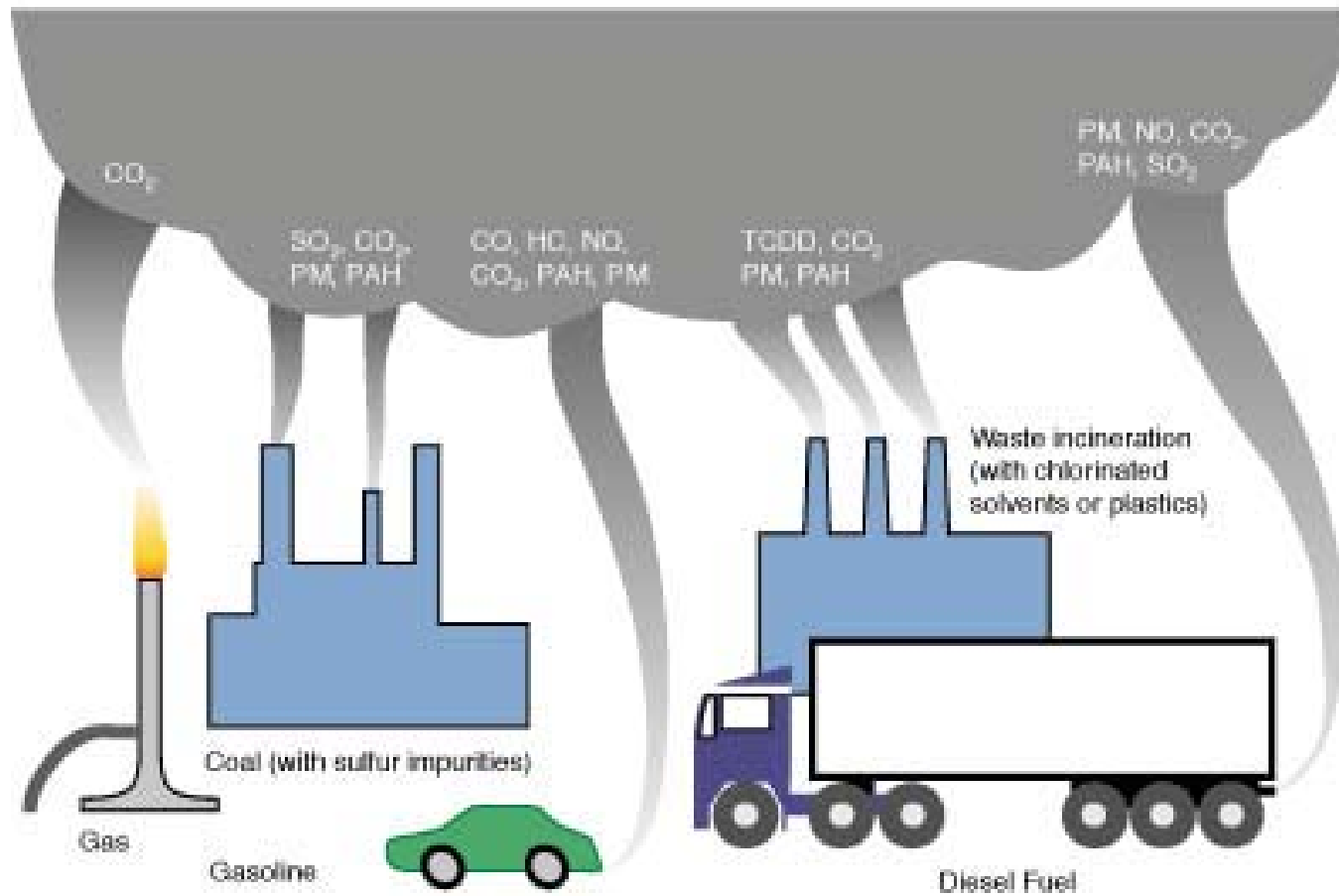




Anthony Ciccone, Ph.D., P.Eng. – Principal
Golder Associates Ltd.

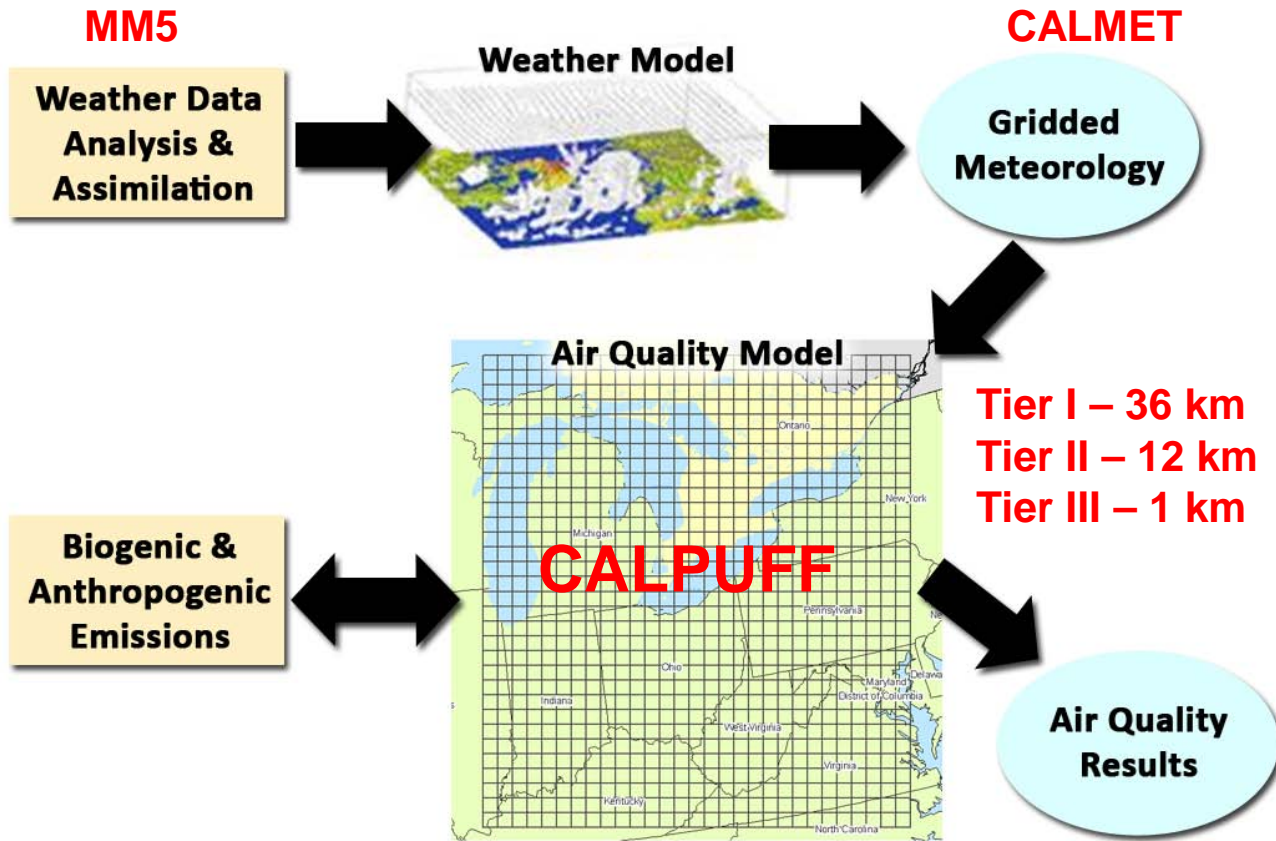
**All Sources and Cumulative Air Quality Study –
City of Toronto**

- ❑ Background
- ❑ Purpose of Study
- ❑ Accomplishments
 - List of PAC's
 - Emissions
 - Meteorology
 - Neighborhood assessments
- ❑ End Results



- The purpose of this study is to evaluate at the neighborhood level
- 1. the origin of the emissions considering both local and trans-boundary sources
- 2. the cumulative concentration of local and trans-boundary multiple emission sources
- 3. the health impact of these emissions on the air quality.

1. Selection of an appropriate air quality modelling system
2. Selection of contaminants of known or suspected concern that influence the airshed.
3. Determination of the size and extent of the surrounding domain which contributes to the airshed of interest.



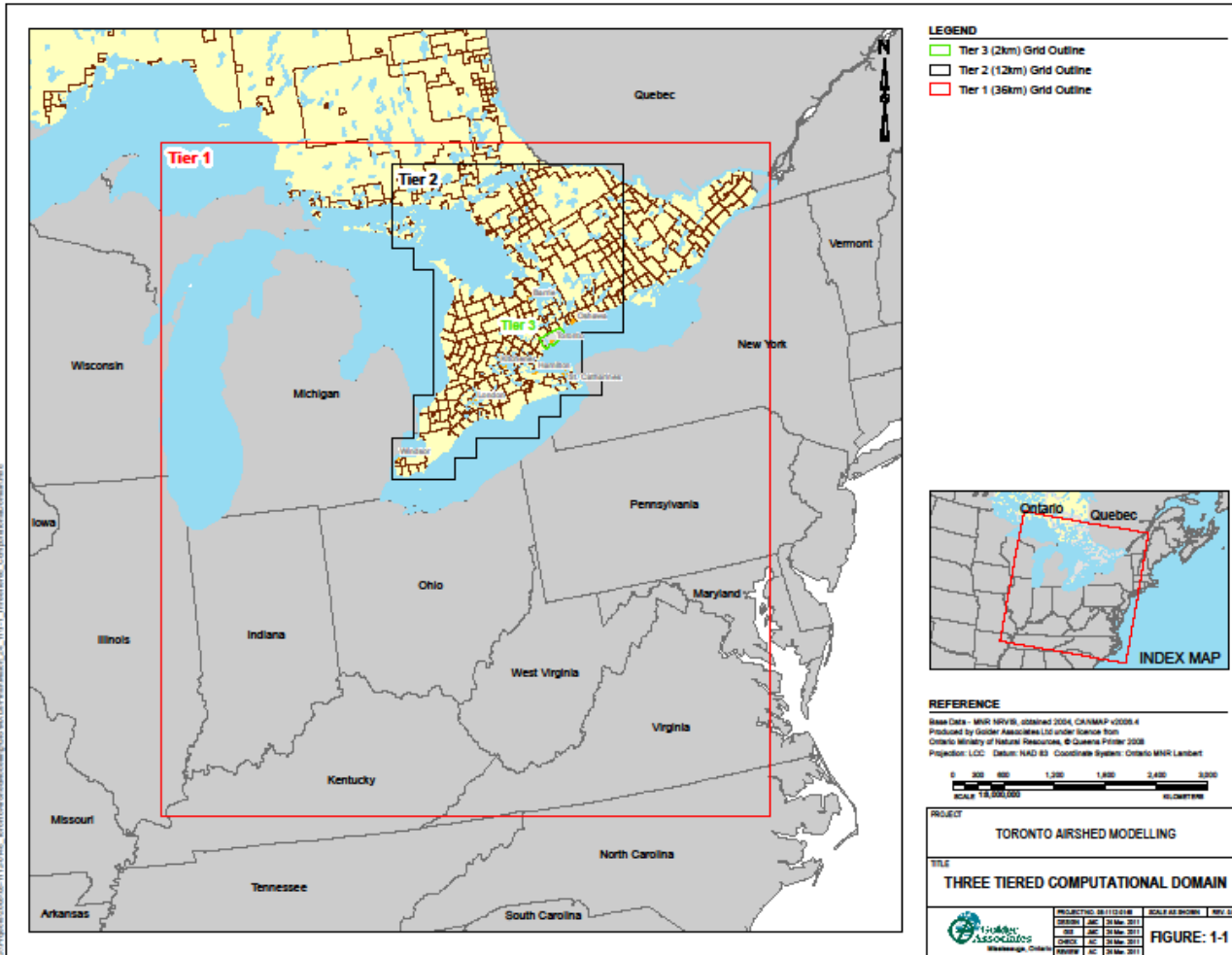
1. Acetaldehyde
2. Acrolein
3. Benzene
4. 1,3-Butadiene
5. Cadmium
6. Carbon tetrachloride
7. Chloroform
8. Chloromethane
9. Chromium
10. 1,4-Dichlorobenzene
11. 1,2-Dichloroethane
12. Dichloromethane
13. Ethylene dibromide
14. Formaldehyde
15. Lead
16. Manganese
17. Mercury
18. Nickel compounds
19. Nitrogen Oxides
20. PAHs (as B[a]Ps)
21. PM_{2.5}
22. Tetrachloroethylene
23. Toluene
24. Trichloroethylene
25. Vinyl Chloride
26. Carbon Monoxide (CO)
27. PM₁₀
28. Sulfur Dioxide
29. VOC (anthropogenic/Biogenic)
30. Ozone

