# THE DOWNSTREAM PETROLEUM SECTOR WATER CONSERVATION, EFFICIENCY AND PRODUCTIVITY (CEP) PLAN

**PREPARED BY EMS CONSULTING**
**FOR**
**THE CANADIAN PETROLEUM PRODUCTS INSTITUTE**
**MARCH 22$^{ND}$ , 2012**

# Table of Contents Page

# Acknowledgements

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**Statement of Disclaimer**



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# Executive Summary

The Canadian Petroleum Products Institute[8] (CPPI) is a national association representing the public policy interests of the downstream petroleum industry for all aspects of petroleum refining, distribution, transportation and marketing of petroleum products for transportation, home energy and industrial uses. Collectively, CPPI member companies operate 16 refineries representing 80 per cent of Canadian refining capacity and supply some 10,000 branded stations with transportation fuels across Canada.

The petroleum industry continues to be an economic contributor for Alberta and is a net exporter of refined petroleum products to the United States and other provinces.

This Conservation, Efficiency and Productivity (CEP) plan is being developed to provide information and direction to the various constituents within the petroleum sector. The CEP Plan will identify specific and quantifiable goals or targets for improving water use and achieving measurable outcomes. In addition, this plan is intended to provide the sector with an array of tools and mechanisms that will enable implementation and monitoring of CEP-related activities.

This CEP Plan covers three (3) refineries, one asphalt plant and a large number of marketing and distribution facilities in Alberta that are operated or managed by CPPI member companies.

The three refineries in Edmonton source their water from the North Saskatchewan River in accordance with their water licenses. The Husky asphalt plant in Lloydminster uses groundwater and municipal water for their operation. The vast majority of marketing operations typically draw water from a municipal system, and some located in rural areas use groundwater sources, however, the amount of water used in marketing operations is negligible compared with the amount used in refining operations.

Based on the current refinery utilization rates, the refining segment of the petroleum industry uses up to 60% of its allowable water usage under combined licenses allocated to them by Alberta Environment and Water.

Water is used in a refinery for a variety of purposes and approximately 40% of water diverted for refinery use is returned back to the river after being treated to a high quality. In marketing and distribution operations, water, for the most part, is used for sanitation purposes.

According to a recent study conducted for the North Saskatchewan Watershed Alliance, petroleum refineries are not among the top ten users of water. In fact, refineries are considered to be one of the lowest users of water among all industries in the province.

In accordance with the Alberta Water Council (AWC) guidelines, the downstream petroleum industry has selected the average of year's 2000 to 2002 water diversion as its **base year** which equates to total water diversion of 11.4 million $m^3$/year, and total water use of 7.4 million $m^3$/year.

Over the past decade, many environmental regulations related to petroleum product quality have resulted in re-configuration of refining operations and the addition of energy intensive units which have added a significant need for water to be diverted from various sources. Changes in feed stock quality (i.e. crude slate) have also demanded use of technologies that are more water intensive.

Despite these additional requirements, the downstream petroleum industry has made significant gains in water use efficiency. Through continuous improvement and new technologies in operations, the downstream petroleum industry has achieved a 32% reduction in total water use from the base year.

In addition to refineries, this sector has spent a significant amount of capital to upgrade its marketing and distribution facilities which has resulted in increased pollution prevention and less impact on surface and groundwater. Marketing network rationalization during the past two decades has reduced demands on municipal water systems and groundwater sources.

The sector will continue utilizing practical opportunities, including the ones identified in this report, to further reduce water diversion and/or water use from the North Saskatchewan River by 2015.

*Note1: Discharge volumes used to calculate use rates includes storm water runoff collected on site.*
*Note 2: intake and discharge water used for calculating base year are rounded numbers from actual 11,371,383 $m^3$ and 7,431,913 $m^3$ per year*

## Alberta Sector CEP Plan Metrics

| Component | Units | 2000 | 2009 | F(U) | %F(U) |
|---|---|---|---|---|---|
| **Refinery Throughput** | 1000$m^3$ /day | 61.6 | 58.9 | (2.76) | (4.48) |
| **Refinery Utilization** | | 95% | 86% | (9%) | - |
| **Water Intake (actual)** | $Mm^3$ | 11.4 | 9.9 | 1.50 | 13.16 |
| **Water Discharge (actual)** | $Mm^3$ | 4.2 | 4.9 | 0.70 | 16.67 |
| **Water Use (actual)** | $Mm^3$ | 7.3 | 4.9 | 2.40 | 32.88 |
| **Water Use(normalized)** | $m^3/m^3$ crude | 0.325 | 0.228 | 0.10 | 29.88 |
| **Water Intake License** | $Mm^3$ | 17.3 | 17.3 | 0.00 | 0.00 |
| **% License Utilized** | | 66% | 57% | 9% | - |
| **Refinery Effluent Quality (% of allowable limits)** | | <15% | <10% | 5% | |

**F= Favourable, (U)= Unfavourable**

# The Downstream Petroleum Sector

The Canadian Petroleum Products Institute[8] (CPPI) is a national association representing the public policy interests of the downstream petroleum industry for all aspects of petroleum refining, distribution, transportation and marketing of petroleum products for transportation, home energy and industrial uses. Collectively, CPPI member companies operate 16 refineries representing 80 per cent of the Canadian refining capacity and supply some 10,000 service stations across Canada with transportation fuels. The downstream petroleum industry employs about 17,500 workers in refining and 82,000 workers in marketing operations. In 2009, the industry spent $394 million in environmental expenditures. From 2003 to 2008 the Industry's total environmental expenditures were $5.34 billion as a result of proactive initiatives, regulatory response and product quality upgrades.

CPPI members include:

- Bitumar Inc.
- Chevron Canada Limited
- Husky Energy Inc.
- Imperial Oil Limited
- North Atlantic Refining Limited
- NOVA Chemicals (Canada) Limited
- Parkland Fuel Corporation
- Shell Canada Products
- Suncor Energy Products Partnership
- Ultramar Limited

## CPPI Mission Statement

The **Canadian Petroleum Products Institute** is an association of major Canadian companies involved in the refining, distribution, and/or marketing of petroleum products.

Our mission is to initiate discussion and dialogue in the development of public policy and regulation serving the long term interests of the Canadian consumer and of the Canadian petroleum industry. CPPI represents members on public policy issues to governments, media and interest groups on matters such as environment, health and safety.

CPPI also maintains a network to advance best practices in the handling, use and storage of refined petroleum products in Canada.

# 1.0 Overview of the Downstream[6] Petroleum Sector CEP Plan

The Alberta Government's *Water for Life* strategy[1] (2003) has set a target for Albertans to achieve a 30 percent improvement in water-use efficiency and productivity. The Alberta Water Council (AWC) was established by the province to spearhead this goal.

Under the auspices of the AWC, a Conservation Efficiency Productivity (CEP) Team recommended that seven major water-using sectors in the province prepare a CEP plan to guide their sector towards achieving the *Water for Life* goals. The CEP team prepared a set of guidelines in the form of an "Annotated Table of Contents" for the development of the plan, a framework to guide the process, and a set of criteria by which the plan would be evaluated.

CPPI's National Environment Committee established a task force, representative of Alberta downstream petroleum operations, to develop the CEP plan. A third party consultant completed the aggregation of data and information received from CPPI members and from publicly available information.

The Downstream Petroleum Sector CEP Plan covers refining, marketing and distribution operations in Alberta and provides details on the current state of water use and progress that has, and is being made, toward more efficient use of this resource. It also identifies potential opportunities to enhance CEP efforts.

The sector will continue to focus on specific measures to achieve further CEP gains and to define targets and mechanisms that will assist them in achieving the CEP gains targeted through AWC's response to Alberta's *Water for Life* strategy (2003).

EMS Consulting was contracted by CPPI Western Division to prepare this CEP Sector Plan on behalf of the member companies operating in Alberta, and to derive a strategy that would commit the sector to identifiable on-going CEP gains.

## 1.1 Goals and Objectives[4]

According to Alberta's strategy for water sustainability, as delineated in the *Water for Life* strategy (2003 and updated in 2008), the following principles, goals and outcomes are the basis for developing this CEP plan:

**Principle:**

*Albertans must become leaders at using water more effectively and efficiently, and will use and reuse water wisely and responsibly.*

**Goals:**

*1) Safe, secure drinking water supply*
*2) Healthy aquatic ecosystems, and*
*3) Reliable, quality water supplies for a sustainable economy*

**Outcomes:**

*1) All sectors are demonstrating best management practices and improving efficiency and productivity associated with their water use.(2007-2010)*
*2) Water is managed and allocated to support sustainable economic development and the Strategic Priorities of the Province.(2010-2014)*

According to the "Water Conservation, Efficiency and Productivity, Final Report 2008" issued by the Alberta Water Council, the following are the accepted definitions of Conservation, Efficiency and Productivity (CEP) for plan development:

*Water Conservation:*

- Any beneficial reduction in water use, loss or waste.
- Water management practices that improve the use of water resources to benefit people or the environment.

*Water Use Efficiency*:

- Accomplishment of a function, task, process or result with the minimal amount of water feasible.
- An indicator of the relationship between the amount of water needed for a particular purpose and the quantity of water used or diverted.

*Water Productivity*:

- The amount of water that is required to produce a unit of any good, service or societal value.

Based on the above principles, the CPPI members' achievements and long-term goals:

**Our target is to continue to improve our water use further from the base year by 2015**

***"The overall water use by the petroleum sector in Alberta has improved by 32 percent from the base year (7.4 million $m^3$/year). The sector will continue to use opportunities identified in this report to further reduce its water use".***

The further water use reduction will be achieved by a combination of the following steps:

- ✓ Continue to implement projects to reduce the volume of water diverted from Alberta's rivers, lakes and streams per unit of production.
- ✓ Continue to increase recycling of water in the refineries.
- ✓ Increase staff training to improve their understanding of the significance of this resource to Alberta.
- ✓ Provide full management support for water conservation projects and continual improvement activities
- ✓ Continue to ensure that water diverted for use in the operation is returned in an acceptable quality
- ✓ Improve operational performance to reduce impact on water courses
- ✓ Marketing rationalization to meet market demands

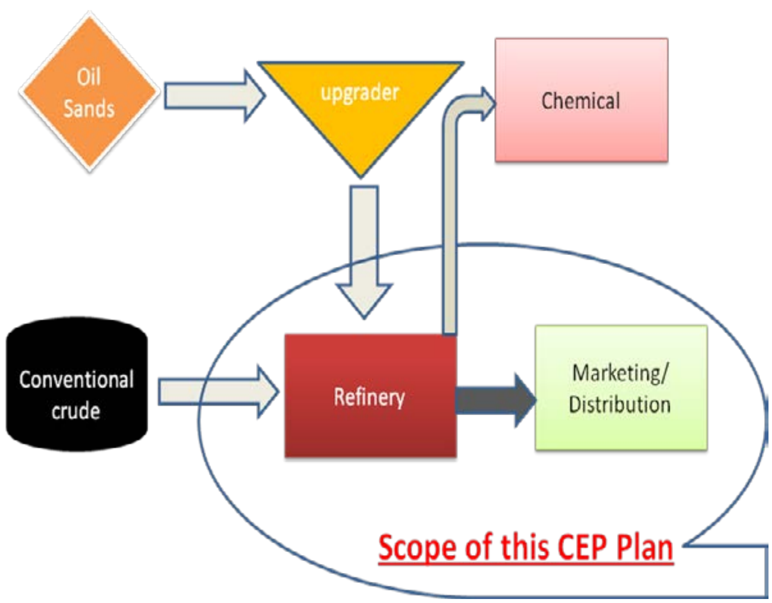
## 1.2 Scope of Plan

The petroleum industry continues to be an economic development engine for Alberta as the largest exporter of product to the United States and other provinces.

Two distinct sectors make up the petroleum industry, the upstream and downstream.

The **upstream** sector includes exploration and development companies involved in the search for, and production of, crude oil, natural gas and oil from the Oil Sands.

The **downstream**[6] sector includes crude oil refiners, product distribution terminals, associated pipelines, truck, rail and marine transportation and retail wholesale gasoline/diesel and lubricants marketers.




*Upgraders: Oil sands[17] production in northern Alberta could triple by 2020, to four million barrels a day. Some of this incremental oil sand bitumen production could be upgraded in Alberta depending on market conditions.*

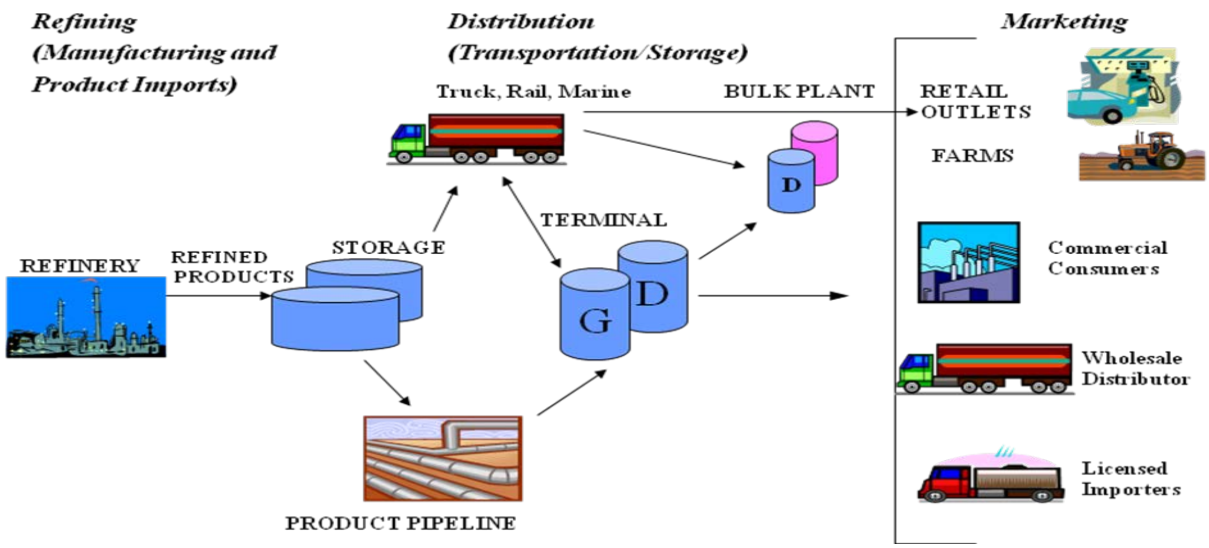
*Upgraders are large scale industrial complexes similar to oil refineries. They take the oil sand bitumen and "upgrade" it to synthetic crude oil that can be used as feedstock by refineries.*

*In 2010, there was one upgrader northeast of Edmonton and three in the Fort McMurray area converting bitumen to synthetic crude oil.*

*Petrochemical Plants: Petrochemical plants occasionally work alongside oil refineries. Petrochemical feedstock from the refining process are sent to petrochemical plants and converted into chemical compounds for processing.*

*The upgraders and petrochemical plants are not in the scope of this CEP Plan.*

**The scope of this CEP plan is the refining, marketing and distribution segment of the industry as illustrated below:**




Familiar downstream sector products include:

