How Crude moves through the Enbridge System – Quality Perspective

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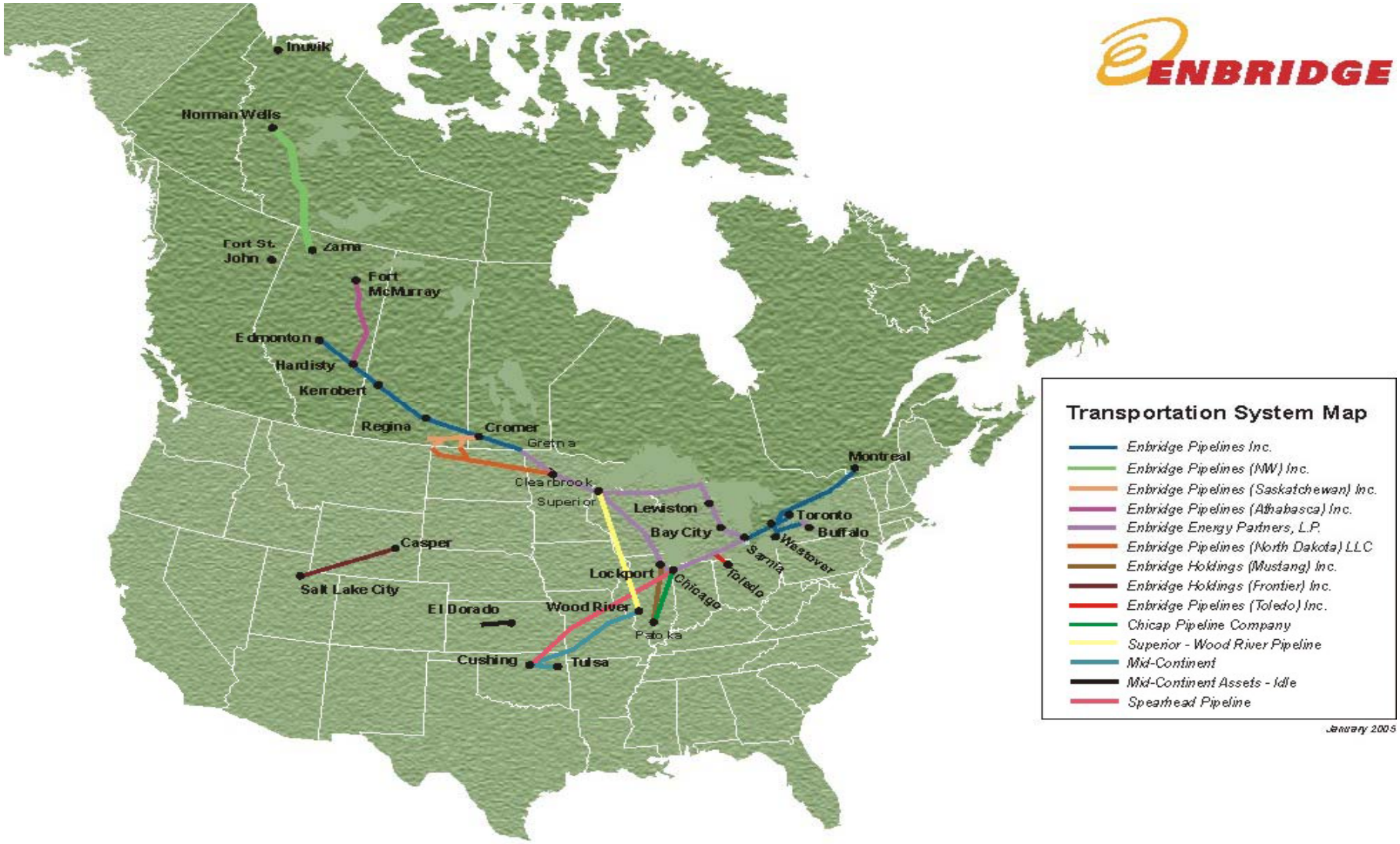
Presentation Outline

- General Enbridge System information
- Crude types Transported – quality variation
- Quality Impact of Batching in the Line
- Quality Impact of Crossing Tank Bottoms
- Cumulative Quality Impact at Various Locations
- Special Procedures & Batching for pigged lines
- Quality Metrics
- Summary

