

COSIA CHALLENGE

Mobilizing the world's minds and resources to improve environmental performance.



Direct Hot Water Production for an Oil Sands Mining & Extraction Process

SOLUTION DESCRIPTION: Replace conventional hot water production approaches, which use economizers or low grade steam, in either new or existing mining operations.	CHALLENGE SPONSOR: COSIA's GHG EPA is sponsoring this challenge. Our aspiration is to produce our oil with lower greenhouse gas emissions than other sources of oil.
CREATED: October 1st, 2015 All projects are evaluated and actioned as they are received.	<i>COSIA has four Environmental Priority Areas (EPAs): Water, Land, Tailings, and Greenhouse Gases (GHGs).</i>
For more information on this COSIA Challenge please visit www.cosia.ca	

Canada's Oil Sands Innovation Alliance (COSIA) accelerates the pace of environmental performance improvement in Canada's oil sands through collaborative action and innovation. COSIA Members represent more than 90 per cent of oil sands production. We bring together innovators and leading thinkers from industry, government, academia and the wider public to identify and advance new transformative technologies. Challenges are one way we articulate an actionable innovation need, bringing global innovation capacity to bear on global environmental challenges.



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WHAT TO SUBMIT TO COSIA

COSIA requires sufficient non-confidential, non-proprietary information to properly evaluate the technology.

Some items that will be especially important to present in your submission are:

- Concept and basic unit operations
- Technical justification for the approach (e.g. laboratory batch or continuous experiments; pilot or demo plants; process modeling; literature precedent)
- Describe quantities and qualities of utilities and consumables that are required
- Energy inputs – quantity and type(s)
- Capital and operating cost estimates if available based on described capacity targets
- 3rd party verified comparison of your proposed technology against an MEA baseline. 3rd party verifiers should be reputable, independent engineering companies if possible
- Basis of cost estimation, including estimation scope, contingency, etc.
- IP status of your proposed technology
- What operating environment restrictions might your technology face:
 - Explosive atmospheres
 - Severe weather
 - Power fluctuations

FUNDING, FINANCIALS, AND INTELLECTUAL PROPERTY

COSIA Members are committed to identifying emerging technologies and funding the development of the technologies to the point of commercialization, while protecting the Intellectual Property (IP) rights of the owner of the technology.

Successful proposals can receive funding from COSIA members to develop and demonstrate the technology in an oil sands application. Multiple technologies may be funded, at the discretion of the Members.

HOW TO SUBMIT TO COSIA

Submit a summary of your solution using COSIA's Environmental Technology Assessment Portal (E-TAP) Process, available at:

<http://www.cosia.ca/initiatives/etap/idea-submission-form>

Please note: ETAP is a staged submission process.



The initial submission requires only a brief description and limited technical information. Upon review by COSIA, additional information may be requested. Instructions for submission are provided on the

ETAP site.

All information provided is non-confidential. COSIA will respond to all submissions.



#0013: Direct Hot Water Production for an Oil Sands Mining & Extraction Process

DETAILED SOLUTION DESCRIPTION

The COSIA Greenhouse Gas Environmental Priority Area has identified Direct Hot Water Production as a technology which could improve the environmental performance of mineable oil sands. New technology is sought which could replace conventional hot water production approaches, which use economizers or low grade steam, in either new or existing mining operations.

The successful technology will:

- Directly produce commercial scale (5,000 – 10,000 m³/hr) of 40-90 °C hot water without using existing (or new) steam resources for heat exchange purposes;
- Target approximately a 25% reduction (for a single solution, or cumulatively through multiple solutions) in energy requirements, or CO₂ emissions, for hot water production; and
- Be amenable to retrofitting of existing operations.

Technologies at all stages of technical maturity are of interest.