- Gasoline
- Sulphur
- Butane
- Diesel
- Asphalt
- Jet Fuel
- Lubricants
- Home heating oil
- Propane
- Lubricating oils

## The Downstream Sector (CPPI Members) in Alberta

### *Refining*

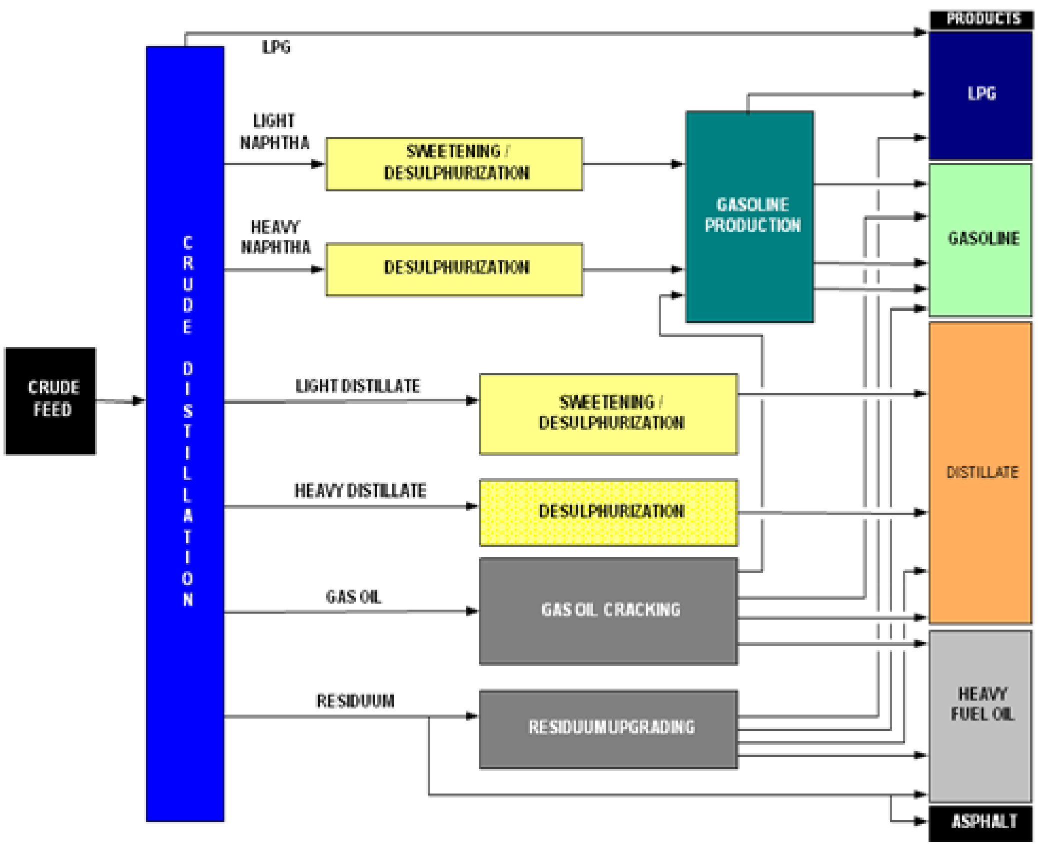
CPPI members in Alberta operate three refineries, located north of Edmonton (Shell, Suncor and Imperial) and the Husky Asphalt plant located in Lloydminster, Alberta. The three Edmonton refineries divert water from the North Saskatchewan River and the Lloydminster asphalt plant relies on groundwater and municipal water for its operation.

This report is developed based on the water diverted from the North Saskatchewan River by the three refineries in Edmonton. The Husky operation and water withdrawal is not included in this CEP Plan. However, CEP opportunities described in this plan will be reviewed by Husky for consideration and implementation. CEP activities implemented by Husky are also discussed in this report.

Oil refineries are complex manufacturing facilities that take crude oil and produce a variety of products. Most refineries look similar but typically produce different products. The actual products available from a particular refinery differ according to:

- Type of refinery processing units
- Refining processes
- Type of crude oil feedstock

Refineries are built to match the crude oil feedstock. Some refiners use conventional oils, others upgrade to heavy crude oil, and some refine synthetic crude oils. All crude oil contains sulphur and some contain wax, depending on the type and origin. Sour crude has more sulphur than sweet crude. Sulphur is not desirable and, along with wax, is removed during the refining process.



Over the years, refiners have made significant investments in plant improvements, emissions reduction, and cleaner fuels. In the past 10 years, CPPI members have invested $8 billion in total environmental expenditures. This investment has resulted in reducing emissions of harmful substances which has significantly improved air quality. Despite the fact that these changes have resulted in higher energy need and more water use, the downstream petroleum industry has reduced its total water use over the past decade.

*Distribution and Marketing*[6]

In addition to refineries, the CPPI member companies operate the distribution and marketing facilities in Alberta[6]:

- 7 Terminals (company owned and operated) for storage and distribution of various products to the market, normally supplied by pipeline and with a capacity of 250 million litres of product per year
- 184 Bulk Plants (agency operated distribution centres)
- 334 Card Locks
- 674 Service Stations
  - 450 Marketers (owned by 3rd party)
  - 224 Dealers (company owned)

***Note:*** *Many of the marketers and dealers operate facilities with car washes*

The petroleum industry's marketing facilities generally are not significant users of water and the amount of water consumed is negligible. Water in marketing is used as potable, for sanitary and in car washes.

The petroleum industry has upgraded its marketing facilities over the past 20 years utilizing significant capital expenditures to ensure integrity of its equipment and prevention of leaks or release of products to the environment. These upgrades will be discussed in detail in the following sections. In addition, marketing and distribution facility rationalization due to market demand changes, operating efficiency, and industry re-structuring, has resulted in the reduction of sites and a reduction on water demands.

## 1.3 The Case for Water CEP

This plan has been developed to provide information and direction to all downstream petroleum sector stakeholders. The CEP Plan identifies specific and quantifiable goals or targets for improving water use efficiency and achieving measurable outcomes. In addition, this Plan is intended to provide the sector with an array of tools and mechanisms that will enable implementation and monitoring of CEP-related activities.

On the broader scale, it is intended that CEP improvements will result in additional water being available to support social, economic, and environmental needs that are thoroughly evaluated.

The industry has made significant improvements in water use efficiency throughout the past decade by implementing various technologies in its operations. This improvement has been achieved in spite of many regulatory changes requiring reconfiguration of the refineries, the addition of units to upgrade refined products, and changes in feedstock quality that have resulted in increased use of water per barrel of crude refined.

Despite the substantial CEP gains that have been achieved over the past number of years, the downstream petroleum sector is still perceived to be one of the largest users of water, when in fact, compared to other sectors, it is a fairly small user as indicated in *Water for life, current and future water use in Alberta.*

## 1.4 CEP Plan Champion and Leaders

The most significant gains to be realized through CEP initiatives will occur within the three refinery operations. Each refinery is unique in its uses and capabilities to conserve and reduce water diversion and use, increase water use efficiency, and each will contribute differently to the projected outcomes.

The sector's collective efforts will be promoted by CPPI, which has the mandate to represent the interests of its members in Alberta.

Much has been achieved in recent decades in this sector with respect to CEP gains, primarily through collaborative initiatives between the member companies through CPPI, the federal and provincial governments and various stakeholders.

# 2.0 Profile of Existing Water Systems

## 2.1 Water Use Profile

The three refineries in this CEP Plan are located in Edmonton area and take water from the North Saskatchewan River.

The following table provides a summary of water use and discharge quality in all three refineries in the Edmonton area, from 2000 to 2009.

**Total intake and discharge for three refineries in the Edmonton area**

(Source: Statistics Canada Industrial Water Use Survey)

| Year | Crude Throughput 1000m$^3$/d (1000 bbls/d) | Intake water m$^3$ | Discharge water m$^3$ | Water Used m$^3$ |
|---|---|---|---|---|
| 2000 | 61.61(387) | 11,444,630 | 3,939,309 | 7,505,321 |
| 2001 | 60.37(380) | 11,223,325 | 4,110,269 | 7,113,056 |
| 2002 | 60.30(402) | 11,446,194 | 3,744,831 | 7,701,363 |
| 2003 | 63.93(390) | 10,952,369 | 4,094,577 | 6,857,792 |
| 2004 | 65.12(410) | 10,604,983 | 3,910,403 | 6,694,580 |
| 2005 | 65.97(415) | 10,638,280 | 4,469,739 | 6,168,541 |
| 2006 | 62.56(393) | 10,690,065 | 4,128,482 | 6,561,583 |
| 2007 | 66.40(417) | 11,297,896 | 4,449,979 | 6,847,917 |
| 2008 | 57.64(363) | 10,105,847 | 4,075,332 | 6,030,515 |
| 2009 | 58.85(370) | 9,857,270 | 4,923,807 | 4,933,463 |

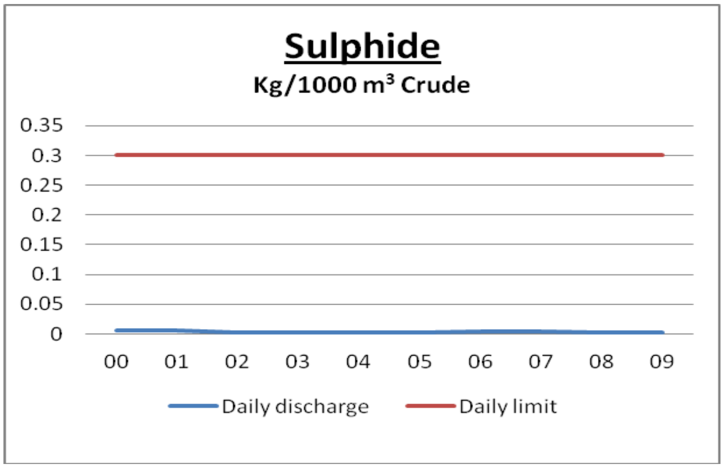
**Total water discharge quality for three refineries in the Edmonton area**

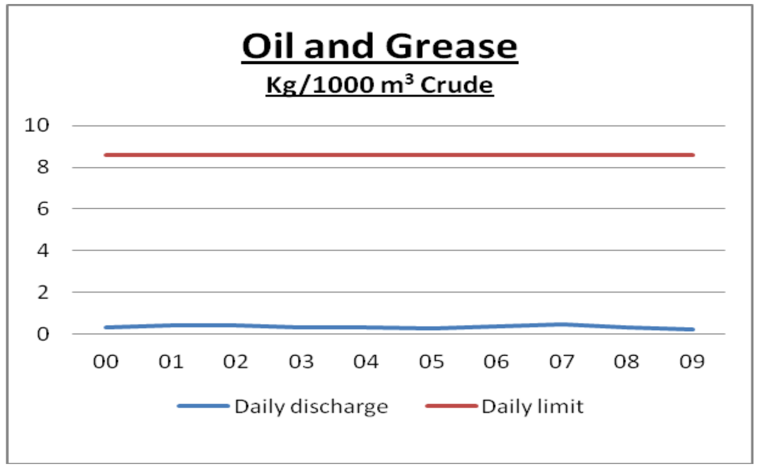
Source: Environmental & Safety Performance Report (ESPR) (Federal Refinery Effluent Regulation)

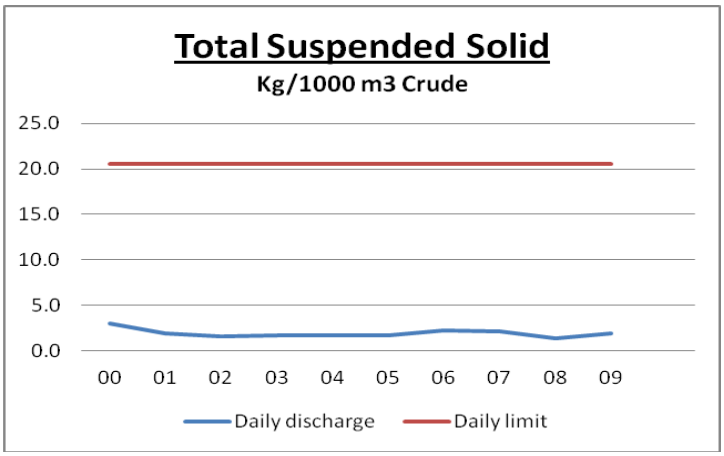
| | Oil& Grease | Sulphide | Ammonia Nitrogen | Phenol | TSS |
|---|---|---|---|---|---|
| Unit | Kilograms/1000 m$^3$ Crude Throughput | | | | |
| Regulation | 8.6 | 0.3 | 10.3 | 0.9 | 20.5 |
| 2000 | 0.34 | 0.0058 | 0.08 | 0.002 | 3.0 |
| 2001 | 0.43 | 0.0061 | 0.066 | 0.003 | 1.9 |
| 2002 | 0.41 | 0.0026 | 0.08 | 0.004 | 1.6 |
| 2003 | 0.34 | 0.0023 | 0.091 | 0.003 | 1.7 |
| 2004 | 0.30 | 0.0027 | 0.066 | 0.002 | 1.7 |
| 2005 | 0.20 | 0.0025 | 0.047 | 0.001 | 1.7 |
| 2006 | 0.35 | 0.0034 | 0.085 | 0.003 | 2.2 |
| 2007 | 0.48 | 0.0038 | 0.06 | 0.002 | 2.1 |
| 2008 | 0.31 | 0.0024 | 0.061 | 0.001 | 1.4 |
| 2009 | 0.24 | 0.0024 | 0.088 | 0.0008 | 1.9 |

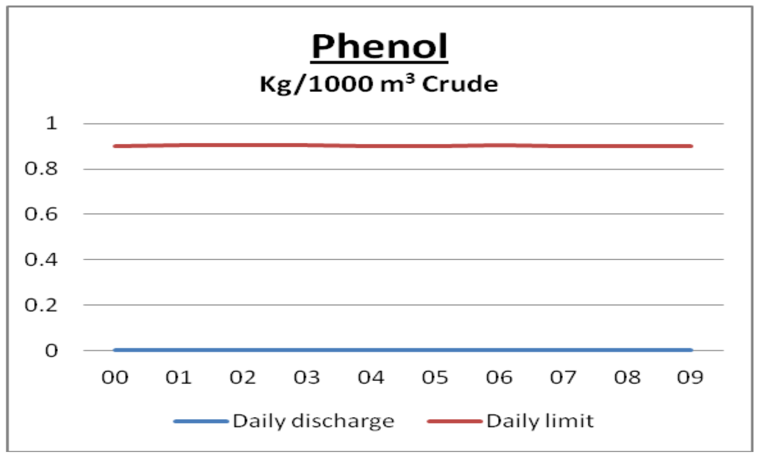
# Compliance with Federal Refinery Water Effluent Regulations

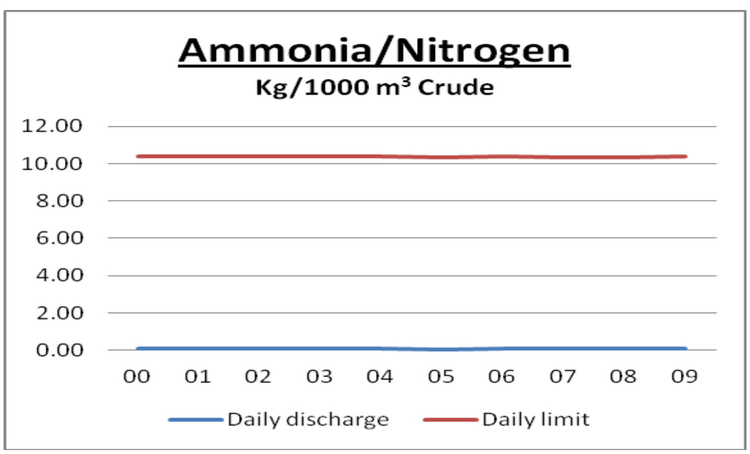
## 2000-2009




The above charts reflect the refinery effluent quality in accordance with the refinery effluent guidelines under the Federal Fisheries Act. Effluent quality has improved from less that 15% in 2000 to less that 10% of allowable federal limits in 2009. In addition, the Alberta government has prescribed site specific limits for each refinery in their respective water licenses.

