



ACOUSTIC ASSESSMENT REPORT

HYDRO ONE - LEAMINGTON TRANSFORMER STATION LEAMINGTON, ONTARIO

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1.0 INTRODUCTION

Conestoga-Rovers & Associates (CRA) was retained by Hydro One Networks Inc. (Hydro One) to prepare an Acoustic Assessment Report (Assessment) for the proposed Leamington Transformer Station (Station) located at 609 Mersea Road 6 in Leamington, Ontario. The Assessment has been prepared to support the Certificate of Approval (C of A) (Air) Application for the installation of two transformers identified as T1 and T2.

The transformers operate 24 hours per day, 7 days per week.

The Assessment presented herein provides an evaluation of the potential noise impacts from the Station's noise emissions generated during normal operations on the sensitive receptors located nearest to the Station. The Assessment was prepared consistent with the following Ministry of the Environment (MOE) guidance:

- NPC-233, "*Information to be Submitted for Approval of Stationary Sources of Sound, October 1995*"
- "*Appendix A – Supporting Information for an Acoustic Assessment Report or Vibration Assessment Report Required by a Basic Comprehensive C of A*" as specified in the MOE guidance entitled "*Basic Comprehensive Certificates of Approval (Air) – User Guide, April 2004*"
- NPC-232, "*Sound Level Limits for Stationary Sources in Class 3 Areas (Rural), October 1995*"
- NPC-103, "*Procedures, August 1978*"
- NPC-104, "*Sound Level Adjustments*"

The Station is located on land zoned as Agricultural (A3). The land use immediately surrounding the Station is zoned as Agricultural (A1-A5) and Institutional (I). A Station location map is provided as Figure 1 and zoning maps and definitions are provided in Appendix A. Hydro One site plans are provided in Appendix B.

The Station is located in an Acoustical Class 3 area defined by NPC-232 as an "a rural area with an acoustical environment that is dominated by natural sounds having little or no road traffic". The topography surrounding the Station is essentially flat.

2.0 NOISE SOURCE SUMMARY

This Assessment focused on the sound emissions from the noise sources identified at the Station with a potential to adversely impact the sensitive receptor(s). The Noise Source Summary is provided in Table 1.

The proposed Station will be installing two transformers identified as T1 and T2.

The Assessment is based on two new identical 125 MVA Hyundai Heavy Industries Co., LTD. transformer units. The manufacturer measured maximum sound power level under the rated voltage and with cooling fans operating is 65.24 dBA and the manufacturer specification is provided in Appendix C. The manufacturer sound level specification was used to assess noise emissions from the proposed transformer units and is provided in accordance with IEEE C57.12.90-2006, "IEEE Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers."

The transformer outline drawing for the unit is provided in Appendix D.

The sound level calculations for the transformers that were subject of this Assessment are based on the IEEE standard and are summarized in Appendix E.

For proposed transformers the IEEE calculation results in a total A-weighted sound power level based on the manufacturer's specified sound power level and the total surface area of the transformer unit including the radiator cooling fans, if applicable. The total A-weighted sound power level must be adjusted to obtain octave band data for modelling purposes, however the total A-weighted sound power level must not be increased or decreased. Octave band correction factors were obtained from Table 1 of the Encyclopedia of Acoustics, 1997, Chapter 86 - "Sound Power Level Predictions for Industrial Machinery."

There are no other sources of noise emissions at the Station.

3.0 POINT OF RECEPTION SUMMARY

The identification of appropriate sensitive point(s)-of-reception is necessary to conduct the Assessment for the Station. A "point-of-reception" is any point on the premises of a person where sound, originating from other than those premises, is received. The point-of-reception may be located on permanent or seasonal residences, hotels/motels, nursing/retirement homes, rental residences, hospitals, campgrounds, parks, schools, cemeteries or places of worship.

The objective of this Assessment is to determine the predictable worst-case 1-hour equivalent sound level (1-hour Leq) at the worst-case point(s)-of-reception. The worst-case point(s)-of-reception is defined as the sensitive receptor(s) with the greatest potential exposure to the Facility noise sources due to proximity and direct line-of-sight exposure.

The worst-case sensitive point(s)-of-reception has been identified as follows:

- POR1 - Mersea Rd. Residential Façade (4.5 metres [m] above grade [AG]) located approximately 195 m south-west of the Station
- POR2 - Mersea Rd. Residential Property Line (1.5 m AG) located approximately 144 m south of the Station
- POR3 - Mersea Rd. Residential Property Line (1.5 m AG) located approximately 200 m south-east of the Station
- POR4 - Mersea Rd. Church Façade (4.5 m AG) located approximately 297 m west of the Station

The noise impact at all potential receiver locations were considered, however only the most-exposed and worst-case residential receivers were subject of this Assessment. The location of the worst-case PORs is identified on Figures 1 and 2.

