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HALIFAX
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Harbour East Community Council
August 3, 2006

TO: Councillor Jim Smith, Chair and Members of the Harbour East Community Council

SUBMITTED BY: Audrey Manzer, Chair, Dartmouth Lakes Advisory Board

DATE: July 25, 2006

SUBJECT: **Recommendations for Phosphorus Thresholds - Russell and Morris Lakes**

ORIGIN

Dartmouth Lake Advisory Board meetings held on May 31, 2006 and July 12, 2006.

RECOMMENDATION

The Dartmouth Lakes Advisory Board recommends to Harbour East Community Council that:

1. **A phosphorus threshold value of 12 micrograms (μg) per litre (L) based on an annual average be established for Russell Lake and that HRM expediently remediate the sewage issues which are presently impacting the phosphorus level.**

2. **A phosphorus threshold value of 12 micrograms (μg) per litre (L) based on an annual average be established for Morris Lake.**

3. **The phosphorus threshold level be revisited every five (5) years with a view to reducing the level should the data indicate it is appropriate to do so.**

AND FURTHER THAT:

Harbour East Community Council:

1. **Require that total phosphorus in the lakes be monitored on at least a monthly basis for one year.**

2. **Encourage the adoption of voluntary phosphorus reduction strategies, such as reducing the use of lawn fertilizers, throughout the Russell and Morris Lake watersheds.**

3. **Require that the current development and any future developments monitor phosphorus levels at a near source of discharge, whether it be at point source or nearest predicted area of release of potential phosphorus, in addition to the current monitoring sources.**

BACKGROUND

The Dartmouth Lakes Advisory Board considered phosphorus levels in Russell and Morris Lakes at its May 31, 2006 and July 12, 2006 meetings.

Russell Lake

The Morris-Russell Lake area Secondary Planning Strategy requires eutrophication (TP) threshold levels to be set for Morris and Russell Lake. The development agreement for lands at Russell Lake West requires that Clayton Developments undertake a water monitoring program. The terms of that program have been developed at arms length from Clayton Developments by Jacques Whitford. The terms of the study were reviewed/accepted by HRM staff and the work was carried out by Jacques Whitford.

Dr. Jay Walmsley, Project Manager, Jacques Whitford presented the phosphorus modelling and findings for Russell Lake to the Board on May 31, 2006. A copy of the Modelling the Watershed of Russell Report is included withthis report as Attachment 5. Dr. Tony Blouin also presented staff's recommendation for a phosphorus threshold value of 15 micrograms (μg) per litre (L). The Board deferred a decision on the matter pending an opportunity for members to fully consider the information provided to them.

The Board met again on July 12, 2006 and, after considerable discussion, approved the above recommendation regarding Russell Lake. Extracts of the draft May 31, 2006 and the July 12, 2006 minutes are attached. Submissions dated May 31 and June 23, 2006 from the Russell Lake Residents Association were also considered by the Board and are included as an attachment to this report.

Morris Lake

As noted above the Morris-Russell Lake area Secondary Planning Strategy requires that eutrophication (TP) threshold levels be set for Russell Lake. At the July 12, 2006 meeting, Dr. Blouin presented staff's report indicating that staff is also recommending a phosphorus threshold value of 15 micrograms (μg) per litre (L) for Morris Lake. Although there is less background data, the lake is in a mesotrophic state based on current testing. Like Russell Lake, Morris Lake is significantly urbanized. Testing has indicated that the existing phosphorus level in the lake is 12.5 micrograms (μg) per litre (L).

DISCUSSION

See staff report attached.

BUDGET IMPLICATIONS

Not applicable. Staff is aware of the content of this report and, if necessary, will comment regarding possible budget implications.

FINANCIAL MANAGEMENT POLICIES / BUSINESS PLAN

This report complies with the Municipality's Multi-Year Financial Strategy, the approved Operating, Capital and Reserve budgets, policies and procedures regarding withdrawals from the utilization of Capital and Operating reserves, as well as any relevant legislation.

ALTERNATIVES

Not applicable.