BACKGROUND

Oil sands mining and extraction processes require large amounts of hot water in two separate streams: In the 40-60 °C range and the 70-90°C range. Currently this hot water is produced indirectly through contact with steam produced in natural gas fired boilers. Hot water volumes will differ between operations, but generally would be in the range of 5,000 – 10,000 m³/hr in total. Current operations use 900 -1,300 GJ/hr of energy to produce hot water in naphthenic-based froth treatment operations; and 1,000-1,900 GJ/hr for paraffinic froth treatment dependent on season and ore grade.

Heat integration and efficient use of recycle water can significantly improve overall energy efficiency of hot water generation. While use of non-conventional energy sources (like deep geothermal) or novel concepts for hot water generation has been studied, no clear technology options have emerged.

APPROACHES NOT OF INTEREST

The following approaches are currently considered to be lower priority:

- Solar hot water generation (limited days of sunshine, given northern latitudes); and
- Deep geothermal heating.

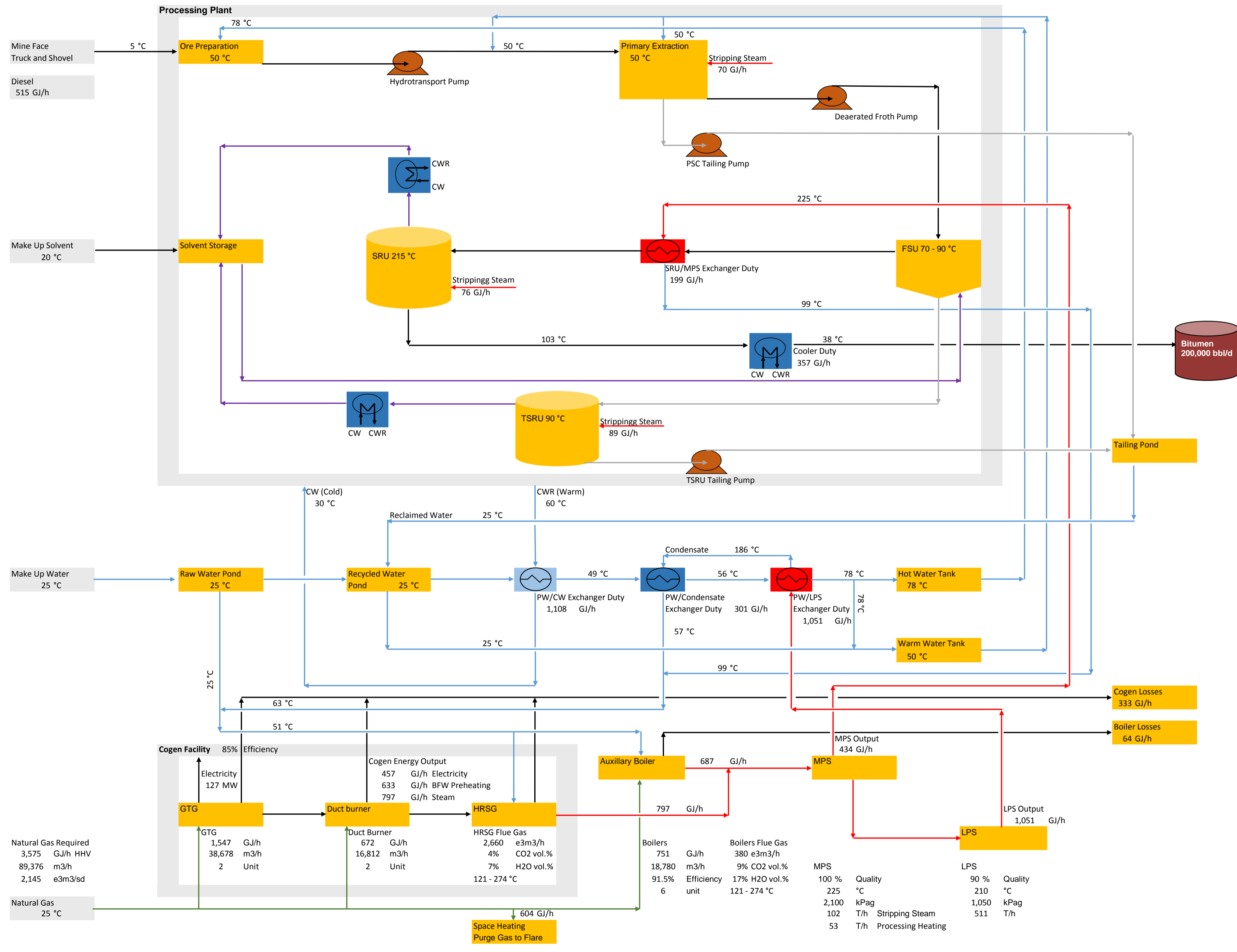
ADDITIONAL INFORMATION

The following link provides information on COSIA's Mine Reference Facility, which includes energy and material flow diagrams for a reference oil sands mine:

<http://www.cosia.ca/uploads/documents/id39/Tetra%20Tech%20Development%20of%20a%20Static%20Oil%20Sands%20Mine%20Ref.pdf>

COSIA Mining & Extraction: High Grade - Paraffinic Froth Treatment - Energy Flow

Ore Grade 12 wt%
 Fine Contents 11.9 wt%