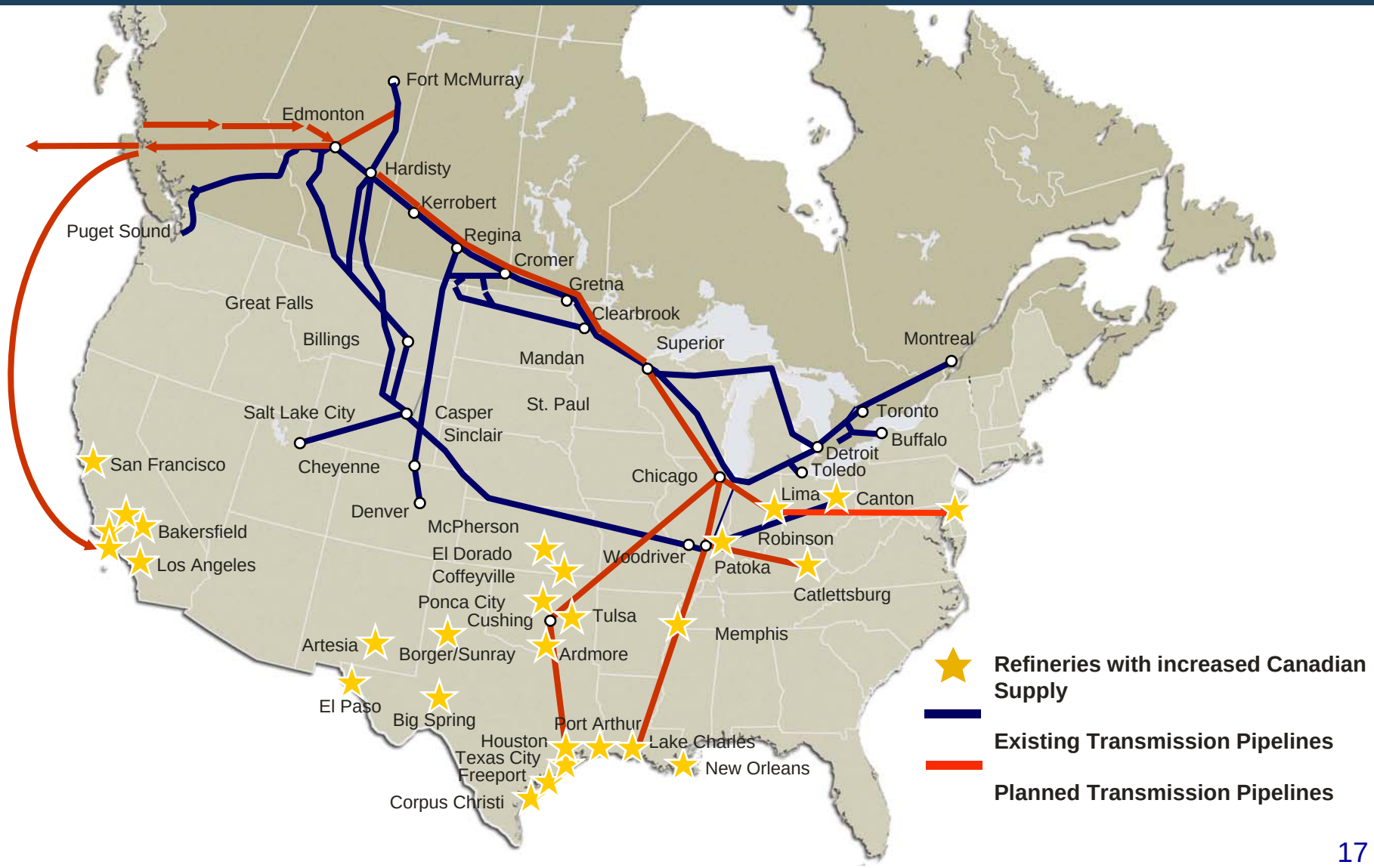
Enbridge Overview

- Enbridge is a ‘common carrier’
- Enbridge does not own any product
- Over 60 active shippers
- Over 70 different commodities
- 35 receipt or delivery transfer locations
- Line Fill – 5.4 million m^3 (33.8 million bbl)
- Tank Inventory – 6.0 million m^3 (37.9 million bbl) - 355 tanks in mainline and feeder systems

