



#### Case Study

• THE ALBERTA TO BRITISH COLUMBIA TRANS MOUNTAIN EXPANSION PROJECT

#### Introduction

• The Trans Mountain Pipe Expansion Project may have some advantages but is also a controversial project which will have impacts on environmental, economic, and social systems.

# Problem Solving Process 1 – Exploring the mess

#	Question	Answer
Q1.1	What problems (or opportunities) did they face?	The opposition from Indigenous group
Q1.2	Where was there a gap between the current situation and the desired one?	Yes
Q1.3	What were the stated and unstated goals?	proposal to expand the existing Trans Mountain Pipeline

# Problem Solving Process 2 – Searching for information

#	Question	Answer
Q2.1	What were the symptoms and causes?	The First Nations groups opposed the project The effectiveness of measures to protect First Nations group Environmental impacts caused from pipeline activities
Q2.2	What measures of effectiveness seemed appropriate?	Free, Prior, And Informed Consent (FPIC)
Q2.3	What actions were available?	UNDRIP Canada's Constitution Act International agreement with Kyoto Protocol

# Problem Solving Process 3 – Identifying a problem

#	Question	Answer
Q3.1	Which was the most important problem in this situation?	The Trans Mountain Pipeline Expansion Project is controversial and will have impacts on environmental, economic, and social systems.
Q3.2	Was the problem like others they had dealt with?	No
Q3.3	What were the consequences of a broad versus narrow problem statement?	

# Problem Solving Process 4 – Searching for solutions

#	Question	Answer
Q4.1	What decisions were open to them?	Whether to go ahead with the project or not
Q4.2	What solutions had been tried in similar situations?	Free, Prior, And Informed Consent (FPIC) Act
Q4.3	How did the various candidate solutions link to the outcomes of interest?	

# Problem Solving Process 5 – Evaluating solutions

#	Question	Answer
Q5.1	How did the solution impact each of the criteria?	
Q5.2	What factors within their control could have improved the outcomes?	Avoidance of oil spills Addressing concerns surrounding construction and operation
Q5.3	What factors outside their control could have altered the outcomes?	Increased marine shipping traffic may result in negative impacts on marine populations

# Problem Solving Process 6 – Implementing a solution

#	Question	Answer
Q6.1	What were the barriers to successful implementation?	The objection from the First Nation group Environmental hazards
Q6.2	Where was there support and motivation, or resistance and conflict?	Provision of new pipeline capacity to accommodate the transportation demand for increased production of Canadian oil Increase of returns to oil producers
Q6.3	Were there resources available for successful implementation?	12 new pump stations, new storage tanks, and other components

## 5W 1H Analysis 1 – Who

#	Question	Answer
Q1.1	Who is involved?	The Federal Government of Canada ,Indigenous Peoples, The Kinder Morgan company, Environmental organizations
Q1.2	Who is affected?	The Indigenous Peoples, Canadians, Federal Government
Q1.3	Who will benefit?	Canadians, Federal Government
Q1.4	Who will be harmed?	The Indigenous Peoples

## 5W 1H Analysis 2 – What

#	Question	Answer
Q2.1	What is your topic narrowed down in a simple phrase/sentence?	Pipeline capacities and throughput
Q2.2	What does your topic involve? (i.e. What are the different parts to it?)	increasing the pre-existing pipeline's capacity and efficiency
Q2.3	What is it similar to / different from?	
Q2.4	What might be affected/changed by your topic?	If the ongoing litigations goes in favor of the Indigenous group

### 5W 1H Analysis 3 –When

#	Question	Answer
Q3.1	When does this take place? When did this take place? When will it take place? When should this take place?	No yet ascertained
Q3.2	Does when this takes place affect the topic?	No

## 5W 1H Analysis 4 – Where

#	Question	Answer
Q4.1	Where does this take place? (Where did it Where will it Where should it?)	Canada and USA
Q4.2	Does it matter where it takes place? Is it affected by location?	Yes