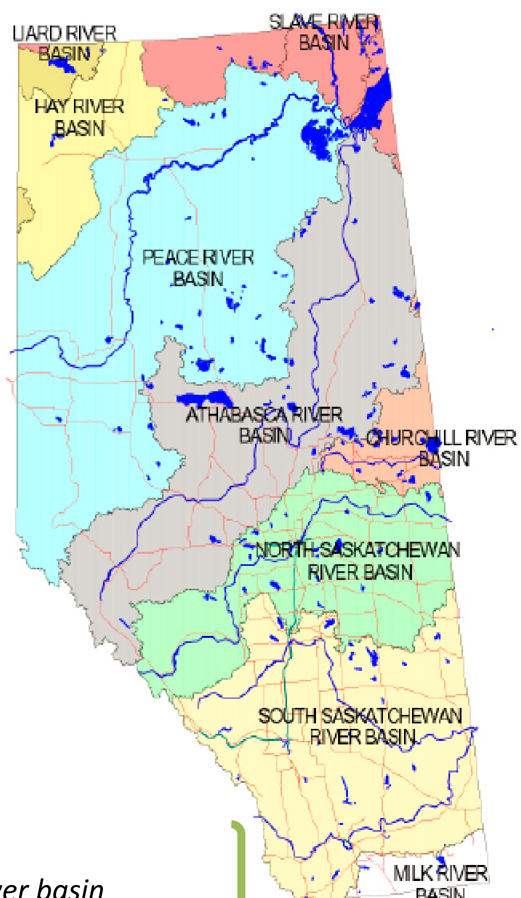
### 2.1.1 Physical Characteristics

The majority of water used in the downstream petroleum sector is in refining operations. Water use in the marketing and distribution operations is limited to potable water use and in car washes which is negligible when compared to refineries.

All refineries included in this CEP Plan divert water from the North Saskatchewan River Basin[15]. The largest water users in the North Saskatchewan watershed are power generators, energy companies and the City of Edmonton as shown in "Water for life, current and future water use in Alberta". The total amount of water used by the refineries is not in the list of top ten users of water from the North Saskatchewan River.

Water is used in refining operations for a variety of reasons and its uses are described in detail in Section 2.1.3

The majority of water diverted from the river is used as non-contact water for cooling purposes and is returned back to the river after treatment and at a high quality. A portion of the water diverted is mixed with the refinery feedstock (either in liquid or steam form) and as a result becomes contaminated. This portion of water is either treated in the waste water treatment plant and discharged to the river or in the case of heavily contaminated water, is disposed in a licensed deep well.




*Alberta river basin*

*Region where refineries are Located*

### 2.1.2 Baseline Water Use

*Water License Conditions*

*The Water Act, R.S.A. 2000*, supports and promotes the conservation and management of water, including the wise allocation and use of water, while recognizing the need for economic growth and prosperity. The act considers:

- the need to manage and conserve water resources to sustain our environment and to ensure a healthy environment and high quality of life in the present and the future;
- the need for Alberta's economic growth and prosperity;
- the need for an integrated approach and comprehensive, flexible administration and management systems based on sound planning, regulatory actions and market forces;
- the shared responsibility of all residents of Alberta for the conservation and wise use of water and their role in providing advice with respect to water management planning and decision-making;
- the importance of working co-operatively with the governments of other jurisdictions with respect to trans-boundary water management, and
- the important role of comprehensive and responsive action in administering this Act.

The *Water Act* requires that an approval under the Environmental Protection and Enhancement Act must be obtained for any activity, diversion of water or operation of a works. Small volume use and some private or municipal use of water are exempt from this requirement. The act also dictates that the Minister must establish a framework for water management planning for the Province of Alberta by December 31, 2001 and includes…

(a) Water management principles,

(b) The geographical limits or boundaries within which water management planning is to be carried out in the province, including limits or boundaries for the development of strategic and operational plans,

(c) Criteria for establishing the order in which water management plans are to be developed,

(d) An outline of the processes for developing, implementing, reviewing and revising water management plans, including opportunities for local and regional involvement,

(e) Matters relating to integration of water management planning with land and other resources, and

(f) Matters relating to the development of water conservation objectives.

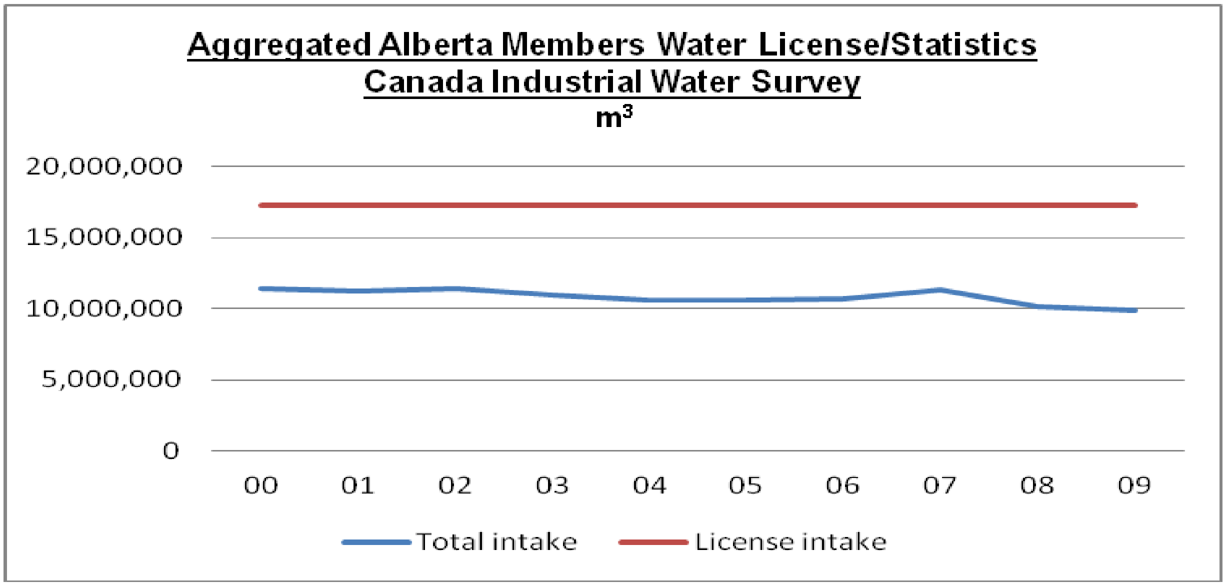
The *Water for Life s*trategy was introduced to support the stewardship of water in the province.

All three refineries operating in the province have licenses to either divert water from the North Saskatchewan River or use groundwater. Water licenses granted to the refineries after 1999 have expiry dates. Water licenses typically limit the maximum annual volume with some site specific conditions, such as rate of diversion.  Some licenses also specify a return flow. *A*ll licenses require that records of water use be maintained. Most users are required to report their actual water use to Alberta Environment and Water. Alberta Environment and Water publishes the water use and discharge for various industries in their annual report.

Some water licenses include provisions under the *Water Act* which references the *"Water Management Framework for the Industrial Heartland and Capital Region"* requiring that users adhere to sector-based water conservation targets.

*Actual Water Intake*

Total allowable water diversion and actual diversion of water for the three Edmonton refineries for the period 2000-2009 is in the following chart:



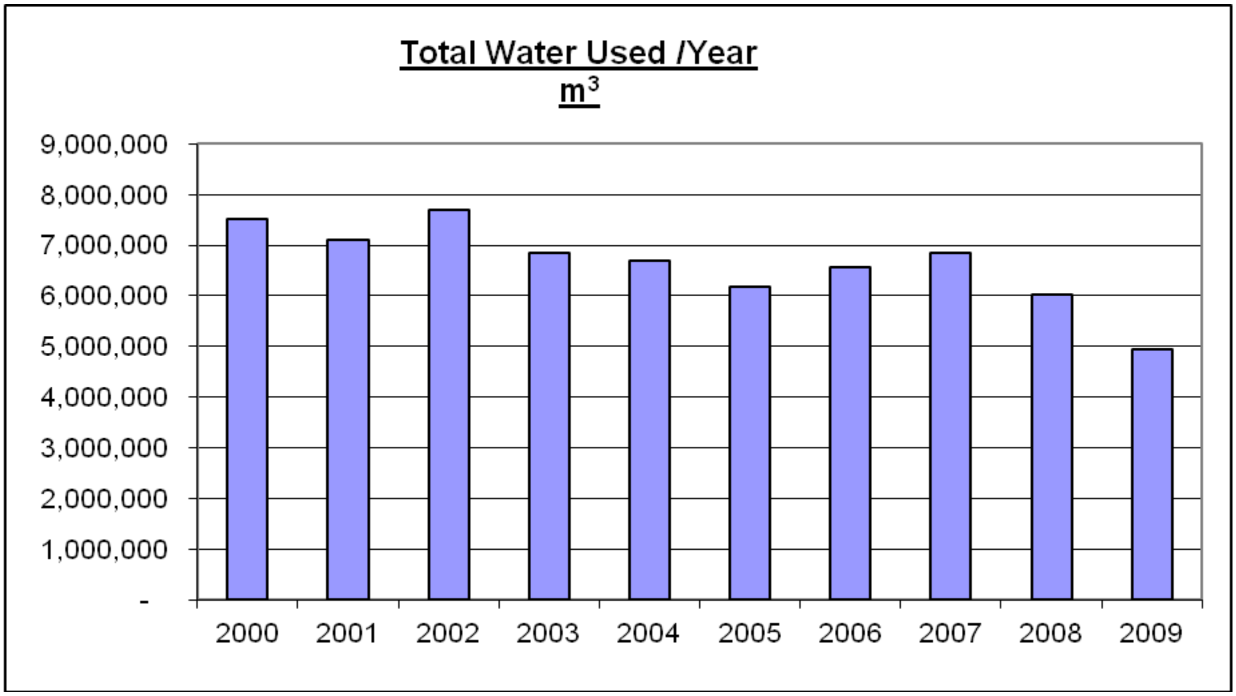

In a typical refinery, approximately 60% of intake water is used for the cooling system and it is generally returned back to the river after being treated to a high quality. Some of this water is evaporated in cooling towers.

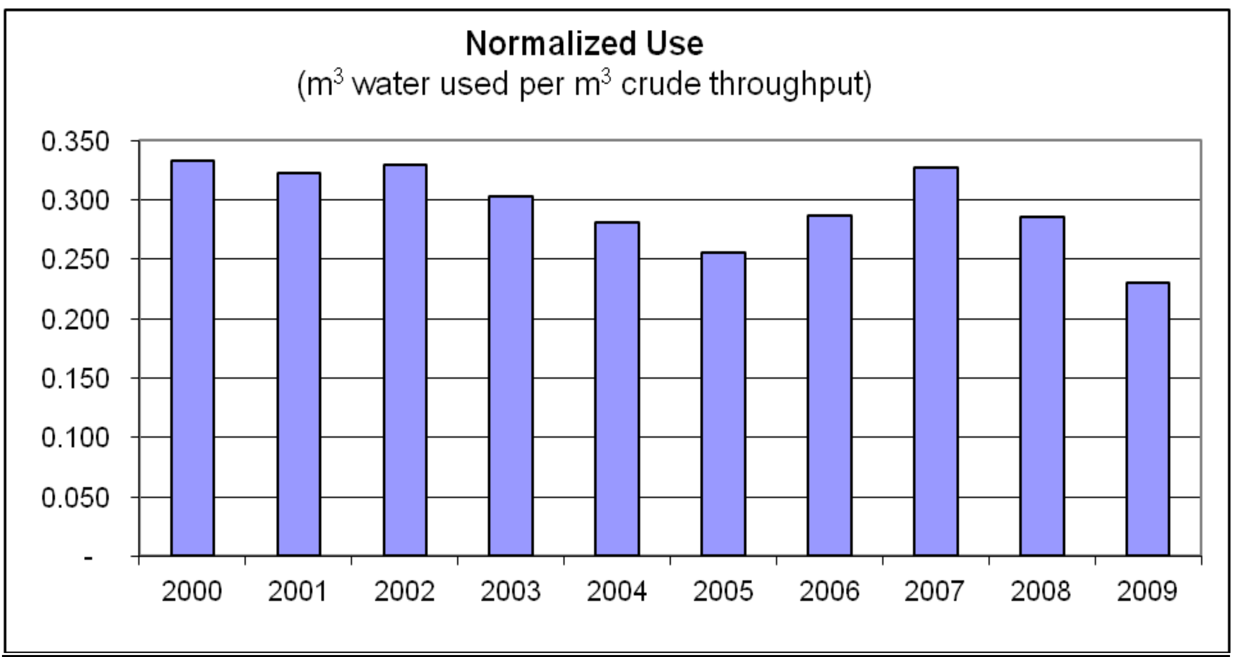
Approximately 35-40% is used in the refining process, either by direct contact with crude such as de-salting of product, steam production or production of hydrogen in the hydrogen plant.

Contaminated water from refinery operation is treated in waste water treatment plants (WWTP) before it is returned back to the environment. Each refinery's WWTP has varying degrees of complexity. Details of a WWTP in a typical refinery are provided in Section 2.1.3. Some contaminated water is disposed of in deep wells, in accordance with specific refinery permits.

Approximately 1% of intake and some city water is used for sanitation. Sewage is normally transported off site by a licensed contractor.