 Waste to Ore 4.3 wt%



Legend	
Bitumen	
Water	
Steam	
Fuel gas	
Solvent	
Tailing	

Abbreviations	
BFW	Boiler Feed Water
CW	Cooling Water
CWR	Cooling Water Return
FSU	Froth Settling Unit
GTG	Gas Turbine Generator
HHV	High Heating Value
HRSG	Heat Recovery Steam Generator
LPS	Low Pressure Steam
MPS	Medium Pressure Steam
PSC	Primary Separation Cell
PW	Process Water
SRU	Solvent Recovery Unit
TSRU	Tailing Solvent Recovery Unit

Energy Output Summary				
	Input (GJ/h)	Output (GJ/h)		
Cogen	GTG	1,547	Electricity	457
	HRSG	672	BFW Preheating	633
			Steam	797
			Cogen Losses	333
Subtotal - Cogen	2,220		2,220	
Boilers			Steam	687
			Boiler Losses	64
Subtotal - Boilers	751		751	
Total	2,971		2,971	

Flue Gas - Based on Stoichiometric Combustion			
Natural Gas HHV	40	MJ/m ³	
Excess air @ 13% O ₂	179	%	
Excess O ₂	13	%	
Cogen Flue Gas	2,660	e3m ³ /h	
CO ₂ in Flue Gas from Cogen	4%	vol.%	
H ₂ O in Flue Gas from Cogen	7%	vol.%	
Boiler Flue Gas	380	e3m ³ /h	
CO ₂ in Flue Gas from Boilers	9%	vol.%	
H ₂ O in Flue Gas from Boilers	17%	vol.%	
Flue Gas Temperature - Acid Dew Point Limit	121	°C	
Flue Gas - Max. without Economizer	274	°C	

Exchanger & Cooler		Duty (GJ/h)
Process Water / Cooling Water		1,108
Process Water / Condensate		301
Process Water / LPS		1,051
SRU Feed / MPS		199
Cooler		357

Energy Consumption Summary			
	GJ/h	e3m ³ /d	
Natural Gas	GTG	1,547	928
	HRSG	672	403
	Building Heating and Flare	751	363
	Boilers	604	451
Diesel	515	0.3	
Energy Intensity (GJ per bbl of bitumen produced)	0.49	GJ/bbl	
Electricity Generated	3,044	MWH/d	
Electricity Consumed	3,142	MWH/d	