## 5W 1H Analysis 5 – Why

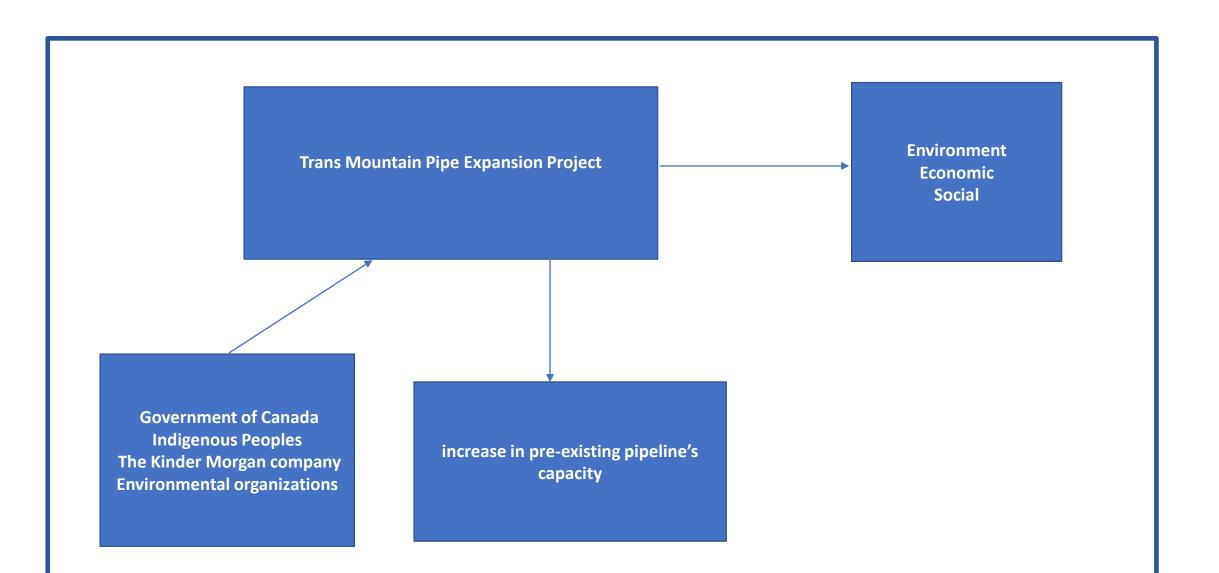
#	Question	Answer
Q5.1	Why is this topic important? Why does it matter?	The topic helps us understand how expanding the existing Trans Mountain Pipeline will increase pre-existing pipeline's capacity The topic helps us evaluate pipeline
Q5.2	Why do certain things happen? (What are some causes and effects within the topic?)	Pipeline Expansion Project and it's effects on environmental, economic, and social systems

## 5W 1H Analysis 6 – How

#	Question	Answer
Q6.1	How does this topic work? How does it function? How does it do what it does?	The topic helps us understand important metrics like ratio of throughput to maximum capacity per trade type Ascertain the rate of efficiency of pipelines
Q6.2	How did it come to be?	
Q6.3	How are those involved affected?	oil spills in Burrard Inlet are extremely likely and less than half of the volume of spilled oil can be cleaned up



## Data Modeling – Conceptual Model



## Data Dictionary

No	Topic	Definition
1	Pipeline Name	Name of pipeline system determined by corporate entity
2	Throughput (1000 m3/d)	The volume of natural gas flowing though the pipeline at the Key Point indicated, in thousand cubic meters per day
3	Throughput (GJ/d)	The energy content of the natural gas flowing though the pipeline at the Key Point indicated, in Gigajoules per day
4	Capacity(GJ/d)	The maximum amount of natural gas that the pipeline can theoretically move at a given time, measured in Gigajoules per day
5	Trade Type (Intra Canada, Export)	Whether volume of natural gas is being imported, exported, or shipping intra-provincially.
6	Longitude	The longitude coordinate at the key point where throughputs are reported
7	Latitude	The latitude coordinate at the key point where throughputs are reported
8		
9		
10		



#### Business Questions

- What is the ratio of throughput to maximum capacity per trade type from 2010 – 2020?
- Determine the rate of efficiency of pipelines by using the percentage of utilization on quarterly basis as measurement?