***The following charts show total and normalized water use during 2000-2009 periods***

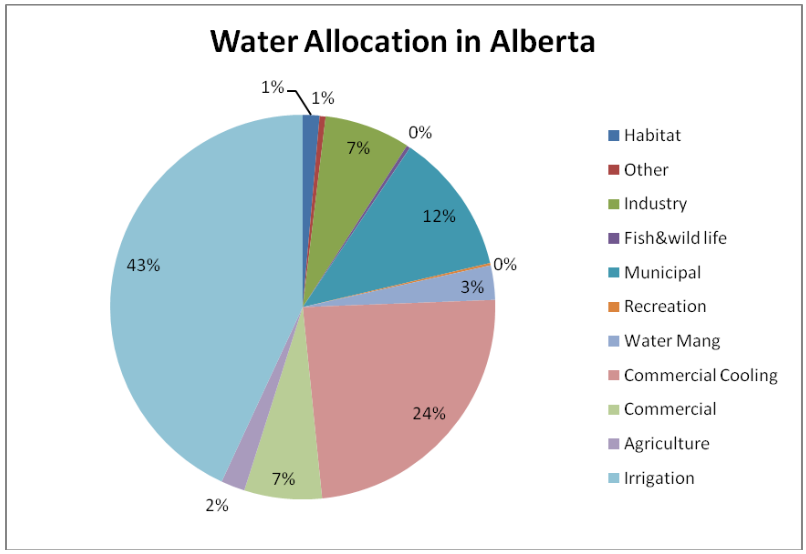



A 32% reduction in total used and 30% in normalized used from the base year has already been achieved.

*Water Sources*

By the end of 2005, Alberta had allocated more than 9.5 billion m³ of water for various uses throughout the province. The majority (97 percent) of this was from surface water sources. Although reliance on groundwater is much less than surface water, groundwater is typically a much more important source for individual domestic water supplies in rural areas. Many smaller communities may rely on groundwater, as well as, some industrial and commercial operations where surface water supplies are not sufficient.




Data from Alberta Government WEB site-2009 [1]

Water allocations vary across the province. Most allocations are in the eastward-flowing Saskatchewan River Basin (the North and South Saskatchewan Rivers and their tributaries), where 88 percent of the population of Alberta is located.

When shown as a percentage of total surface and groundwater allocations, the South Saskatchewan River Basin is the most licensed basin in terms of total allocations. It accounts for over 58 percent of all allocated water in the province. The second largest, in terms of overall allocation, is the North Saskatchewan River Basin (29 percent)[15].

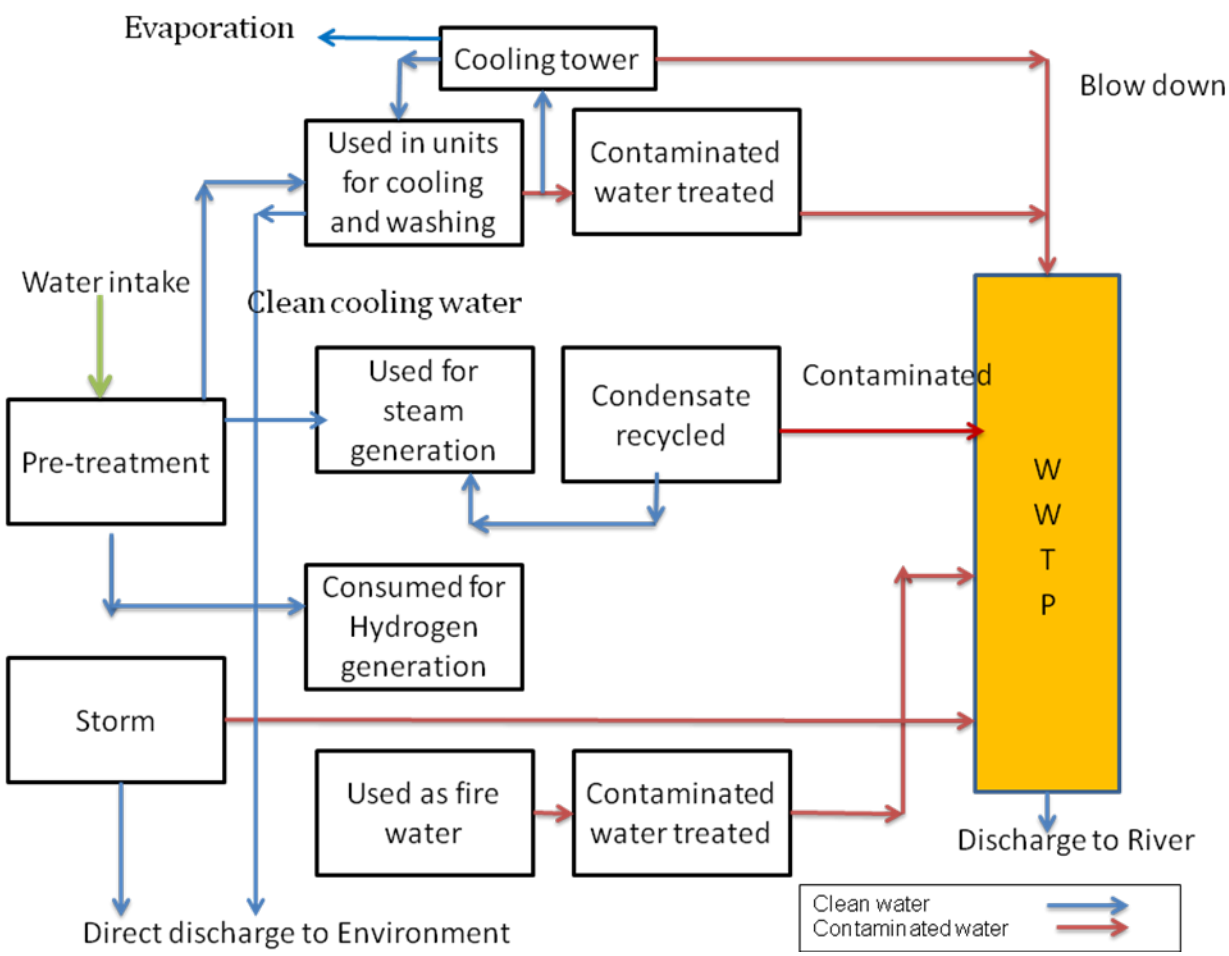
The petroleum refineries in Edmonton source their water from the North Saskatchewan River in accordance with their licenses with the exception of municipal water for sanitation. Generally, marketing operations source their water from municipal systems. There are some rural marketing operations that use groundwater sources.

### 2.1.3 Description of Key Water Uses/Users

Fresh water is a fundamental part of a refinery operation and is used in many different ways. In many cases, the water withdrawn from the ecosystem is used, treated and returned to source at equivalent or better quality level than source water intake. Only a portion of the water withdrawn is used as a chemical feedstock or lost to evaporation in cooling towers. During high precipitation periods, the amount of water collected and treated at the site actually exceeds the refinery water use. In these situations, a refinery returns more water to the ecosystem than it removes.

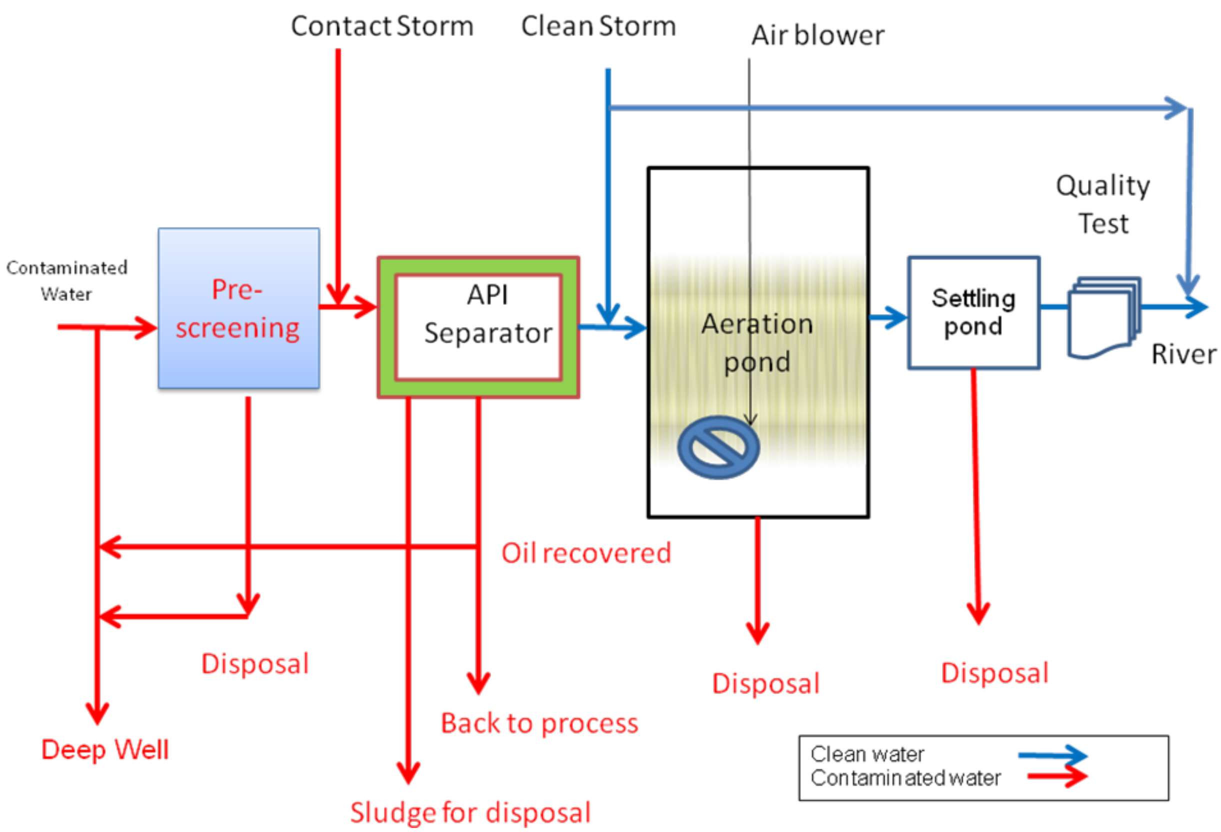
*Water Usage in Refining*

The following chart provides an overview of water use in a **typical** refinery:

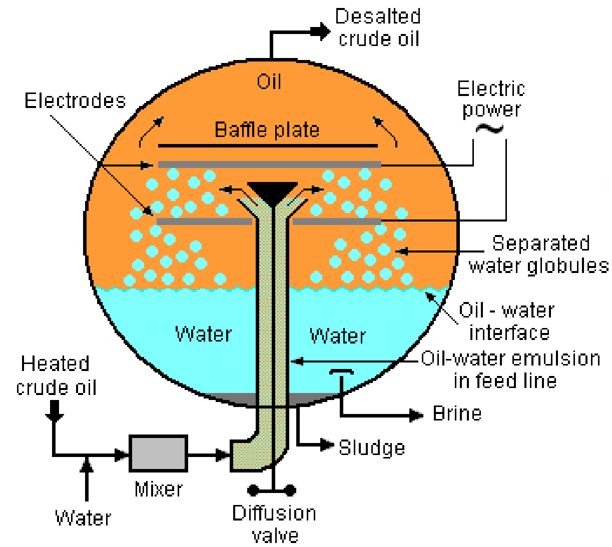



*See next page for schematic of a typical refinery Wastewater Treatment Plant in Alberta*

**A schematic of a typical refinery waste water treatment plant in Alberta is provided below:**



*__Water Used to Remove Salt from Crude Oil__*




**Cross-sectional view of Electrostatic crude oil desalter**

All conventional crude oils have about 60 -100 kilograms (kg) of salt per 1,000 cubic metres (m3). This salt must be removed from the crude oil prior to fractionating and subsequently processing the crude oil. This processing step occurs in a de-salter where crude and fresh water are intimately mixed at a high temperature. The salt dissolves in the water phase and the brine is removed from the crude.

*__Water Used as a Process Fluid in the Form of Steam__*

There are many refining process units where water in the form of steam is required to come into contact with hydrocarbons to facilitate distillation and separation of hydrocarbon components. Steam stripping (fractionation by injecting steam into the process) is an example, as is injection steam for catalytic crackers to strip the adsorbed hydrocarbons from the catalyst. All the water is recovered and either reused, returned after treatment to the water ecosystem source, or disposed into deep underground wells.

*__Water Used as a Heating Fluid__*

All refineries need water in the form of steam for heating purposes. For this use, the steam does not come in direct contact with the hydrocarbon. Most refineries will use the pressure energy in the steam to drive the motors of rotating equipment (pumps, compressors, air blowers) instead of using electricity. Most of the steam (60 – 90%) is recovered as hot liquid condensate (hot water) and recycled for reuse. In addition to the steam plant, all refineries recover waste heat from refinery furnaces and boiler stacks to boil water and convert to steam for use as a heating medium.

*__Water Used as Chemical Feedstock__*

Most refineries use treated fresh water as a chemical feedstock for the synthesis of hydrogen, which is needed in the refinery to remove sulphur from fuel products and to upgrade heavy oil into transportation fuels. Water chemically reacts with a hydrocarbon stream (most commonly methane). The reaction products are carbon dioxide and hydrogen. Hydrogen manufacturing is a net consumer of water.

$$2H_2O + CH_4 \longrightarrow 4H_2 + CO_2$$

*Water Used as a Cooling Fluid*

The largest single use of water in a refinery is as a fluid to cool most hydrocarbon streams. Refineries are generally heavily heat integrated with heat exchangers to transfer heat from hot hydrocarbon streams to cooler ones. Water cooling typically represents the last cooling step to return the hydrocarbon close to ambient temperature. None of the cooling water comes into contact with the hydrocarbon and after use is either recycled or returned to the receiving body of fresh water.

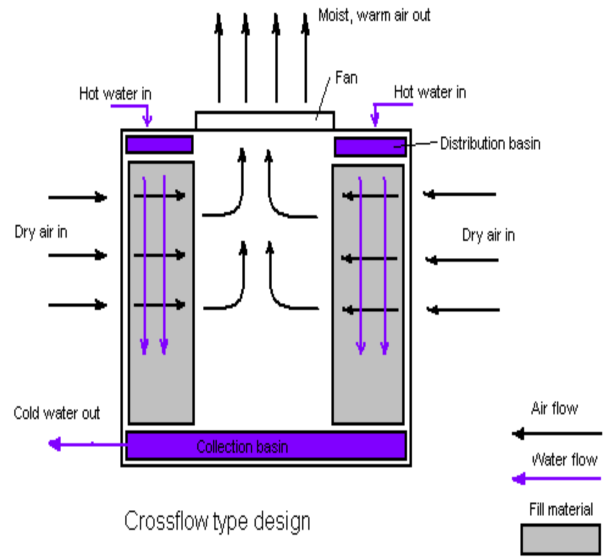
There are two primary types of cooling water systems:

1) *Once Through Cooling Water (OTCW)*

   These systems take water from the ecosystem and use it only once for cooling and then return the heated water to the water ecosystem typically at a temperature that is 1–3 degrees Celsius warmer than what is taken in. OTCW system is not used in Alberta refineries.

2) *Cooling Water Systems (CWS) (Re-circulating)*

   These systems recover and reuse cooling water many times over. The heat picked up by the cooling water is released to the atmosphere by flowing the warm water across wood slats of a 15 - 25 metre high structure called a cooling tower. About 10% of the water is lost to atmosphere as water vapour. As the cooling water re-circulates through the system, it builds up contaminant levels and therefore, requires purge rates of 2 to 5% of the total flow. The purged water is routed to the water effluent treating system to keep these contaminants from being discharged into the environment.