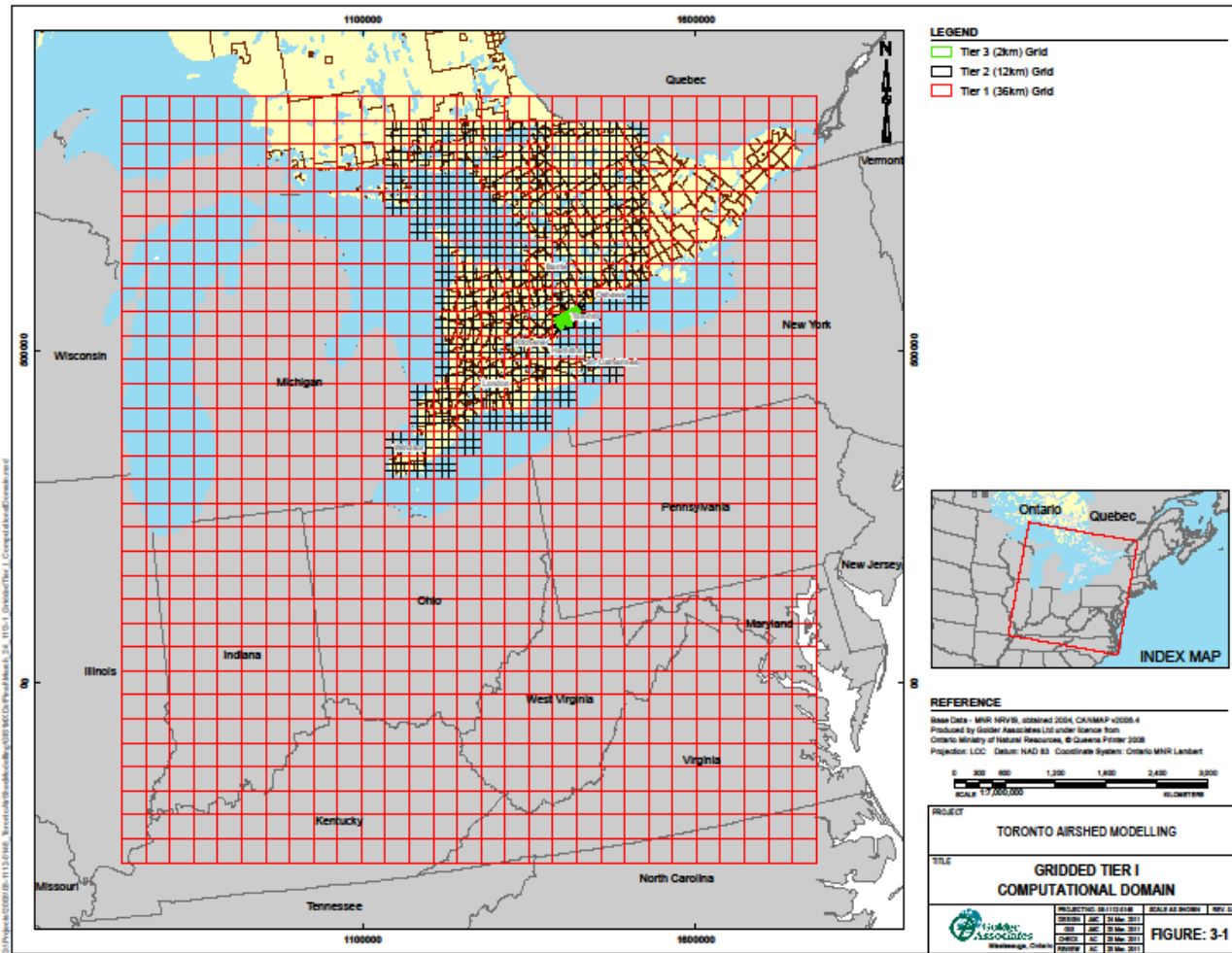
❑ Three Tiered System

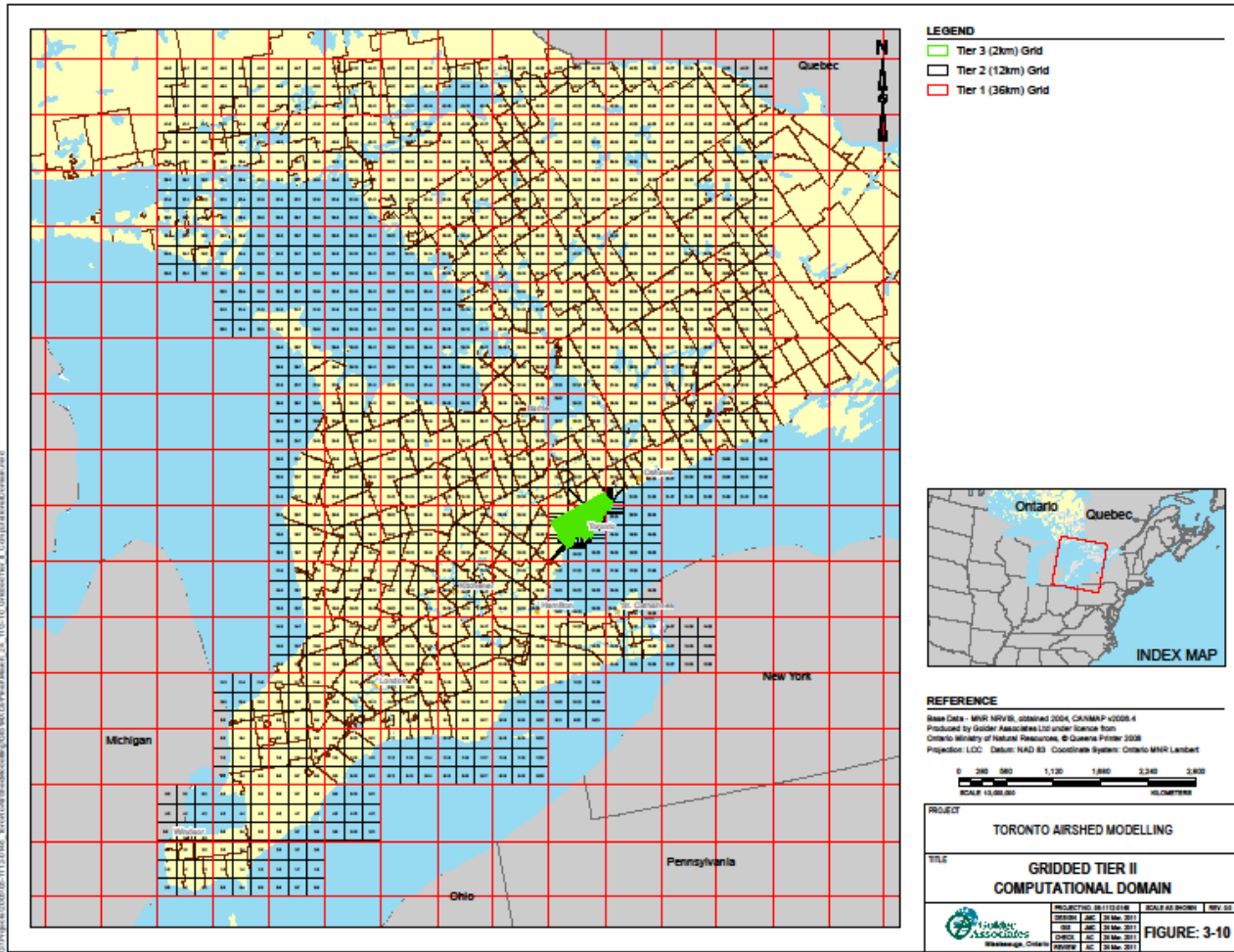
- Tier 1 – 36 km Grid - United States Emissions
- Tier 2 – 12 km Grid - Ontario Emissions
- Tier 3 – 1 km Grid - City of Toronto Emissions Only

