On the Precarious State of Sandy Lake (Bedford, NS)

David Patriquin for discussion with Stantec, June 22, 2023
(re: Stantec's HRM contract to conduct the Future Serviced Communities Study)

The points are numbered to facilitate discussion. Related charts (Figs 1-4 cited below) are attached.

1. AECOM (2014) applied the Lakeshore Capacity Model (Dillon and Rigler 1975) as elaborated by Brylinski (2004) and MOE (2011) to predict the effects of the proposed development on lake water Total P. They concluded that a development to the west of the lake accommodating up to 15,000 people and occupying circa 350 ha would be compatible with maintaining water and fish habitat quality.

2. There are four serious problems with the manner in which AECOM (2014) applied the model:

(i) **As cited by AECOM (2014), modelled phosphorus concentrations differed by far more than 20% of the measured concentrations (it was 67% higher), indicating the model is not valid,** but the recommended procedures to revise the model were not followed.

(ii) **Setting the Water Quality Objective (WQO) for Total P in Sandy Lake at 50% above the "current value" rather than at the "predevelopment level" is not justified**, as concluded also by professional limnologist S. Mandaville in documents submitted to HRM in 2013 and 2014. Had AECOM used a "predevelopment level" of Total P in their model estimated from the earliest available total P value, by "hindcasting" the Total P value by computer modelling (as conducted by S. Manadaville), or by using the paleolimnological values for Sandy Lake available from a Queens University study - none of these options were considered in AECOM 2014 - most or all of of the predicted outcomes with development would likely have been shown to be not acceptable.

(iii) **AECOM 2014 presents but does not highlight evidence showing that in its current state (at 12 ug P/L), Sandy Lake is already seriously degraded,** notably in relation to the elevated deep water P values, discussed briefly on p22, not elsewhere in AECOM 2014)

(iv) **Varying the phosphorus export coefficient, rather than increasing the lake retention coefficient would be a more realistic "fix" to make the model work** and would likely increase the predicted impacts of development on Total P.

View details here: http://versicolor.ca/sandylakebedford/waters/lakes/sl-report-more-details/critique-of-predictions-lack-of-follow-up/

3. Regardless of those issues, AECOM (2014) recognized practical limitations to their predictions and proposed "a robust water quality monitoring plan... for the Sandy Lake watershed to provide a further assessment of current conditions and to evaluate the impacts of development on the water quality". Such monitoring was not subsequently initiated.

4. With assistance of volunteers from the Sandy Lake Conservation Association, I initiated some monitoring in 2017, obtaining to date 6 limnological profiles in the deepest area of the lake. Those profiles of temperature, oxygen, and specific conductivity (a measure of salt concentration), in combination with some historical data, illustrate clearly two troubling trends (see Fig. 1, attached):

(i) Deep water oxygen levels during the period of summer stratification have already declined to levels inhospitable to salmonids (circa 5 mg/L and less) and low enough (2 mg/L and less – Nurnberg 2004) to cause anoxia and release of phosphorous from sediments (sometimes described as "internal P loading"), accelerating eutrophication.

Two limnological profiles obtained in Sandy Lake by Casey Doucet in relation to her research for a Masters in Applied Science at Dalhousie University provide some independent verification of these observations. (View thesis on Dalspace). She sampled two sites on Sandy Lake in the latter half of August 2021, one at the deepest point or close to it; her max. depth sampled was approx.* 19 m; and a second site with max. depth sampled approx 5.5 m. At the 19 m site, the oxygen value for deepest sample was approx 0.41 mg/L. She also measured total P at 0, 3, 7, 10 and approx 18 meters; values 0-10 m were close to 10 ug/L; the 18 m value was approx. 22 ug/L, i.e. there appears to have been significant internal P loading. At the shallower site, oxygen declined between 3 and 5.5 m from approx 8 mg/L down to close to 2 mg/L; and there was an overall increase in total P with depth. *I say "approx." as values that I cite were interpolated from graphs in her Fig. B1.