Crossflow type design

*Air Fan Coolers*

One of the actions that industry has taken to reduce the amount of water needed for cooling is increasing the use of air fan cooling systems.

*Fire Water*

All refineries need instant access to large amounts of water in the event of a refinery fire. The water is required to extinguish the fire and prevent the spread of the fire to other process units and petroleum storage tanks in the refinery by cooling. The water remaining after a fire is extinguished is normally directed to the wastewater treatment plant and ultimately discharged back to the source.

*Water Usage in Distribution and Marketing*

Distribution terminals are facilities that receive petroleum products, hold those products in inventory, and then load the product onto trucks or rail cars to the end use customers.

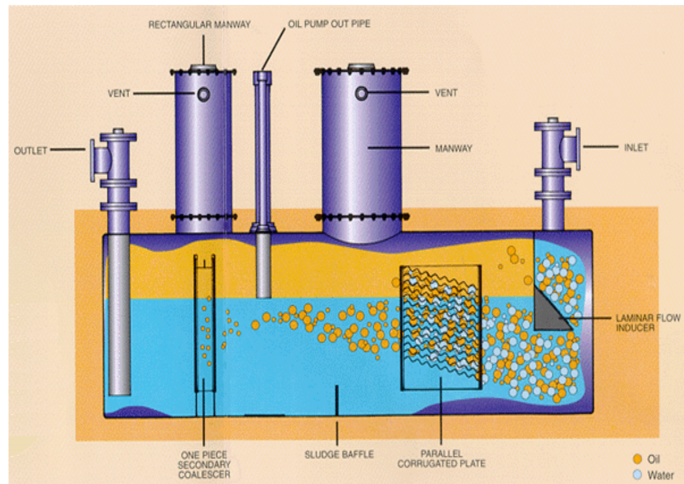
Two types of facilities perform this role:

1) Primary terminals, which handle larger volumes, and are typically the first point of inventory after the refinery. They receive product usually from a refinery via pipeline or ship.

2) Bulk plants, which handle smaller volumes, and almost always receive the product by truck from a primary terminal.

Terminals are usually located in major urban centres. Storage capacities vary greatly, generally in the range of 20,000 cubic metres ($m^3$) to 1,000,000 $m^3$ or more. Tanks generally are floating roofs with capacities of (30,000 $m^3$). Terminals normally do not use water for any purpose other than sanitation.

*Typical oil/water separator used in a terminal or marketing facility*




Storm water which may come into contact with product loading/unloading areas is collected in an oil/water separator which separates the oil. Clean water is discharged to the sewer or the environment.

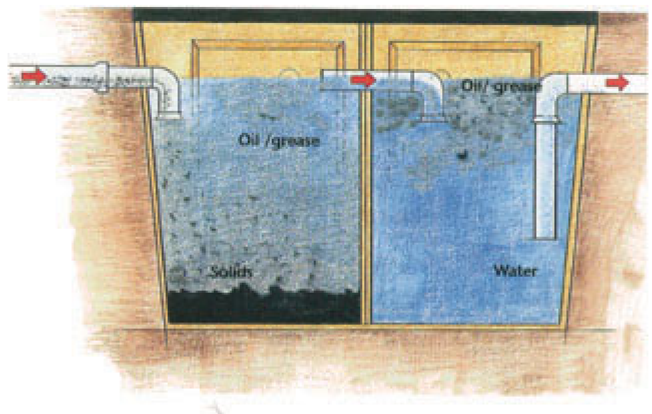
Bulk plants[10] are usually located in more remote or distant markets where it would not be economical nor practical to deliver product to the end-use customer (or other petroleum facility such as a gas station) directly from a primary terminal.

The vast majority of bulk plants receive product by means of tanker truck from a primary terminal. Bulk plant storage facilities generally consist of between four and eight tanks, each with a capacity of around 100 $m^3$ (100,000 litres).

A cardlock[10] is a commercial version of a retail gas station. Cardlock facilities provide fuel to commercial truckers such as long-distance haulers and city delivery vehicles. Like terminals, bulk plants and cardlocks, other than for sanitary purposes, do not use water for their operations. Again oil/water separators are used to separate oil from storm water which may come into contact with petroleum products around the loading/unloading areas.

Typical car wash sand box

The largest amount of fresh water used in marketing facilities[9,11] is in a car wash operation. In a standard car wash, the used water is passed through a "sand box" which acts like an oil/water separator and removes debris and salt from used water. The water is then either recycled back or discharged to the sanitary sewer system.
.




### *Water Users and Economic Impact*

Alberta's oil and gas industry is a source of energy and petrochemical feedstock for all of North America. Its products are used for:

- heating
- transportation
- electricity generation
- energy for manufacturing and
- production of:
    - ✓ plastics
    - ✓ petrochemicals
    - ✓ synthetic materials
    - ✓ medicine
    - ✓ food
    - ✓ fertilizer
    - ✓ construction material

Economic evaluations and impact studies of the oil industry on the overall economy of Alberta are usually conducted using economic metrics for total oil and gas, which includes the upstream, as well as, downstream sectors. Therefore, there is no specific economic data readily available to measure the impact of the downstream sector on the provincial economy.

Analysts have attributed anywhere from 20% to 50% of the economy to the entire oil and gas industry, depending on which industries are included and whether indirect impacts on the economy are taken into account.

- According to the narrowest definition "oil and gas extraction and related support activities", the oil and gas sector accounted for 14.9% of Alberta's real Gross Domestic Product (GDP) in 2006.

- A broader definition of the oil and gas sector that includes relevant portions of the transportation, manufacturing and construction industries raises the share of the oil and gas sector to 24.5% of real GDP in 2006. (Source: Alberta Department of Finance)

Many analysts argue that the oil and gas sector is much broader in scope and that it should include activities related to the oil and gas sector beyond simple extraction and refining. A broader definition includes the following sub-industries:

- oil and gas extraction
- support activities for mining and oil and gas extraction
- upgraders and synthetic crude production
- oil and gas engineering construction
- petroleum and coal products manufacturing
- chemical manufacturing
- mining and oil and gas field machinery manufacturing
- natural gas distribution
- pipeline transportation of natural gas
- crude oil and other pipeline transportation

In addition to its direct contribution, the oil and gas sector has indirect impacts as it spurs demand for goods and services in other sectors of the Alberta economy. However, these indirect impacts are hard to quantify and are usually estimated using input-output models.

The use of water allows industry to function and produce product used in the market. Compared with other sectors, the downstream petroleum sector is a small user of water and most of the water used is returned back to the source at a high quality after receiving treatment.

## 2.2. Linkage with Other Water Systems and Operating Parameters

*Concurrent Water Uses*

Water used by the refineries is taken from the North Saskatchewan River and is not used concurrently by any other industry. As previously mentioned, except for the water used in processing and/or disposed of in deep wells, most of the water used is treated and returned to the source.

*Normal Operating Parameters*

Water licenses granted to each refinery have strict, regulated site specific conditions to ensure high quality water is returned to the source. Refineries taking water from the North Saskatchewan River are not normally faced with seasonal water restrictions.

## 2.3 Review of Current Policies, Programs, Plans and Legislation

### 2.3.1 Related Policies, Programs and Plans

In addition to the *Water for Life* strategy, there are other policies, programs and plans that apply to water management in Alberta that ***could*** affect the downstream petroleum sector.

CPPI members consider all government initiatives important and historically have participated in consultation and implementation of these policies. CPPI has promoted, over the years, the importance of water conservation. Its members have invested heavily in conservation, recycling and management systems to reduce the impact on provincial water supplies and resources. CPPI believes that consistency, good science and practicality of any water policies will be important for overall industry competitiveness while resulting in a positive impact on the environment.

*Water Management Framework for the Capital Region and the Industrial Heartland*

Released in December 2007 by the Minister of the Environment, the Framework outlines water management for the Edmonton-Fort Saskatchewan area. It lists the strategic objectives of the Framework and the actions to be taken on water. More specifically,

- Promoting water conservation for all users, greater use of reclaimed or recycled water, and minimizing the impact on the North Saskatchewan River.
- A phased approach implementation.

The last phase of implementation will see transition of all facilities into the framework and a maximum re-use of recycled water.

*Wetland Management in Settled Areas of Alberta*

Functioning wetlands in the settled areas of Alberta (where most of CPPI member refineries are located) are valuable natural resources that provide many benefits. This policy could apply to refining/marketing operations if, and when, an application for new site construction and/or expansion of the existing facilities may impact wetlands.

*Code of Practice for Pipelines and Telecommunication Lines Crossing a Water Body*

This Code of Practice, under the Water Act, could apply to a refining operation where there is a need for construction of a pipeline across any water body. Any future pipeline project will require compliance with this Code.

*EMS/QMS Registration*

Since the end of 2005, three refineries in Edmonton have been registered under the ISO 14001, Environmental Management System. Under this Management System, refineries have undertaken various projects to continually reduce their reliance on water usage in the refineries. In addition, refineries are also registered under the ISO 9000 Quality Management System which provides an additional layer of compliance with codes, policies, standards and regulations.

*Refinery Projects Risk Assessment and Hazard Identification*

Hazard Assessment and Operability Procedure (HAZOP) is a fundamental step in any project implementation. Environmental risk assessment and mitigation plans are also a necessary step for proper project management and as a result are rigorously implemented in all petroleum refinery projects.

*Capital Improvement Plans*

In response to regulatory changes, the need for improving efficiency and/or reducing their environmental foot print, capital expenditures for environmental improvement are allocated each year by CPPI members. Annual capital expenditures are reported in the CPPI member companies' individual annual reports.

### 2.3.2 Related Legislated Conditions or Clauses[18]

There are two distinct regulations/guidelines which directly apply to refinery effluent in Alberta.

1) *Waste Water Effluent Guidelines for Alberta Petroleum Refineries-1985*

These are intended to define the minimum acceptable levels for waste water treatment at refineries, consistent with good operating practices and environmental protection. Permits or licenses for petroleum refining plants under The Water Act will only be issued if there is provision for an effective control program for plant liquid effluents originating from the refinery process units, surface runoff from the developed area within property boundaries, and sanitary sewage.

2) *Federal Fisheries Act, R.S, 1985*

This Act applies to waste water discharge from petroleum refineries to water bodies and requires rigorous sampling and reporting on a monthly basis for specific parameters.

3) *Other Acts, Guidelines and Regulations that apply to downstream petroleum operations*

- *Canadian Environmental Protection Act*
- *Statistics Canada Industrial Water Survey*
- *Alberta Environmental Protection and Enhancement Act*
- *Water Act*
- *Directive 0 51, Injection and Disposal Wells - Well Classifications, Completions, Logging, and Testing Requirements*
- *Navigable Water Protection Act*
- *Fish Conservation Strategy (1998)*
- *Water Conservation and Allocation Policy for Oil Field Injection*
- *Water and Waste Water Operators Certification Guidelines (2004)*
- *Waste Water and Storm Drainage Regulation (Alberta Regulation 119/93)*
- *Surface Water Quality Guidelines for Use in Alberta*
- *Various Energy Utility Board (EUB) Directives*
- *Code of Practice for Water Works System Using High Quality Ground Water (Sept. 2003)*
- *Code of Practice for Waste Water System Using a Waste Water Lagoon (Sept. 2003)*
- *Guide to Content of Industrial Approval Application*
- *Code of Practice for Tanker Truck Washing Facilities*
- *Approvals and Registration Procedure Regulation (Reg. 13/93)*
- *Municipal Government Act*

## 2.4 Sector History of CEP[8]

*Refining*

Access to fresh clean water is a prerequisite for petroleum refining operations. Pursuing opportunities in water conservation, efficiency and productivity in water usage has significant environmental benefit and results in operating cost savings since there is a direct relationship with energy use. Unlike many other industries, a typical refinery uses water mostly (60%) for cooling which is returned to the source with high quality treatment. A smaller amount (30%) is used as contact water and needs to be treated before it is discharged. The remaining water (10%) is used for activities such as the generation of hydrogen and fire water.

The downstream petroleum sector has been very successful in developing waste water treatment technologies which remove contaminants from the contact water to the lowest possible level. Many of the technologies adopted have now become standard operating procedure.

The following is a brief history of the technological changes in refinery water management:

**1950's** – Basic water treatment in this period consisted of settling ponds and simple removal of visible contaminants by using the American Petroleum Institute (API) designed separators. Gradually, biological oxidation processes for treatment of refinery waste water effluents became necessary to remove contaminants to lower levels which were required by new, more stringent water regulations. This technology, using live organisms, is an adaptation of the method used in municipal waste water treatment plants. This technique virtually eliminates the traces of dissolved hydrocarbons and other contaminants (ammonia, nitrates, and sulphides) in refinery waste water. The microorganism is acclimatized to convert petroleum refinery water effluent contaminants into harmless by-products (water, carbon dioxide and nitrogen).

**1960's** –In addition to biological oxidation, was the use of corrugated tilted plate (CTP) filters, sand filters, dissolved air floatation (DAF) units, use of coagulant and flocculants for more clarifying effect in clarifiers and many other pre-treatments to reduce contaminants to even lower levels.

**1970's** – Water conservation efforts led to segregation of non-contact storm water from the process water for direct discharge, and construction of more re-circulating cooling water systems for a 60 to 80 percent reduction in water intake when compared to once through cooling water systems. In some cases, refineries also began a gradual process of displacing water cooling exchangers with air cooling exchangers where applicable.

**1990's** - In some jurisdictions, refineries installed tertiary treatments such as use of activated carbon filters and oxidation systems to meet very stringent limits for water discharge. Canadian refineries typically discharge water effluents at very low levels and usually return the water used back to the ecosystem with very good quality.

**Current** - CPPI member companies in Alberta operate refineries with varying water treatment complexities and needs. The availability of deep well disposal, has added to this complexity. Disposal via deep well is a regulated practice in Alberta, and has been deemed a safe and viable disposal option where wells are properly constructed, operated and monitored. Volumes of wastewater disposed via deep well injection are reported to regulatory bodies.

As a result of these efforts, the sector has already realized significant and measurable water efficiency and productivity improvements. Although the most obvious CEP opportunities with the largest gains have already been implemented, the sector continues to conduct research and development to pursue further reductions in water use and improve the quality of their discharges.

*Research and Development*

**1970's**
Canadian refiners through CPPI and its predecessor (PACE - Petroleum Association for Conservation of the Canadian Environment) worked in cooperation with the Federal government to study the behaviour of live fish in treated refinery effluents. This was the first sector in Canada (and the world) to use and research the behaviour of live fish living in treated refinery effluents (prior to the discharge of the effluent back into the water ecosystem). Over the next 15 years, more resilient fish such as perch and carp were replaced with more sensitive species such as rainbow trout. This became the cornerstone of fish toxicity testing which is now required in many regulations applicable to effluent discharge from different industries.