#### Data Set(s)

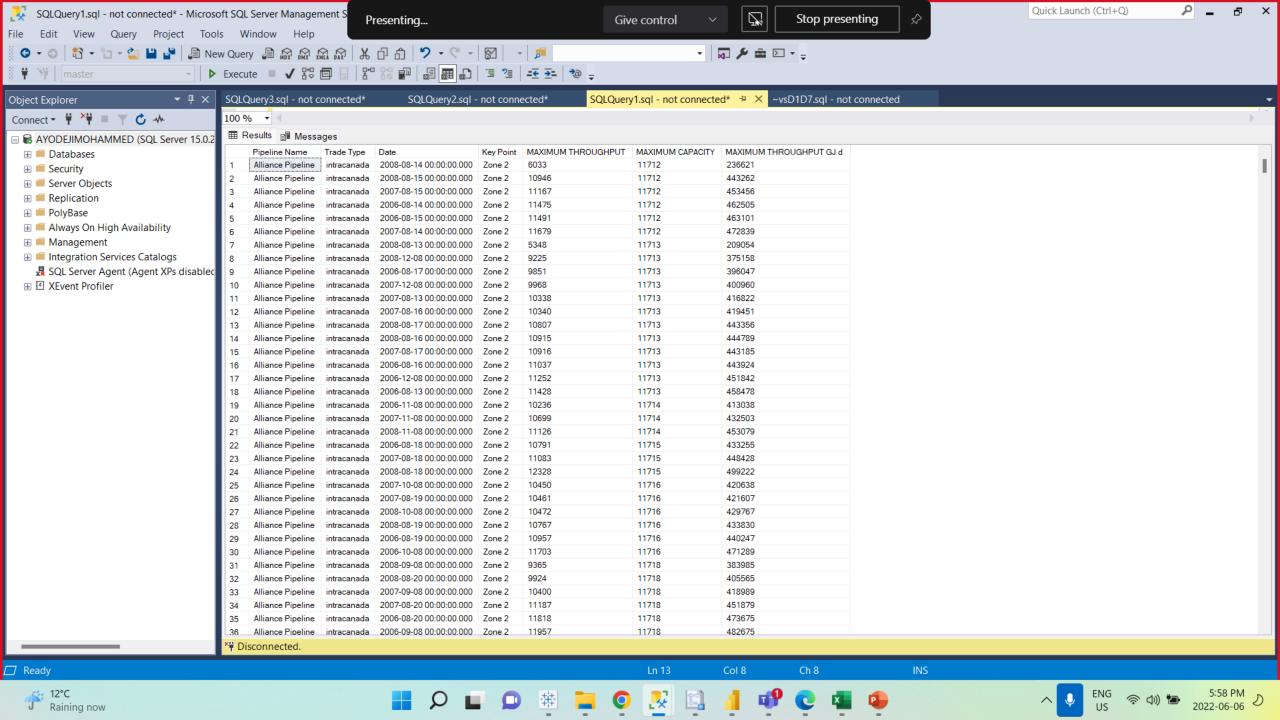
alliance-throughput-and-capacity-dataset.csv

https://www.cer-rec.gc.ca/en/dataanalysis/facilities-we-regulate/pipelineprofiles/natural-gas/pipeline-profilesalliance.html

