Directive 081

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Water Disposal Limits and Reporting Requirements for Thermal In Situ Oil Sands Schemes

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Contents

1 Introduction

1.1 Purpose of this directive

This directive consolidates various aspects of water management requirements for thermal in situ oil sands operations. It sets water disposal limits and includes guidance for reporting facility water streams to Petrinex. The goal is that operators minimize the use of high-quality nonsaline make-up water by recycling produced water efficiently and using alternative water sources where possible. Efficient water treatment, recycle, and disposal at thermal operations will optimize overall water use and energy efficiency.

In addition to limiting disposal, this directive provides formulas for water make-up, water productivity ratios, and produced-water recycle used for monitoring and comparing thermal operations in Alberta. Scheme volumetric data are published on the Alberta Energy Regulator (AER) website in the Thermal In Situ (TIS) Water Publication.

1.2 AER Requirements

Following AER requirements is mandatory for the responsible duty holder as specified in legislation (e.g., licensee, operator, company, applicant, approval holder, or permit holder). The term "must" indicates a requirement, while terms such as "should," "recommends," and "expects" indicate a recommended practice.

Each AER requirement is numbered.

Information on compliance and enforcement can be found on the AER website.

1.3 What's New in This Edition

Inlet water types in the previous edition of *Directive 081* mirrored Petrinex water types and did not completely align with AER's water use performance reporting. To address this issue, the inlet water types for calculating actual disposal and disposal limits are redefined in section 2.1.

The actual disposal and disposal limit formulas in section 3 maintain the same structure in this edition, but higher disposal factors are introduced to encourage the use of alternatives over high-quality fresh water (i.e., water from shallow aquifers, lakes, and rivers).

Table 1. New disposal factors for alternative make-up water

Alternative water source	Old disposal factor	New disposal factor
Alternative nonsaline groundwater	0.03	0.10
Treated wastewater	0.03	0.10
Industrial runoff	0.03	0.10
Oil sands process-affected (tailings) water from mines	0.03	0.55
Nonsaline groundwater in contact with bitumen	0.03	0.55
Saline groundwater	0.35	0.55
Saline water balance credit	0.35	1.0
Raw wastewater (otherwise disposed)	0.03 to 0.10	1.0

We also increased the disposal factor for excess produced water to allow mature projects to dispose of the excess without having to apply for a variation.

With the introduction of new inlet water types, the actual disposal and disposal limit formulas have been simplified so facility opening and closing inventories and transfers are no longer used in sections 3.1 or 3.2.

The injection facility water balance section has been removed because the AER found the root cause associated with water imbalance noncompliances were metering differences, and those are addressed by *Directive 017* (sections 3.2, 12.3 and 12.4), and overall scheme water imbalances are addressed under measurement, accounting, and reporting plans approved under *Directive 042*.

The exemption criteria in section 3.3 have been changed to allow small projects more flexibility around when they implement produced water recycling.

References to monthly water reporting requirements have been removed because they are redundant with *Directive 007* requirements (section 2.1, 2.2 and 2.3). Appendices with examples of how to report various water production, receipts, injection, and dispositions in Petrinex have also been removed because *Manual 011* provides this guidance. Appendix 2 and appendix 3 have been updated to show how Petrinex data is to be entered and used for the purpose of calculating actual disposal and disposal limits with the new inlet water types.

The appendix for scheme performance indicators has been moved to the TIS Water Publication so it can be updated as policy and regulatory changes occur.

New terms are defined in the body of the directive. Other terms are defined in appendix 1.

2 Water Reporting

2.1 Inlet Water Types

Inlet water is grouped into four categories: high-quality nonsaline and alternative types 1, 2, and 3. Definitions and some examples of each inlet water type are listed below. The lists of examples are not exclusive and should not hinder innovative efforts to use a new or overlooked alternative water

source. We will provide and maintain a well and facility list with assigned water sources in the TIS Water Publication to ensure water is properly categorized into the right inlet water type.

High-Quality Nonsaline (HQN)

This includes surface water (e.g., rivers and lakes) and high-quality nonsaline groundwater, defined as groundwater that has total dissolved solids less than or equal to 4000 milligrams per litre. It does not include nonsaline water that falls under one of the three alternative types or any type of wastewater.