**1980's**
The petroleum industry, in cooperation with the University of Waterloo, conducted research in areas of in-vitro fish toxicity which included the applications of the Aims test (using fish egg as species for test) to refinery effluent containing residual contaminants.
In addition, benthic surveys were conducted in the vicinity of refinery out-fall in Lake Ontario over a period of 12 years proving that the refinery effluent has no impact on the marine environment.

**1990's**
Ontario petroleum refiners in cooperation with the Ontario government embarked on research into the most sensitive aquatic species (water fleas – Daphnia Pulex and Daphnia Magna) to test mortality, morbidity and their ability to reproduce. This work led to the development of more stringent petroleum refining sector water regulations in Ontario.

*Distribution and Marketing*

As already mentioned, the distribution and marketing segments of the downstream petroleum sector are not significant users of water when compared to refinery operations. Most of the CEP improvements in this part of the industry have been in the form of measures to prevent any adverse impact on water courses and to reduce contamination.

To achieve this objective, the petroleum industry over the past 20 years, has invested many millions of dollars to upgrade their marketing and distribution facilities. The following are examples of the upgrades undertaken:

- ✓ underground tank and piping replacement program
- ✓ aboveground tank upgrading and maintenance
- ✓ installation of leak detection system in all tanks
- ✓ overflow protection for storage tanks
- ✓ overflow protection for loading tank truck and rail car
- ✓ automated shut off system during loading/unloading
- ✓ collection and testing of storm water before discharge
- ✓ proper disposal of tank draw off

- ✓ establishment of an emergency response plan to prevent soil and water contamination
- ✓ staff training and communication
- ✓ preparation and use of best management practice documents

As a result of these upgrades, the marketing facilities have reduced potential impact on the quality of groundwater or surface water.

*Examples of CEP Developments in Recent Years*

**Suncor – Edmonton Refinery**

A recycled water line from the City of Edmonton's Gold Bar Wastewater Treatment plant reduces the amount of water drawn directly from the North Saskatchewan River and provides water for Suncor's Strathcona County refinery. The 5.5-kilometre pipeline, the first of its kind in Canada, sets a new standard for environmental best practices. The award-winning project meets Suncor's water needs for new processes and provides surplus water for other users along the river valley, including snow making at the Sunridge and Nordic ski clubs and irrigation and pond recharging in the parks system. The public/private partnership between the City of Edmonton, Suncor and Strathcona County was funded by Suncor for approximately $25 million. The membrane-treated water is cleaner than the wastewater formerly returned to the river at Gold Bar. The recycled water will help Suncor meet new federal standards in the manufacture of fuels to reduce vehicle emissions. Suncor will use the water to produce hydrogen and for general refining purposes, such as steam production and cooling.

Under the water line arrangement, Strathcona County will purchase the recycled water, operate and maintain the pipeline on behalf of Suncor, and deliver the water to the refinery. About 30% of the water used for refining processes will be returned to the river through the Alberta Capital Region Wastewater Treatment Plant.

The Recycled Water Line project has been singled out by the Alberta Government for going beyond expectations in protecting water resources and exemplifying the province's *Water for Life* Strategy.

**Suncor-Community Partnership Environmental Funding**

In 2009, with an investment of nearly $2 million, Suncor launched three new water partnerships created jointly with the Canadian Parks and Wilderness Society, the Centre for Affordable Water and Sanitation Technology and the Alberta Ecotrust Foundation. The programs created through these partnerships will educate and empower youth to make socially responsible decisions when it comes to water and to be role models for others in their water stewardship. Protecting water and water-related ecosystems is important to Suncor, which is why the company is focusing its Community Partnerships environmental funding in these areas. These new partnerships support the corporate-wide water principals that guide business operations around the world and help consistently manage the water footprint.

**Imperial Oil - Youth Education on Water Management in 2008**

The Society for Environment and Energy Studies Development (SEEDS) introduced the Water Systems and Habitats educational module to Grade 7 to 12 students across Canada. The module instructs students in making informed decisions about the responsible allocation of water. It presents a case study based on a real-life development project outside Calgary. In this case study, there is not enough available water in the immediate area to support the project and to make it work would require negotiation of water rights from surrounding regions. Students assume the point of view of one of 12 stakeholders, playing roles such as the developer, mayor, environmental activist, rancher, or farmer. They then work through water allocation issues by looking at the project's rationale and options. In the end, each decides, based on what they've learned, their perspective and their own thought processes, whether they would give the project the green light or not. Their results are presented in a final statement to their classmates and teacher. This module is part of the SEEDS Habitat in the Balance series which Imperial Oil is funding with $500,000 over five years.

**Imperial Oil- Voluntary Reduction in Water Use Under License**

Imperial Oil's permitted volume to withdraw water from the North Saskatchewan River in 1990 was 15,418,523 m3/yr. As a result of discussions with Alberta Environment and Water, the company agreed to reduce the allocated/permitted volume by 40% to the current level of 9,251,114 $m^3$/yr.

**Husky-Lloydminster Asphalt Plant**

Husky has supported Ducks Unlimited Canada in its habitat conservation efforts since 1989. The company has contributed to the creation of healthy, productive wetlands near its in-situ oil sands project and other development sites in Alberta. Ducks Unlimited has acknowledged Husky as an industry leader in recognizing the importance of wetlands and setting aside resources for their protection.

**Shell- Scotford**

Beginning operation in 1983, Shell Scotford Refinery is one of North America's most modern refineries utilizing energy efficient processing technologies and an environmental design basis including water conservation features. Included in the design basis is air cooling of process streams eliminating the need for cooling water systems thus avoiding water use and the need for water treatment. Process water from hydrocracking/hydrotreating processes is segregated and until recently was injected in deep well, leaving storm water and utility blowdowns as streams being returned to the North Saskatchewan River. Effective 2003 as part of the integration of processes with the Shell Scotford upgrader, refinery process water is treated at the upgrader, a portion of which is recycled back to the refinery as process make up water, and the balance is treated and returned to the river. Effectively more than 50% of the previously injected water in deep well is now recovered.

*Corporate Sustainability Reports*

Many companies formally report on their environmental performance, including metrics for water use, in annual corporate sustainability reports.

The most commonly reported metric is total annual water use, but others include efficiency (water used per volume of oil or barrel of oil-equivalent produced), reuse rates, volume of water withdrawn and returned, and annual water use broken down by sector or source.

The Global Reporting Initiative (GRI) Standards are often used or referenced to document water use in corporate sustainability reports. The GRI indicators for water include:

Total water withdrawal by source;

- Water sources significantly affected by withdrawal of water; and
- Percentage and total volume of water recycled and reused.

**Quote from Imperial Oil 2009 Corporate Citizenship Report**

*"We focus on freshwater conservation opportunities, efficient use of water through the design and operation of our facilities, and recycling and reuse. Company-wide, we are exploring opportunities to further reduce freshwater use and preserve water quality by:*

*- recycling water and minimizing freshwater use in existing operations*
*- managing freshwater use for new projects*
*- reassessing freshwater licence allocations that can be returned to the Crown for redistribution*
*- collaborating with industry to reduce impacts on local water resources*

*Each of our businesses implements strategies to meet specific water needs and challenges. In the Downstream, our efforts are focused on preventing spills from facilities and ensuring that water returned to the environment meets high standards".*

**Quote from Shell 2009 Annual Report**

*"One in three people do not have enough water to meet their needs, according to the World Health Organization. This situation is expected to intensify as cities and populations grow and demand for water increases. The potential impact of global warming on water supplies is also a concern. Our industry is not as big a water user as some others, such as power generation but some of our industry's operations use quantities of water that can be significant – for example, refining processes. Extracting one barrel of bitumen from oil sands takes two to three barrels of water, which is mainly recycled".*

*Gradual reduction in water use in Shell globally:*

*Million $m^3$*

*2007 - 315*
*2008 - 224*
*2009 - 198*

**Quote from Husky 2009 Annual Report**

*"Water stewardship is a fundamental part of sustainable development. Husky continues to undertake efforts to conserve and recycle water, and to find water sources to meet its operational water requirements.*

*The water module of Husky's EPRS (Environmental Performance Reporting System) currently in development, enables Husky to track water usage trends with improved efficiency, accuracy and frequency. This information will aid Husky in identifying and prioritizing opportunities for water use reduction and recycling in its operations. While Husky continues to strive for overall* *reductions in water use and intensity, water use will also be considered in the context of local watershed concerns".*

**Quote from Suncor 2009 Annual Report**

*"Water is an essential part of Suncor's operations. We use water in the bitumen extraction process, as cooling and utility water during upgrading, and to generate steam at our in situ operations.*

*Our refineries also require water for heating and cooling. We know it is a precious resource that must be managed wisely. Our commitment to sustainable development means balancing our company's water requirements with the need to maintain a clean, safe and plentiful supply of this important natural resource.*

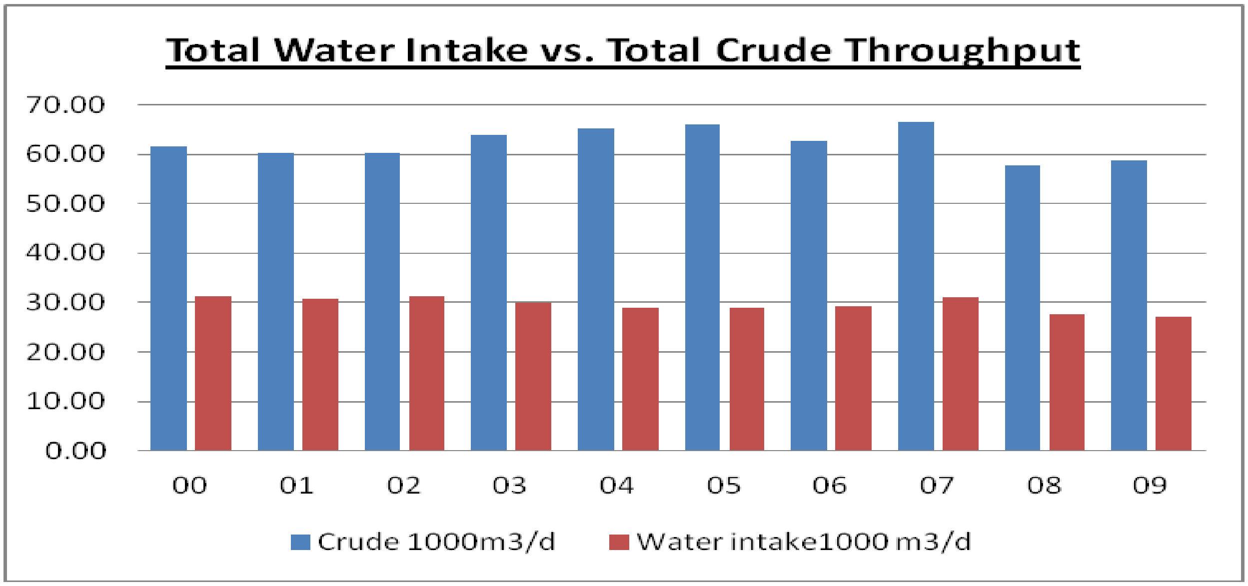
*We have made significant strides in reducing our water use, but we are committed to further reducing our water use through internal use efficiency measures, recycling and new technologies".*

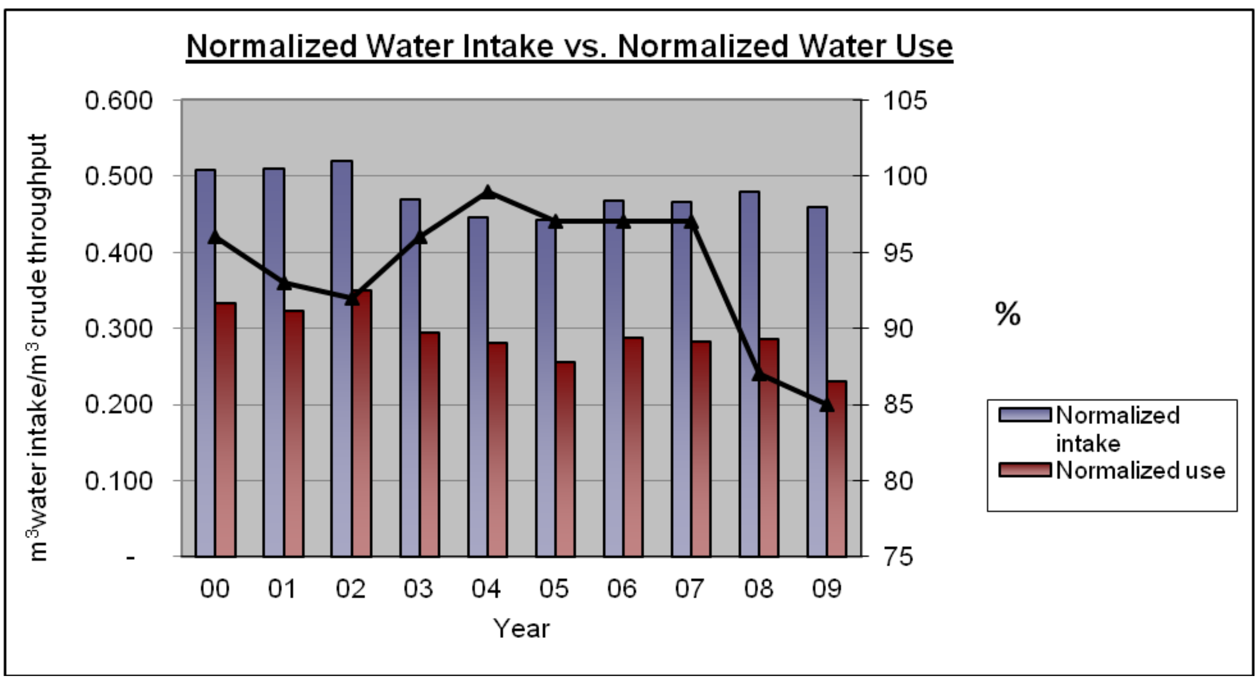
## 3.0 Water Supply and Demand Considerations

Water demand in refining during the past ten years has fluctuated for a number of reasons, including:

- Response to regulations affecting quality of refined products
- Economic trends
- Crude slate changes requiring refinery reconfigurations

The following charts show the historical trend in water demand over the past 10 years:



*Response to Regulations Affecting Quality of Refined Products*[18]

Over the past 15 years, there have been a number of Federal government environment initiatives to changing the specifications of petroleum products:

- Benzene in Gasoline Regulations (1997)
- Sulphur in Gasoline Regulations (1999)
- Sulphur in Diesel Regulation (2002)
- Renewable Fuel Regulations (2010)

In most cases, the need for the removal of contaminants such as benzene or sulphur in products requires a high degree of hydrogenation or molecular cracking, which subsequently require a much higher amount of steam in the form of energy for the production of hydrogen in a hydrogen plant. Throughout the past 15 years, refineries have added a large number of units to reformulate gasoline and diesel as required in the various regulations. In addition, provincial environment regulations have impacted energy use and resulted in higher use of water in refineries.

*Economic Trends*

Water use in refineries very closely follows economic market trends and is affected by refinery utilization. In the past decade, there has been a significant economic change in Canada and the rest of the world. This in turn has impacted consumer behaviour and resulted in a fluctuation in the demand for petroleum products. During lower demand periods, refinery utilization is reduced resulting in less water and energy use by the refinery.