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$M_1 \qquad \vee \mid \times \checkmark f_x$																
A	В	С	D	Е	F	G	Н	1	J	K	L	М	N	0	Р	C
1 Date	Corporate Entity	Pipeline Name	Key Point	Latitude	Longitude	Direction of	Trade Type	Capacity (1000 m3/d)	Throughput (1000 m3/d)	Throughput (GJ/d)						l
2 1/1/2006	Alliance Pipeline Limited Partnership	Alliance Pipeline	Border	49	-101.588	southeast	export	51717.21232	48884.19922	1973513.811						
3 2/1/2006	Alliance Pipeline Limited Partnership	Alliance Pipeline	Border	49	-101.588	southeast	export	51733.31091	48708.10156	1968322.062						
4 3/1/2006	Alliance Pipeline Limited Partnership	Alliance Pipeline	Border	49	-101.588	southeast	export	51748.75089	48355.30078	1964453.463						
5 4/1/2006	Alliance Pipeline Limited Partnership	Alliance Pipeline	Border	49	-101.588	southeast	export	51763.52754	49248.5	1999267.528						
6 5/1/2006	Alliance Pipeline Limited Partnership	Alliance Pipeline	Border	49	-101.588	southeast	export	51777.63637	49377.80078	2000304.61						
7 6/1/2006	Alliance Pipeline Limited Partnership	Alliance Pipeline	Border	49	-101.588	southeast	export	51791.07306	48571.60156	1967702.015						
8 7/1/2006	Alliance Pipeline Limited Partnership	Alliance Pipeline	Border	49	-101.588	southeast	export	51803.83352	47770.80078	1935414.83						
9 8/1/2006	Alliance Pipeline Limited Partnership	Alliance Pipeline	Border	49	-101.588	southeast	export	51815.91386	48405.80078	1961557.994						
10 9/ 1/ 2006	Alliance Pipeline Limited Partnership	Alliance Pipeline	Border	49	-101.588	southeast	export	51827.31039	49452	1975602.344						
11 10/1/2006	Alliance Pipeline Limited Partnership	Alliance Pipeline	Border	49	-101.588	southeast	export	51838.01963	49155.39844	1969784.684						
12 11/1/2006	Alliance Pipeline Limited Partnership	Alliance Pipeline	Border	49	-101.588	southeast	export	51848.03833	48324.5	1926069.521						
13 12/1/2006	Alliance Pipeline Limited Partnership	Alliance Pipeline	Border	49	-101.588	southeast	export	51857.36341	47855	1914396.244						
14 13/1/2006	Alliance Pipeline Limited Partnership	Alliance Pipeline	Border	49	-101.588	southeast	export	51865.99205	51964.69922	2086699.524						
15 14/1/2006	Alliance Pipeline Limited Partnership	Alliance Pipeline	Border	49	-101.588	southeast	export	51873.9216	50187.30078	2015436.797						
16 15/1/2006	Alliance Pipeline Limited Partnership	Alliance Pipeline	Border	49	-101.588	southeast	export	51881.14965	50475.39844	2029085.832						
17 16/1/2006	Alliance Pipeline Limited Partnership	Alliance Pipeline	Border	49	-101.588	southeast	export	51887.67399	49944.80078	2006442.406						
18 17/1/2006	Alliance Pipeline Limited Partnership	Alliance Pipeline	Border	49	-101.588	southeast	export	51893.49264	49409.60156	1985035.606						
19 18/1/2006	Alliance Pipeline Limited Partnership	Alliance Pipeline	Border	49	-101.588	southeast	export	51898.60381	49166.19922	1975345.418						
20 19/1/2006	Alliance Pipeline Limited Partnership	Alliance Pipeline	Border	49	-101.588	southeast	export	51903.00595	45024.39844	1808973.855						
	Alliance Pipeline Limited Partnership			49	-101.588	southeast	export	51906.69772								
	Alliance Pipeline Limited Partnership			49	-101.588	southeast	export	51909.67799								
23 22/1/2006	Alliance Pipeline Limited Partnership	Alliance Pipeline	Border			southeast		51911.94585	49356.69922							
	Alliance Pipeline Limited Partnership					southeast		51913.50061	49293.5							
25 24/4/2006	AII.	VII. P. I.	n I	40	404 500			F4044 2440	40762-20070							1
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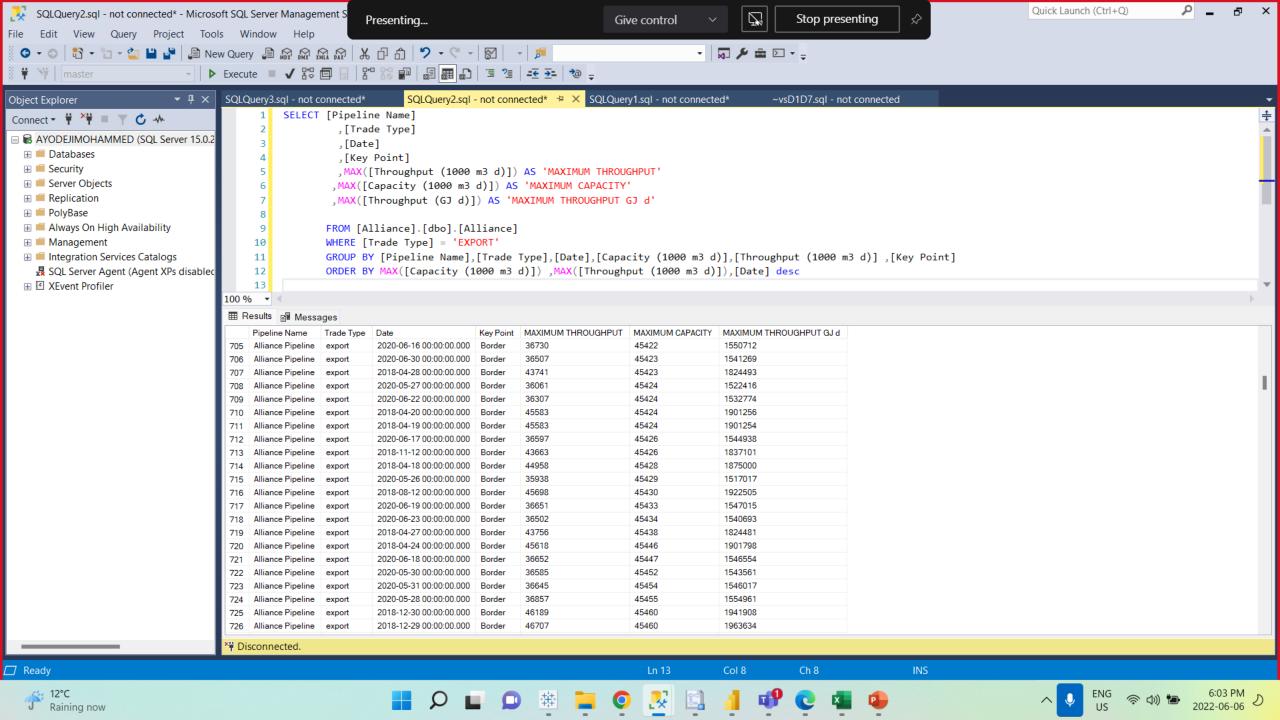
### Data Preparation – SQL Query for Question 1

```
SELECT [Pipeline Name]
,[Trade Type]
,[Date]
,[Key Point]
,MAX([Throughput (1000 m3 d)]) AS 'MAXIMUM THROUGHPUT'
,MAX([Capacity (1000 m3 d)]) AS 'MAXIMUM CAPACITY'
,MAX([Throughput (GJ d)]) AS 'MAXIMUM THROUGHPUT GJ d'
FROM [Alliance].[dbo].[Alliance]
WHERE [Trade Type] = 'intracanada'
GROUP BY [Pipeline Name], [Trade Type], [Date], [Capacity (1000 m3 d)], [Throughput
(1000 m3 d)], [Key Point]
ORDER BY MAX([Capacity (1000 m3 d)]), MAX([Throughput (1000 m3 d)]), [Date] desc
```