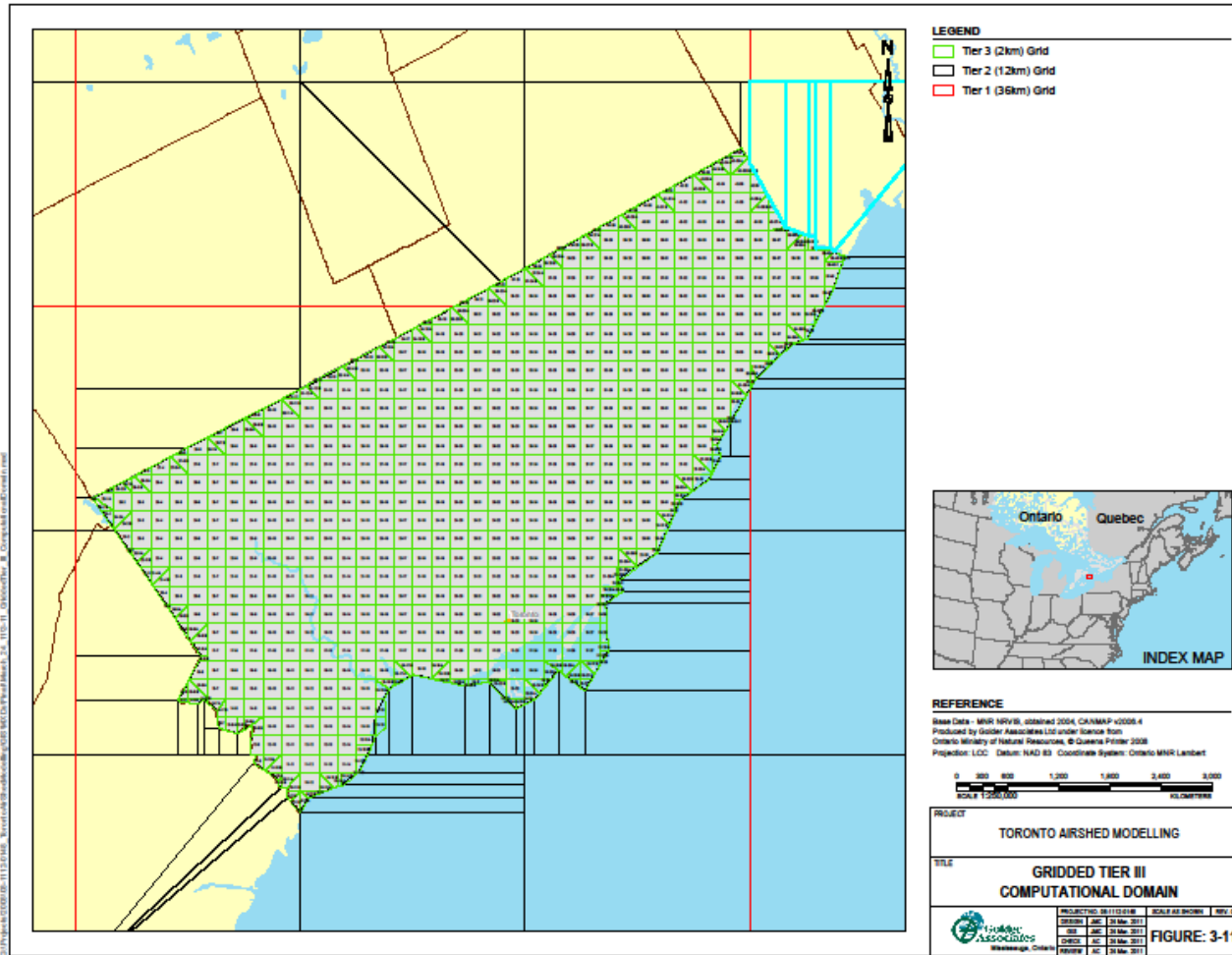
❑ Evaluate the impact of each grouping on community of interest independently

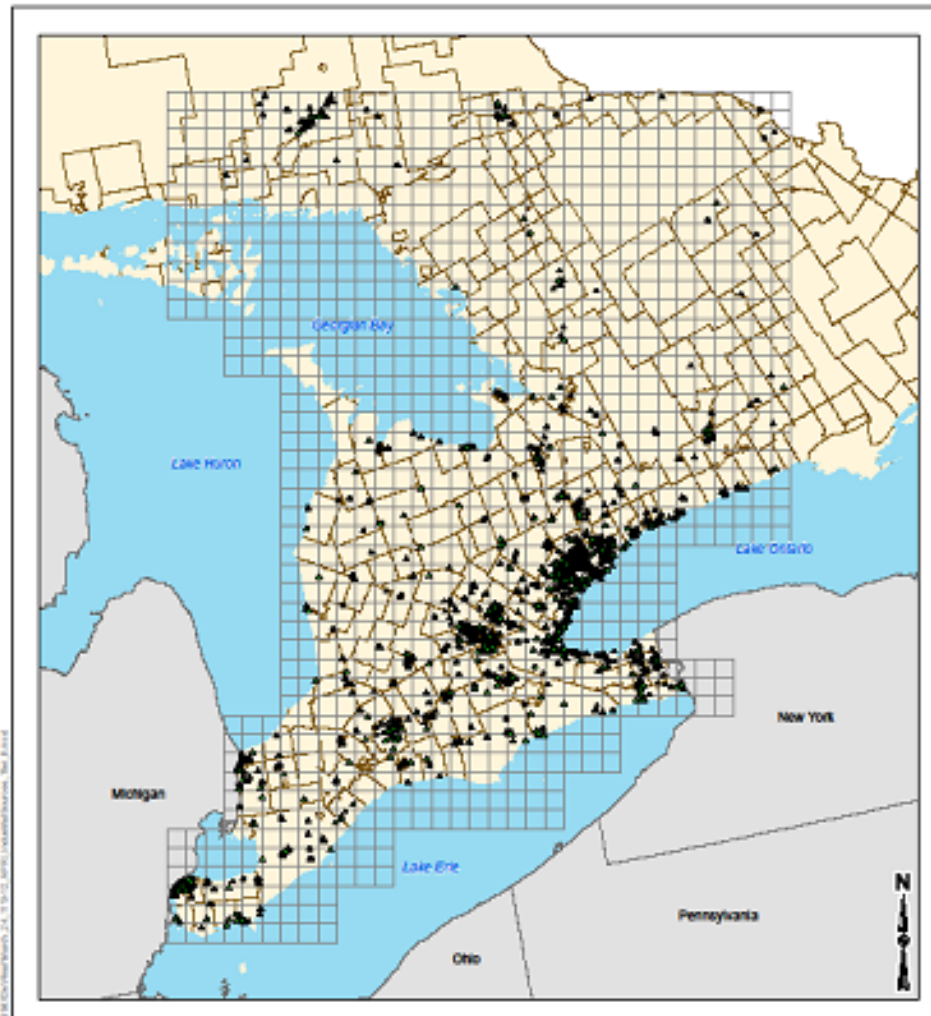
❑ Effectively determining the cumulative effects of all sources on a community

