therefore can be implemented at lower cost than for existing facilities. In addition to higher costs, retrofitting existing facilities may be difficult to implement and may also be ineffective.

6.3 Best Management Practices Cost Summary

Presented in this section is a cost summary of selected stormwater best management practices. These stormwater BMPs are applicable for a wide variety of manufacturing businesses including the specific industrial sectors evaluated in this report. In keeping with the BMPs classifications used in Section 5, the cost information is categorized into the two broad classes of BMPs:

- Source control; and,
- Runoff control/treatment.

6.3.1 Source Control Best Management Practices

Presented in the following table are the unit costs for selected source control best management practices. The cost information has been compiled/derived from:

- vendors/suppliers;
- *Means Building Construction Cost Data; and,*
- in-house Lower Mainland construction cost data.

Table 6.1 Source Control Best Management Practices - Cost Summary			
Item	**Description**	**Unit ($)**	**Rate**
	Spill Prevention and Emergency Cleanup		
1.0	**Absorbent Materials**		
1.1	Small Spill Kit (trucks or heavy equipment)	250	each
1.2	Medium Spill Kit (indoor or outdoor locations)	300	each
1.3	Large Spill Kit (industrial sites)	700	each

Table 6.1 Source Control Best Management Practices - Cost Summary (Continued)			
Item	**Description**	**Unit ($)**	**Rate**
	Secondary Containment		
2.0	**Curbing**		
2.1	Concrete Curb, 150 mm Barrier	45	/m
2.2	Concrete Curb, Small Area	220	$/m^2$
2.3	Concrete Containment Structure, 2 m x 2 m x 0.15 m ht.	400	each
2.4	Asphalt Curb, 150 mm Barrier	20	/m
2.5	Asphalt Curb, Small Area	100	$/m^2$
3.0	**Spill Pallet**		
3.1	Holds Two 55-Gallon Drums	450	each
3.2	Holds Four 55-Gallon Drums	650	each
3.3	Holds Two Intermediate Bulk Containers	2,500	each
4.0	**Covered Storage Unit**		
4.1	Holds Two 55-Gallon Drums	1,300	each
	Liquid/Chemical Storage		
5.0	**Flammable Liquid, Above-ground Double-wall Vacuum Monitored Tank**		
5.1	1,900 Litre (500 US Gallon) Tank (not including installation)	5,000	each
5.2	3,800 Litre (1,000 US Gallon) Tank (not including installation)	7,000	each
5.3	7,600 Litre (2,000 US Gallon) Tank (not including installation)	9,000	each
5.4	11,400 Litre (3,000 US Gallon) Tank (not including installation)	10,500	each
5.5	18,900 Litre (5,000 US Gallon) Tank (not including installation)	14,000	each
6.0	**Waste Oil Storage, Above-ground Double-wall Tank**		
6.1	500 Litre (132 US Gallon) Tank	2,800	each
6.2	1,000 Litre (264 US Gallon) Tank	3,500	each
6.3	1,500 Litre (396 US Gallon) Tank	3,900	each
6.4	2,000 Litre (528 US Gallon) Tank	4,200	each
6.5	2,500 Litre (660 US Gallon) Tank	4,700	each
7.0	**Chemical Storage Unit, Secured, Weather-proof Secondary Containment**		
7.1	One-piece Molded Polyethylene, 1.3 m x 1.3 m	3,000	each
7.2	Wood Framed c/w Fiberglass Roof, 2 m x 2 m, Concrete Containment	1,000	each
8.0	**Cover/Roof**		
8.1	Polyethylene Sheeting	3	$/m^2$
8.2	Corrugated Fiberglass Panels	45	$/m^2$
8.3	Shed Roof, Wood Framed c/w Plywood Roof	30	$/m^2$
8.4	Truck Dock, 20 m x 6 m Steel Structure with Concrete Footings	10,000	each
8.5	Covered Fuel Island, 5 m x 4 m, Roof Cover, Concrete Pad, Sump	5,000	each
9.0	**Sweeping**		
9.1	Sweeping Service (owner provides water and disposal site, not including travel time)	85	/hour

6.3.2 Runoff Control/Treatment Best Management Practices

Presented in the following table are the unit costs for selected source control best management practices. The cost information has been compiled/derived from:

- vendors/suppliers;
- *Means Building Construction Cost Data; and,*
- in-house Lower Mainland construction cost data.

Table 6.2 Runoff Control/Treatment Best Management Practices - Cost Summary

Item	Description	Unit ($)	Rate
	Runoff Control		
1.0	**Site Work**		
1.1	Clearing, Grubbing and Stripping	10	$/m^2$
1.2	Grading, Small Area	20	$/m^2$
1.3	Grading, Large Area	10	$/m^2$
1.4	Structural Fill	20	$/m^3$
2.0	**Paving**		
2.1	Concrete Paving (including granular base)	55	$/m^2$
2.2	Asphalt Paving (including granular base)	25	$/m^2$
3.0	**Curbing**		
3.1	Concrete Curb, 150 mm Barrier	45	/m
3.2	Asphalt Curb, 150 mm Barrier	20	/m
4.0	**Stormwater Conveyance**		
4.1	Open Ditch	30	/m
4.2	Pipeline (including pipe bedding)	125	/m
	Runoff Treatment		
5.0	**Catchbasin/Pond**		
5.1	Small, Open-top Catchbasin	400	each
5.2	Standard Precast Concrete with Grate	1,100	each
5.3	Concrete Retention Pond, 2 m Wide x 6 m Long x 2 m Deep	9,000	each
5.4	Concrete Retention Pond, 4 m Wide x 6 m Long x 2 m Deep	12,000	each
6.0	**Oil/Water Separator**		
6.1	Concrete Tank, 30 cu m Capacity (Including design and engineering cost)	25,000	each
6.2	Oil/Water Disposal	0.6	/litre

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