Overview
System Map



New Market Pipeline Delivery Network - 2012



Crude Types Transported by Enbridge

Crude Type	Batch ID	Long Name
Heavy	AHS	Albian Heavy Synthetic
	BR	Bow River
	CL	Cold Lake
	ESB	Echo Synthectic Blend
	F	Fosterton
	CNH	Canadian Natural Heavy
	LLE	Lloydminister Echo
	LLB	Lloydminister Hardisty
	LLG	Lloydminister Gibsons
	LLK	Lloydminister Kerrobert
	SC	Smiley Coleville Heavy
	WCB	Western Canadian Blend
	WCS	Western Canadian Select
	WH	Wabasca Heavy
Heavy - High TAN	AWB	Access Western Blend
	AVB	Albian Vaccum Gas Oil Blend
	CSB	Christina Lake Syn-Bit
	MKH	Mackay River Heavy
	OSH	Suncor - H
	PH	Peace River Heavy
	PSH	Optinexen Synthetic Heavy
	SH	Seal Heavy
	SHB	Surmont Heavy Blend
Medium	M	Midale Blend
	UMC	Midale - Clearbrook
Sour	FOM	Foreign Sour - Mokena
	LSB	Light Sour Blend
	MJT	Moose Jaw Tops
	SO	Mixed Sour Blend
	SHE	Sour Heavy Edmonton
	SLE	Sour Light Edmonton
	UOC	U.S. High Sour - Clearbrook
	UOG	U.S. High Sour - Griffith
	UOM	U.S. High Sour - Mokena

Crude Type	Batch ID	Long Name
Sweet	FHM	Foreign Sweet - Mokena
	SW	Mixed Blend Sweet
	UHC	U.S. High Sweet - Clearbrook
	UHG	U.S. High Sweet - Griffith
	UHL	U.S. High Sweet - Lewiston
	UHM	U.S. High Sweet - Mokena
Synthetic	CNS	Canadian Natural Synthetic
	HSB	Husky Synthetic Blend
	NSA	Newgrade Synthetic Premium
	OSA	Suncor - A
	OSC	Suncor - C
	OSD	Suncor - D
	PAS	Premium Synthetic Light
	PSC	Optinexen Synthetic Crude
	SSX	Shell Synthetic Light
	SYN	Syncrude
Condensate	CRW	Condensate Blend
	UCM	U.S. Condensate - Mokena

Special	SSS	Sarnia Special
	CCA	Caroline Condensate
Cracked	PBS	Pine Blend Special
	OCC	Suncor Cracked C

Enbridge Commodity Types (Enbridge.com & crudemonitor.ca)

	API	%S	MCR	TAN
Heavy	19-21	2.6-4.5	8.5-11.3	0.5-1.05
Heavy Hi Tan	19-21	3.0-4.5	7.5-10	1.4-3.5
Heavy Lo Resid	20	3.0	<1.0	3.5
Medium	30-35	2.5	6.0	0.2
Sour	30-35	1.1-1.8	4.0-6.0	0.3
Sweet	40	<0.5	2.0	0.2
Lt Sweet Synthetic	30-35	0.1-0.25	<0.5	0.1
Condensate	60	0.2	-	-
Olefinic				
NGL				
Refined Products				

Batch Quality Impact in the line

- **In the Line (single batch size=60,000bbls)**
  - **Batch size varies from single to quadruple. Larger volume crudes allow multiple batching (such as CL, WCS,SYN) whereas lower volume (less than batch/day receipts) travel as single batches**
  - **Expected interface contamination therefore is more pronounced for boutique crudes than large liquidity crude types**
  - **Estimated range of 1,000 bbls to 4,000 bbls adjacent "pure" crude volume in the interface being cut into a batch due to line batching**
    - However dilution with subject batch volume keeps characteristics in check.
    - Batch line ups based on minimizing contamination (matrix) and lines dedicated to certain crude types

The Quality Matrix – Interface Selection

ENBRIDGE

CRUDE TYPE MATRIX - THE QUALITY PROCESS

	Heavy -TAN	Heavy	Medium	Sour	Sweet	Synthetic	Condensate
Heavy -TAN	1	2	3	4	5	6	7
Heavy	2	1	3	4	5	6	7
Medium	7	6	1	2	3	4	5
Sour	7	6	2	1	3	4	5
Sweet	7	6	5	4	1	2	3
Synthetic	7	6	5	4	3	1	2
Condensate	7	6	5	4	3	2	1

The above numbers rank the order (as a guideline) that should be followed when changing from crude types.