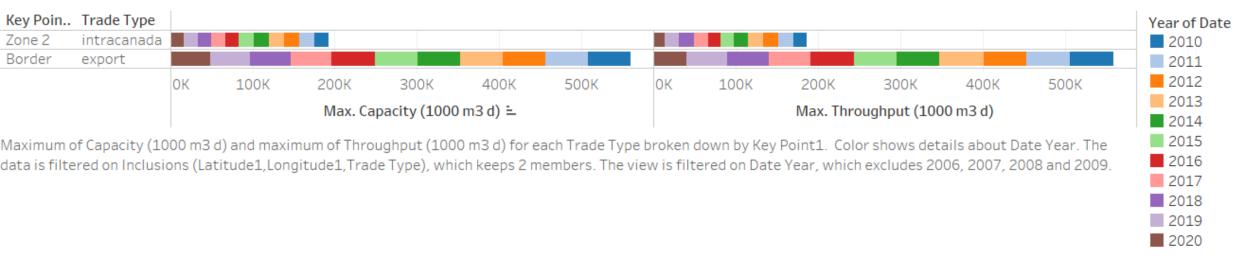
### Data Preparation – SQL Query for Question 2

```
SELECT [Pipeline Name]
,[Trade Type]
,[Date]
,[Key Point]
,MAX([Throughput (1000 m3 d)]) AS 'MAXIMUM THROUGHPUT'
,MAX([Capacity (1000 m3 d)]) AS 'MAXIMUM CAPACITY'
,MAX([Throughput (GJ d)]) AS 'MAXIMUM THROUGHPUT GJ d'
FROM [Alliance].[dbo].[Alliance]
WHERE [Trade Type] = 'EXPORT'
GROUP BY [Pipeline Name], [Trade Type], [Date], [Capacity (1000 m3 d)], [Throughput
(1000 m3 d)], [Key Point]
ORDER BY MAX([Capacity (1000 m3 d)]), MAX([Throughput (1000 m3 d)]), [Date] desc
```