GHG Emissions Summary			
Stationary Combustion & Flaring	4,137	t CO ₂ e/d	
Mobile Equipment	892	t CO ₂ e/d	
Fugitive Mine	0.0001 - 0.0150	kg CO ₂ e/m ² /d	
Fugitive Pond	0.0007 - 0.0201	kg CO ₂ e/m ² /d	
Total Cogen Emissions (Gt)	2,569	t CO₂e/d	
Deemed emissions from Heat by Cogen (D ₁)	2,069	t CO ₂ e/d	
Deemed emissions from electricity by Cogen (D ₂)	500	t CO ₂ e/d	

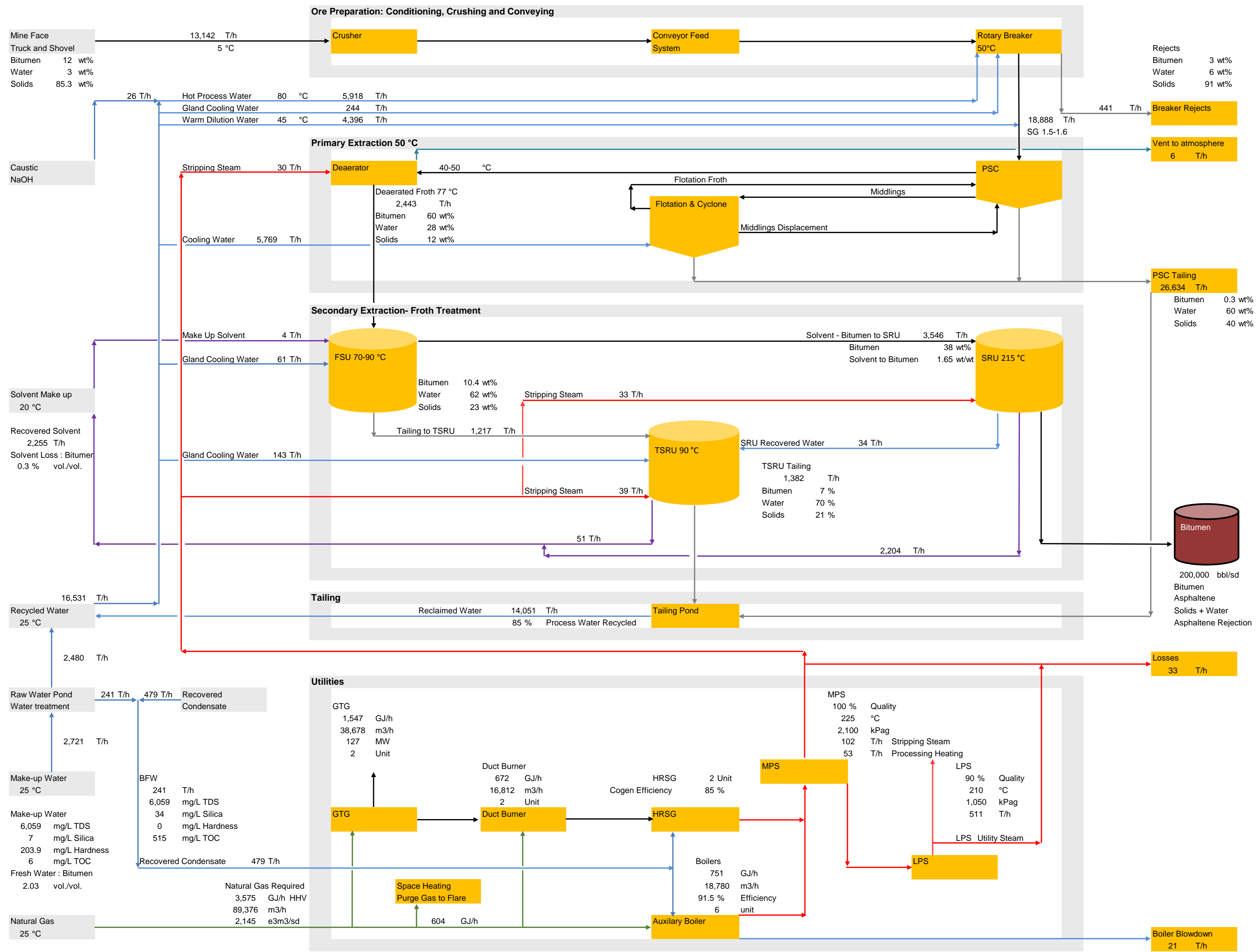
Project:	Static Oil Sands Mine and Extraction Reference Facility		
Case:	Paraffinic - High Grade	Revision:	v 2.3.9
Owner:	COSIA		
Date:	04-Oct-15		
Energy / Heat Flow	High Temperature Extraction, High Grade, Summer Condition		