(ii) Salt levels have risen continuously since 1971 and some salt stratification is occurring. Based on studies by Scott et al. (2019) on changes in salt levels in local lakes over time and my rough estimates of the increase in settled landscape with development, salt stratification could increase to levels observed to inhibit spring turnover in a lake in NY state with similar dimensions; such an outcome would further accelerate decline of Sandy Lake (see Fig. 2, attached)

5. There have been some early warning signs of deterioration in the health of Sandy Lake:

– Elevated deep water Total P levels were noted by AECOM (2014) for two of three samplings in 2008, 2010 and 2011; these were suspected to be associated with low oxygen levels. And as noted above, Casey Doucet's observations in 2021 showed highly elevated deep water Total P.

– An intense algal and to swimmers, a very unpleasant bloom – the beach was closed - occurred in August of 2019. It coincided with a rapid drop in lake water level, and subsided as the water level stabilized; I later found out that the drop in water level was associated with removal of a beaver dam in Peverill's Brook. I have suggested the bloom was caused by some transient "destratification" and movement of phosphorous-rich deep waters into the photosynthetic zone.*

*In the document circulated to an earlier meeting with Stantec, I cited also a BGA Warning in 2022 which had been announced on the novascotia.ca website and in the local newspaper. When I mentioned the BGA bloom at a meeting with the NW Community Council on June 12, 2023, Councillor Tim Outhit said that HRM sampling showed these blooms were in fact due to pollen. I followed this up with provincial and HRM personnel: the warning was issued publicly by the province based on a citizen report in latter June, but they did not do any follow-up. HRM personnel followed up with sampling at Sandy Lake Beach Park; that did not reveal BGA. The follow-up sampling

was not announced publicly because the swim season had not yet opened. HRM personnel confirmed that the 2019 bloom was associated with diatoms, i.e. it was an "algal bloom" (as I had described it), not a BGA bloom and not pollen. To date there have been no confirmed BGA blooms at Sandy Lake. To put this in perspective: BGA blooms have been less common in NS than in many other places because our lakes are generally quite acidic which is not favourable for BGA. However, BGA blooms have been increasing in recent years likely due at least in part to increasing anthropogenic inputs, also because of S emission controls.

6. Ongoing development already approved to accommodate approx. 2400 people in Bedford West Area 12 and new development to accommodate approx. 15,000 people west of the lake (AECOM, 2014) would increase the settled area from approx 29% of the watershed in 2014 to about 45%. Further it would occur, as I understand it, in the area to the SW where surface waters entering the lake are concentrated (see attached Fig. 3) and could involve loss of a significant wetland (see attached Fig. 4) in the headwaters. Climate warming is another emerging stressor (re: lower oxygen solubility, increased BGA blooms, and earlier development of summer stratification).

7. Water quality of Sandy Lake has already declined to precarious levels and the trend is for further decline, i.e., remedial measures are required even without further development. I cannot see how these issues can be addressed and collapse of the lake with attendant loss of its substantive recreational and ecological values prevented if development on the scale being discussed goes ahead. At a minimum, the buffer zones recommended in the **McCallum Report** must be respected (50 m for wetlands, 100 m for watercourses).

8. It's important to note that as well as Sandy Lake being potentially very negatively affected by a major development in its headwaters, the health of Marsh Lake and Peverills Brook downstream and the seagoing fish those waters support (salmon, trout, gaspereau, American eel) are pretty well entirely dependent on the health of Sandy Lake.

9. Another concern: the possible impacts of significant additional development in the Sandy Lake Watershed on downstream flooding were NOT modelled in the 2018 Sackville River Floodplain study. I was told by consultant Alexander Wilson at an open house that's because they had not been instructed to model the Sandy lake watershed, presumably, he said, because it was assumed by HRM that there would be no significant additional development over the next 100 years! (Sandy lake is the largest or 2nd largest sub-watershed in the Sackville River Watershed, depending on how they are aggregated.) Surely that is a major issue that needs to be addressed.