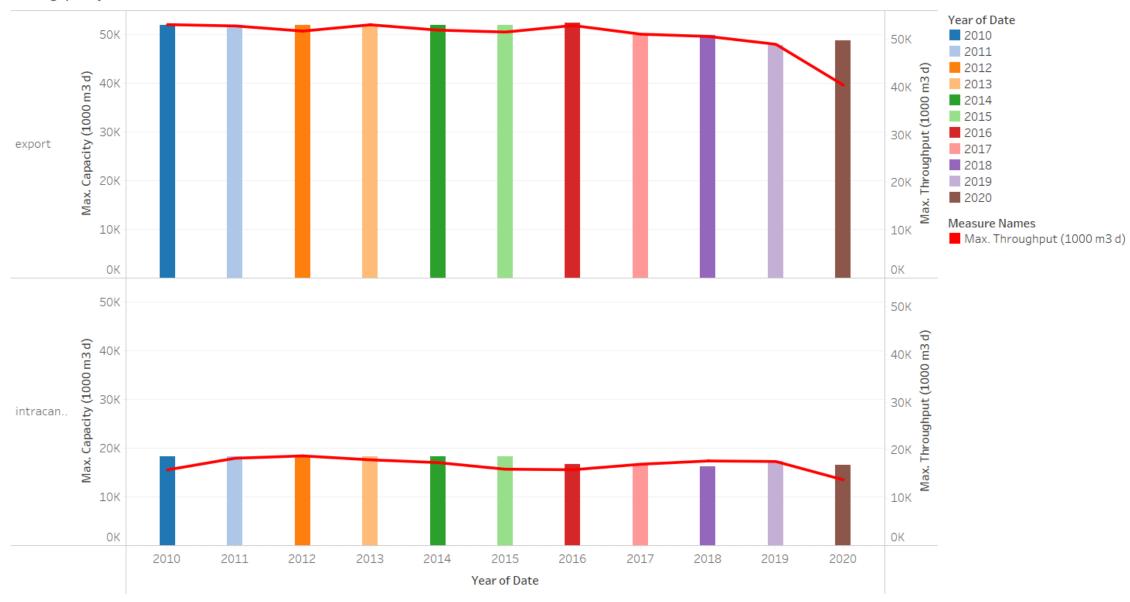




#### ThroughPut



Capacity per Throughput by Export and Capacity per Throughput by Intracanada



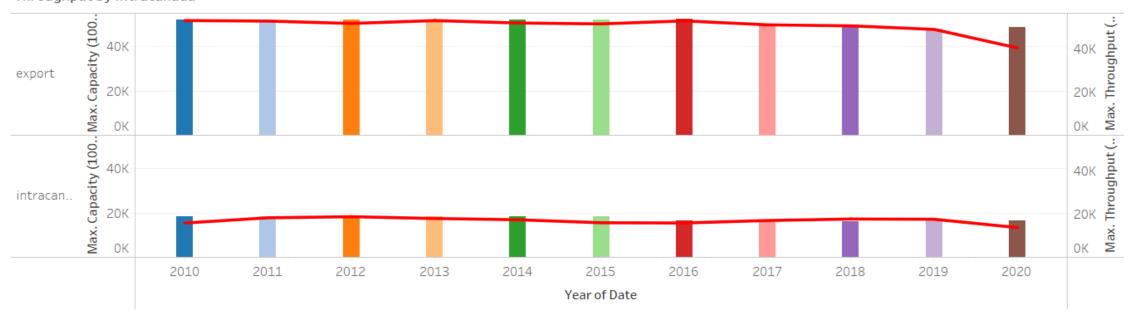
The trends of maximum of Capacity (1000 m3 d) and Max. Throughput (1000 m3 d) for Date Year broken down by Trade Type. For pane Maximum of Capacity (1000 m3 d): Color shows details about Date Year. For pane Maximum of Throughput (1000 m3 d): Color shows details about Max. Throughput (1000 m3 d). The data is filtered on Inclusions (Latitude1,Longitude1,Trade Type) and Action (Latitude1,Longitude1,Trade Type). The Inclusions (Latitude1,Longitude1,Trade Type) filter keeps 2 members. The Action (Latitude1,Longitude1,Trade Type) filter keeps 2 members. The view is filtered on Date Year, which excludes 2006, 2007, 2008 and 2009.