ATTACHMENTS

Attachment 1: Extract of Draft May 31, 2006 Dartmouth Lakes Advisory Board Minutes
Attachment 2: Extract of Draft July 12, 2006 Dartmouth Lakes Advisory Board Minutes
Attachment 3: Staff report dated May 26, 2006 re Russell Lake Phosphorus Level
Attachment 4: Staff report dated June 16, 2006 re Morris Lake Phosphorus Level
Attachment 5: Modelling the Watershed of Russell Lake Report
Attachment 6: Submissions from th Russell Lake Residents Association dated May 31 and June 23, 2006

A copy of this report can be obtained online at HECC then choose the appropriate meeting date, or by contacting the Office of the Municipal Clerk at 490-4210, or Fax 490-4208.

Report Approved by: Audrey Manzer, Chair, Dartmouth Lakes Advisory Board

Attachment 1

EXTRACT - DRAFT MINUTES OF DARTMOUTH LAKES ADVISORY BOARD
MAY 31, 2006

5. NEW BUSINESS

Referring to items 5.1 and 5.2, the Chair indicated that there is a misconception that the Dartmouth Lakes Advisory Board would be establishing a phosphorus threshold value for Russell Lake. She advised that the Board is advisory to the Harbour East Community Council and as such will make a recommendation to the Community Council in this regard. The decision to set the levels will be made by the Harbour East Community Council.

The Chair went on to indicate that Board members had not received the information relative to this matter in sufficient time to undertake a thorough review of the material. Consequently, the Board will hear the presentations, ask questions but defer their decision to allow members an opportunity to digest the information.

5.1 Presentation: Clayton Developments re Russell Lake Modelling

- A report entitled Modelling the Watershed of Russell Lake (Report No. SD191984) was before the Board.
- Correspondence from Ben Jenkins, Russell Lake Residents Association, dated May 31, 2006 regarding agenda items 5.1 and 5.2 was before the Board.

Mr. Paul Morgan, Planner, noted that the agreement for the Russell Lake West development introduced a requirement for water quality monitoring. Mr. Morgan went on to indicate that he had mistakenly been working from the position that the Dartmouth Lakes Advisory Board would be setting the threshold levels. In fact, as the result of an amendment to the proposed Development Agreement, the matter will be referred back to Community Council for decision.

Mr. Mike Hanusiak, Vice President, Clayton Developments, noted that as part of the development agreement to develop lands at Russell Lake West, Clayton Developments is obligated to undertake a water monitoring program. The terms of that program have been developed at arms length from Clayton Developments by Jacques Whitford. The terms of the study were reviewed/accepted by HRM staff and the work was carried out by Jacques Whitford. The findings have been disseminated to HRM staff and are now the property of HRM.

Mr. Hanusiak introduced Dr. Jay Walmsley, Project Manager, Jacques Whitford and Dr. Walton Watt, a PhD in Liminology, who prepared the phosphorus modelling for Russell Lake.

Dr. Walmsley addressed the Board and presented the report including the following highlights:

- Provided an aerial photo to orient the Board to Russell Lake and to illustrate the level of development around the lake
- Identified four (4) sampling sites on the lake as follows: the North inlet, the deepest point of the lake, the South inlet, and the outlet
- Samples were taken in April, June, August and November
- The data is available from April 2005 to March 2006
- Monitoring will be ongoing with the same sites and same timing
- Sampling has indicated that the PH was well within the range expected and metals, oil and grease were not an issue
- Sodium Chloride occurred in most of the lakes, indicating that salts going into the lake is a problem
- Nutrient levels varied widely throughout the year
- At the south inlet there are very high phosphorus levels
- Provided an explanation of the phosphorus modelling which was undertaken
- Two samples were taken prior to any work being carried out on the site which identified: 1. that high levels of phosphorus pass through the wetland to the lake 2. estimated the differences in phosphorus in the lake pre-construction and post construction

Conclusions:

- Russell Lake has been experiencing a reduction in trophic status in recent years
- During the study period (2005-06) the lake passed through periods of apparent oligotrophy, then mesotrophy and eutrophy
- In the 2005-06 study period, about 25 kg of excess phosphorus leached out of the contaminated west wetland -- probably as result of sewage discharge from the trailer park
- The Russell Lake West development is expected to increase the TP concentration in the lake by about 1.5mg/M
- This can be mitigated by reducing or eliminating the TP input from the contaminated wetland
- It is not feasible to restore Russell Lake to it's presumed pre-development oligrotrophic condition because of the extensive land use changes in the drainage area
- Russell Lake can be restored to a stable mesotrophic state and maintained in that state for the foreseeable future

Dr. Walmsley and Dr. Watt responded to questions from members of the Board.