Examples include water from

- a well licensed under *Directive 056* drilled to a depth greater than 150 m,
- a shallow well licensed under the *Water Act* with a depth less than 150 m, or
- a surface water source, such as a diversion point at a lake or a river, regardless of TDS.

Alternative Type 1 (A_1)

- Alternative nonsaline groundwater: See section 2.1.1.
- Industrial runoff: Precipitation that falls on or traverses the plant developed area as defined within the scheme's *Environmental Protection and Enhancement Act* approvals.
- Treated wastewater: Wastewater that is treated or tested against applicable standards so it can be returned to the environment. It may include camp wastewater, wastewater from central processing facilities and supporting buildings, upgrader wastewater, and municipal wastewater.
- Recyclable produced water: See section 2.1.2.

Alternative Type 2 (A_2)

- Oil sands process-affected water (tailings water) from an oil sands mine
- Nonsaline groundwater in contact with bitumen
- Saline groundwater, minus any saline water balance credit (see section 2.1.3)

Alternative Type 3 (A_3)

- Wastewater that would otherwise be sent to disposal wells (including produced water from an external project, upgrader wastewater from an external project, and landfill leachate)
- Excess produced water (see section 2.1.2)
- Any saline water balance credit (see section 2.1.3)

2.1.1 Alternative Nonsaline Groundwater

Has total dissolved solids less than or equal to 4000 milligrams per litre but only includes deep nonsaline groundwater that has not been sourced from a water-short area, has limited potential to interact with shallower aquifers or surface water, and has limited potential for future nonindustrial use.

Regardless of its depth, groundwater sourced from Neogene- or Quaternary-aged aquifers will be categorized as high-quality nonsaline because it has higher potential to interact with shallower aquifers and surface water and has higher potential for future nonindustrial use. Conversely, groundwater sourced from wells completed in bedrock aquifers where the base of the overlying aquitard (aquifer top) is deeper than 150 m will be categorized as alternative because it is less likely to interact with shallower aquifers or surface water and has less potential for future nonindustrial use due to the high cost of meeting regulatory requirements associated with drilling deeper in Alberta. The decision tree in figure 1 provides guidance for classifying nonsaline groundwater.

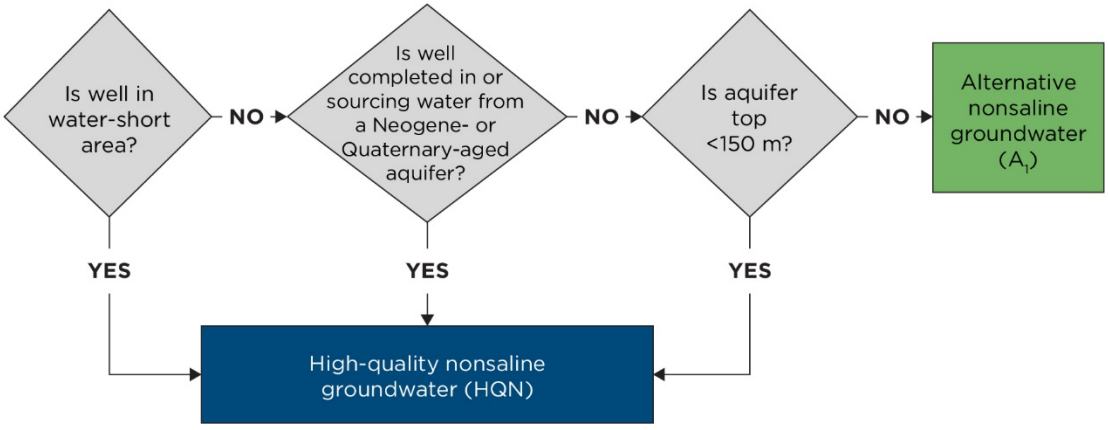


Figure 1. Decision tree for determining if nonsaline groundwater should be treated as "high-quality" or "alternative"

"Water-short" areas are designated by Alberta Environment and Parks in the *Water Conservation and Allocation Guideline for Oilfield Injection* (2006), as amended.

Water from wells shallower than 150 m may be considered alternative nonsaline groundwater if they are completed in hydrocarbon-bearing zones and are licensed by the AER under *Directive 056*. Groundwater remediation wells authorized under the *Water Act* or the *Environmental Protection and Enhancement Act* may also be considered alternative nonsaline groundwater.