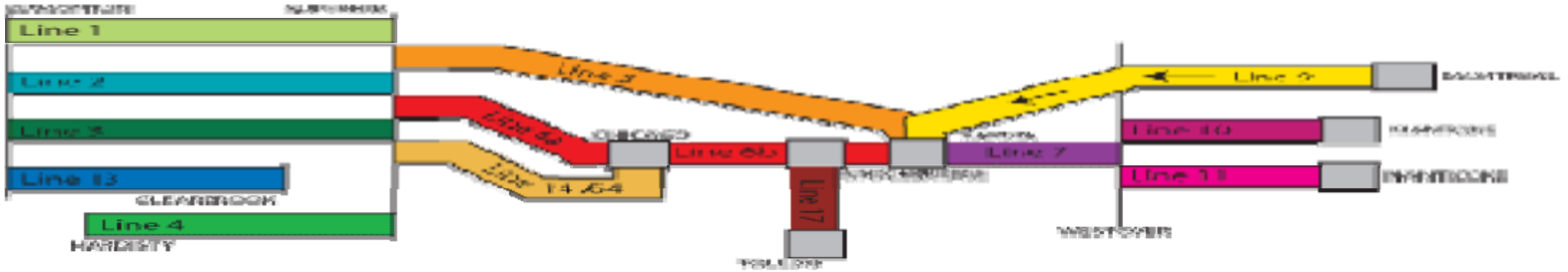
One being first choice. **Seven** being the last choice.

When making sequence decisions between crudes of the same type(Heavy-Heavy).Reference the crude prices for best choice.

Core Liquid Pipelines
Number & Type

Pipeline System Configuration

Quarter 1, 2008



Line 1

37,600 m³/d
NPS 18/20 1767 km

NGL
Refined Products
Synthetics

Line 2

Line 2a
34,000 m³/d
NPS 24 1038km
Line 2b
62,000 m³/d
NPS 24/26 1038 km

Condensates
Synthetics
Light Crudes
Medium Crudes

Line 3

80,000 m³/d
NPS 34 1787 km

Light Crudes
Medium Crudes
Heavy Crudes

Line 4

126,500 m³/d
NPS 36/48 1392 km

Heavy Crudes

Line 6

78,100 m³/d
NPS 30 1038 km

NGL
Condensates
Synthetics
Light Crudes

Line 6

Line 6A
136,000 m³/d
NPS 34 762 km
Line 6B
45,000 m³/d
NPS 20 762 km

Light Crudes
Synthetics
Medium Crudes
Heavy Crudes

Line 7

23,800 m³/d
NPS 20 249 km

Condensates
Synthetics
Light Crudes
Medium Crudes
Heavy Crudes

Line 9

38,200 m³/d
NPS 36 943 km

Condensates
Light Crudes

Line 10

18,000 m³/d
NPS 12/20 948 km

Condensates
Synthetics
Light Crudes
Medium Crudes
Heavy Crudes

Line 11

18,000 m³/d
NPS 16/20 79 km

Condensates
Synthetics
Light Crudes
Medium Crudes
Heavy Crudes

Line 13

27,240 m³/d
NPS 10/18/20 1403 km

Synthetics
Light Crudes
Medium Crudes

Line 14/64

59,500 m³/d
NPS 24 762 km

Condensates
Synthetics
Light Crudes
Medium Crudes
Heavy Crudes

Line 14/61/64

79,500 m³/d
NPS 24/12 761 km

Condensates
Synthetics
Light Crudes
Medium Crudes
Heavy Crudes

Line 17

15,900 m³/d
NPS 16 142 km

Heavy Crudes

NPS to:
- The pipeline OD size
- Capacities provided are Physical Capacities
- Effective January 2008

Quality impact due to Tank Bottoms

- **Table 5 formulated to ensure as part of Service Levels to outline what bottoms each crude type can cross at each location**
  - **Stay within own crude type and category as first two options before going to 3rd which requires Petroleum Quality approval**
  - **Typical tank working bottoms is 20,000 to 30,000 bbls**
  - **Larger streams have dedicated tanks while boutique crude types share bottoms**
  - **Practice to land multiple batches before pumping out to minimize contamination**

What can a Crude Batch expect Enroute to Destination?