This is a generic and hypothetical mine and extraction facility developed by COSIA. While representative, it is not based on any one facility. Recovery and solvent loss is based on Alberta Energy Regulator requirements.



COSIA Mining & Extraction High Grade - Paraffinic Froth Treatment - Material Flow

Ore Grade 12 wt%
 Fine Contents 11.9 wt%
 Waste to Ore 4.3 wt%



Legend	
Bitumen	
Water	
Steam	
Fuel gas	
Solvent	
Tailing	

Abbreviations	
BFW	Boiler Feed Water
FSU	Froth Settling Unit
GTG	Gas Turbine Generator
HHV	Higher Heating Value
HRSG	Heat Recovery Steam Generator
LPS	Low Pressure Steam
MPS	Medium Pressure Steam
Bitumen	99.9 %
PSC	Primary Separation Cell
SG	Specific Gravity
SRU	Solvent Recovery Unit
TDS	Total Dissolved Solids
TOC	Total organic carbon
TSRU	Tailing Solvent Recovery Unit

Bitumen Recovery Summary	
Ore Preparation	99.0%
Primary Extraction	94.6%
Froth Treatment (without rejected asphaltenes)	98.4%
Total Bitumen Recovery	92.2%
Asphaltenes Rejection	7.6%
Total Bitumen Recovery (with rejected asphaltenes)	85.1%

Water Summary (T/h)		
Process Water	Cooling Water	6,217
	Heated Water	10,314
Reclaimed Water		14,051
Raw Water		2,480
BFW		241
Boiler Blowdown		21
Make-Up Water		2,721
Condensate Return		479