*Crude Slate Changes and Refinery Reconfigurations*

Some of the Alberta refineries have upgraded their refining units to utilize synthetic crude from oil sand. The conversion usually involves the addition of units which require a higher degree of energy resulting in more water use for steam, hydrogen and/or cooling systems.

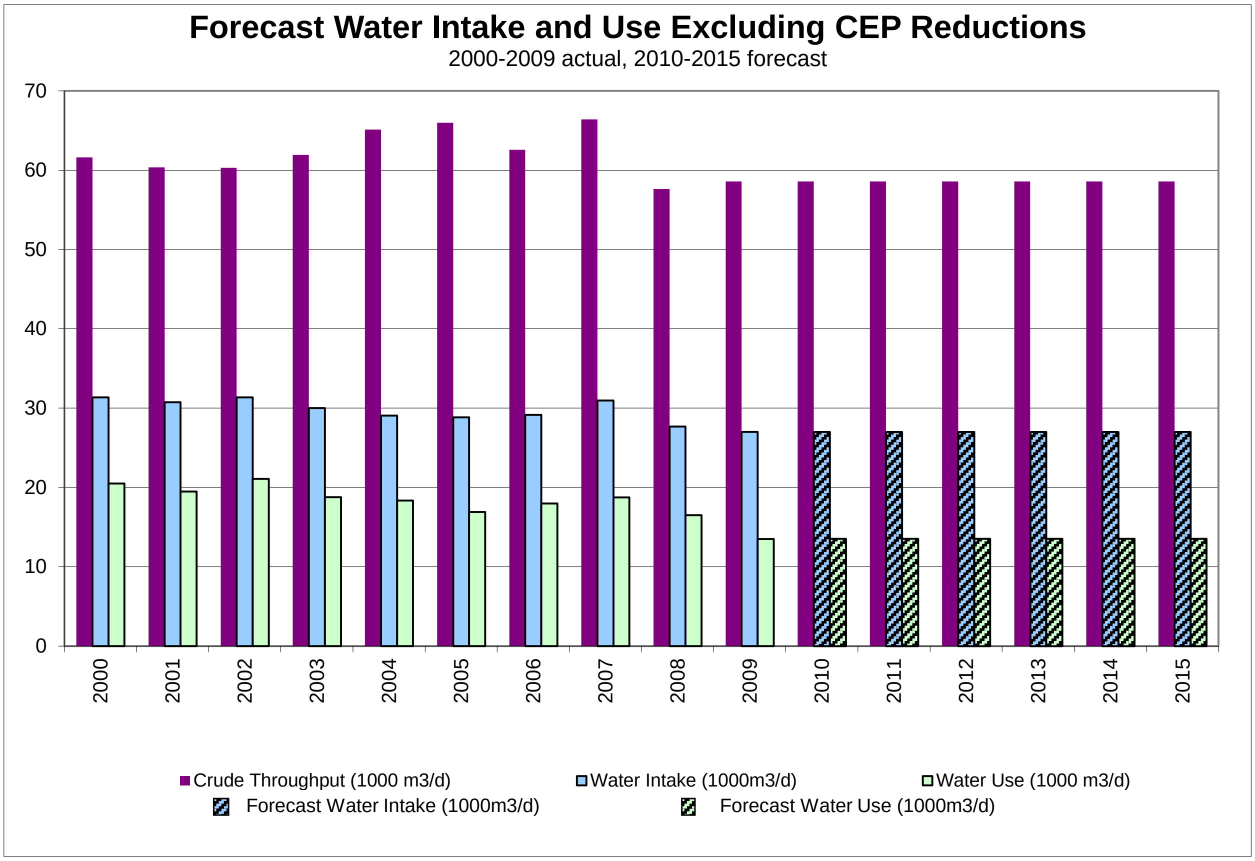
## 3.1 Water Demand Forecasting

The water demand forecast discussed in this section covers the period up to 2015. The volume of water demand in the forecast period is based on the 2009 production and water use rate (i.e. water diversion per unit of crude processed) since this time period reflects a more stable market and economy.

*The following assumptions were made in developing the forecast:*

- No change in regulations requiring additional units to be constructed
- No change in the quality of crude as it is currently utilized
- No significant change in the market demand

Refineries covered in this plan have indicated that they **do not expect a significant change in water demand during the next 5 years provided no external changes are imposed on them**. In addition, no major capital expenditures are expected which may result in a change in water use. However, the sector will continue utilizing practical opportunities, including the ones identified in this report, to further reduce water diversion and/or water use from the North Saskatchewan River by 2015.



## 3.2 Water Supply Considerations

As noted earlier, the three Alberta petroleum refineries are among the lowest industrial users of water and over half of the water withdrawn is returned back to the eco-system at a high level of quality after treatment.

The North Saskatchewan Watershed Alliance has embarked upon an Integrated Water Management Planning Process with the following goals:

- Develop strategies, including establishment of water conservation objectives that will support sustainable use and management of land and water resources of the watershed.
- Identify land users that could adversely affect the future sustainability of the watershed and propose strategies to address these land use issues
- Prepare the Integrated Water Management Plan in collaboration with watershed communities and the public so the watershed meets local and regional needs.

CPPI member companies are in full support of this initiative and are willing to participate in the consultation process over the next 12 months while the Alliance is preparing their report.

## 4.0 Overview of Opportunities for CEP

### 4.1 Identification of All CEP Opportunities

Many opportunities for water CEP have been examined and implemented in the downstream petroleum industry. In marketing and distribution operations, water use is limited and is normally drawn from local water supplies or municipalities. In some cases, groundwater is used to a limited extent where municipal water supply is not available. The refinery operations are continually looking for opportunities to be more efficient users of water. As such, many of the opportunities identified are proven, have been implemented, or are in the process of being designed and implemented.

It is important to note that due to the complexity and unique set up of each refinery and the different ages of each refinery, some operational limitations exist which limit the implementation of identified CEP actions in all refineries. Water use and reduction projects are very site specific. A project which is practical in one refinery may not be suitable for another.

In this report, the opportunities are divided into the three categories consistent with the guidance provided in the CEP framework:

- Conservation:
  1. Any beneficial reduction in water use, loss, or waste.
  2. Water management practices that improve the use of water resources to benefit people or the environment.

  For example, the CEP opportunities identified may decrease overall use of water and therefore the water diverted by refineries, such as using alternative water sources.

- Efficiency:
  1. Accomplishment of a function, task, process, or result with the minimal amount of water feasible.
  2. An indicator of the relationship between the amounts of water needed for a particular purpose and the quantity of water used or diverted.

  For example, the CEP opportunities identified would decrease the overall water use, these opportunities may reduce water losses to the atmosphere and/or increase the volume of water discharged back to the source.

- Productivity:
  1. The amount of water that is required to produce a unit of any good, service, or societal value.

  For example, The CEP opportunities identified would increase production while maintaining the same amount of water used (i.e. improve water use per unit of crude utilized).

**CEP Opportunities for Consideration by CPPI Member Companies**

| Type of Opportunity | | | Description of Opportunity | Probability of Implementation/Comments |
|---|---|---|---|---|
| **Conservation** | **Efficiency** | **Productivity** | | |
| X | X | | Reuse of water from other sources such as Municipal Treatment Plants | **Probability :** Medium **Comment**: One refinery is currently using this option. Availability of water should be considered dependent on site specific applicability |
| | X | | Optimization of wastewater disposal via deep well. Possible re-direction of select streams of contaminated water to WWTP | **Probability**: Medium **Comment:** Increased focus regarding wastewater streams currently disposed of via deep well will optimize the use. |
| | X | | Reduce evaporative losses from cooling towers where applicable by maintenance and upgrades | **Probability:** High **Comment:** Maintenance program requires low capital to maintain operating efficiency. Upgrade is a high capital required project. |
| X | X | | Use of air fans in place of water cooling | **Probability:** Medium **Comments:** Is already being utilized in various refineries where practical and applicable. Higher use of energy should be considered |
| X | X | | Reduce leaks in steam lines/traps and improve condensate collection systems for recycling | **Probability:** High **Comments:** Methods used for VOC reductions through Leak Detection and Repair can be applied to water and steam sources as well |
| X | | | Improve de-salter unit which results in less contaminated water | **Probability:** Low **Comments:** Could require a high capital cost |
| X | | X | Segregation of storm water from contaminated water and recycling of clean storm water | **Probability:** Medium **Comments:** Would not be practical in some refineries due to plant layout and sewer lines |

| Type of Opportunity | | | Description of Opportunity | Probability of Implementation/Comments |
|---|---|---|---|---|
| **Conservation** | **Efficiency** | **Productivity** | | |
| X | | X | Improve the operation of the WWTP to allow recycling of water in process areas | **Probability:** Medium<br>**Comments:** Could result in a high capital cost. May require real estate which is normally limited in an existing refinery |
| | | X | Reduce possibility of leaks and spills by improving maintenance and providing rapid response to spills | **Probability:** High<br>**Comments:** Currently in place in all refineries. Tank and pipeline integrity programs vary in each plant |
| X | | | Continue upgrading marketing facilities to prevent impact on surface and groundwater | **Probability:** High<br>**Comments:** Large capital has already been spent to reduce impact. Each member reviews opportunities as required by regulations and internal company policies. |
| **The following options are considered as Optimization of Equipment, Operating Practices, and Steam Use** | | | | |
| | X | | Superheating stripping steam | **Probability** : High<br>**Comments**: Will result in better stripping and reduction in use of steam |
| X | X | | Heat Exchanger monitoring and maintenance | **Probability**: High<br>**Comments**: Could already be in place in some of the refineries |
| | X | | Boiler Feed Water Blowdown monitoring | **Probability**: High<br>**Comments**: Can be monitored daily to reduce to 0.8-1.3% of steam load |
| | | X | Use higher pressure steam | **Probability**: Low<br>**Comments**: Could be a very expensive and capital intensive project |
| X | | X | Internal re-use and recycling of process water | **Probability:** High<br>**Comments:** Already used for sour water in de-salter |

## 4.2 Analysis of CEP Opportunities

*Use of Water from Other Sources Such as Municipal Treatment Plants*

Application of this option greatly depends on the availability of water, quality of water treated, proximity to the alternate source of water, and the distribution capability of the alternate source of water. This option is currently in place in one of the refineries and has been successful in reducing the refinery dependence on river water. The capital for construction of such a diversion system is relatively high and significant additional treatment is required by both the municipal water treatment plant and the refinery to obtain the necessary quality of the re-used water, to ensure it is suitable for use in the refinery and various operations. Proper pre-treatment of water is essential to ensure improved reliability so that expensive equipment in a refinery is not damaged, and refinery operations are not interrupted.

*Continue to Focus on the Efficient Use of Deep Well Disposal*

Deep wells are used at all refineries in Alberta for disposal of water that cannot be treated in the WWTP. This is based on the treatment capacities of the WWTP and the stringent government regulations that the refineries must meet prior to water being discharged. Optimizing the use of the deep well disposal will continue to be a focus for refineries to ensure that only streams which cannot be treated in the WWTP are disposed of via deep well disposal.

In addition to the benefits in reducing water use, proper maintenance of deep wells and use of compatible waste will result in a longer lifetime for this important disposal option. Generally, there are limitations in use of deep wells that must be considered.

- ✓ Injected wastes must be compatible with the mechanical components of the injection well system.
- ✓ High concentrations of suspended solids can lead to plugging of the injection interval.
- ✓ Corrosive media may react with the injection well components, with injection zone formation, or with confining strata with very undesirable results.
- ✓ Waste streams containing organic contaminants above their solubility limits may require pre-treatment before injection into a well.

*Reduce Evaporative Losses from Cooling Towers*

In Alberta refineries, cooling towers are used in place of once through cooling systems to reduce water intake. Cooling towers can be a source of evaporative losses of up to 10% of the re-circulating rate, depending on the age and design of the towers. Proper maintenance, use of chemicals and increasing efficiency could result in reduced water loss therefore, less reliance on makeup water. It should be noted that upgrading and / or replacing a cooling tower is a capital intensive project.

*Use of Air Fans in Place of Water Cooling*

In newer refineries, the technology of air fans rather than water cooling is the practice of industry. In some of the older refineries, fan cooling has been utilized, where possible. This technology has limited application in units due to the space requirements and difficulty associated with retrofitting equipment, and where more efficient water cooling is essential.

Air fan cooling also requires increased use of electricity to power the fans which can have an adverse affect on GHG production.  Competing environmental priorities must be evaluated when considering replacing water cooling with air fan cooling use.

*Application of Leak Detection and Repair Methodology*

Leak Detection and Repair has been in place in refining, marketing and distribution segments for many years. It has mostly been used for fugitive emissions reduction to address air quality concerns. The program consists of a systematic maintenance inspection program followed by repairs to any identified leaks. One of the major sources of steam loss is malfunctioning steam traps which could be managed by a rigorous preventative maintenance program. This CEP opportunity suggests the application of this concept for the elimination of leaks where water or steam is being discharged.

*Improving De-salter Units*

Desalting of crude is one of the primary and essential processes in a refinery and is done to eliminate salt in the crude which could cause significant corrosion. Desalting is one of the processes that creates a contaminated water stream because the water is in direct contact with the crude. This wastewater is disposed of in deep wells. One way to reduce the volume of wastewater to deep wells is to improve the efficiency of de-salters. This could be a very highly capital intensive project for some of the refiners.

*Segregation of Sewer and Storm Water Systems*

In some older refineries, the sewer system is constructed in such a way that requires storm water to be combined with the process water and directed to the treatment plant. This can result in the unnecessary treatment of clean water that has not come into contact with any petroleum product and could potentially be used for other purposes.

The segregation of sewer and storm systems could be a challenging project for some refineries due to the age and the manner by which the wastewater is collected. In some refineries, the non-contact (clean storm water) is already segregated and discharged as clean water.

*Improving the Operation of the WWTP to Allow Recycling of Water in the Process Area*

WWTPs in Alberta refineries are designed to treat contaminated water to meet the discharge limits required by federal and provincial regulations. They typically consist of primary separation with an air floatation system.

Additional wastewater treatment technologies exist and further remove contaminants by either allowing treatment of more contaminated water and diverting the water from deep wells or by allowing for the recycling of the discharged water for further refinery use.  This option, would require a major reconfiguration to the WWTP, and would not be practical in some cases due to a lack of availability of space in a refinery and/or the very high capital cost.

*Enhancement of Maintenance and Emergency Response Initiatives and Continued Upgrading of Marketing Distribution Facilities*

Refineries traditionally use a comprehensive maintenance program to inspect and repair underground tanks and piping and above ground storage tanks. As a result, leakage of product to groundwater and surface water has been reduced significantly over the past decade. Continued diligence will further increase environmental protection performance.

Marketing and distribution facilities are small users of water when compared to refinery operations, but if a leak or spill occurs, it could impact a large volume of ground or surface water. The petroleum sector is committed to continued risk evaluation and tank upgrading at these sites to prevent impact on surface and ground water.