1. For Clearbrook
   - Only line batching impact
2. For Chicago
   - Line impact to Superior
   - Tank bottoms at Superior
   - Line to Chicago
3. For Oregon/Samaria
   - Line impact to Stockbridge
   - 2 + tank bottoms at Griffith and Stockbridge
4. For Sarnia
   - Line impact to Sarnia (light crude only)
   - 2 + tank bottoms at Griffith (Hvy crude only)
5. For Kiantone (United) and Nanticoke
   - Line to Westover and then to Kiantone and Nanticoke
   - 4 + tank bottoms at Sarnia & Westover

Storage Breakout Locations

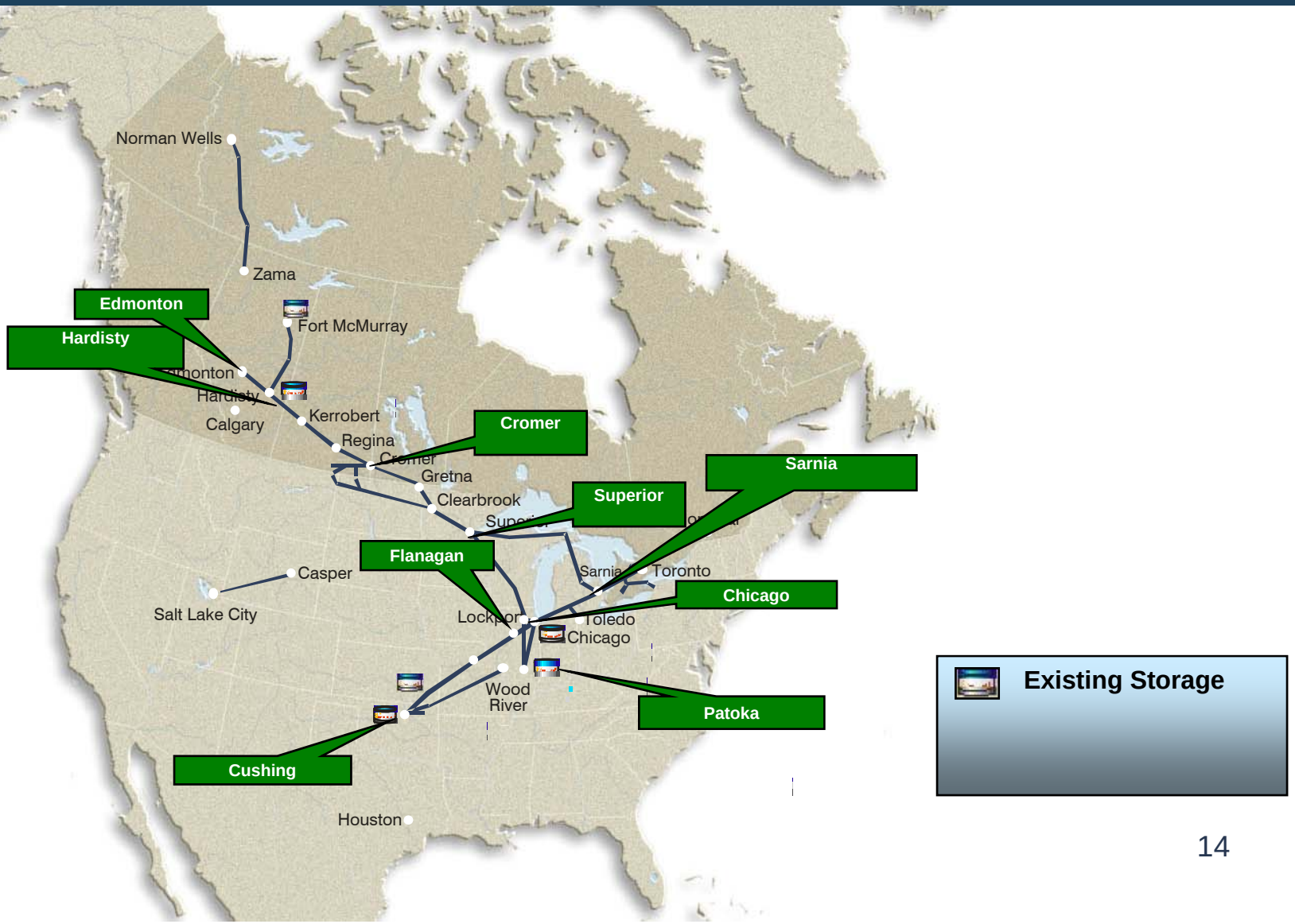


Table 5

Transport Commodity	Crude Quality Category	Edmonton	Hardisty	Kerrobert	Regina	Cromer	Clearbrook	Superior	Griffith	Stockbridge	Sarnia	Westover
Condensate Blend (CRW)	Condensate	R/C				B/B^{G,F}		B/B^{G,F}	B/B^{G,F}		B/B^{G,F}	
BP Condensate Blend (ACB)											R/B	B/B^{G,F}
Suncor A (OSA)	Light Synthetic	R/S	R/S			B/B^{G}		B/B^{G}	B/B^{G}			
Suncor C (OSC)		R/B	R/B			B/B^{G}		B/B^{G}	B/B^{G}			
Syncrude (SYN)		R/S				B/B^{G}	B/S	B/B^{G}	B/B^{G}		B/B^{G,H}	B/B^{G,F,H}
Premium Albian Synthetic (PAS)		R/S				B/B^{G}		B/B^{G}	B/B^{G}			
Shell Synthetic Light (SSX)		R/S				B/B^{G}		B/B^{G}	B/B^{G}			
Husky Synthetic Blend (HSB)			R/S			B/B^{G}	B/S	B/B^{G}	B/B^{G}		B/B^{G,H}	B/B^{G,F,H}
BP Sweet Synthetic Blend (BSS)						B/B^{G}		B/B^{G}	B/B^{G}			
Newgrade Synthetic Blend (NSA)					R/S	B/B^{G}		B/B^{G}	B/B^{G}		B/B^{G,H}	B/B^{G,F,H}
Newgrade Synthetic Blend (NSB)	Sweet				R/B	B/B^{F}		B/B^{F}	B/B^{F}		B/B^{G,H}	B/B^{F,G,H}
Mixed Blend Sweet (SW)		R/C				B/C B/B^{F}		B/B^{F}	B/B^{F}		B/B^{F}	B/B^{F,G,H}
Kerrobert Light (SW)						B/C B/B^{F}		B/B^{F}	B/B^{F}		B/B^{F}	B/B^{F,G,H}
BP Sweet Blend (BSW)						B/C B/B^{F}		B/B^{F}	B/B^{F}			

Group Codes – **A**-Heavy, **B**-Heavy High Tan, **C**-Cracked, **D**-Medium, **E**-High Sour, **I**-Light Sour, **F**-Sweet, **G**-Light Synthetic, **H**-Condensate, **X**- L-9 Sweet basket, **Y**- L-9 Sour basket, **Z**- L-9 Condensate basket

Special Procedures