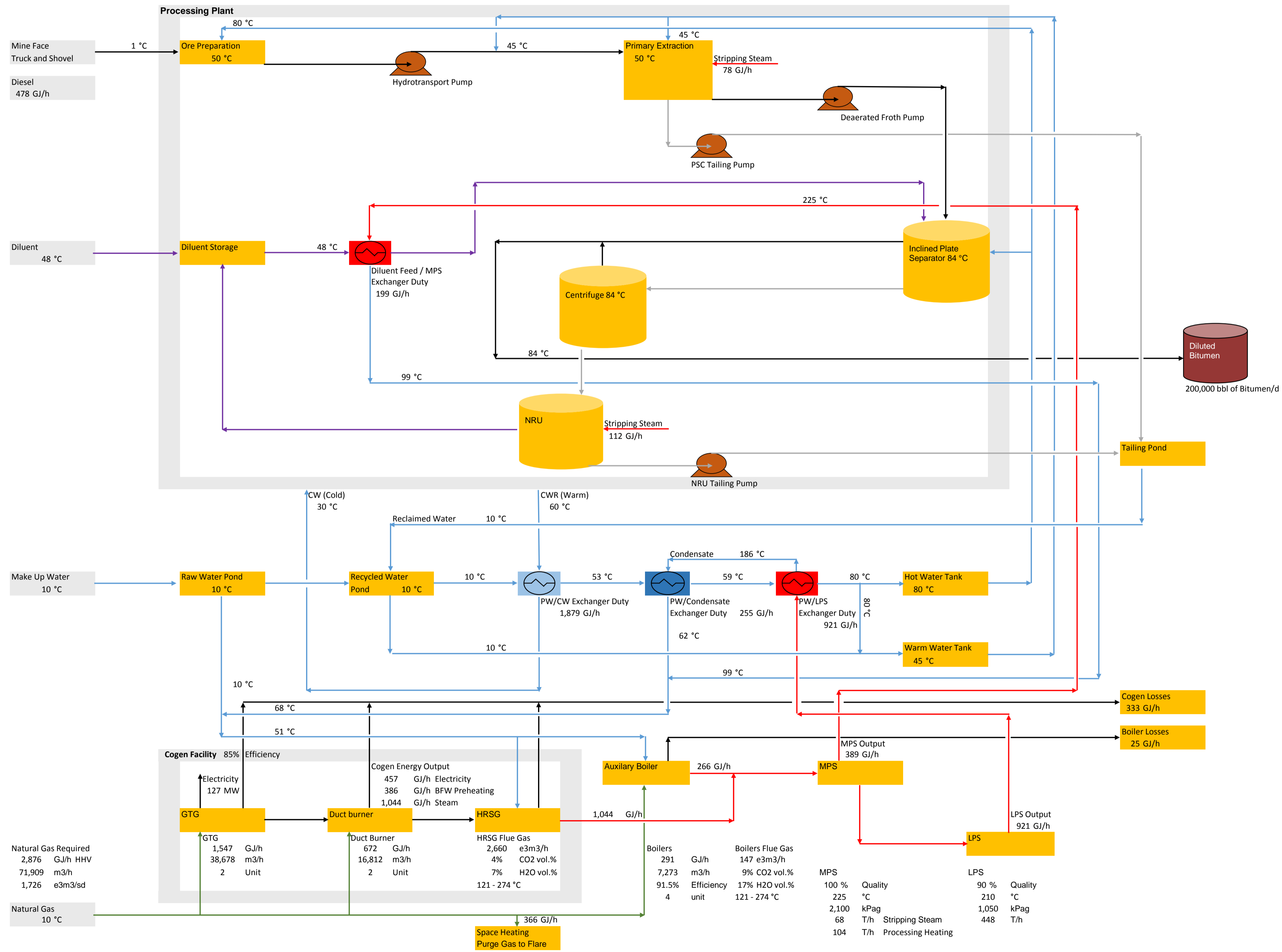
Project: A Static Oil Sands Mine and Extraction Reference Facility
 Case: Paraffinic - High Grade | Revision: V 2.7.7
 Owner: COSIA
 Date: 04-Oct-15
 Material Flow
 High Temperature Extraction, High Grade, Summer Condition

This is a generic and hypothetical mine and extraction facility developed by COSIA. While representative, it is not based on any one facility. Recovery and solvent loss is based on Alberta Energy Regulator requirements.



COSIA Mining & Extraction: High Grade - Naphthenic Froth Treatment - Energy Flow

Ore Grade 12 wt%
 Fine Contents 11.7 wt%
 Waste to Ore 4.3 wt%



Legend	
Bitumen	
Water	
Steam	
Fuel gas	
Diluent	
Tailing	

Abbreviations	
BFW	Boiler Feed Water
CW	Cooling Water
CWR	Cooling Water Return
GTG	Gas Turbine Generator
HHV	High Heating Value
HRSG	Heat Recovery Steam Generator
LPS	Low Pressure Steam
MPS	Medium Pressure Steam
NRU	Naphtha Recovery Unit
PSC	Primary Separation Cell
PW	Process Water

Energy Output Summary		
	Input (GJ/h)	Output (GJ/h)
Cogen	GTG 1,547	Electricity 457
	HRSG 672	BFW Preheating 386
		Steam 1,044
		Cogen Losses 333
Subtotal - Cogen	2,220	2,220
Boilers		Steam 266
		Boiler Losses 25
Subtotal - Boilers	291	291
Total	2,511	2,511