Significant capital has been invested to upgrade marketing facilities and distribution terminals reducing the potential incidence of a release that would contaminate surface or groundwater. In addition, the establishment of comprehensive emergency response and contingency plans (ERP's) has improved response capability to mitigate damage to the environment from accidental releases. ERP's are continuously improved with regularly scheduled simulations and response exercises.

*Optimization of Equipment, Operating Practices, and Steam Use*

Opportunities may exist within some refinery operations to optimize the pressure and temperature of stripping steam use, so that the volume of steam (and therefore water) could be reduced. These options may be prohibitively expensive as it may involve a redesign of the steam system and boilers in the refinery. Steam production operating practices may also be an opportunity to reduce water use. Through careful monitoring of wastewater produced from steam production equipment (boilers), steam production could be optimized based on the steam requirements.

Cleaning and monitoring of heat exchangers may result in improvements in efficiency of the equipment and may reduce the volume of water to provide the same level of cooling.

## 4.3 Selected/Recommended CEP Opportunities and Targets

Opportunities to implement conservation, efficiency, and productivity (as defined) exist for the downstream petroleum sector. As noted throughout this report, due to a varying complexity of operations, varying ages of facilities, internal company business plans, and external public policies, it is very difficult to identify specific CEP actions that can uniformly apply to all operations or facilities. Each CPPI member will consider the opportunities and select those based on business plan assessments and operating feasibility for their companies.

In addition to the varying feasibility constraints, each refinery will experience varying levels of cost constraints due to the varying complexity and unique set up within each refinery. In most cases, the CPPI member company refineries have been operating their units utilizing the concept of proven and applicable Best Available Technology Economically Available (BATEA) and have used available capital to improve the overall environmental performance of the sector, in particular, water use.

The CEP opportunities detailed in sections 4.1 and 4.2 have been aggregated for the sector by the author and have been reviewed individually by CPPI members considering site specific issues and each company's approach to pollution prevention.

# 5.0 CEP Plan Implementation and Monitoring

## 5.1 Implementation Schedule

This plan has been developed in full cooperation with CPPI member companies. It is expected that when the report is finalized, the opportunities presented will be considered and individual site specific CEP plans will be developed to implement CEP opportunities as they are applicable to each site. The timing of this plan extends to the end of 2015.

CPPI has developed and implemented many Best Management Practices. There are also many industry standards which refiners have and continue to apply in order to reduce refinery impact on all aspects of the environment. It is expected that the member companies will look to CPPI for guidance on how to best collectively achieve the target.

The report will be distributed to the CPPI Water Network members and the CPPI National Environmental Committee to monitor progress.

Companies will continue to maintain reliable records on all water use and identify areas for improvement. CPPI will be used as a vehicle for consultation and communication amongst the members. Annually, CPPI member companies will be requested to provide water use information to CPPI. This information will be analyzed and consolidated by CPPI and included in the most recent edition of the CPPI publically available document “Water – A Precious Resource” available on the CPPI website.

This report may be used, in addition to specific member company training material, as a basis for training operators and improving the employee knowledge with respect to water use and the importance of conservation and efficiency. The collective information provided in this report will be used to identify trends and to develop water use forecasts. It also can be used as an audit tool, in conjunction with the annual water use reporting and benchmarking, for measuring a company’s performance, as well as, in the development of metrics to measure water use and conservation.

## 5.2 Integration with Other Plans

The CEP Plan implementation will be integrated with existing CPPI and individual member company initiatives. Best management practices may be updated to include the agreed-to opportunities, findings and metrics in the plan. It must be noted however, that due to the variation in member company refinery operations, not all opportunities are applicable at each refinery.

This plan may be used in conjunction with the existing water metric collection as a tool for internal reporting and also as a basis for member company evaluation of water use. It is expected that the information on water use in the plan will be updated when each company provides their water use and discharge data to Statistics Canada every two years.

## 5.3 Monitoring and Reporting

*Performance Measurement*

For refinery operations, monitoring and reporting of water intake, discharge, and use is the best method for each company to measure the impact of operations on the ecosystem. For marketing and distribution facilities, a reduction in spills and leaks is the best measure of performance.

These metrics are currently measured by each CPPI member company. Marketing and distribution spills are also reported in the CPPI internal Environmental and Safety Performance Report (ESPR) on an annual basis. Water use data is used to update the CPPI document "Water – A Precious Resource" available to the public online through the CPPI website.

*Monitoring and Auditing*

Monitoring information related to licensed water use is collected and managed by Alberta Environment and Water (AEW), the Energy Resources Conservation Board (ERCB) and by industry organizations such as CPPI. Currently, all licensees are required to retain records of water use. Most large municipal, irrigation, commercial, and industrial users are required to report their water use to AEW. For all licensees, AEW has developed an online reporting system to obtain additional water use information. Companies are expected to submit all of their water use data electronically to Alberta's Water Use Reporting System. All CPPI member companies also report water use to Statistics Canada on a bi-annual frequency.

*Reporting*

CPPI, through consultation with its members, will communicate the implementation progress on water management and CEP opportunities identified in this report. The Statistics Canada Industrial Water Survey is updated bi-annually (2012 and 2014 during this sector plan period) and will be the frequency (year end 2013 and 2015) for reporting on this plan.

*Evaluation and Continuous Improvement*

The downstream petroleum sector will continue to comply with all regulations related to water and will continue to pursue improvements in water CEP. The water CEP plan will be reviewed and updated in December 2015.

## 6.0 Participation and Accountability

The downstream petroleum sector will be using **Option C** as outlined in the *Water for Life*[4] strategy “Framework for CEP Sector Planning”. CPPI has established a team of experts in refinery water management (CPPI Water Network) who will assume responsibility for updating this plan.

CPPI will share the CEP sector plan and invite external comment from interested and relevant stakeholders. External stakeholders contacted will include the North Saskatchewan Watershed Alliance (NSWA), the Northeast Capital Industrial Association (NCIA), Chemistry Industry Association of Canada (CIAC), Alberta Environment & Water (AEW), and the AWC Sector Planning for CEP Plan Project Team.

The plan will be presented to the Alberta Water Council board after review and approval by the CPPI Board of Directors.

The CPPI Water Network members will be responsible for providing company data on all environmental performance, including water use and discharge quality, to the CPPI office for preparation of the ESPR. CPPI member companies are required as part of their membership to follow CPPI’s ten Environment, Health and Safety Guiding Principles.

CPPI will be responsible for the communication and dissemination of this report.

## 7.0 Summary

This plan documents the current water use in the downstream petroleum sector and describes some of the actions taken to date to reduce water diversion from various natural sources, as well as, increase the efficiency of the water used in refinery operations. It also provides opportunities for consideration by members to evaluate their capabilities to further reduce water use and increase efficiency and productivity.

The petroleum sector, representing the downstream industry, is submitting this CEP plan as part of the Chemical and Petrochemical sector identified under the AWC guidelines.

Overall, the downstream petroleum industry is expecting limited growth in market demand resulting in similar levels of refining utilization and production of petroleum products.

In this sector, refineries are the largest users of water and have taken many steps in the past to increase the efficiency of water use. Marketing and distribution facilities use very little water when compared to refinery operations and were not the focus of the CEP opportunities in this report. CEP actions for marketing and distribution facilities have been focused on measures to prevent spills and leaks.

Three refineries in Edmonton source water used in the refinery from the North Saskatchewan River in accordance with their licenses. Based on the current refinery utilization, the refining segment of the petroleum industry uses approximately 60% of its allocated water usage under combined licenses given to them by Alberta Environment and Water. Water is used in a refinery for a variety of purposes and approximately 40% of water diverted for refinery use is returned back to the river after being treated to a high quality. Groundwater is used in an asphalt plant and some of the rural marketing facilities.

The downstream petroleum sector is a relatively small water user when compared to other sectors in the province. The sector has already achieved approximately 32% reduction in water use from the base year. However, the sector will continue utilizing practical opportunities to further reduce water diversion and/or water use from the North Saskatchewan River by 2015.

Most of the CEP opportunities identified in this plan are highly capital intensive and may not be applicable to all member company refineries due to the differences in refinery operations and complexity. Allocation of capital will be reviewed in consideration of other environmental expenditures.

CPPI will be responsible for the overall monitoring and reporting of member company progress in implementing the various plans and meeting the target. Performance metrics will be developed for members to report and document their progress.

CPPI will continue updating this plan using member companies' annual data and using the overall methodology presented in this report.

## Alberta Sector CEP
## Plan Metrics

| Component | Units | 2000 | 2009 | F(U) | %F(U) |
|---|---|---|---|---|---|
| **Refinery Throughput** | 1000m$^3$ /day | 61.6 | 58.9 | (2.76) | (4.48) |
| **Refinery Utilization** | | 95% | 86% | (9%) | - |
| **Water Intake (actual)** | Mm$^3$ | 11.4 | 9.9 | 1.50 | 13.16 |
| **Water Discharge (actual)** | Mm$^3$ | 4.2 | 4.9 | 0.70 | 16.67 |
| **Water Use (actual)** | Mm$^3$ | 7.3 | 4.9 | 2.40 | 32.88 |
| **Water Use(normalized)** | m$^3$/m$^3$ crude | 0.325 | 0.228 | 0.10 | 29.88 |
| **Water Intake License** | Mm$^3$ | 17.3 | 17.3 | 0.00 | 0.00 |
| **% License Utilized** | | 66% | 57% | 9% | - |
| **Refinery Effluent Quality (% of allowable limits)** | | <15% | <10% | 5% | |

**F= Favourable, (U)= Unfavourable**

## 8.0 Glossary

**AEW** – Alberta Environment and Water

**Air Fan**— cooling system in a refinery using large fans

**AWC** – Alberta Water Council

**API**—American Petroleum Institute

**Automated Shut Off System**— Shut off system activated at a specific level of liquid in the tank

**Base Year**— Average water intake in 2000, 2001 and 2002 (intake, used, discharged)

**Best Management Practices (BMPs)** - Management practices or techniques recognized to be the most effective and practical means for meeting goals, while minimizing adverse environmental and other effects.

**Biological Oxidation Unit**— Aeration tank with microorganisms to allow biological degradation of oily material. Oil will break down into water and CO2.

**Bitumen** – Petroleum in semi-solid or solid forms.

**Bulk Plant—** A receiving and distributing facility for petroleum products; includes storage tanks, warehouses, railroad sidings, truck loading racks, and related elements.

**Card Lock—** A commercial version of a retail gasoline station with no attendants, allowing customers to automatically access facilities and purchase fuel.

**CPPI** – Canadian Petroleum Products Institute
.
**CEP** – Conservation, efficiency and productivity.

**Cooling Tower**— Equipment used in a facility to cool down hot water for re-use as cooling fluid

**Conservation –** Any beneficial reduction in water use, loss or waste. In addition, water management practices that improve the use of water resources to benefit people or the environment.

**Conventional Crude Oil** – Petroleum found in liquid form, flowing naturally or capable of being pumped without further processing or dilution.

**CTP**— Corrugated Tilted Plate filters

**Deep Well**— Injection of waste streams into cavities of varying depths previously used for recovery of conventional oil and gas

**Dissolved Air Floatation Unit**— a unit normally used in the waste water treatment plant, air bubbles moving upward, will force oil or solid particles to the surface for removal.

**Downstream**—The refining, marketing and distribution sector of the petroleum industry.

**Ecosystem** – A dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit.

**Efficiency** – The accomplishment of a function, task, process or result with the minimal amount of water feasible. Efficiency is an indicator of the relationship between the amounts of water required for a particular purpose and the quantity of water used or diverted.

**EMS/QMS**— Environmental and Quality Management Systems normally in line with ISO 14001 and 9000 standards.

**Enhanced Oil Recovery (EOR)** – Any method that increases oil production by using techniques or materials that are not part of normal pressure maintenance or water flooding operations.

**ERCB** – Energy Resources Conservation Board

**ERP**— set of procedures used for preparedness and response to an emergency
.
**GRI** – Global Reporting Initiative

**Heavy Crude Oil** – Oil with a gravity below 28 degrees API.

**HAZOP**— Hazard Assessment and Operability Procedure, is a systematic procedure used to evaluate the level of risk in the operation of a unit in a refinery

**Heating Fluid**— normally a hot fluid, used as a heating medium, such as steam

**In- Vitro toxicity**— injection of toxic material into a fish egg and measuring the impact on the fish after birth

**Light Crude Oil** – Liquid petroleum that has a low density and flows freely at room temperature.

**Makeup Water** – Additional water required for a process to make up for losses such as blow down or evaporation.

**Normalized Water Use** – Total water consumed per total crude processed

**Oil Sands** – Naturally-occurring deposits of sand, clay or other minerals saturated with bitumen, found mainly in the Athabasca, Peace River and Cold Lake areas of Alberta.

**Overflow Protection**— a mechanism used to automatically shut off flow of a liquid when a desirable level in a tank is achieved

**Petrochemical Plant**— a plant using petroleum feedstock for production of petrochemicals

**Potable Water** – Water suitable for human consumption, used for drinking, cooking and other domestic use. Health Canada defines potable water as containing less than 500 mg/L of total dissolved solids.

**Primary Distribution Terminals** —Facilities for the storage of petroleum products normally receiving product by pipeline directly from a refinery with capacity of equal or more than 250 million litres per year

**Process Water**— Water used in a process for washing or cooling, and also used for production of hydrogen

**Process Fluid**— any liquid used in a process for cooling or heating, such as steam

**Productivity –** Refers to the amount of non-saline water required to produce a unit of any good, service, or societal value.

**Recycle Water**– The process of using water multiple times for similar purposes.

**Refinery Utilization Rate**-- Represents the use of the atmospheric crude oil distillation units. The rate is calculated by dividing the gross input to these units by the operable refining capacity of the units.

**Reuse Water** – The process of using water that has already been used for one purpose, such as condensate

**Sand Filter—** Filters used for final polishing of treated water; it is comprised of a bed of graded sand which is supported by a layer of gravel. The filter media is confined in a box with openings at both ends allowing water to flow in and out, while operating on a top-down, gravity basis.

**Stakeholders** – Industry activities often affect surrounding areas and populations. People with an interest in these activities are considered stakeholders. They may include nearby landowners, municipalities, Aboriginal communities, recreational land users, other industries, environmental groups, governments and/or regulators.

**Surface Water –** Water located above ground (e.g., rivers, lakes, wetlands).

**Upstream** – The companies that explore for, develop and produce Canada's petroleum resources are known as the upstream sector of the petroleum industry.

**Water Allocation** – Amount of water that can be diverted for use, as set out in water licenses and registrations issued in accordance with the *Water Act.*

**Water Diversion** (or withdrawal) – Describes the amount of water being removed from a surface or groundwater source, either permanently or temporarily.

**Water Use** – Net water use or the difference between the amount of water diversion and the return flow.

**Withdrawal** – A volume of water removed under license from a water source.

**WWTP**— Waste Water Treatment Plant

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Information to prepare this document came from many sources, some of which are not listed as they are not compiled in one specific publication. All information is available through public sources.


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