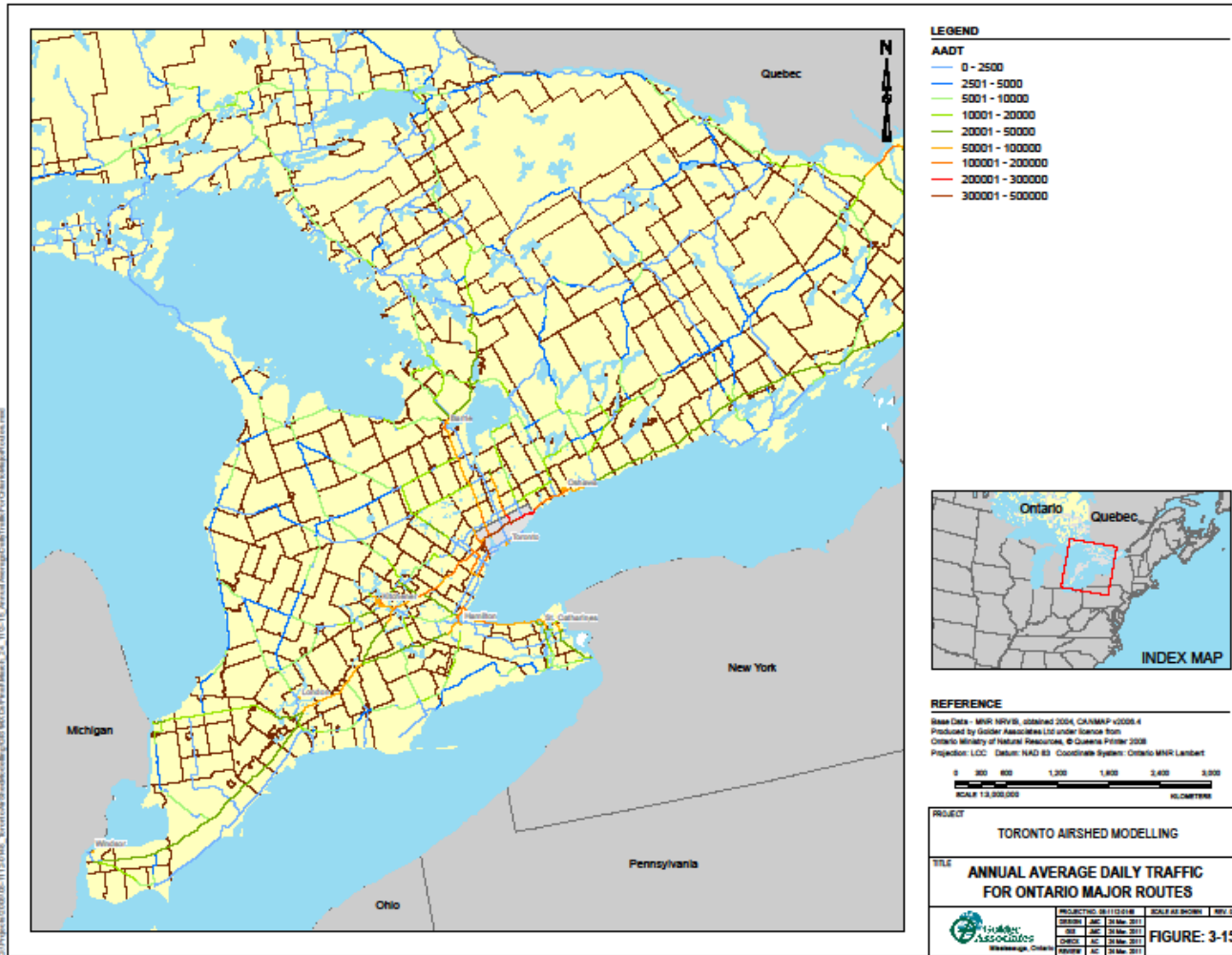


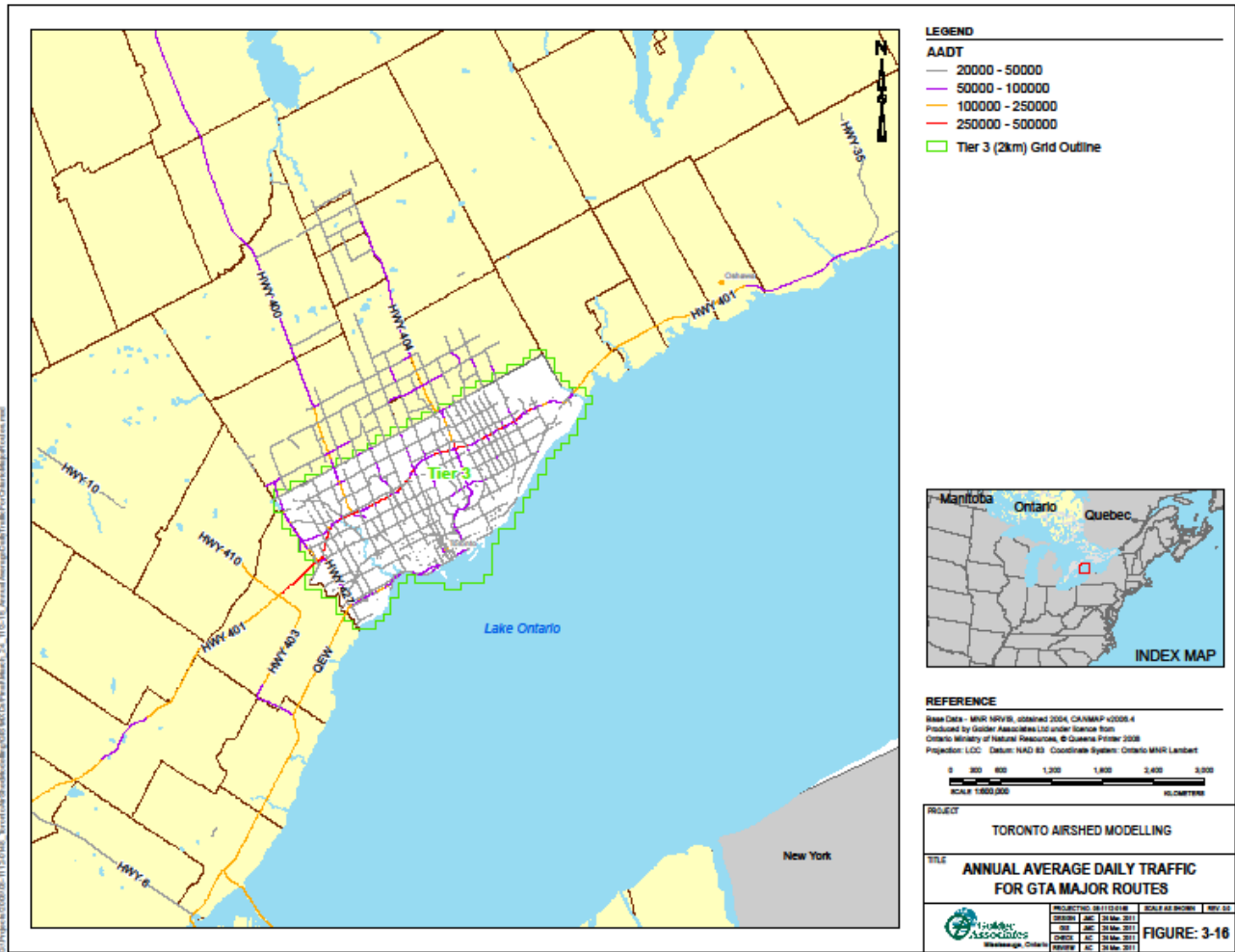


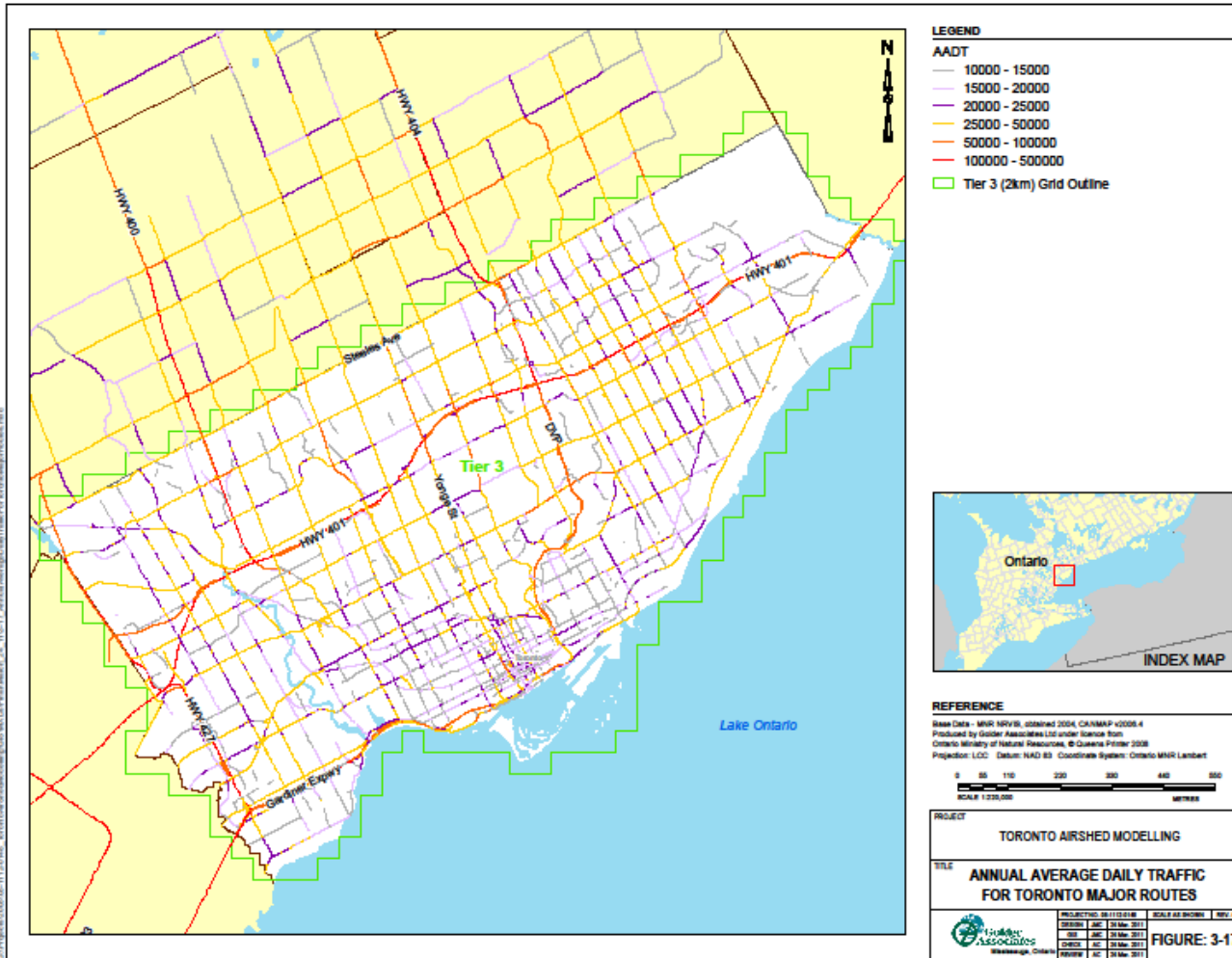


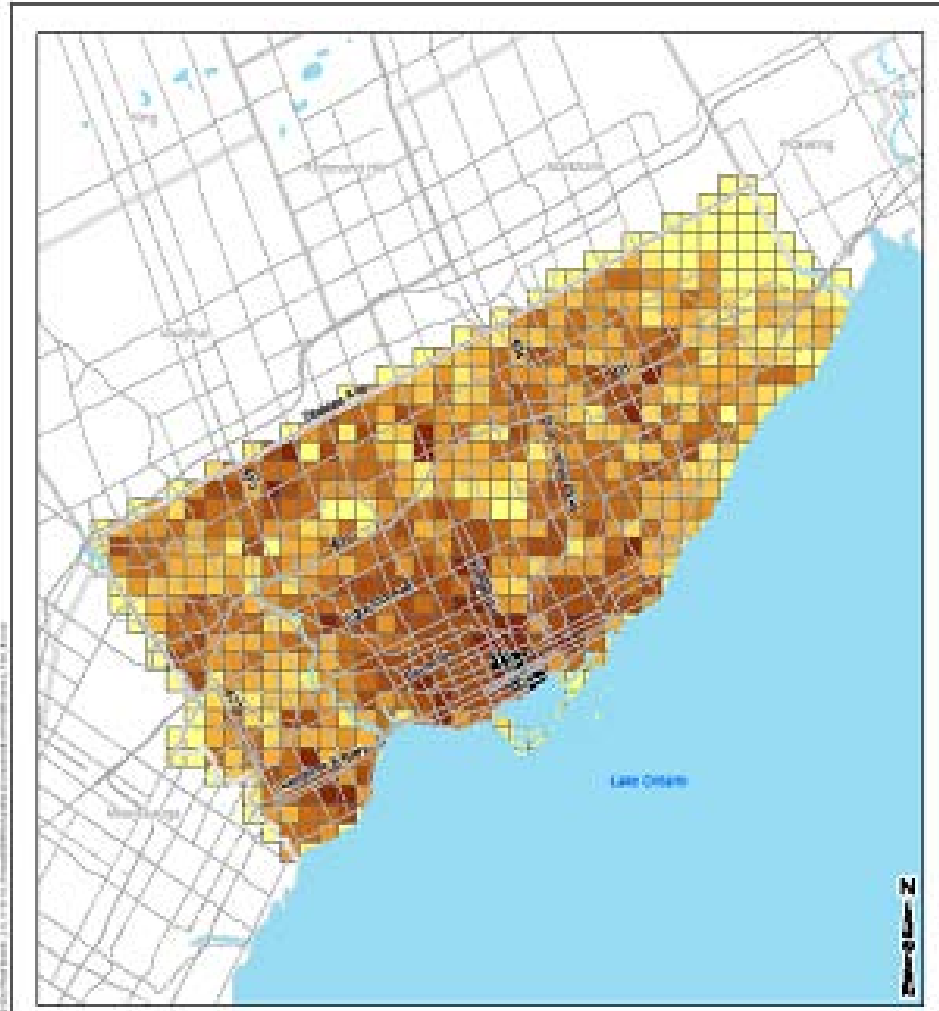