Mr. Hanusiak suggested, in light of the phosphorus issue in Russell Lake and the relative lack of metal, oil and grease findings, HRM may wish to decrease the sampling for these and increase it for phosphorus.

In this regard, Dr. Watt suggested, for example, the following program:

- Four samples taken every second month
- Phosphorus sampling each month

- Full range of testing four times per year

The Chair reiterated her previous comments regarding the resolution of this matter and noted that the Board would be making a recommendation to Harbour East Community Council.

Mr. Morgan noted that the policies relative to the water quality monitoring have been approved. Harbour East Community is anticipating a recommendation relative to the eutrophication threshold levels.

5.2 Russell Lake Phosphorus Threshold

- A staff report dated May 26, 2006 was before the Board.

Dr. Tony Blouin, Manager, Environmental Performance, briefly reviewed the May 26, 2006 staff report noting that:

- The report outlines staff's position relative to a phosphorus threshold on Russell Lake
- He had presented a process by which to determine a phosphorus threshold to the Board at a previous meeting
- There is a national protocol for managing phosphorus in freshwater lakes - Canadian Council of Ministers of Environment (CCME) Guidelines
- As guidelines they have no regulatory force
- The guidelines do not recommend a national threshold, but provide a protocol and process for determining a phosphorus threshold

Dr. Blouin went on to review with the Board pages 4 and 5 of the staff report. Dr. Blouin indicated that as Russell Lake is not a pristine lake, and there is significant development on the lake, a reasonable management objective is to preserve the current mesotrophic status. Consequently staff have recommended a threshold of 15 micrograms (μg) per litre (L).

Concluding his remarks, Dr. Blouin indicated that HRM is investigating the source of phosphorus at the south inlet.

In response to questions from members of the Board, staff indicated the following:

- The threshold set for Russell Lake will apply to future development
- HRM will not likely take action unless the threshold is found to be consistently above that what is set and may even use an annual average
- In terms of the source of the phosphorus, there is a pumping station at the downstream end of the of the trailer park which overflowed three times in 2005 during heavy rain conditions. Phosphorus levels are equally as high up stream which may be the result of cross connections. HRM will be working toward identifying the source of the phosphorus and will take the appropriate remedial action as budget allows.

In response to the Chair, Mr. Hanusiak indicated that at least a portion of the cattail marsh is contaminated and this contamination contributes to the phosphorus in the lake. He indicated that consideration is being given to re-directing the water from that portion of the bog once the source of the contaminant has been found. A large portion of the bog will remain intact.

Dr. Blouin responded to questions from members of the Board providing the following information:

- Short term measures to moderate the flow from the cat tail bog would be subject to the budgetary process (i.e. identification of priority)
- Overall an annual average phosphorus measure from the deep station would be most representative of the lake as a whole
- HRM is not able at this time to regulate the personal use of fertilizers, but can educate the public with regard to the issues around the use of fertilizers adjacent to water bodies

The Chair invited representatives of the Russell Lake Residents Association to present their concerns.

A representative indicated that the Association's concerns are set out in the May 31, 2006 written submission. He went on to indicate that the Russell Lake Residents Association is not against development, but are looking at ways to mitigate areas of concern. He expressed concern that the Russell Lake Modelling report was prepared on behalf of the developer rather than being funded by the developer and prepared on behalf of HRM.

Mr. Hanusiak reiterated that the testing and reporting had been carried out at arms length from Clayton Developments.

The Board agreed that consideration of this matter would be deferred to the next meeting of the Board scheduled for June 28, 2006.

Attachment 2

EXTRACT - DRAFT MINUTES OF DARTMOUTH LAKES ADVISORY BOARD JULY 12, 2006

4.2 Phosphorus Threshold for Russell Lake

- This matter was deferred from the May 31, 2006 meeting of the Dartmouth Lakes Advisory Board.
- A memo dated June 5, 2006 from Dr. Tony Blouin in response to the May 31, 2006 memo from the Russell Lake Residents Association, was before the Board. Also before the Board was a June 23, 2006 memo from the Russell Lake Residents Association.

The Chair read the June 5, 2006 memo from Dr. Tony Blouin, Manager, Environmental Performance, responding to questions in the Russell Lake Residents Association memo of May 31, 2006. She further indicated that Dr. Trevorrow had provided an e-mail summarizing this matter including recommendations and suggested that he review with the Board this information.