2.1.2 Produced Water – Recyclable and Excess

Because it is preferable to use produced water over make-up water to produce steam, produced water is broken up into two categories: recyclable and excess.

First calculate the volume of all steam injection of varying quality over a year in cold water equivalent (CWE).

If the volume of water produced in a calendar year is less than or equal to the steam injection volume, it is classified as "recyclable" and falls under alternative type 1 water, with its lower disposal allowance.

The portion of water produced in a calendar year that exceeds the steam injection volume can be classified as "excess" and falls under alternative type 3 water, with its higher disposal allowance. (Excess produced water cannot be less than 0 m^3.)

For example, if a scheme injected 1 000 000 m^3 CWE of steam in a year and produced 1 100 000 m^3 of water, 1 000 000 m^3 of that produced water would be classified as "recyclable," and the other 100 000 m^3 would be "excess."

2.1.3 Saline Water Balance Credit

The saline water balance credit only applies to schemes that source saline groundwater from the same aquifer used for disposal. In Alberta, saline aquifers receive very little to no water recharge from precipitation or shallower groundwater zones. Saline groundwater withdrawals can depressurize a large area if wastewater disposal volumes are not injected back into the same zone. Similarly, wastewater injection for disposal can increase pressure over a large area if saline groundwater is not sourced from the same zone. If a scheme re-injects its disposal volumes back into the same aquifer it sourced the water from, a higher disposal factor can be granted because the wastewater disposal pressure increases are balanced by the pressure decreases from the water withdrawals.

For each saline aquifer being used by the scheme for water sourcing and disposal, the credit cannot exceed the lesser of the disposal volume returned to the zone or the make-up water volume withdrawn from the zone. It also cannot be less than 0 m^3.

For example, if a scheme sources 300 000 m^3 of saline make-up water from the McMurray Formation and 700 000 m^3 from a different formation, and disposes 1 000 000 m^3 back into the McMurray Formation, the saline water balance credit for the scheme is 300 000 m^3, and the remaining 700 000 m^3 of saline make-up water is included in alternative type 2 water.

Knowledge of how much water a scheme sources from and re-injects back into an aquifer is required for properly assessing the saline water balance credit for a given year. For some schemes, this information needs to be attained at the well level (as opposed to the facility level) from Petrinex. We will provide a well list with assigned aquifers in the TIS Water Publication.

2.2 *Directive 081* Water Inlet and Outlet Types and Petrinex

Operators are to use the tables in appendix 2 to ensure Petrinex water entries are properly categorized for actual disposal and disposal limit calculations.

The tables in appendix 2 list various Petrinex activity and product codes and then maps them to the inlet and outlet water types defined in this directive.

Appendix 3 provides is a simplified water-flow diagram with showing Petrinex reporting codes for the inlet and outlet water types defined in this directive for a sample thermal scheme.

3 Formulas and Limits for Disposal at Thermal In Situ Schemes

1) A scheme's actual disposal (section 3.1) in a calendar year (January 1st to December 31st, starting in the year 2019) must not exceed its maximum disposal limit (section 3.2). This applies to all thermal in situ schemes, with some exceptions outlined in section 3.3.
2) Formulas must be applied on a scheme basis. Schemes with multiple injection and disposal facilities cannot apply these formulas to individual facilities.
3) In calculating the scheme's actual disposal (section 3.1) and disposal limit (section 3.2), operators must ensure Petrinex water entries are properly categorized into inlet and outlet water types in accordance with the definitions in section 2 and the tables in appendix 2.

3.1 Actual Disposal Formula

The actual disposal formula gives the total scheme disposal as a percentage of the scheme's total inlet water volume:

$$Actual\ Disposal\ (\%) = \frac{Total\ disposal}{Total\ inlet} \times 100$$

where *Total disposal* is the annual volume in cubic metres of scheme water injected into designated disposal wells ("Disposal" in table 4) and annual volume of scheme water dispositions delivered out of the scheme ("Disposition Out" in table 4), and *Total inlet* is the annual volume in cubic metres of all four categories of inlet water for the scheme: high-quality nonsaline and alternative types 1, 2, and 3 (as defined in section 2).

3.2 Disposal Limit Formula

Water disposal at a scheme is affected by

- the quality and quantity of water streams entering the facilities in the scheme,
- the treatment technologies being used, and
- the bitumen recovery mechanism.