10. For details including references, view **A DRAFT Report On the State of Sandy Lake, the Historical Trends and its Future Trajectory** and associated web pages; also this post: Deep water oxygen levels in Sandy Lake (Bedford, NS) fall to precariously low levels 21Mar2023

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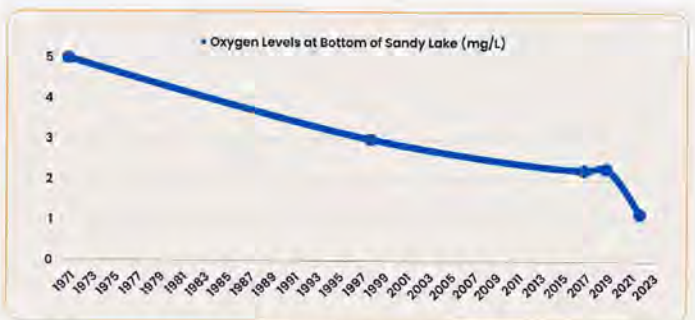
My observations were conducted on an entirely voluntary basis; there was no contract, no expectations from the groups advocating for a Sandy Lake-Sackville River Regional Park.

Fig 1.

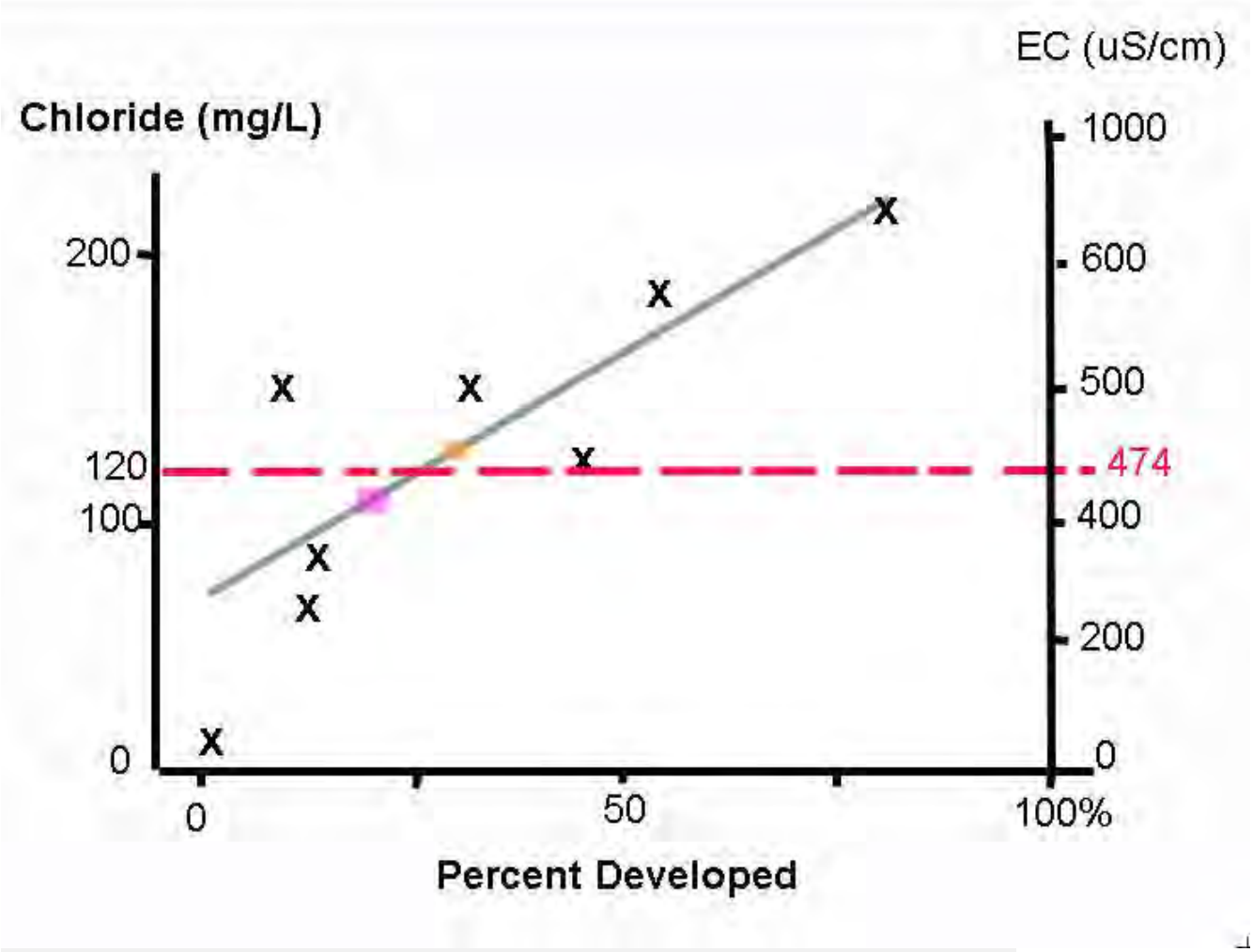
Variable	1971	1998	2017	2019	2022	2021*
Temp (^{O}C):						
Surface	21	22	17.1	16.9	24.7	**25**
Bottom	-	6	5.7	7.2	7.6	**6.5**
Conductivity (µS/cm)						
surface	37	125	169	159	209	
bottom	39	146	248	204	229	
Oxygen (mg/L)						
Surface	7.25	8.6	9.42	8.85	8.06	**9**
Bottom	5.0	3	2.25	2.29 6.5	1.18	**0.4**