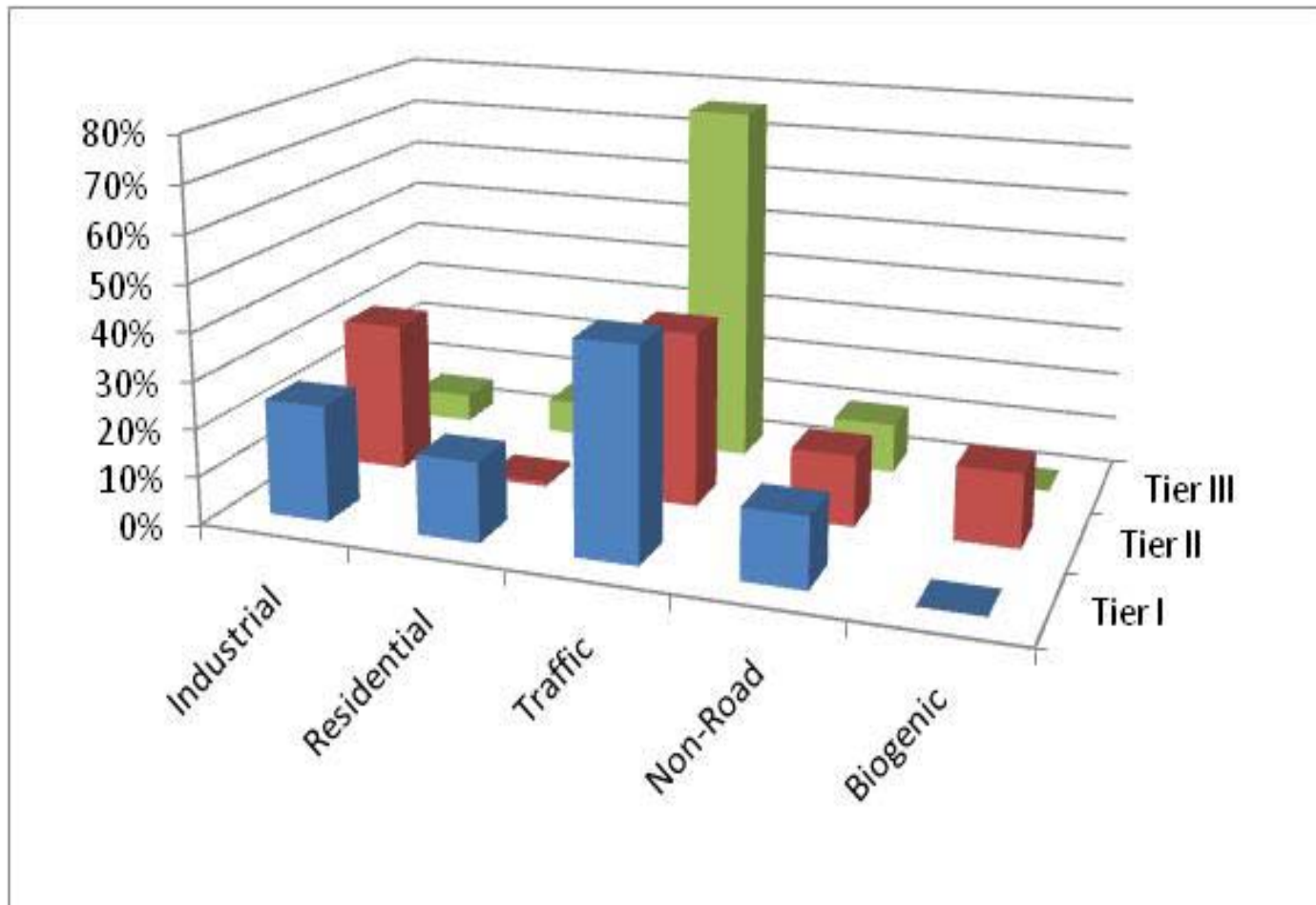


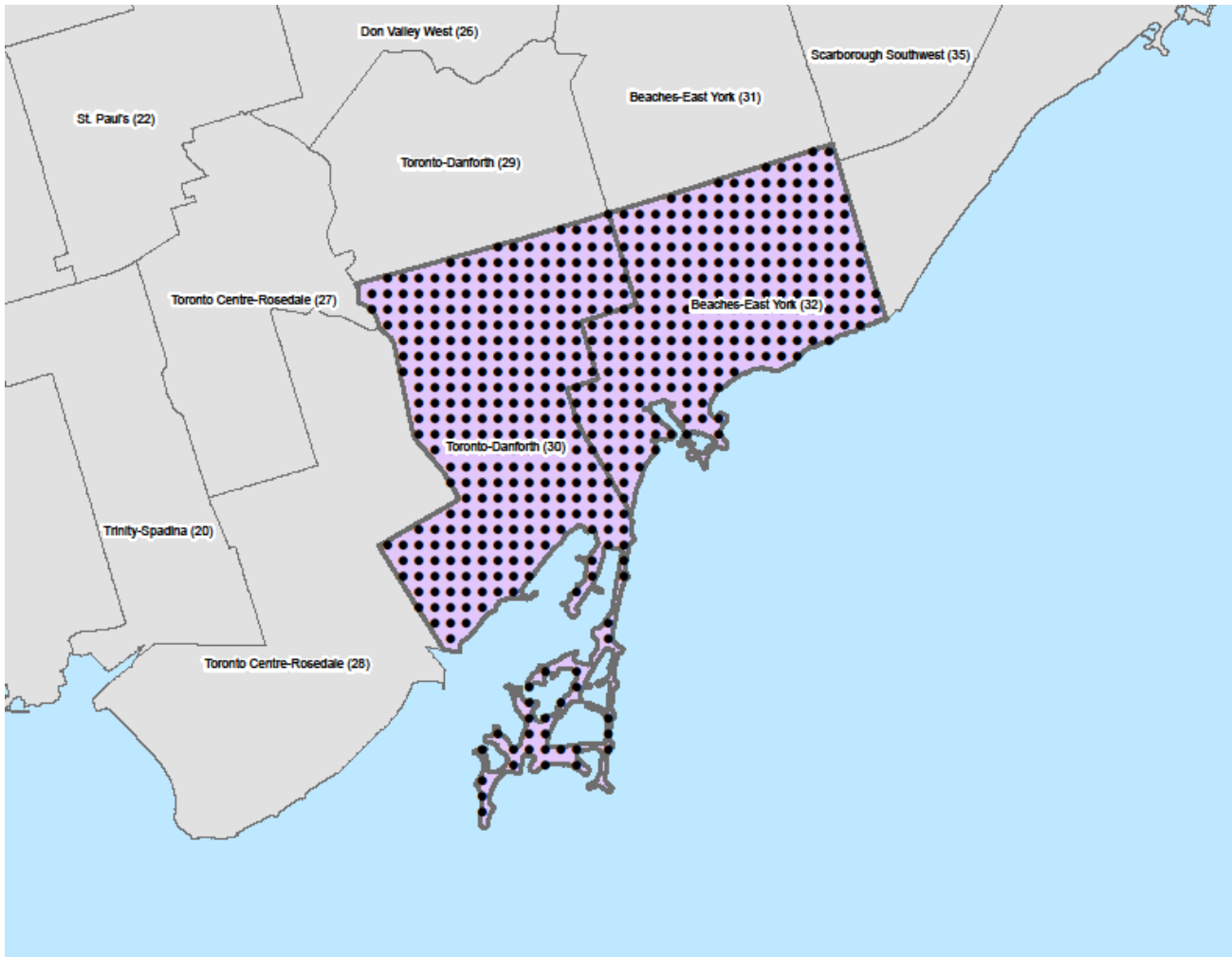




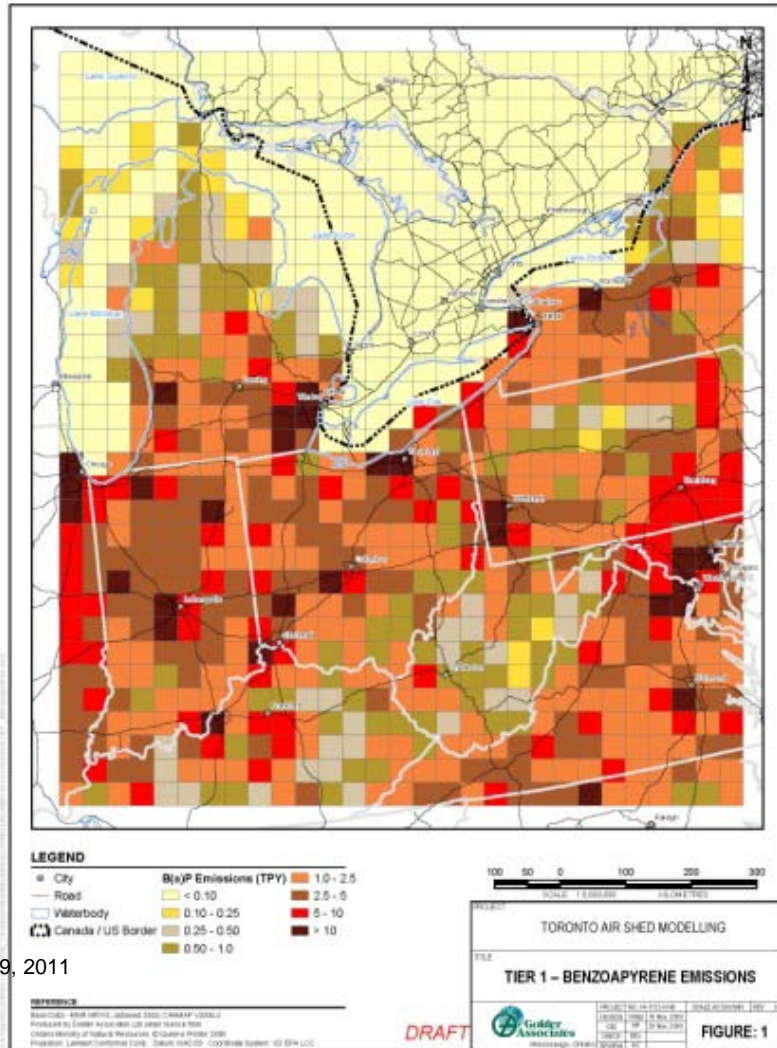




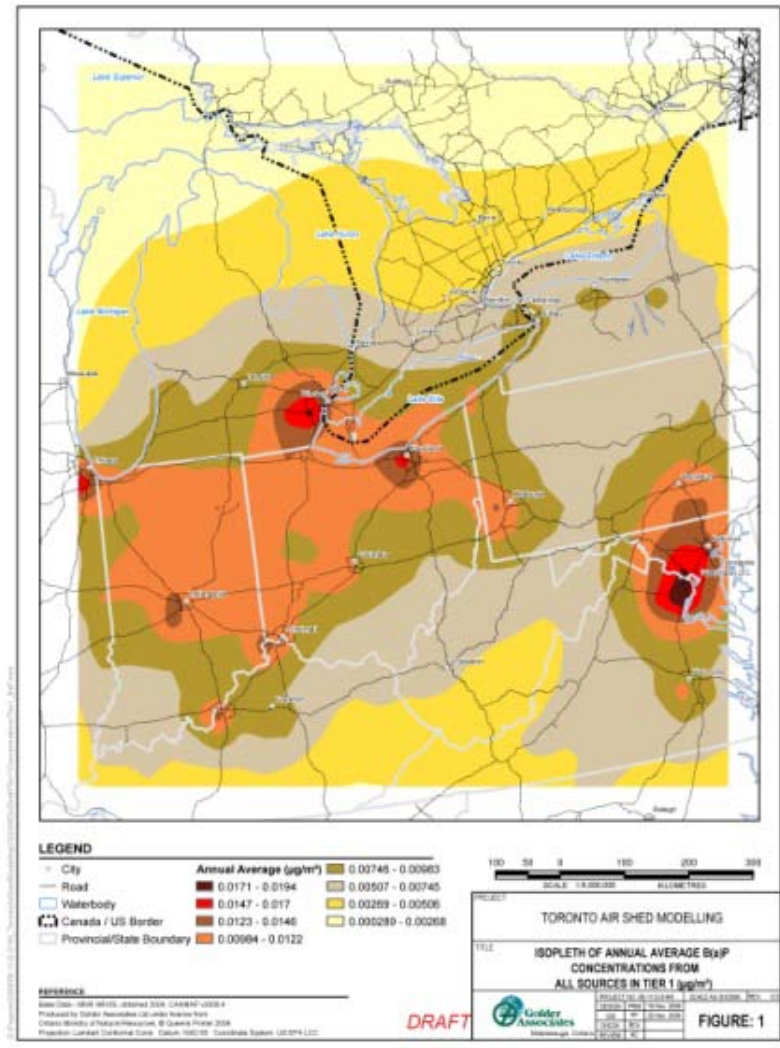




Annual Emissions (T/a)