4.0 SOUND LEVEL MEASUREMENTS

4.1 BACKGROUND SOUND LEVEL MEASUREMENTS

CRA conducted background sound level monitoring from November 23 to November 24, 2009. The monitoring was necessary in order to characterize the ambient sound environment of the area and to estimate the background sound levels at the nearest sensitive receptors of interest.

Long-term background sound level monitoring was conducted at the southern side of the proposed Hydro One site and identified as location LT on Figure 1. Location "LT" had similar line-of-sight exposure and proximity to Mersea Road 6 as POR2.

The long-term sound level monitoring was conducted using a microphone and data logging system. The sound level measurements were taken using a Larson-Davis 870B Class 1 Precision Integrating SLM (Serial Number 870B1409) and a Larson-Davis 2560 1/2" Microphone (Serial Number 2785). The system was calibrated and checked at 114 decibels (dBA) before and after the measurement period using a Larson-Davis CAL200 Acoustic Calibrator (Serial Number 0931).

Continuous sound level measurements were taken with the detector in slow response. Meteorological weather conditions during the noise-monitoring period were obtained from Environment Canada. The Windsor station data was used to estimate adverse weather conditions that could have affected the sound level measurements and was considered in validating the minimum background levels used in this Assessment.

The background sound level was estimated at the selected PORs using the lowest validated one-hour Leq for the day and nighttime periods. The complete long-term sound level data was reviewed and determined to be invalid due to inclement weather.

5.0 ASSESSMENT CRITERIA

Assessment criteria may be determined for a point-of-reception based on the MOE's minimum exclusionary sound level limits, as presented in NPC-232, in comparison to the background sound levels experienced in the area. The "background sound level" is defined as the sound level present in the environment that is produced by noise sources other than those from the Station, and would include traffic sound levels and sound from neighboring industrial/commercial activity. The higher of the two assessment criteria is selected for purpose of assessment.

The Station is located in an Acoustic Class 3 Area. Class 3 Areas have the following generic minimum sound level limits expressed as a 1-hour Leq that can be applied to assess the sound levels emitted by the Station noise sources:

<i>Time of Day</i>	<i>Minimum Sound Level</i>
7:00 a.m. to 7:00 p.m.	45 dBA
7:00 p.m. to 7:00 a.m.	40 dBA

CRA observed that the background sound levels were characteristic of a Class 3 Acoustic Area but were below the MOE minimum sound level limits. Therefore, the MOE minimum noise limits are applicable and were selected as the most conservative criterion for the purpose of compliance assessment.

6.0 IMPACT ASSESSMENT

6.1 STEADY-STATE SOUND LEVELS

The worst-case assessment of steady-state noise sources at the selected points-of-reception was based on manufacturer sound power level data. Cadna A Acoustical Modelling Software (Cadna A), version 3.7, was used to model the potential impacts of the significant noise sources. Cadna A calculates sound level emissions based on the ISO 9613-2 standard "Acoustics - Attenuation of sound during propagation outdoors".

The worst-case cumulative Station-wide sound levels estimated at the receptor(s) included attenuation affects due to geometric divergence, atmospheric attenuation, barriers/berms, ground absorption and directivity, as applicable for all significant noise sources.

Cadna A modelling assumptions used in this Assessment included:

- Noise Source: The adjusted 1/1 sound power octave band levels were modelled using a point-type noise source to account for noise emissions radiating from the transformer core
- Noise Source Elevation: Transformer noise was modelled at 75% height of the transformer core as it is not accurate to model the noise emissions from the maximum height of the transformer unit since the noise is emitted from the core
- Reflection Order: Maximum reflection order of 1 was evaluated to consider indirect noise impact from one reflecting surface
- Ground Absorption: The area surrounding the transformer Station property is predominantly agricultural, therefore, a ground absorption factor of 1.0 was used in the Cadna A model to represent this; a value of 0.5 was used to represent the gravel ground cover at the Station
- Receptor elevation: PORs 1 and 4 were modelled at a height of 4.5 m to represent a two story house elevation, POR2 and POR3 were modelled to a height of 1.5 m to represent the nearest and most exposed property line
- Noise Source Directivity: No directivity was applied to any sources

The typical noise emitted from a transformer is characterized by the hum of the current passing through the transformer, which emits tonal sound. Therefore, a tonal penalty of 5 dBA was assigned to each transformer.

The steady-state unattenuated noise impact at the selected PORs is summarized in Table 2 and the noise contour plot is shown as Figure 2.

7.0 CONCLUSIONS & RECOMMENDATIONS

The Station-wide steady state sound levels estimated at the selected worst-case PORs comply with the minimum MOE sound level limits as summarized in Table 3. This includes the addition of a 5 dBA tonal penalty. No additional noise control measures are required to mitigate sound levels from this Station.