#### ThroughPut Key Poin.. Trade Type Zone 2 intracanada Border export 200K 400K 200K 400K Year of Date Max. Capacity (1000 m3 d) ≒ Max. Throughput (1000 m3 d) 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019

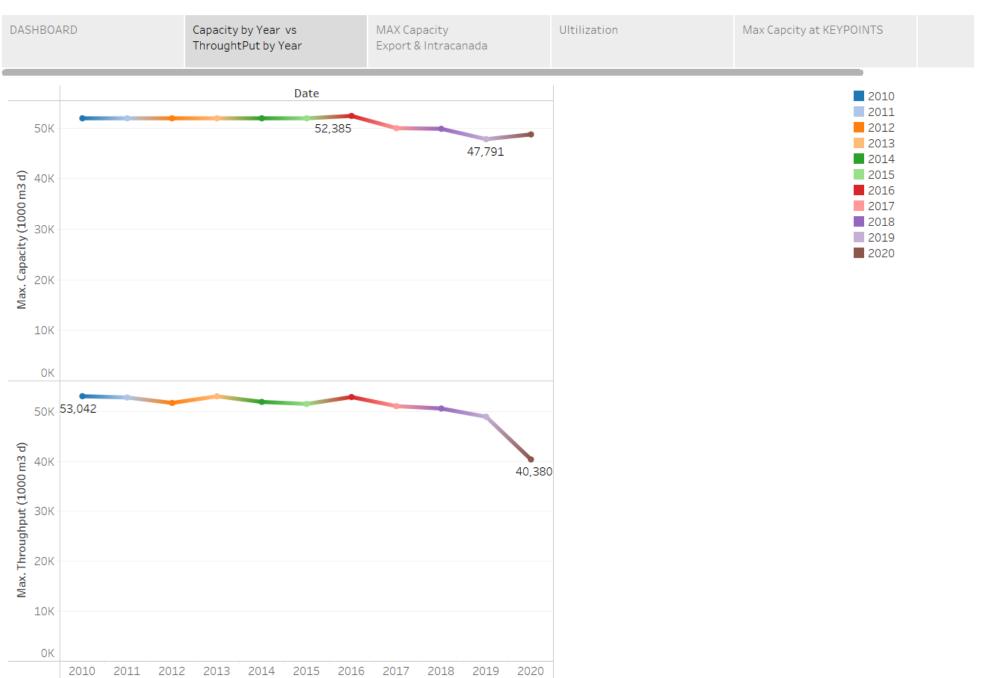
© 2022 Mapbox © OpenStreetMap

#### Capacity per Throughput by Export and Capacity per Throughput by Intracanada

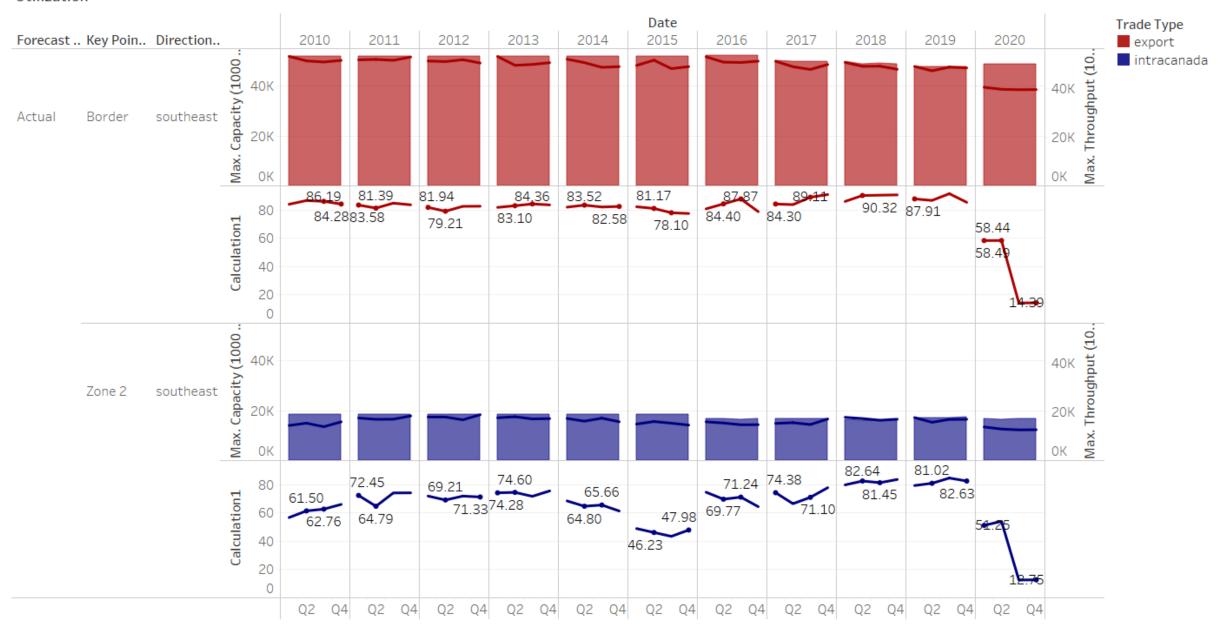
2020



#### Capacity by Year vs ThroughtPut by Year

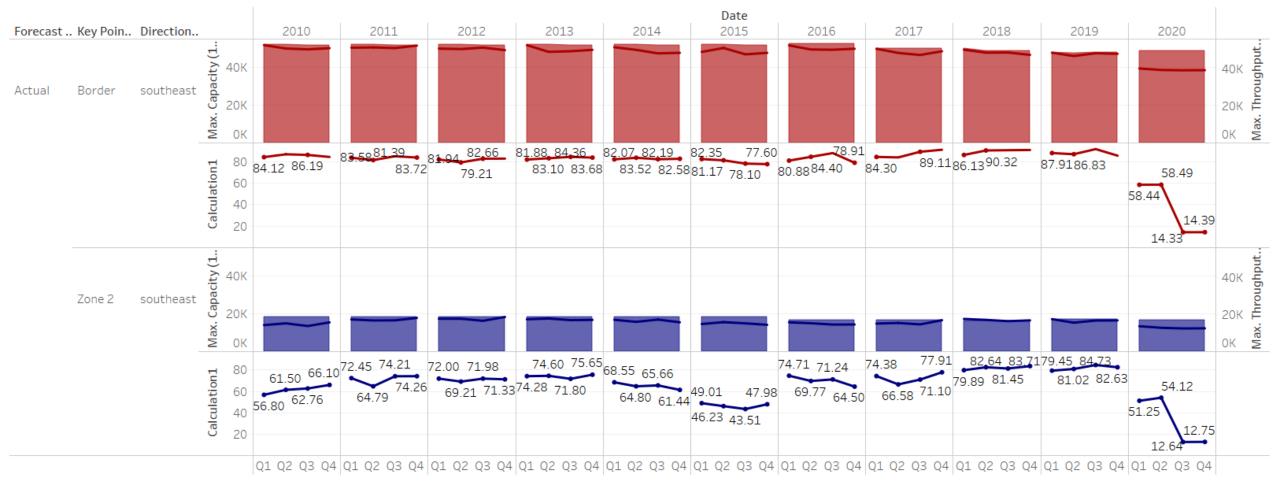


#### Utilization



The trends of maximum of Capacity (1000 m3 d) (actual & forecast), maximum of Throughput (1000 m3 d) (actual & forecast) and sum of Calculation1 (actual & forecast) for Date Quarter broken down by Date Year vs. Forecast indicator, Key Point1 and Direction of Flow. Color shows details about Trade Type. The data is filtered on Inclusions (Latitude1, Longitude1, Trade Type), which keeps 2 members. The view is filtered on Date Year, which excludes 2006, 2007, 2008 and 2009.

#### Utilization



#### **Utilization Table**

			Max. Capacity (1000 m3 d)												Max. Throughput (1000 m3 d)										
Forecast	Key Poin	Trade Ty	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Actual	Border	export	51,914	51,914	51,914	51,914	51,914	51,914	52,385	49,966	49,840	47,791			53,042	52,778	51,694	53,015	51,898	51,490	52,873	51,050	50,579	48,932	
	Zone 2	intracan	18,294	18,294	18,294	18,294	18,294	18,294	16,625	16,688	16,216	17,258			15,848	18,271	18,768	17,944	17,362	15,977	15,866	17,021	17,704	17,590	
Estimate	Border	export											49,120	49,120											50,03
	Zone 2	intracan											16,951	16,951											17,43



## Conclusion – Answer to Question 1

• From the visuals, there was a drop in 2020. Likely reason was due to the Covid-19 outbreak

## Conclusion – Answer to Question 2

- From the visuals, it is seen that there are varying utilization per year from 2010 2020. This is observed especially in 2020.
- The rate of efficiency which was considerably low in 2020 would most likely have been affected by
- 1)the Covid -19 outbreak
- 2) a global slump in demand for fuel
- 3) A \$5.2-billion rise in its estimated cost to \$12.6 billion