* From Casey Doucet. 2022. **Identifying lake water quality trends and effective monitoring strategies in a rapidly urbanizing region.** Masters in Applied Science thesis, Dalhousie University. Values were interpolated from graph in Fig. B 1. She also plots values for total P, interpolated values below:

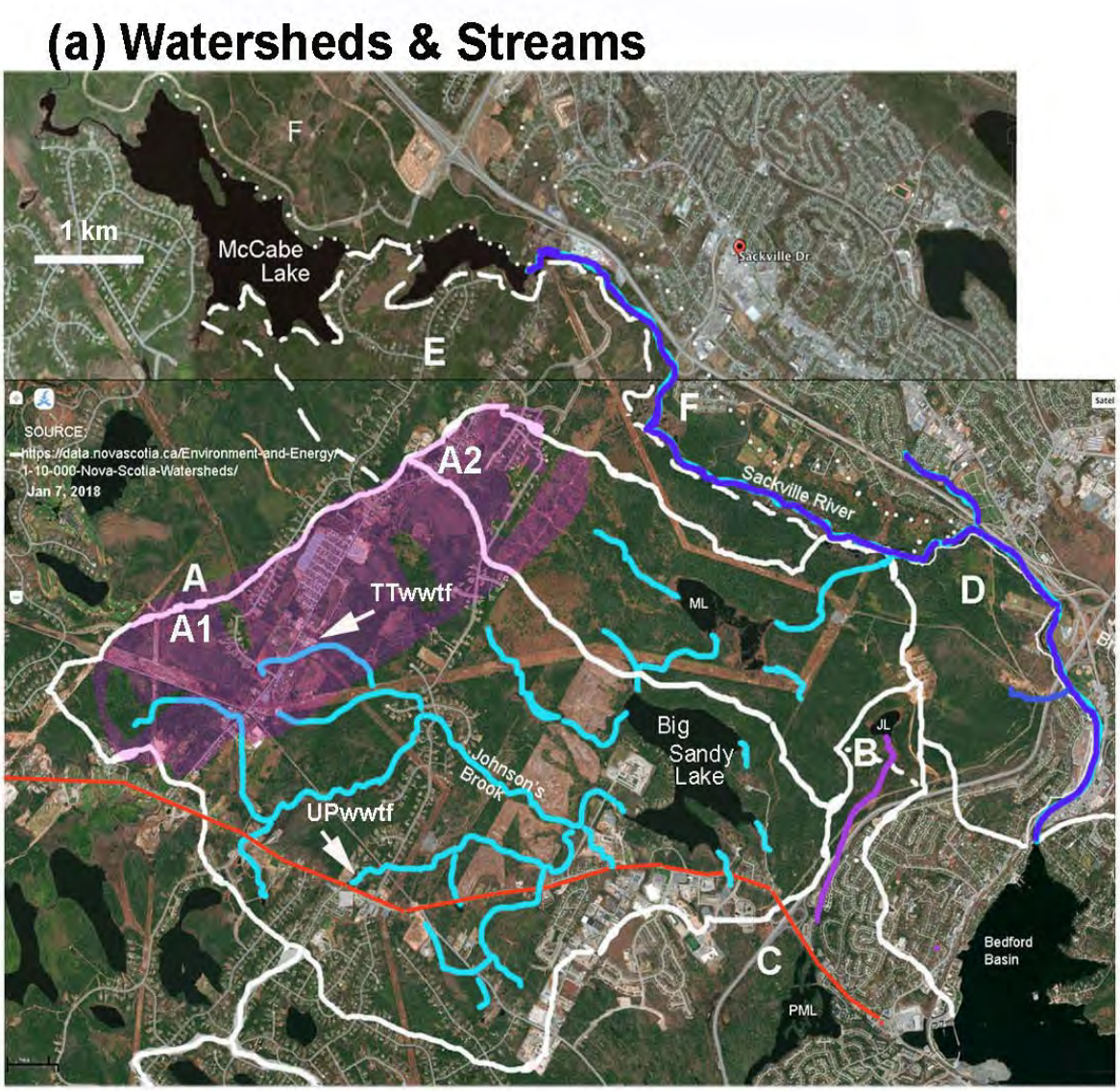
Depth (m)	Total p (ug/L)
0	4.5
3	5
7	5
10	5.2
18	22