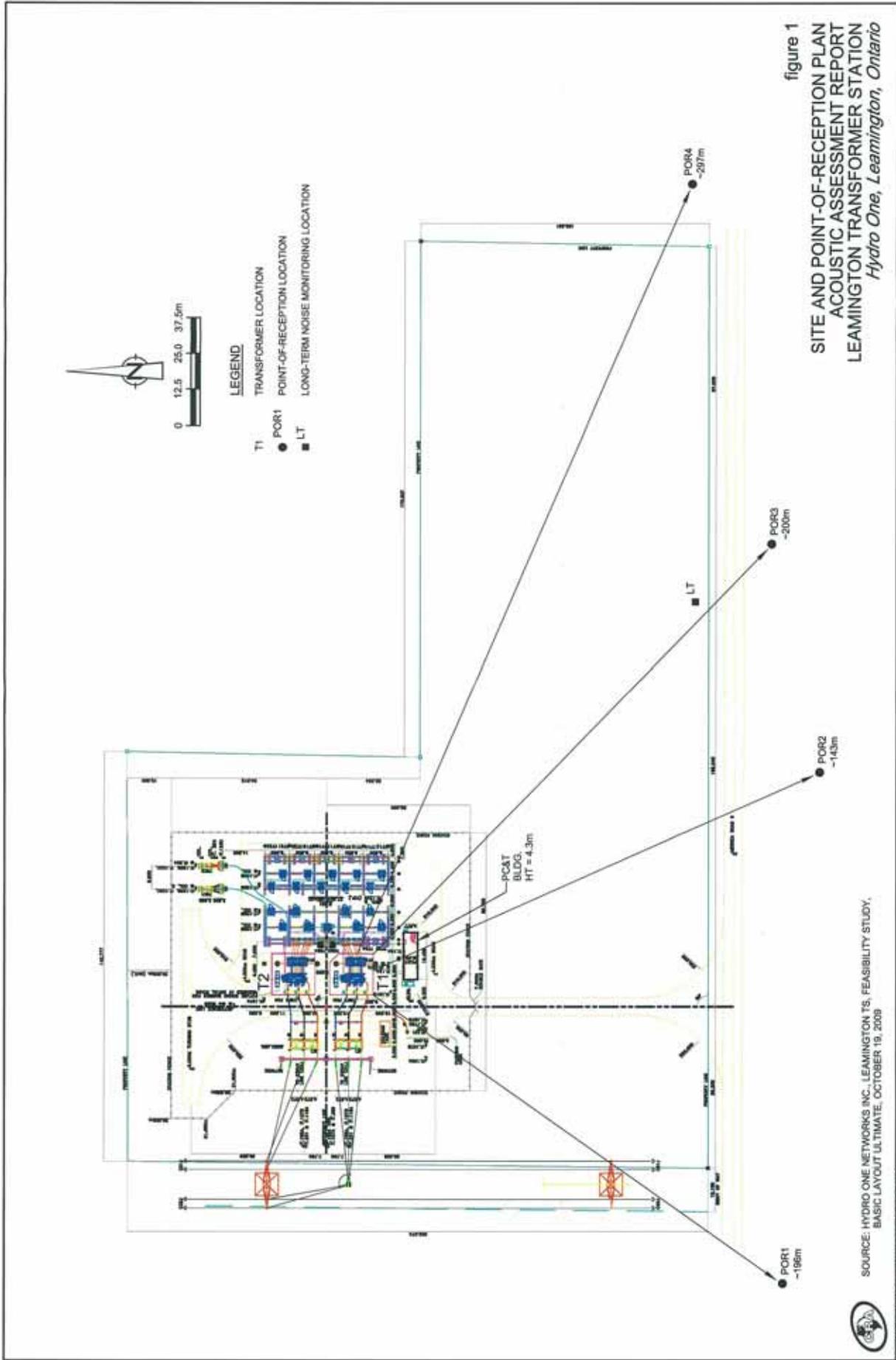


figure 1
 SITE AND POINT-OF-RECEPTION PLAN
 ACOUSTIC ASSESSMENT REPORT
 LEAMINGTON TRANSFORMER STATION
 Hyaro One, Leamington, Ontario

