



**ONTARIO ENERGY BOARD**

**IN THE MATTER OF the Ontario Energy Board Act, 1998, S.O.1998, c.15, Schedule B;**

**AND IN THE MATTER OF an application by Pembina Infrastructure and Logistics LP for a permit to drill hydrocarbon injection and withdrawal wells within the vicinity of the Moore 3-21-XII Designated Storage Area and to expand the storage capacity at the Corunna Storage Terminal;**

**AND IN THE MATTER OF Ontario Energy Board File Number EB-2015-0032**

**Responses of Pembina Infrastructure and Logistics LP ("Pembina")  
to Interrogatories of Ministry of Natural Resources and Forestry**

**Interrogatory #1**

- 1. Reference:** Reference Additional Evidence: Risk Assessment
- Preamble:** The requirements for a Risk Assessment are stipulated by CSA Z341-14 Section 7.1 and Annex D, which reads:
- 7.1 Risk Assessment*  
*Operators shall*
- (a) establish, document, implement, and maintain a Risk Assessment process to effectively identify risks associated with underground storage facilities;*
  - (b) perform baseline risk assessments for all new cavern storage development;*
  - (c) evaluate the severity of the identified risks;*
  - (d) review and update the Risk Assessment when changes to the facility are made; and*
  - (e) retain records of the Risk Assessment for a period of 5 years after the decommissioning for the storage facility.*
- Note:* *where storage facilities form a part of a larger or integrated facility or are located in close proximity to other facilities, the risk assessment process should be integrated with the assessment of these other facilities. See Annex D for Risk Assessment Guidelines.*
- Question/Request:** Pembina filed a Risk Assessment as part of its additional evidence.
- a) Please confirm that the Risk Assessment has been completed as per the requirements of CSA Z341 Section 7.1 and Annex D.
  - b) Please explain the processes developed to manage and mitigate risks, as per CSA Z341, Section 7.1 (d).
  - c) Did the Risk Assessment take into account the integration of other facilities in a close proximity such as existing storage caverns and the existing natural gas storage operations?
  - d) Please comment on the hazard identification and risk evaluation for subsurface storage operations including the well casing integrity.
  - e) As a follow-up, did the Risk Assessment identify any issues that require further evaluation?



- Response:**
- a) Confirmed – it was completed as per the requirements of CSA Z341 Section 7.1 and Annex D.
  - b) Pembina and its engineering contractors utilize accepted industry design practices when designing above ground and below ground facilities. During the project design stage, various design analyses are undertaken. These include Hazard Identification (“HAZID”) Hazard in Operation (“HAZOP”), Safety Integrity Level (“SIL”), and Layer of Protection (“LOP”). Pembina’s project development practices require the aforementioned analyses to be completed in the engineering phase and that the appropriate safe guards are then in place in the design as identified in these analyses.  
  
During construction, Pembina’s contractors adhere to accepted quality assurance/quality control standards for inspection and testing. The piping systems are inspected by the Technical Standards and Safety Authority (“TSSA”) prior to commissioning.  
  
Also, Pembina’s Integrity group has developed inspection and monitoring schedules for all its facility piping and conducts inspections based on industry practice and historical data.
  - c) The Risk Assessment took into account the existing, operational caverns at the Corunna Facility. Results and conclusions represented in the Assessment address the overall footprint of exposure to the surrounding area as a result of a release. The Risk Assessment also presents the overall land use restrictions based on the MIACC guidelines for the area around the Pembina lands and facility as a result of an incident. MIACC suggests that a large release will occur at a frequency of 1 in 10,000 years, making multiple major releases at the same time a statistically non existent event.  
  
While the Risk Assessment did not take into account the natural gas storage operation operated by Enbridge, Pembina is committed to collaboration efforts with neighbouring third parties to develop a regional risk assessment prior to the commencement of Project operations as a condition of approval of this Application if required by the OEB.
  - d) CSA Z341 Subsection 5.3 Well completion and Conversion outlines the requirements for any new casing that will be installed. Any of the 11 caverns proposed to be converted to hydrocarbon storage will first have a new casing inspection and cement bond log performed to ensure that all cavern entries have both cement and casing integrity as per Section 5.5 of CSA Z341. New production and casing string will be supplied with surface monitoring venting capabilities as per section 9.4.1 of CSA Z341..
  - e) The Risk Assessment did not identify any issues that required future evaluation.



