APPENDIX D

BIOACCUMULATION

A more thorough examination of the literature

Few comparative studies of bioaccumulation of persistent organic pollutants (POPs) have been conducted on Blanding's turtle, however there has been extensive work done on the Common Snapping turtle as a sentinel indicator of pollutants in estuaries and freshwater ecosystems. Snapping turtles share many of the same habitats as Blanding's turtles, have a similar lifespan, and like Blanding's turtles, they sit high in their food chains so tend to magnify the contaminants consumed through predation. In theory, both Blanding's turtles and snapping turtles may be susceptible to negative effects on individual health or reproduction due to bioaccumulation of organic toxins (Golden and Rattner, 2003). This supplementary section reviews the status and threat of bioaccumulation to turtles, focusing primarily on snapping turtles in Ontario, and then brings the discussion back to Blanding's in the South March Highlands. It is important to note that within the Reptilia Class and Testudines Order, the various turtle species have evolved along separate pathways and therefore will reflect different risk profiles with respect to their vulnerability to bioaccumulation of pollutants; so our interspecies comparison should be interpreted with caution.

Common snapping turtles stay in one general area from year to year, often for their whole life span, so are likely to remain exposed to the same chemicals year after year. As in most carnivorous or omnivorous species, persistent contaminants accumulate in the fatty adipose tissues, liver, skeletal muscles and may be passed through to their young in the lipid content of eggs. Studying Common snapping turtles in the Hudson River in New York State, Stone *et al.* (1980) found PCB's, DDE, dieldrin in 70% of the specimens. In tissue samples of one specimen from Lake Ontario, total PCB's were 663 μg/g compared with 3608 μg/g in one specimen from the Hudson River (Olafsson *et al.*, 1983), reflecting the relative pollutant concentrations within each waterbody. Persistent organochlorine contaminants (OCS) were measured in 78 adult snapping turtles collected in 1988-89 from 16 sites in southern Ontario (Hebert *et al.*, 1993). The range of mean contaminant levels in muscle for all sites were as follows (ng/g wet weight): 0.00-655.28 total PCB, 0.00-164.60 total DDT, 0.00-3.95 mirex, and 0.00-1.26 [other] OCS. Significant site differences were found for all four substances. A highly significant relationship was found between contaminants in adult female turtles and their eggs (Hebert *et al.*, 1993), where over 95% of the total toxicity in an egg resides in the yolk (Bryan *et al.*, 1987). No direct exposure data is available on cholinesterase inhibiting pesticides or data on petroleum residues in snapping turtles (USGS, 2012). Overall, the evidence of negative impacts on health or reproduction appears mixed and inconclusive.

A significant body of research exists from Ontario, looking at contaminant levels in the eggs. Organochlorine accumulation and intra-clutch variation was studied in snapping turtles collected

from 7 nests in 1986 and 1987 from Cootes Paradise in western Lake Ontario (Bishop *et al.,* 1995). In comparing the first five eggs laid, the last five eggs, and a composite sample of eggs laid after the first five and before the last five, the first five tended to have the highest mean concentrations of chlorinated hydrocarbons on a wet weight basis and on a lipid weight basis (Bishop *et al.,* 1995). The last five eggs tended to have the lowest values, and composite eggs were generally intermediate (Bishop *et al.,* 1995). In studies on tributaries to the St. Lawrence River from 1989-1991, heavy metals have also been found in turtle eggs, commonly mercury (Hg), cadmium (Cd) and lead (Pb) (Bishop *et al.,* 1998; Bonin *et al.,* 1995), with Hg found in all samples. A more recent study suggests no correlation between lead accumulation and ulcerative shell disease in two turtles species in an urban lake (Bishop *et al*., 2007), suggesting that the toxicological effects of metals on turtles is felt to be somewhat inconsequential to their rates of survival.

Even in pristine areas, contaminates can accumulate. Snapping turtles in Algonquin Park were found to have high levels of PCBs, DDE, HCB, dieldrin and mirex, with eggs tending to be the most contaminated (Bishop *et al.,* 1996). PCB's have been strongly associated with deformities and hatching success from eggs collected in Algonquin Park, including deformities of the tail, hind legs, head, eyes, scutes, forelegs, dwarfism, yolk sac enlargement and missing claws (Bishop *et al*., 1998; Bishop *et al*., 1991). The incidence of abnormal development increased significantly with increasing concentrations of PAH's, particularly PCDD and PCDF, yet was not correlated with TEQ's in eggs. The percentage of unhatched, contaminated eggs due to infertility or interrupted embryonic development ranged from 0-10% (Bishop *et al*., 1998).

Historically, the South March Highlands has been relatively undeveloped, save from the railway routed through the wetlands, a single electricity line, farming in the drier areas and further back in time, lumber extraction from the hillsides. The prey species of frogs, toads, salamanders and the three fish species identified in the system (Brook stickleback, Central mudminnow and Northern redbelly dace) are small, omnivorous and short lived, and therefore less likely to accumulate significant loads of OCS and heavy metals.

Although contaminant levels have not been sampled in this area, we hypothesize that it is quite possible that the creosote, PAH's and OCS in the preservatives for the railway ties and hydro poles may have resulted in some low levels of OCS for the existing Blanding's turtle population prior to the development of Terry Fox Drive and the proposed residential developments.

Most of the SMH population occurs in areas upstream of the planned development and therefore most of their reproductive activities, feeding and life cycle processes should remain apart from the residential areas and relatively free of contaminants. The exception to this is the Blanding's turtle population in the Kizell Drain wetland which will be surrounded by residential developments and the potential for food sources to come into contact with the residential contaminants. Currently, storm water from much of the development is managed in the Kizell Drain wetland, with no pre-treatment. Additional storm water treatment has been proposed for the Kizell Wetland. Gravimetric settlement of silt particles is the primary mode of treatment in the Beaver Pond. Residential communities are

known to shed heavy metals, pesticides, herbicides, hydraulic fluids, N-P-K nutrients, detergents, oils and grease. Although influxes of herbicides and pesticides should decrease over time in response to provincial regulations, the levels may be expected to increase in the short term with the nearby expansion of residential developments.