The AER has established a disposal factor for each inlet water type used at thermal operations (table 2). These factors are entered into the disposal limit formula to determine the maximum disposal limit for the scheme.

Table 2. Disposal factor for thermal in situ schemes

Inlet water type	Disposal factor	
High-quality nonsaline water	D_{HQN}	0.03
Alternative type 1 water	D_{A1}	0.10
Alternative type 2 water	D_{A2}	0.55
Alternative type 3 water	D_{A3}	1.0

The AER will consider variations of the disposal factors in table 2 upon application. An example of a circumstance where AER would consider a higher disposal factor would be to use a new or overlooked alternative water source not listed in section 2. Operators must provide justification for any deviation from the disposal factors.

The maximum disposal limit for a scheme is calculated as a percentage of the scheme's total inlet water volume:

$$Disposal\ Limit\ (\%) = \frac{\left(HQN \times D_{HQN}\right) + (A_1 \times D_{A1}) + (A_2 \times D_{A2}) + (A_3 \times D_{A3})}{HQN + A_1 + A_2 + A_3} \times 100$$

where HQN, A_1, A_2 and A_3 are the sum of the annual volumes in cubic metres for the scheme, and D_{HQN}, D_{A1}, D_{A2} and D_{A3} are the respective disposal factors for those specific inlet water types.

3.3 Exemptions

The disposal limit does not apply to thermal in situ oil sands schemes that, in the absence of produced water recycle, have an annual volume of high-quality nonsaline make-up water less than 500 000 m^3 and a total annual make-up water volume less than 2 000 000 m^3.

The disposal limit also does not apply during the first twelve months from the commencement of steam injection for a new scheme, or during the first twelve months from the recommencement of steam injection for reactivated schemes (which were suspended). Once this twelve month period is complete, the AER will use the remaining months of that calendar year to calculate the disposal limit to determine compliance for that year. This twelve-month exemption period does not apply to scheme expansions or new scheme phases.

Appendix 1 Definitions

battery	A system or arrangement of tanks or other surface equipment receiving the effluents of one or more wells prior to delivery to market or other disposition, and may include equipment or devices for separating the effluents into oil, gas, or water and for measurement.
BRKWTR (brackish water)	For the purpose of reporting to Petrinex, brackish water is saline groundwater that has total dissolved solids greater than 4000 milligrams per litre.
calendar year	January 1st to December 31st.
FSHWTR (fresh water)	For the purpose of reporting to Petrinex, fresh water is either nonsaline groundwater, which is groundwater that has total dissolved solids less than or equal to 4000 milligrams per litre, or surface water or runoff.
injection facility	A system or arrangement of surface equipment associated with the injection or disposal of any substance through one or more wells.
make-up water	Water used at thermal in situ operations other than produced water from wells within the scheme, used to make up for water losses such as the disposal of water treatment waste streams, boiler blowdown, and reservoir retention of injected steam.
nonindustrial water use	Includes water use for agricultural, domestic, municipal, and other purposes authorized under the *Water Act*.
scheme	Includes all batteries and injection facilities associated with an AER thermal in situ oil sands scheme approval.
STEAM	For reporting to Petrinex, the sum of all steam injection of varying quality, reported in cold water equivalent as defined in *Directive 017*, as amended.
WATER (produced water)	Water that is produced in association with hydrocarbon production from a well that was licensed for the purpose of hydrocarbon production. For the purpose of reporting to Petrinex, this also includes wastewater injected (or that would have otherwise been injected) into disposal wells.

Appendix 2 *Directive 081* Water Inlet and Outlet Types and Petrinex

Table 3. Petrinex activity and product codes mapped to Directive 081 inlet water types