Flue Gas		
Natural Gas HHV	40	MJ/m ³
Excess air @ 13% O ₂ in Cogen	179%	%
Excess O ₂	13%	%
Cogen Flue Gas	2,660	e3m ³ /h
CO ₂ in Flue Gas from Cogen	4%	vol.%
H ₂ O in Flue Gas from Cogen	7%	vol.%
Boiler Flue Gas	147	e3m ³ /h
CO ₂ in Flue Gas from Boilers	9%	vol.%
H ₂ O in Flue Gas from Boilers	17%	vol.%
Flue Gas Temperature - Acid Dew Point Limit	121	°C
Flue Gas - Max. without Economizer	274	°C

Exchanger	
	Duty (GJ/h)
Process Water / Cooling Water	1,879
Process Water / Condensate	255
Process Water / LPS	921
Diluent Feed / MPS	199

Energy Consumption Summary		
	GJ/h	e3m ³ /d
Natural Gas	GTG 1,547	928
	HRSG 672	403
	Building Heating and Flare 366	220
	Boilers 291	175
Diesel	478	0.3
Energy Intensity (GJ / bbl bitumen produced)	0.40	GJ/bbl
Electricity Generated	3,044	MWH/d
Electricity Consumed	3,600	MWH/d

GHG Emissions Summary		
Stationary Combustion & Flaring	3,329	t CO ₂ e/d
Mobile Equipment	827	t CO ₂ e/d
Fugitive Mine	0.0001 - 0.0150	kg CO ₂ e/m ² /d
Fugitive Pond	0.0119 - 0.8054	kg CO ₂ e/m ² /d
Total Cogen Emissions (Gt)	2,569	t CO₂e/d
Deemed emissions from Heat by Cogen (D _h)	2,069	t CO ₂ e/d
Deemed emissions from electricity by Cogen (D _e)	500	t CO ₂ e/d

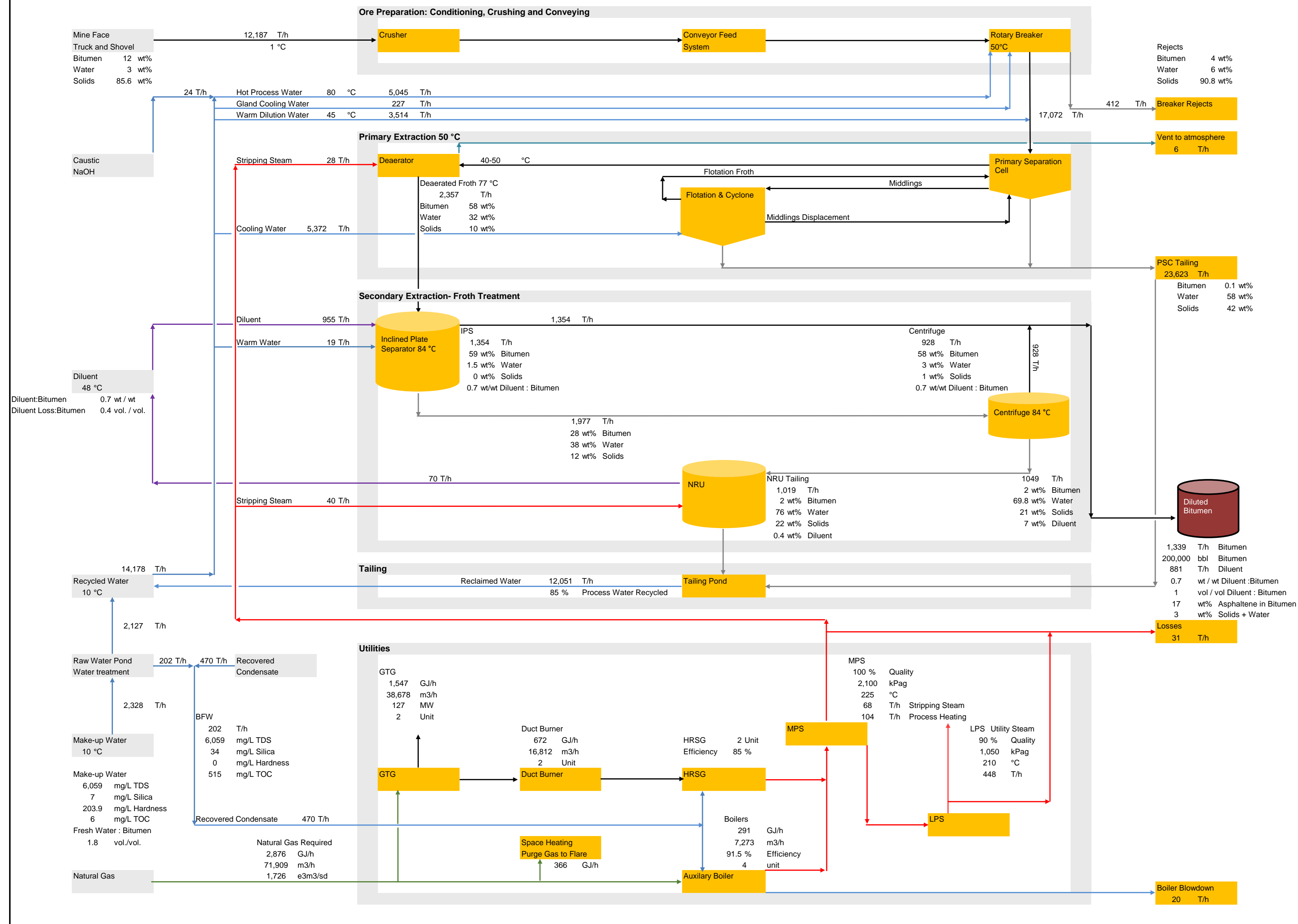
Project:	Static Reference Oil Sands Mine and Extraction Reference Facility	
Case:	Naphthenic - High Grade	Revision: v 1.6
Owner:	COSIA	
Date:	04-Oct-15	
Energy / Heat Flow	High Temperature Extraction, High Grade, Average Condition	