Fig. 2



Relationship of Chloride and EC to Percent Land Area Developed. Graph adapted from Fig 6 in Scott et al., 2019.. The orange-filled rectangle shows where 30% Development (the approx. current level at Sandy Lake*) would fit on the Scott et al., 2019 regression line relating chloride concentrations in the spring of 2013-2017 to the percent watershed developed for 9 Halifax lakes. EC values on the right correspond to the chloride values, based on the relationship given in AECOM (2020). The current spring EC value for Sandy Lake is approx 190 uS/cm. The CCME Guideline for long term exposure to chloride is 120 mg/L (the dashed red line). So if Sandy Lake behaves like the other lakes, it would achieve a steady state value just above (orange rectangle) or just below (purple rectangle) 120 mg/L chloride – at the current level of development, higher if further developed.* My estimate based on measurements shown under Land Use; the purple square represents 21% Developed, the approximate (interpolated) value cited by Casey 2022, Fig 2.2 for Sandy Lake in 2020

Fig 3. **Surface Waters and location of Acid Slates within the Sandy Lake Watershed.**



A1 Sandy Lake and **A2 Marsh Lake** are in the **Sandy Lake subwatershed** of the **Sackville River watershed. E South McCabe Lake** and **F North McCabe Lake** subwatersheds also lie in the Sackville River watershed. **B Jack Lake** subwatershed of **C Papermill Lake watershed.** The **purple-highlighted area** contains bedrock with acid-generating potential. **TTwwtf: Timber Trails** and **UPwwtf: Uplands Park waste water treatment facilities. Turquoise-highlighted streams** are the major streams in the Sandy lake subwatershed as identified in the AECOM 2014 Report.

The developments being considered would be located to the west and southwest of Sandy Lake where surface waters entering the lake are concentrated.

Fig. 4. **Significant wetland on headwaters that could be lost to development.**

The wetland NIA1 (No Information Available - as cited on NS Provincial Landscape Viewer), more recently known as “Walters Marsh”, would, according to scenarios cited in AECOM (2014), be eliminated and replaced by residential landscape.

For more info., view Wetlands SW of Sandy Lake.