## Interrogatory #2

1. **Reference:** Reference: Additional Evidence: Geomechanical Assessment
- Preamble:** The requirements for a geological study are stipulated by CSA Z341-14 Section 7.2 which reads:
- 7.3 Geological Studies
- 7.3.1 General
- Geological studies shall be conducted and shall include:*
- (a) a study of available geophysical data;*
  - (b) an assessment of regional tectonic activity, regional and local fault zones, and structural anomalies;*
  - (c) a study of formations from the surface to the storage zone and to a depth of 100 m below the storage zone, where such information is available;*
  - (d) a study of formations and structures within a 1 km radius of the subsurface perimeter of the storage zone;*
  - (e) a study of the containment properties of the surrounding formations;*
  - (f) identification and characterization of any potentially associated permeability zones and their impact on the proposed storage operation;*
  - (g) a study of regional stresses and strains;*
  - (h) a study of mechanical and chemical properties of the salt and confining rock formations;*
  - (i) a study of structural anomalies, including faulting; and*
  - (j) a study of regional dynamics of the formation, including cavern closure, subsidence, salt behavior, and interference from neighboring activities.*
- Question/Request:** Pembina filed a geological study (geomechanical assessment) as part of its additional evidence
- a) Please advise if a study of regional stresses and strains and structural anomalies was conducted, as per CSA Z341 Section 7.3.1(g) and 7.3.1(l). If yes, please advise if there are any identified peculiarities at this site.
  - b) With reference to the geomechanical studies provided and the opinion of RESPEC on these studies, please advise if there are issues identified for structural stability.
  - c) Based on the available studies, please provide the following:
    - (i) What will be the minimum cavern spacing ratio (S:D) as per section 6.2.2. of CSA Z341-14
    - (ii) Are there limitations to the maximum size of cavern, cavern roof span, and to the cavern diameter?
    - (iii) As per CSA Z341 Section 7.6, please provide the maximum and minimum operating pressure and the maximum injection and withdrawal rates.
- Response:**
- a) Please note that all of the Caverns located in the Corunna Facility were drilled and completed prior to the introduction of CSA Z341. According to all available information, these studies and test were not completed at the time of cavern development. These studies were not a common practice or required during the time of drilling or mining at the Corunna facility.



- b) The review of the Geomechanical Assessments and the opinion of RESPEC did not identify any concerns of structural stability.

Pembina has been working with RESPEC to complete an additional Geomechanical Assessment for the entire Corunna Facility. This Geomechanical Assessment will include all of Pembina's current operating caverns as well as all the suspended caverns that are proposed in our Application to be converted into hydrocarbon storage, and will include the following:

- Available historical data;
- Drilling and mining records;
- Work over reports; and
- Sonar's and mechanical integrity test reports.

RESPEC began this work in July 2015 and has committed to an approximately 9 to 12 week timeline for completion. Currently, RESPEC plans to have this work complete by end of August 2015 for submittal to the OEB and MNR in early September 2015.

- c) Pembina responds as follows:

- (i) Please see attached a Cavern Spacing Table.
- (ii) The cavern size limitations are determined as per section 6.2.2 CSA Z341, depending on the S:D ratio. RESPEC is currently performing an operational and geomechanical review of the Corunna Facility.
- (iii) The minimum and maximum operating pressures for the caverns is 4500 kPa to 6500 kPa on the hydrocarbon side and 0 kPa to 1500 kPa on the brine side. These pressures are due to the depth of the casing seats and the density of the hydrocarbons being stored. They fall within the limits of less than 80 % of area fracture pressure.

The maximum injection and withdraw flow rates for each cavern are determined by the size of the brine string and are set to limit the brine velocity in the string to 12 ft/sec. See tables below for further information:



### Brine Stringer Velocity

String Size	Weight	Inside Diameter	Capacity	Flow @ 12 ft/sec.				
(inches)	(lb/ft)	(inches)	(cu. ft/ft.)	(cu. ft/min.)	(cu. m/min)	(cu. m/hr)	(bbls/hr)	(usgpm)
5	15	4.408	0.106	76.32	2.16	129.67	815.6796	570.92
5.5	15.5	4.9500	0.1336	96.19	2.72	163.43	1028.064	719.57
5.5	17.0	4.8920	0.1305	93.96	2.66	159.64	1004.209	702.87
7	23	6.366	0.221	159.12	4.51	270.35	1700.615	1190.30
8.675	24	8.097	0.3576	257.47	7.29	437.45	2751.765	1926.03

### Pipe Velocity

Pipe	Sched.	Inside Diameter	Capacity	Flow @ 12 ft/sec.				
(inches)	(lb/ft)	(inches)	(cu. ft/ft.)	(cu. ft/min.)	(cu. m/min)	(cu. m/hr)	(bbls/hr)	(usgpm)
4	80.0	3.826	0.07986	57.50	1.63	97.69	614.53	430.13
6	80.0	5.7610	0.1810	130.32	3.69	221.42	1392.811	974.86
8	80.0	7.6250	0.3171	228.31	6.47	387.90	2440.113	1707.90
10	60.0	9.75	0.51872	373.48	10.58	634.54	3991.598	2793.82

### Flow Guidelines

12	ft/sec	target maximim flow rate
13 - 14	ft/sec	high flow alarm setpoint
15	ft/sec	shutdown brine flow