SOURCE: HYDRO ONE NETWORKS INC., LEAMINGTON TS, FEASIBILITY STUDY,
 BASIC LAYOUT ULTIMATE, OCTOBER 19, 2008



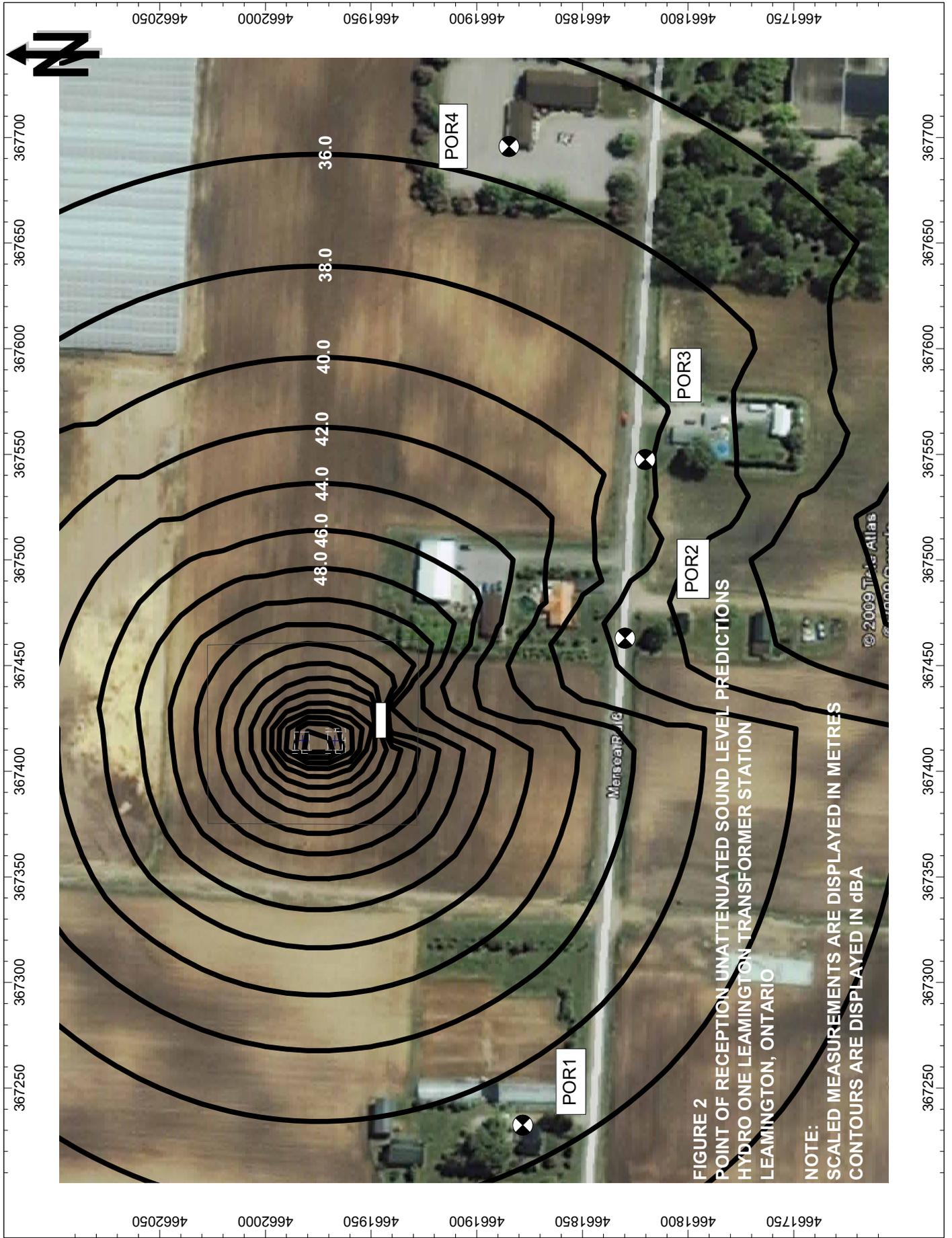


TABLE 1

NOISE SOURCE SUMMARY
 HYDRO ONE - LEAMINGTON TRANSFORMER STATION
 LEAMINGTON, ONTARIO

Source ID	Source Description	Type of Noise Source	Sound Power Level (1) (dBA)	Source Location (2)	Sound Characteristics (3)	Noise Control Measures (4)
T1	Transformer 1	Point Source	94.1	O	S, T	U
T2	Transformer 2	Point Source	94.1	O	S, T	U

Notes:

(1) Sound Power Level in dBA calculated from manufacturer's specifications or measured sound pressure level data and includes + 5 dBA tonal penalty.

(2) Source Location:

- O - located/installed outside of building
- I - located/installed inside of building

(3) Sound Characteristics:

- S - Steady
- Q - Quasi Steady Impulsive
- I - Impulsive
- B - Buzzing
- T - Tonal
- C - Cyclic

(4) Noise Control Measures:

- S - silencer, acoustic louvre, muffler
- A - acoustic lining, plenum
- B - barrier, berm, screening
- L - lagging
- E - acoustic enclosure
- O - other
- U - uncontrolled

TABLE 2

POINT-OF-RECEPTION NOISE IMPACT - UNATTENUATED SOUND LEVELS
 HYDRO ONE - LEAMINGTON TRANSFORMER STATION
 LEAMINGTON, ONTARIO