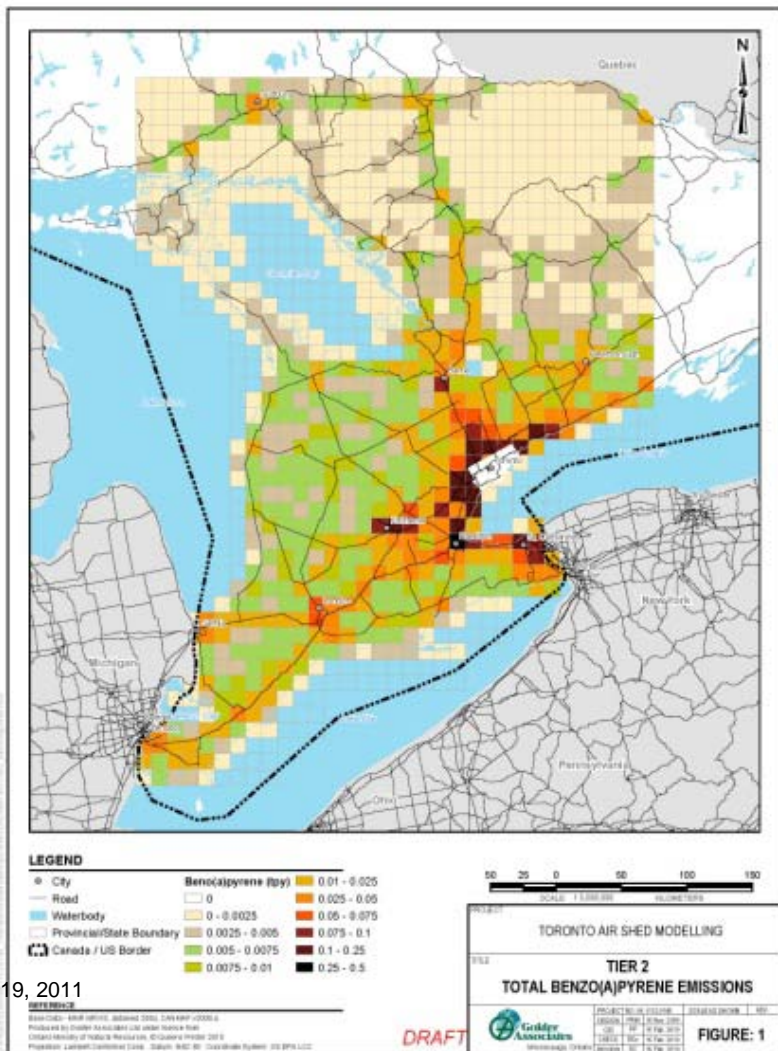


Annual Concentrations ($\mu\text{g}/\text{m}^3$)

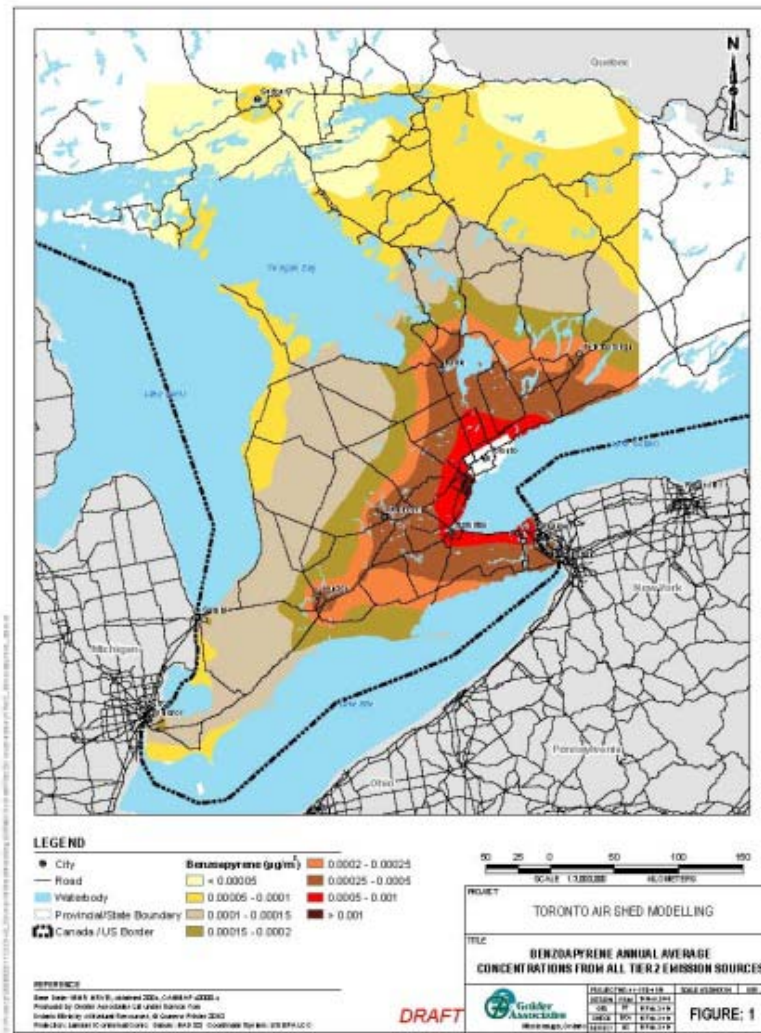


October 19, 2011

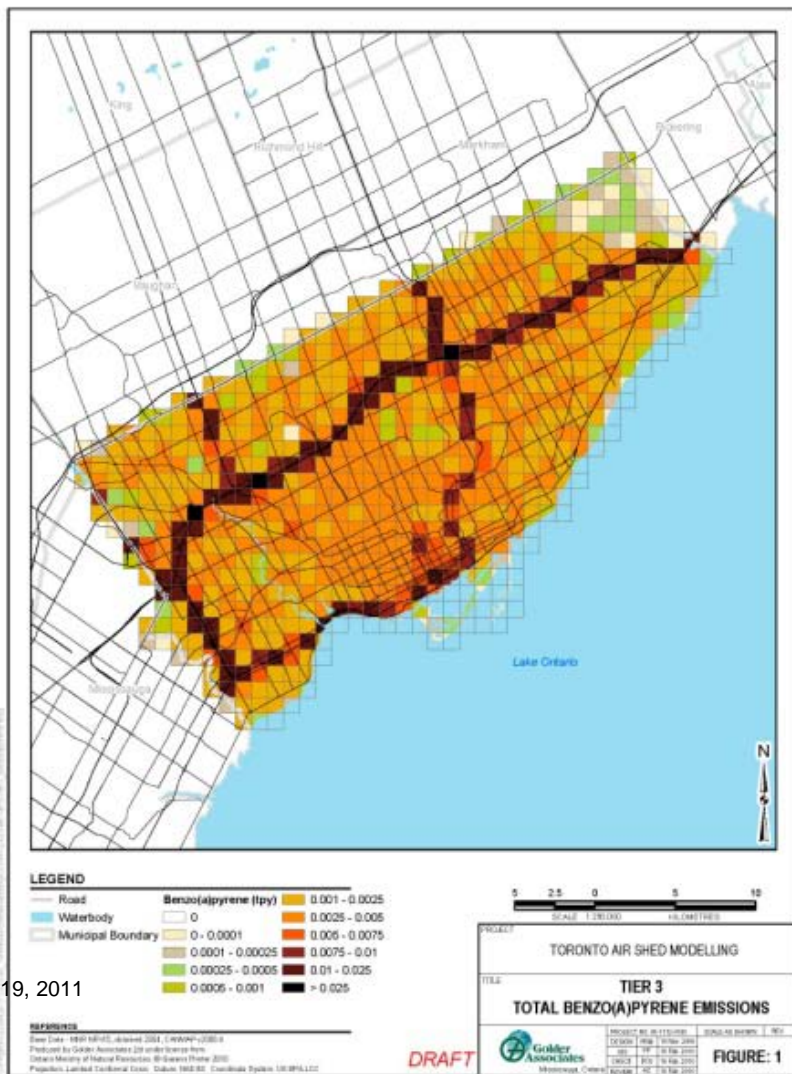
Annual Emissions (T/a)



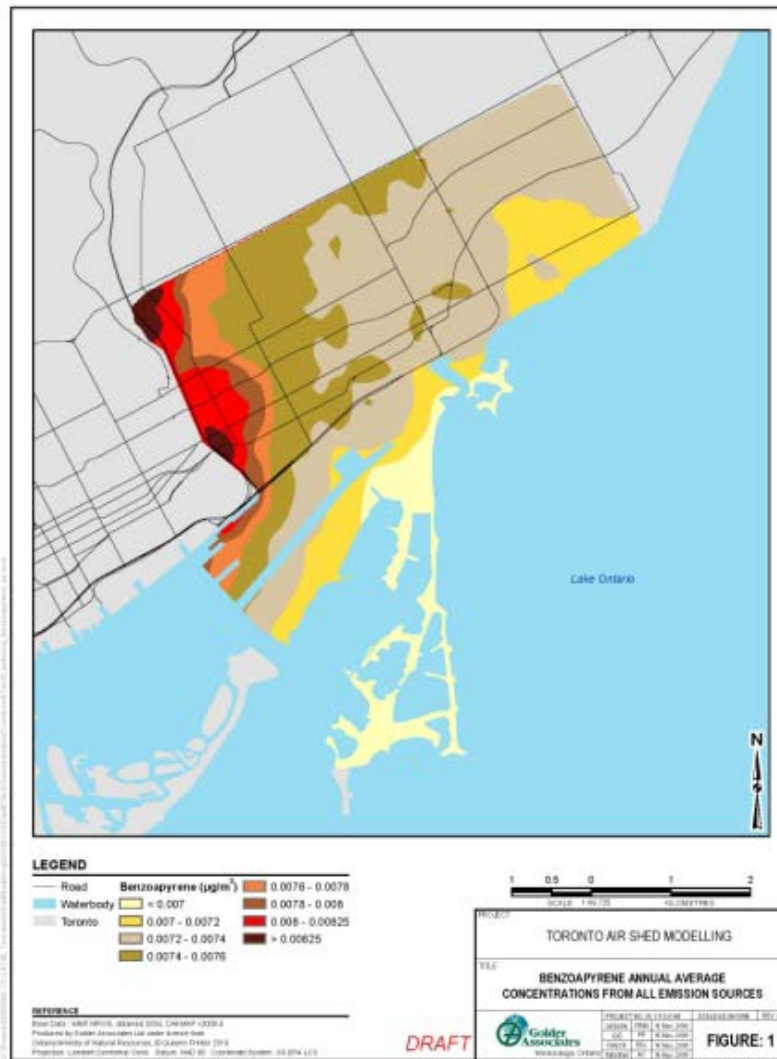
Annual Concentrations ($\mu\text{g}/\text{m}^3$)



Annual Emissions (T/a)