- High Tan (Total Acid Number >1.0) commodities have dedicated tanks or flush batch (destined to same facility) is required if routed through a regular heavy tank.
- Cracked products contain olefins desired by very few refineries. Cracked products require both front and back buffers that are sized to contain the cracked crude interfaces. The whole train (buffers and crude) moves into the same refinery.

Batch Pigged Lines

- Where lines are in laminar flow and batch quality needs to be maintained then batch pigs are used
- 3 such lines – Athabasca (30”) and Spearhead (22”) & future Southern Access (42”)
- Some parameters to keep in mind
  - Efficiency in launching and receiving
  - Contribution of line fill from intermediate stations during bypass – design right
  - Pig condition & slippage
  - Cut Points need to be determined because interfaces still exist albeit smaller in size

ITS Quality Metrics

- Reward/penalty based on meeting or exceeding targets set over 5 years (2005-2009). Targets negotiated based on baseline data on main lines only – to Sarnia & Chicago
- Targets set on formula which includes
  - Absolute change + constant x std dev at delivery
- Quality metrics parameters – receipt to delivery
  - Heavy: sulphur, MCR, TAN
  - Light Synthetic: sulphur, density
  - Refined products: diesel flash, uLSD sulphur pick-up
- Light Targets tighten by 50% and Heavy targets tighten by 30%
- Performance has been excellent – 25 out of 30 targets in 2008 were in bonus situation indicating the gains in quality of crude being delivered
- Connecting pipelines benefiting

Summary

- Quality principles/practices at Enbridge based on minimizing quality impact
  - Batched pipeline challenges overcome by judicious multi-line splits, sequencing and tank bottoms crossings.
- ITS Quality metrics providing quality benefits across system
  - Connecting pipelines benefitting through ITS metrics
- Quality practices to be extended to new pipelines such as Southern Access
- Questions?