Source ID	Source Description	Mersea Rd. Residential Façade - POR1		Mersea Rd. Residential Property Line - POR2		Mersea Rd. Residential Property Line - POR3		Mersea Rd. Church Façade - POR4	
		Distance to Receptor (m)	Sound Level at Receptor (Leq)	Distance to Receptor (m)	Sound Level at Receptor (Leq)	Distance to Receptor (m)	Sound Level at Receptor (Leq)	Distance to Receptor (m)	Sound Level at Receptor (Leq)
T1	Transformer 1	200	36.0 dBA	189	33.8 dBA	198	32.8 dBA	280	32.5
T2	Transformer 2	210	35.7 dBA	199	33.4 dBA	208	33.4 dBA	290	32.4
Worst-case Total Facility Sound Level (1-hour Leq)			38.9 dBA		36.6 dBA		36.1 dBA		35.5 dBA

Note:

(1) Sound level impacts were calculated using Cadna A Acoustical Modelling Software. A 5dBA tonal penalty was applied to Transformer sound levels.

TABLE 3

ACOUSTIC ASSESSMENT SUMMARY - STEADY STATE SOUND LEVELS
 HYDRO ONE - LEAMINGTON TRANSFORMER STATION
 LEAMINGTON, ONTARIO

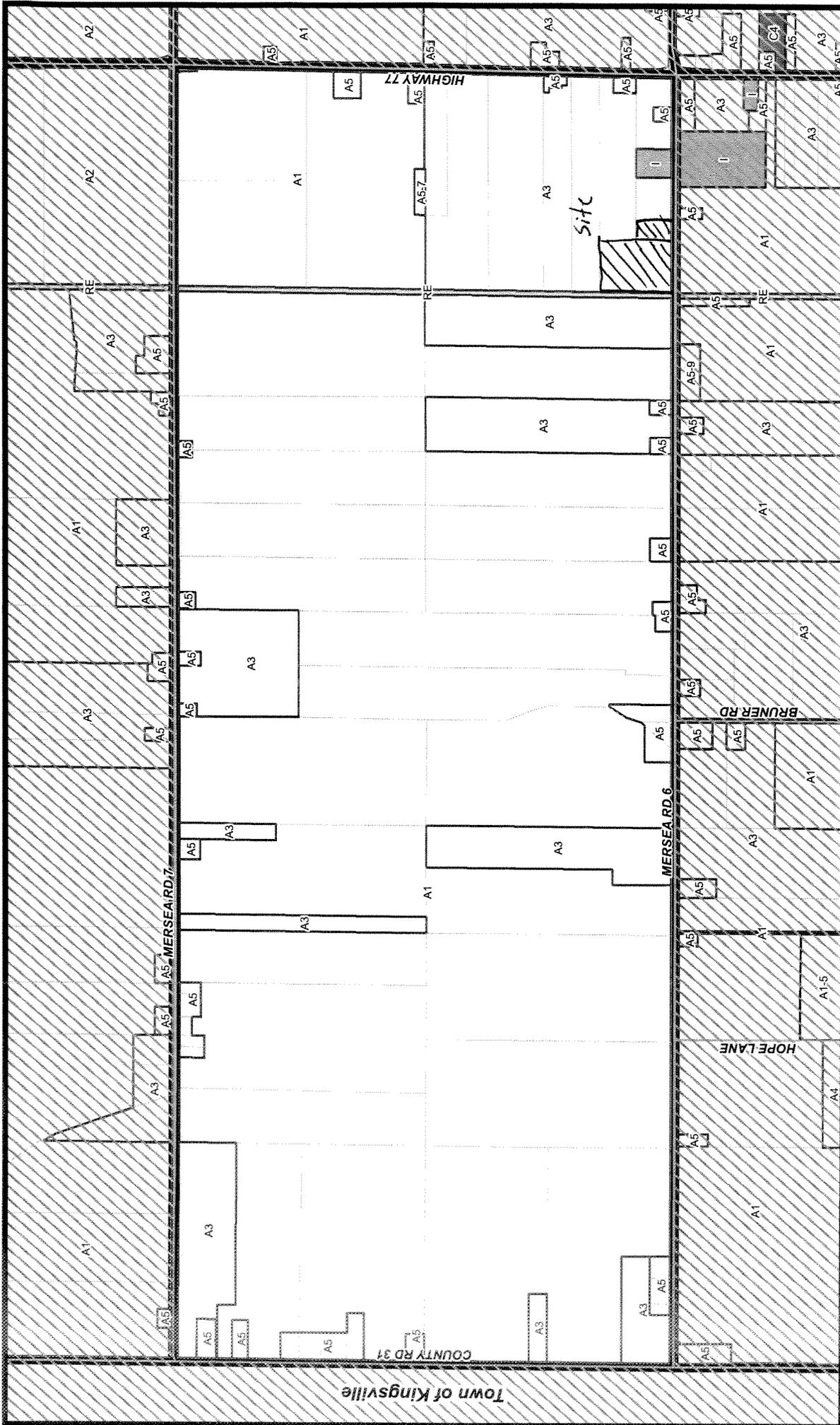
Point-of-Reception ID	Point-of-Reception Description	Unattenuated Sound Level at Point-of-Reception		Verified by Acoustic Audit (Yes/No)	Performance Limit (1) (Leq)	Compliance with Performance Limit (Yes/No)
		Predicted (Leq)				
POR1	Mersea Rd. Residential Façade	38.9 (dBA)		No	40.0 (dBA)	Yes
POR2	Mersea Rd. Residential Property Line	36.6 (dBA)		No	40.0 (dBA)	Yes
POR3	Mersea Rd. Residential Property Line	36.1 (dBA)		No	40.0 (dBA)	Yes
POR4	Mersea Rd. Church Façade	35.5 (dBA)		No	45.0 (2) (dBA)	Yes