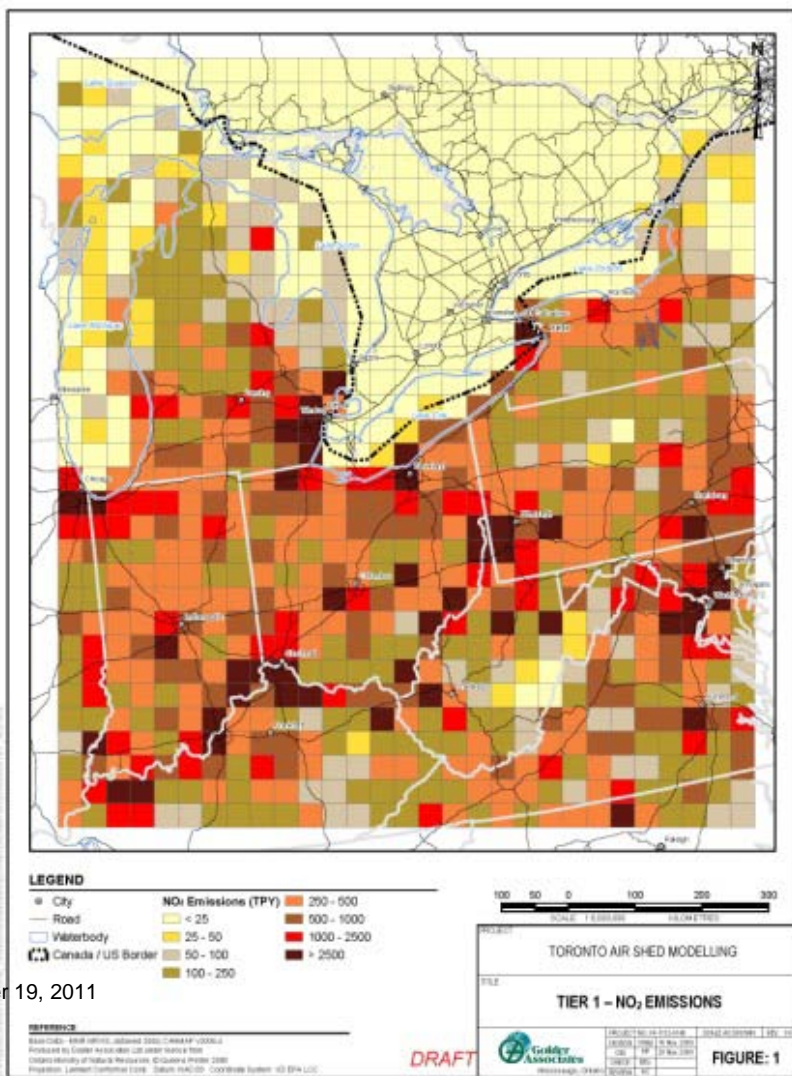


Annual Concentrations ($\mu\text{g}/\text{m}^3$)



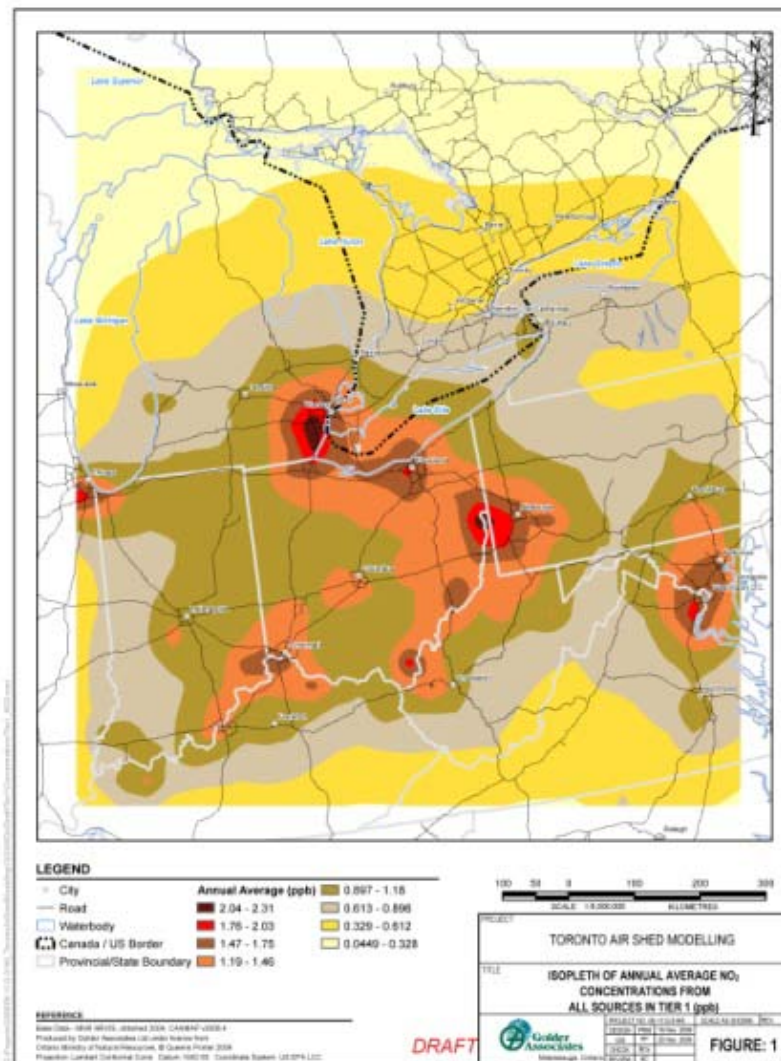
October 19, 2011

Annual Emissions (T/a)



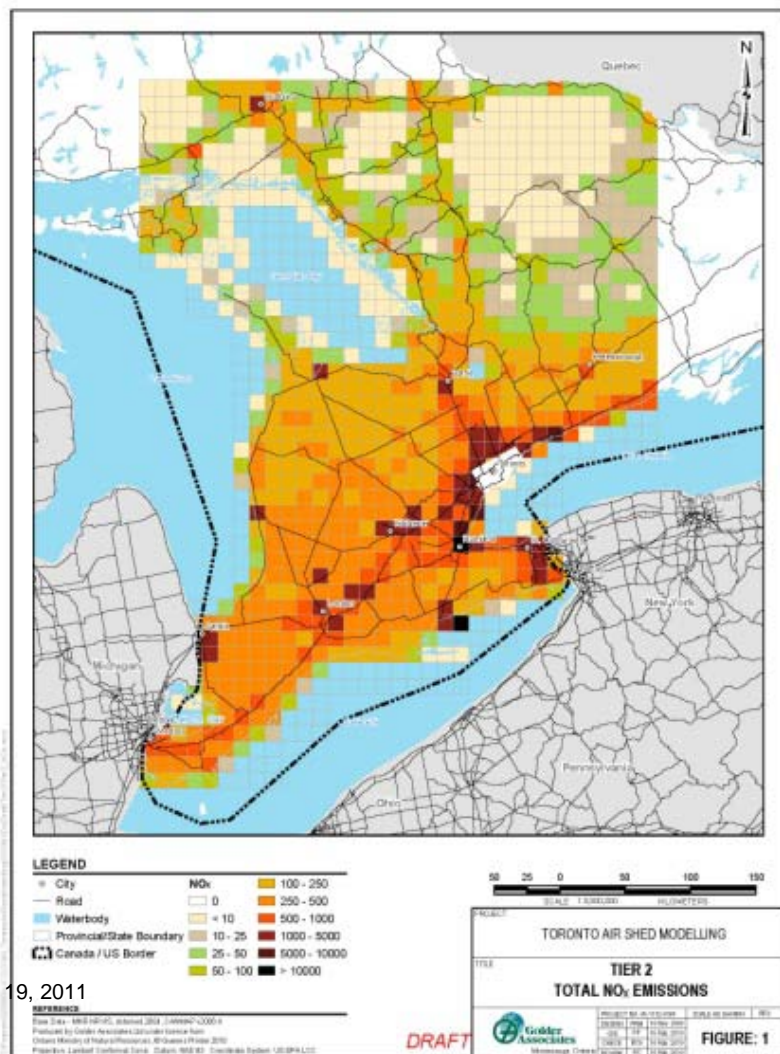
October 19, 2011

Annual Concentrations (ppb)