This is a generic and hypothetical mine and extraction facility developed by COSIA. While representative, it is not based on any one facility. Recovery and solvent loss is based on Alberta Energy Regulator requirements.



COSIA Mining & Extraction: High Grade - Naphthenic Froth Treatment - Material Flow

Ore Grade 12 wt%
 Fine Contents 11.7 wt%
 Waste to Ore 4.3 wt%



Legend	
Bitumen	
Water	
Steam	
Fuel Gas	
Diluent	
Tailing	

Abbreviations	
BFW	Boiler Feed Water
GTG	Gas Turbine Generator
HHV	High Heating Value
HRSG	Heat Recovery Steam Generator
LPS	Low Pressure Steam
MPS	Medium Pressure Steam
NRU	Naphtha Recovery Unit
PSC	Primary Separation Cell

Bitumen Recovery Summary	
Ore Preparation	98.9%
Primary Extraction	98.0%
Froth Treatment (without rejected asphaltenes)	98.2%
Total Bitumen Recovery	95.2%
Asphaltenes Rejection	0.0%
Total Bitumen Recovery (with rejected asphaltenes)	95.2%

Water Summary (T/h)		
Process Water	Cooling Water	5,599
	Heated Water	8,579
Reclaimed Water		12,051
Raw Water		2,127
BFW		202
Boiler Blowdown		20
Make-Up Water		2,328
Condensate Return		470

Project:	Static Oil Sands Mine and Extraction Reference Facility	
Case:	Naphthenic - High Grade	Revision: 1.3
Owner:	COSIA	
Date:	27-Sep-15	
Material Flow	High Temperature Extraction, High Grade, Average Condition	

This is a generic and hypothetical mine and extraction facility developed by COSIA. While representative, it is not based on any one facility. Recovery and solvent loss is based on Alberta Energy Regulator requirements.