Notes:

- (1) NPC-232 minimum exclusionary nighttime noise limit.
- (2) NPC-232 minimum exclusionary daytime noise limit as Institutional Property operates only during the 7a.m. to 7p.m. period.

APPENDIX A

ZONING DEFINITIONS



KEY MAP

17	18	19
24	25	26

**MUNICIPALITY OF LEAMINGTON
ZONING BY-LAW
SCHEDULE "A"
MAP 21**

Scale: 1:15,000

800 Meters

0 200 400

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THIS IS NOT A LEGAL PLAN OF SURVEY.

This map is the property of the Corporation of the Municipality of Leamington and may not be reproduced without expressed permission and authorization. Provided by the Municipality of Leamington Engineering Department - GIS Services 300 Leamington Drive, Leamington, Ontario, Canada N9M 2Z5
TEL: (519) 326-5761 FAX: (519) 326-2481

LEAMINGTON
ONTARIO CANADA

Legend

ZONING DESIGNATION

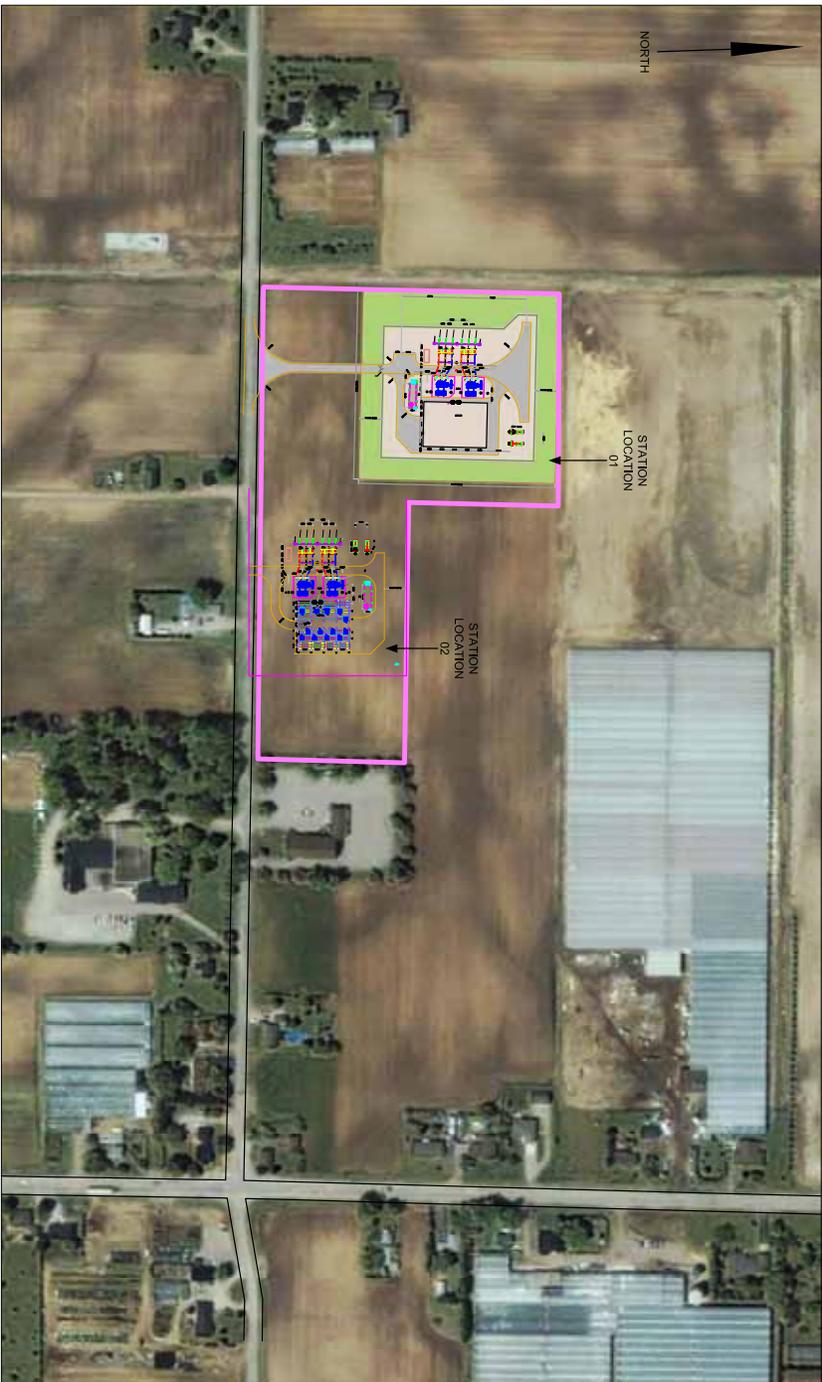
- AGRICULTURAL
- COMMERCIAL
- INSTITUTIONAL
- RECREATIONAL