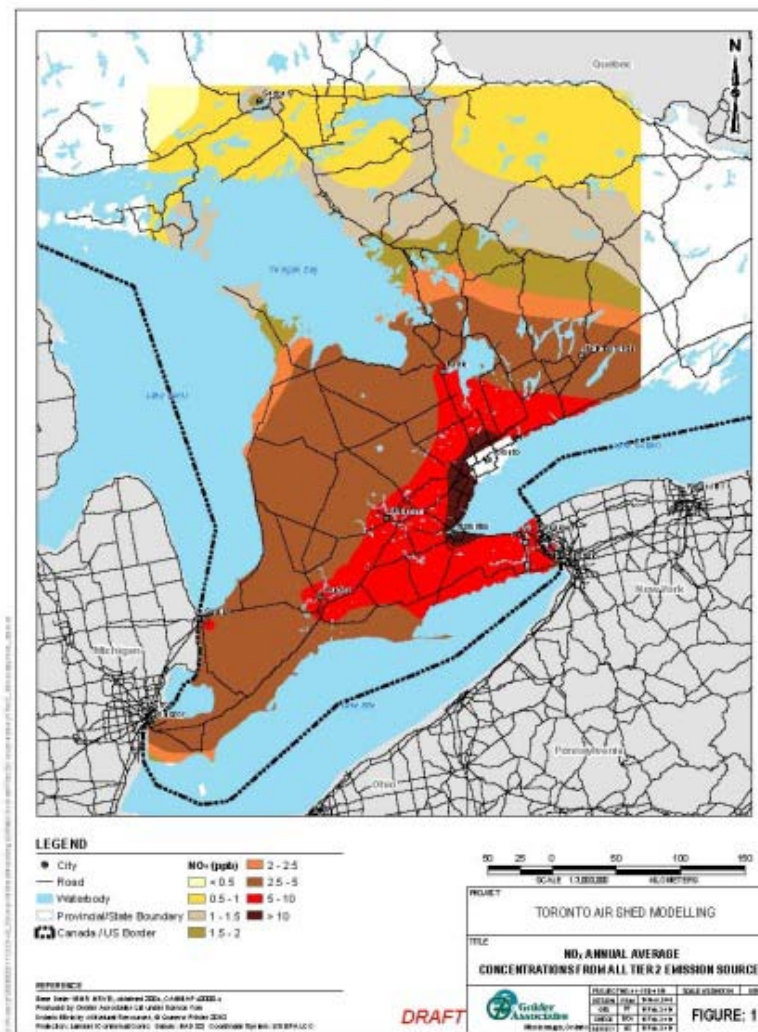


23

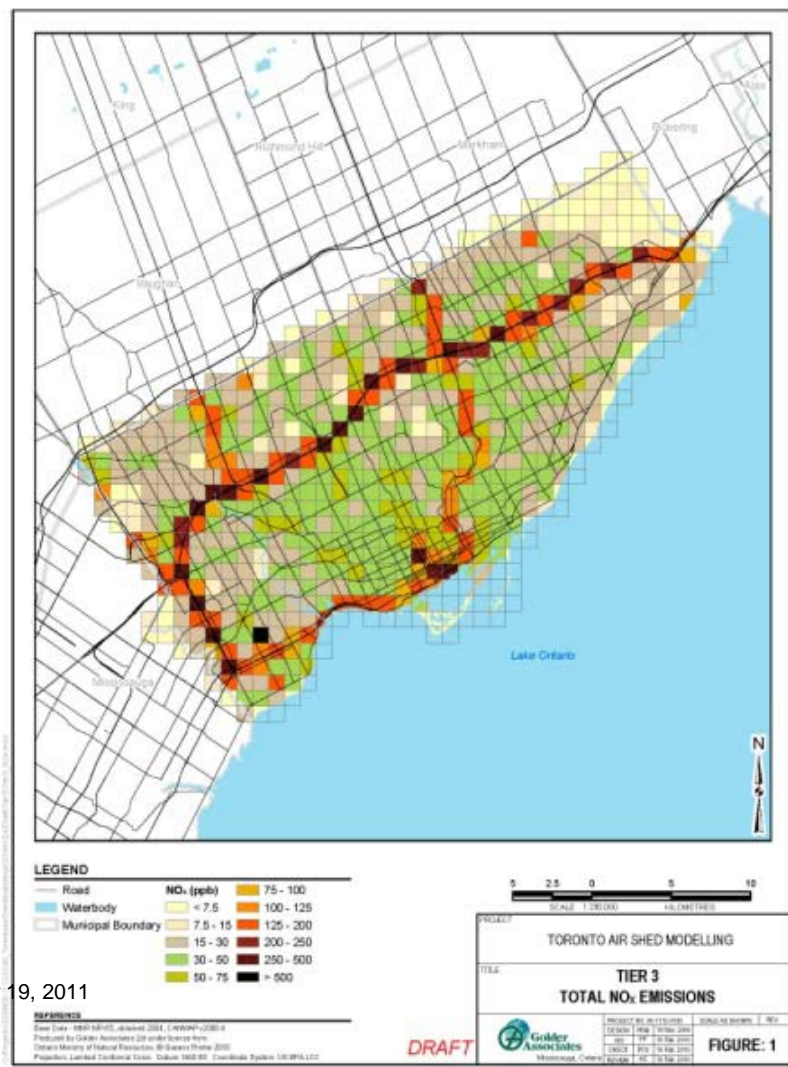
Annual Emissions (T/a)



Annual Concentrations (ppb)

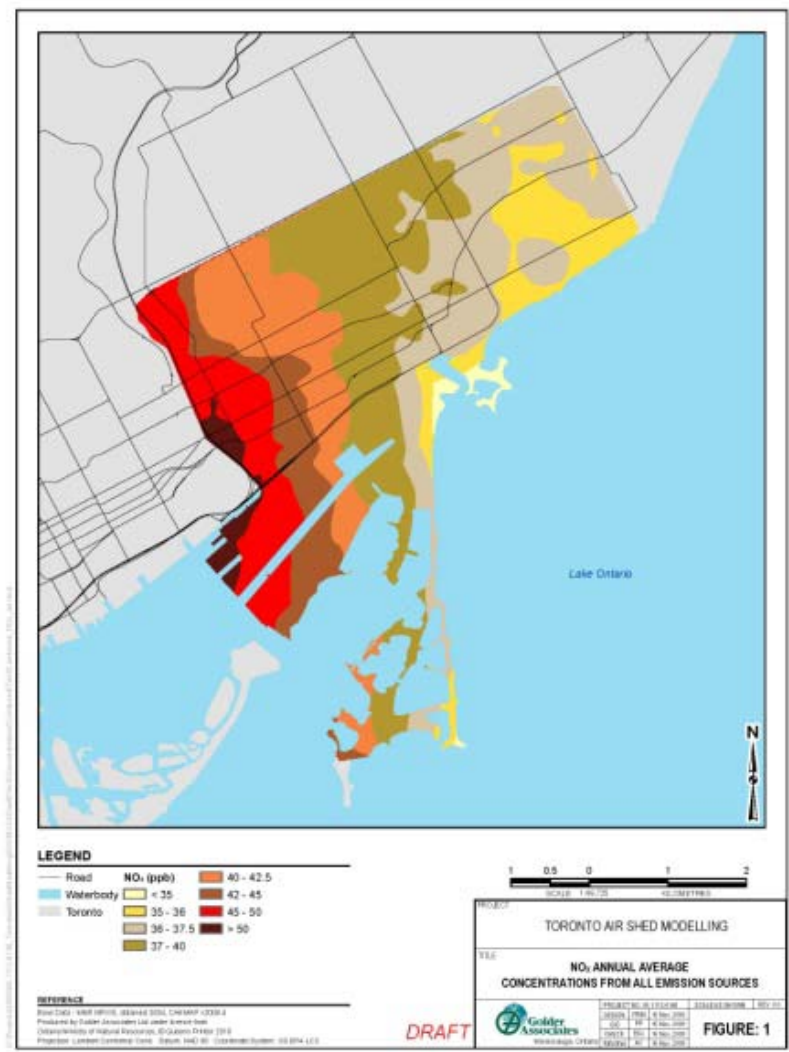


Annual Emissions (T/a)



October 19, 2011

Annual Concentrations (ppb)



25

	Modelled					Monitored		Error
	Units	Tier III	Tier II	Tier I	Cumulative	MOE Monitor ⁽²⁾	NAPS Monitor ^(3,4)	Monitoring/Modelling
Nitrogen Oxides ⁽¹⁾	ppb	34.0	9.5	8.6	52.1	26.1	—	0.5
Carbon Monoxide	ppb	178.5	42.9	45.7	267.1	325.5	—	1.22
Sulphur Dioxide	ppb	0.5	1.3	4.8	6.6	1.9	—	0.29
PM _{2.5}	µg/m ³	4.0	1.4	2.0	7.4	7.3	10 ± 8	0.99
PM ₁₀	µg/m ³	11.6	3.4	4.6	19.6	—	15 ± 11	0.77
1,3-Butadiene	ppb	0.029	0.010	0.007	0.046	—	0.04 ± 0.04	0.87
Benzene	ppb	0.17	0.05	0.06	0.28	—	0.30 ± 0.15	1.07
Toluene	ppb	1.12	0.20	0.27	1.59	—	1.12 ± 0.91	0.70
Lead	µg/m ³	0.000	0.001	0.001	0.002	—	0.002 ± 0.002	1.00
Dichloromethane	ppb	0.045	0.009	0.008	0.062	—	0.19 ± 0.11	3.06
Tetrachloroethylene	ppb	0.039	0.009	0.004	0.051	—	0.042 ± 0.028	0.82
Average								1.03

1) Reported as NO₂.

2) MOE Station (31103) at Bay/Wellesley

3) With reported Standard Deviation

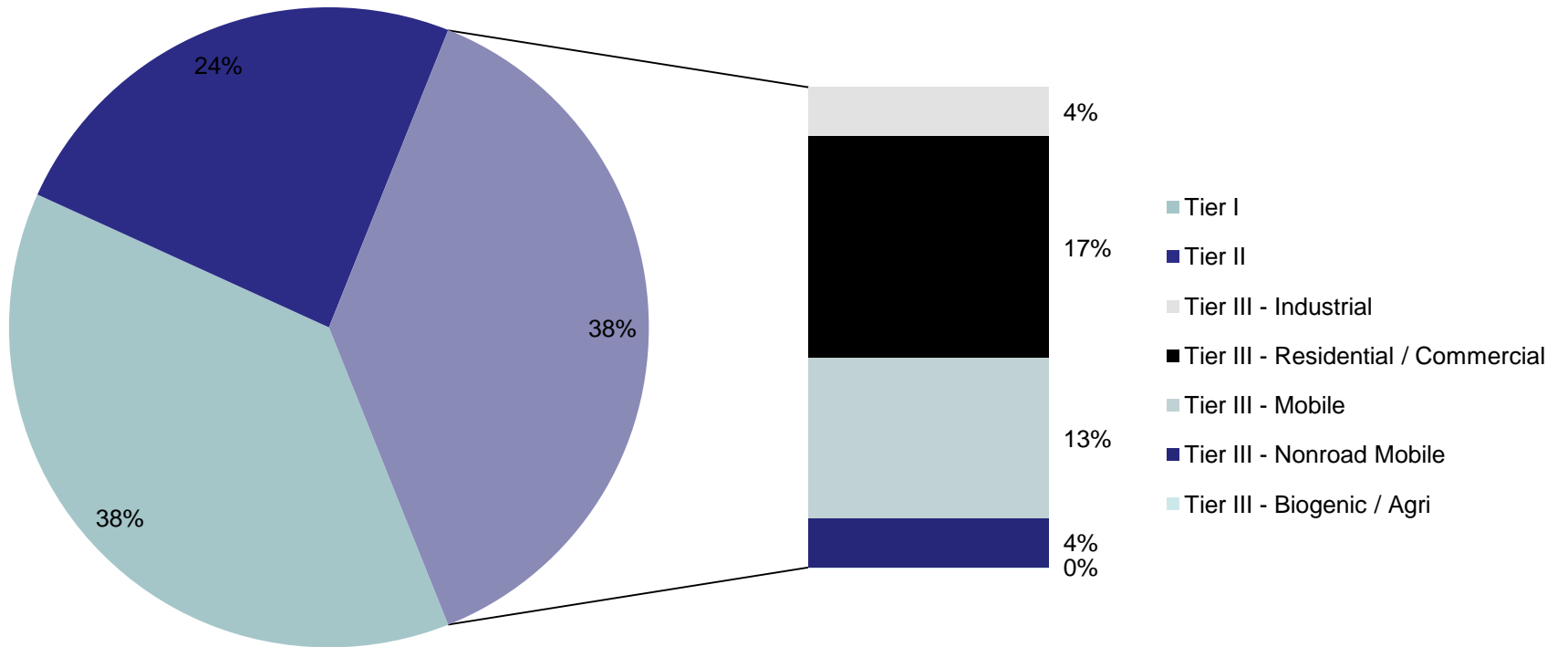
4) NAPS Station (060427) 223 College St

□ Emissions distribution in domain

- US 90%
- Ontario 9%
- Toronto 1%

□ Concentration contribution to Community

- US 38%
- Ontario 24%
- Toronto 38%



□ Mobile emissions contribute strongly to

- CAC's (NO_x & PM₁₀)
- Toxics (Benzene & Acrolien)
- Aromatics

□ Residential/Commercial contribute to

- CACs (NO_x & PM_{2.5})
- Aromatics (Toluene & PAH)
- Halogens

- ❑ Modelling shows exceedence of annual AAQC for
 - Benzene and
 - PAH (as B(a)P)

- ❑ Over 50% of the annual average benzene level is due to Toronto,
 - 39% is attributed to vehicular activity

- ❑ Most of the PAH's (68%) come from sources from beyond the City.

- ❑ 4 PACs exceed their 24-hr AAQC's
 - NO_x ,
 - PM_{10} ,
 - PAH (as B(a)P) and
 - Benzene
- ❑ Exceedences for first 3 PACs are do to traffic while the exceedence for benzene is from an industrial source

THANK YOU!