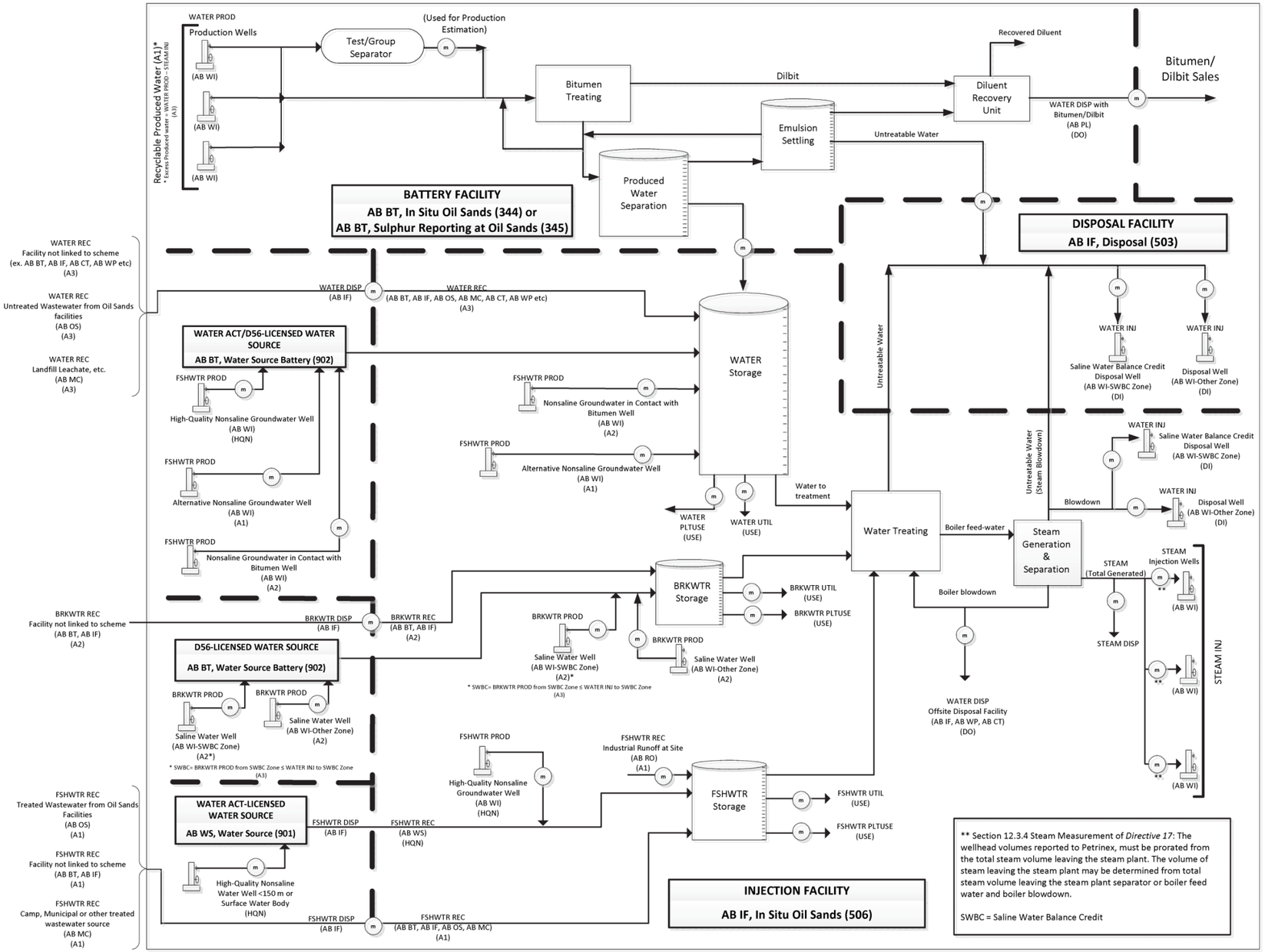
Petrinex activity	Petrinex product	*Directive 081* type	Definitions and allowable water sources
PROD	FSHWTR	High-quality nonsaline	The sum of reported fresh water production into a scheme facility. • Allowable sources include high-quality groundwater source wells linked to the scheme, licensed under *Directive 056* (AB WI) (i.e., water source wells completed in Quaternary or Neogene aquifers, or aquifers with tops <150 m)
		Alternative type 1	The sum of reported fresh water production into a scheme. • Allowable sources include alternative type 1 water source wells linked to the scheme, licensed under *Directive 056* (AB WI) (i.e., alternative nonsaline groundwater source wells)
		Alternative type 2	The sum of reported fresh water production into a scheme facility. • Allowable sources include alternative type 2 water source wells linked to the scheme, licensed under *Directive 056* (AB WI) (i.e., nonsaline groundwater in contact with bitumen source wells)
	BRKWTR	Alternative type 2	The sum of reported brackish water production into a scheme facility. Allowable sources include saline water source wells licensed under *Directive 056* (AB WI)
		Alternative type 3	The sum of reported brackish water production into a scheme facility that qualifies for the saline water balance credit. Allowable sources include water source wells completed in the same zone as the disposal wells linked to the scheme, licensed under *Directive 056* (AB WI) NOTE: The volume of brackish water that qualifies for the SALINE WATER BALANCE CREDIT cannot exceed the volume of water injection into the same zone.
	WATER	Alternative type 1	RECYCLABLE PRODUCED WATER: The sum of produced water from wells into a scheme facility less than or equal to the scheme's total steam injection volume. Allowable sources include wells linked to the scheme, licensed under *Directive 056* (AB WI)