Title:

Y:\Maps\Planning\2009 Zoning By-law\ZONING_BYLAW_SERIES_2008_master.mxd - 1/12/2009 @ 11:07:11 AM

APPENDIX B

HYDRO ONE SITE PLAN



LEAMINGTON TS STUDY AREA and LANDSCAPE LAYOUT CONCEPT (OPTION 1 & 2)

A1 (594 x 841)



DATE	BY	REVISION	APPROVED
04/07/2008	D.CHEE	DESIGN	[Signature]

hydro one
Hydro One Networks Inc.
ENGINEERING & CONSTRUCTION SERVICES

LEAMINGTON TS
LANDSCAPE LAYOUT CONCEPT

DATE	BY	REVISION	APPROVED
04/07/2008	D.CHEE	DESIGN	[Signature]
DATE	BY	REVISION	APPROVED
04/07/2008	D.CHEE	DESIGN	[Signature]

CLASS NO

00

APPENDIX C

MANUFACTURER SOUND LEVEL SPECIFICATIONS



HYUNDAI
HEAVY INDUSTRIES CO., LTD.
 Electro Electric SYSTEMS

HEAD OFFICE

#1.CHUNHA-DONG, DONG-GU, ULSAN KOREA
 Tel : (052) 230-8290, Fax : (052) 230-8668

SEOUL OFFICE

HYUNDAI B/D, 140-2, KYE-DONG, CHONGRO-GU
 SEOUL, KOREA
 Tel : (02)746-1114, Fax : (02)746-7648,7675

INSPECTION & TEST REPORT

**FOR
 TRANSFORMER**

Customer : HYDRO ONE NETWORK SERVICES INC
 Project Name : HYDRO ONE #9643 ITEM 2C
 Applicable Standard : CSA C88-M90
 Cooling Type : ONAN / ONAF/ODAF
 Phase : 3
 Frequency (Hz) : 60
 Capacity (MVA) : 75 / 100 / 125
 High Voltage (KV) : 215.5
 Tap Voltage (KV) : 215.5 ±16 × 1.16% steps (33 taps)
 Low Voltage-1 (KV) : 28.00
 Low Voltage-2 (KV) : 28.00
 Vector Group : YNzn1zn1
 Quantity (set) : 2
 Serial No. : ~~41144TL0007-001~~