Petrinex activity	**Petrinex product**	***Directive 081* type**	**Definitions and allowable water sources**
		Alternative type 3	EXCESS PRODUCED WATER: The sum of produced water from wells into a scheme facility greater than the scheme's total steam injection volume. Allowable sources include wells linked to the scheme, licensed under *Directive 056* (AB WI)
REC	FSHWTR	High-quality nonsaline	The sum of fresh water receipts into a scheme facility. Allowable sources include a water source facility (AB WS)
		Alternative type 1	The sum of fresh water receipts into a scheme identified as alternative type I water, including transfers from outside the scheme. Allowable sources include: • Treated wastewater from Oil Sands Facilities (AB OS) [i.e., upgraders that would otherwise return the wastewater to the environment] • Industrial Runoff (AB RO) • Facilities not linked to the scheme (including battery or injection facilities) • Miscellaneous water source (AB MC) [i.e., camp or municipal wastewater]
		Alternative type 2	The sum of fresh water receipts into a scheme facility that is identified as alternative type 2 water. Allowable sources include Oil Sands Facility process-affected water (tailings - AB OS)
	BRKWTR	Alternative type 2	The sum of brackish water receipts into a scheme from outside the scheme. Allowable sources include: • Facilities not linked to the scheme (including battery or injection facilities)
	WATER	Alternative type 3	The sum of produced water volumes into a scheme facility from outside the scheme, that would have otherwise been disposed of outside the scheme. Allowable sources include: • Facilities not linked to the scheme (including battery or injection facilities) • Miscellaneous Water source (AB MC) [i.e., landfill leachate] • Untreated wastewater from Oil Sands Facilities [i.e., upgraders that would otherwise inject the wastewater into disposal wells]

Table 4. Petrinex activity and product codes mapped to *Directive 081* outlet water types

Petrinex activity	Petrinex product	Directive 081 type	Definitions and allowable water sources
INJ	FSHWTR BRKWTR WATER	Disposal (DI)	The sum of injection volumes for all coded disposal wells linked to the scheme.
	STEAM	Reservoir Injection (ST)	The sum of injection volumes for wells coded as steam injection, SAGD, and cyclical (CSS) linked to the scheme.
DISP	FSHWTR BRKWTR WATER	Disposition Out (DO)	The sum of disposition volumes to facilities outside the scheme.
PLTUSE	FSHWTR BRKWTR WATER	USE	Reported volumes used for purposes other than utilities or injection, such as drilling, potable use, and sludge pond losses.
UTIL	FSHWTR BRKWTR WATER	USE	Reported volumes used at the injection facility for utility, waste stream, and emissions control and not recovered due to evaporation or venting.

Appendix 3 Sample In Situ Scheme Water-Flow Diagram with Petrinex Reporting Codes and *Directive 081* Inlet and Outlet Water Types


WATER PROD
Production Wells
(AB WI)
(AB WI)
(AB WI)
Recyclable Produced Water (A1)*
* Excess Produced water = WATER PROD – STEAM INJ (A3)
Test/Group Separator
(Used for Production Estimation)
Bitumen Treating
Dilbit
Recovered Diluent
Diluent Recovery Unit
Bitumen/ Dilbit Sales
WATER DISP with Bitumen/Dilbit (AB PL) (DO)
Emulsion Settling
Untreatable Water
Produced Water Separation
BATTERY FACILITY
AB BT, In Situ Oil Sands (344) or
AB BT, Sulphur Reporting at Oil Sands (345)
DISPOSAL FACILITY
AB IF, Disposal (503)
WATER REC
Facility not linked to scheme
(ex. AB BT, AB IF, AB CT, AB WP etc)
(A3)
WATER REC
Untreated Wastewater from Oil Sands facilities
(AB OS)
(A3)
WATER REC
Landfill Leachate, etc.
(AB MC)
(A3)
WATER DISP
(AB IF)
WATER REC
(AB BT, AB IF, AB OS, AB MC, AB CT, AB WP etc)
(A3)
WATER Storage
WATER ACT/D56-LICENSED WATER SOURCE
AB BT, Water Source Battery (902)
FSHWTR PROD
High-Quality Nonsaline Groundwater Well
(AB WI)
(HQN)
FSHWTR PROD
Alternative Nonsaline Groundwater Well
(AB WI)
(A1)
FSHWTR PROD
Nonsaline Groundwater in Contact with Bitumen Well
(AB WI)
(A2)
FSHWTR PROD
Nonsaline Groundwater in Contact with Bitumen Well
(AB WI)
(A2)
WATER PLTUSE (USE)
WATER UTIL (USE)
Water to treatment
Water Treating
Boiler feed-water
Steam Generation & Separation
Untreatable Water
Untreatable Water (Steam Blowdown)
Blowdown
WATER INJ
Saline Water Balance Credit Disposal Well
(AB WI-SWBC Zone)
(DI)
WATER INJ
Disposal Well
(AB WI-Other Zone)
(DI)
WATER INJ
Saline Water Balance Credit Disposal Well
(AB WI-SWBC Zone)
(DI)
WATER INJ
Disposal Well
(AB WI-Other Zone)
(DI)
STEAM (Total Generated)
STEAM DISP
STEAM Injection Wells
(AB WI)
(AB WI)
(AB WI)
STEAM INJ
Boiler blowdown
WATER DISP
Offsite Disposal Facility
(AB IF, AB WP, AB CT)
(DO)
BRKWTR Storage
BRKWTR UTIL (USE)
BRKWTR PLTUSE (USE)
BRKWTR REC
(AB BT, AB IF)
(A2)
BRKWTR DISP
(AB IF)
BRKWTR REC
Facility not linked to scheme
(AB BT, AB IF)
(A2)
BRKWTR PROD
Saline Water Well
(AB WI-SWBC Zone)
(A2)*
BRKWTR PROD
Saline Water Well
(AB WI-Other Zone)
(A2)
* SWBC= BRKWTR PROD from SWBC Zone ≤ WATER INJ to SWBC Zone
(A3)
D56-LICENSED WATER SOURCE
AB BT, Water Source Battery (902)
BRKWTR PROD
Saline Water Well
(AB WI-SWBC Zone)
(A2*)
BRKWTR PROD
Saline Water Well
(AB WI-Other Zone)
(A2)
* SWBC= BRKWTR PROD from SWBC Zone ≤ WATER INJ to SWBC Zone
(A3)
FSHWTR PROD
High-Quality Nonsaline Groundwater Well
(AB WI)
(HQN)
FSHWTR REC
Industrial Runoff at Site
(AB RO)
(A1)
FSHWTR Storage
FSHWTR UTIL (USE)
FSHWTR PLTUSE (USE)
FSHWTR REC
Treated Wastewater from Oil Sands Facilities
(AB OS)
(A1)
FSHWTR REC
Facility not linked to scheme
(AB BT, AB IF)
(A1)
FSHWTR REC
Camp, Municipal or other treated wastewater source
(AB MC)
(A1)
WATER ACT-LICENSED WATER SOURCE
AB WS, Water Source (901)
FSHWTR DISP
(AB IF)
FSHWTR REC
(AB WS)
(HQN)
High-Quality Nonsaline Water Well <150 m or Surface Water Body
(HQN)
FSHWTR DISP
(AB IF)
FSHWTR REC
(AB BT, AB IF, AB OS, AB MC)
(A1)
INJECTION FACILITY
AB IF, In Situ Oil Sands (506)
** Section 12.3.4 Steam Measurement of *Directive 17*: The wellhead volumes reported to Petrinex, must be prorated from the total steam volume leaving the steam plant. The volume of steam leaving the steam plant may be determined from total steam volume leaving the steam plant separator or boiler feed water and boiler blowdown.
SWBC = Saline Water Balance Credit