41144TL0007-002 (OCT 12 ~ OCT 20) by Peter Bee
 (Dec 26 ~ Dec 27) by C.C.Yi

APPROVED BY : H. D. Lee

WITNESSED BY

PB	41144TL0007-001
Witnessed	
Checked by	<u>JRB</u>
Date	2004-04

CHECKED BY : C. H. Lee

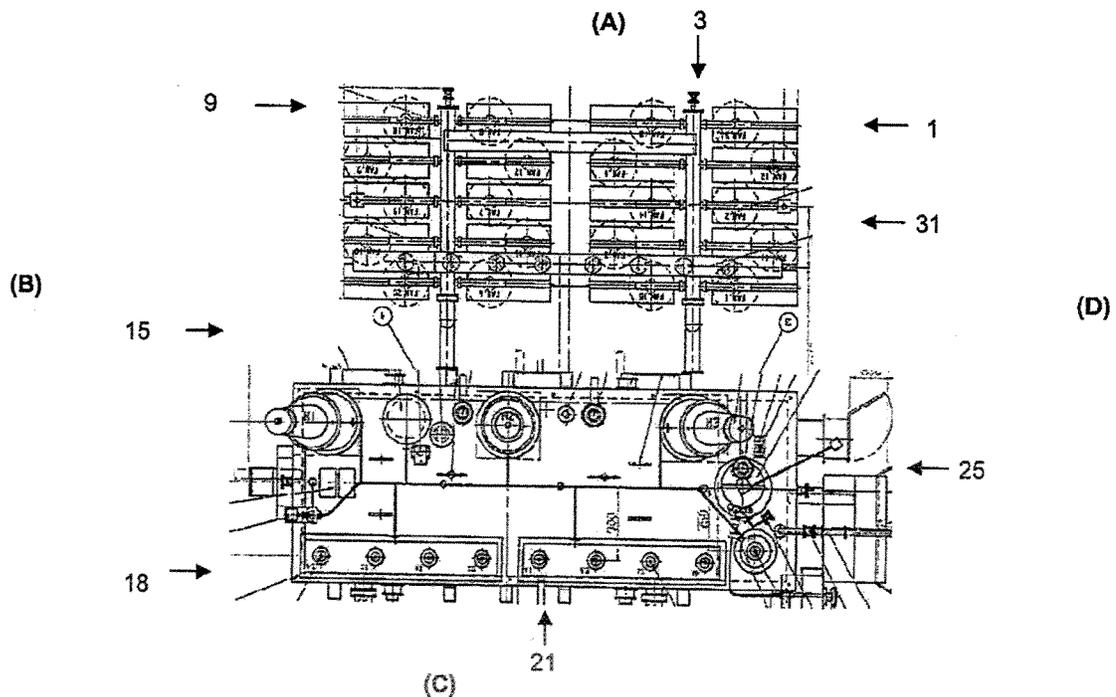
TESTED BY : S. N. Jinn

At rated voltage 215.5/28-28 kV, frequency 60 Hz, and type of cooling (ODAF) in accordance with CAN/CSA-C88-M

- 1. Guaranteed value : 76.00 dB
- 2. Measured value : 65.24 dB with cooling system (6.0ft), Tank (1ft)
- 3. Ambient sound level : 58.25 dB (A : 58 B : 58 C : 59 D : 58)
- 4. Measured value(Unit : dB)

*EMERGENCY
OPIN*

	1/3 H	2/3 H		1/3 H	2/3 H		1/3 H	2/3 H
1	65.0	65.0	12	65.0	65.0	23	66.0	66.0
2	64.0	64.0	13	66.0	66.0	24	66.0	66.0
3	64.0	65.0	14	67.0	66.0	25	66.0	66.0
4	65.0	64.0	15	66.0	65.0	26	66.0	66.0
5	65.0	65.0	16	66.0	65.0	27	66.0	65.0
6	65.0	64.0	17	66.0	65.0	28	66.0	66.0
7	64.0	64.0	18	66.0	65.0	29	66.0	65.0
8	64.0	64.0	19	66.0	66.0	30	65.0	65.0
9	64.0	64.0	20	66.0	67.0	31	65.0	65.0
10	64.0	63.0	21	66.0	67.0	32		
11	63.0	64.0	22	66.0	67.0	33		



Date of Test : 2009. 11. 13

Tested by : S. R. Kim

APPENDIX D

HYDRO ONE TRANSFORMER DRAWINGS

APPENDIX E

TRANSFORMER SOUND LEVEL CALCULATIONS

TABLE E.1

TRANSFORMER 1 SOUND POWER LEVEL CALCULATIONS
HYDRO ONE - LEAMINGTON TRANSFORMER STATION
LEAMINGTON, ONTARIO

Transformer Core Data - T1 & T2

Length	6.90 m
Width	8.70 m
Height	5.16 m

65.24
221
88.7

Measured or Manufacturer Tested Sound Pressure Level (dBA) (1)

Transformer Surface Area (inclusive of fan banks) (m²) (2)

Transformer Calculated Sound Power Rating (dBA) (3)

Octave Band (Hz)	32	63	125	250	500	1000	2000	4000	8000	Total
Correction Factor (4)	-3	3	5	0	0	-6	-11	-16	-23	
Sound Power Level (dB)	86	92	94	89	89	83	78	73	66	97.7
A-weighting	-39.4	-26.2	-16.1	-8.6	-3.2	0.0	1.2	1.0	-1.1	
Sound Power Level (dBA)	46.3	65.5	77.6	80.1	85.5	82.7	78.9	73.7	64.6	89.1

Notes:

- (1) Manufacturer tested sound level in accordance with IEEE or equivalent. See letter from manufacturer.
- (2) The following transformer surface area calculation based on 5 exposed sides and design dimensions provided by Hydro One:

$$= (2 \times (6.9 \times 5.16)) + (2 \times (8.7 \times 5.16)) + (6.9 \times 8.7)$$
- (3) Calculated as per IEEE C57.12.90-2006, "IEEE Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers."
- (4) Octave band correction factors obtained from Table 1 of the Encyclopedia of Acoustics, 1997, Chapter 86 - "Sound Power Level Predictions for Industrial M...