Dr. Blouin indicated that he had outlined the staff report at the May 31, 2006 meeting. He went on to indicate that as per CCME guidelines the pre-development threshold for the lake would be ten (10) micrograms (μg) per litre (L). The first step under the CCME guidelines is to establish a management goal for the lake. The suggested management goal is to maintain the lake in its present mesotrophic state given that it has an extensively urbanized drainage and will be subject to further development. Dr. Blouin indicated that the range for a mestrophic lake is 10-20 μg/L and noted that staff is recommending a mid-point threshold level of 15 μg/L.

Councillor McCluskey expressed concern that setting the threshold at 15 μg/L rather than at ten (10)μg /L provides a greater opportunity to increase the threshold to 20 if 15 μg /L is not attainable.

Dr. Blouin responded that the lake reached a level of 13.5 μg /L in 2005. The next step is further assessment including the identification of the sources of phosphorus and fecal coliform. Dr. Blouin indicated that staff has begun investigating these sources including the bog, overflow from the pumping station and another, undetermined, upstream source.

Dr. Trevorrow reviewed his email including the following highlights:

- There is agreement that Russell Lake has exceeded the threshold levels for oligothrophic category in recent years
- There is a choice as to how the measurement can be arrived at: 1. a spring turnover measurement or a yearly average
- Setting the threshold at 15 μg /L implies that if the measurement goes over 15 μg /L, HRM will take action

- The Jacques Whitford testing is valuable in that it attempts to identify the relative change which will be caused by development. The report indicates that the values in the lake would change by 1.5 μg /L
- The basic question is regardless of whether the level is set at 10 μg /L or 15 μg /L, what is to be done if the level is exceeded
- Obvious actions would include identifying phosphorus sources and carrying out remediation in this regard

Mr. Clement suggested that it is difficult to apply thresholds and perhaps this is not the best course of action. However, if a trigger is to be established, what is the consequence if the trigger is exceeded. Mr. Clement suggested that more work relative to the consequence is required before a threshold is established.

Dr. Hellenbrand suggested that other lakes in Dartmouth have stabilized relative to phosphorus levels post development.

Mr. McLean noted that management decisions are more difficult because there is existing development on the lake, new development and other possible sources of phosphorus. He went on to suggest that perhaps a more focussed monitoring program on new development would be more appropriate.

In response to a question from Mr. Clement regarding what authority HRM has to require that new development not exceed the established phosphorus threshold, Dr. Blouin indicated that the Development Agreement would provide a vehicle to require the developer to manage stormwater and/or nutrients. He further indicated that HRM has adopted new stormwater management guidelines with the intention of incorporating these guidelines into revised by-laws which deal with development and disturbance of sites (e.g. Lot Grading and Top Soil By-laws).

The Chair commented that it appeared staff was proposing some preventative measures along with some measures to remediate the phosphorus which is presently entering the lake.

Dr. Blouin indicated that in terms of identifying the source of phosphorus, staff is focussing on the Gaston Road Pumping Station and the sewer watershed upstream.

Mr. Ian Guppy, indicated that investigation of the situation is ongoing. He noted that the Gaston Road Pumping Station is a Priority 2 project under the capital budget priority process. Overall HRM has approximately $141 million in priority stormwater projects.

Dr. Blouin noted that there are some relatively simple actions to be taken to improve the situation including identifying and correcting cross connections, simple measures to prevent excessive stormwater getting into the system, and repairing manholes. Other more costly remediation will be dependent upon budget.

Mr. Connor suggested that establishing a threshold level will provide a tool to ensure that development does not add to phosphorus levels in the lake.

Dr. Blouin, referring to concern regarding continued monitoring, noted that Clayton Developments is required to carry out monitoring for one year after their development is complete. In addition, HRM has begun a more limited sampling which will serve as a check.

The Chair, summarizing the discussion, noted that the Board appeared to agree with the setting of a phosphorus level. However, there is also a need for remediation and preventative measures.

In response to a question from Mr. Mark McLean, Dr. Blouin indicated that the developer is required to provide data on their sediment control to the Nova Scotia Department of the Environment.

Mr. Connor noted that Mr. Hanusiak had suggested that more frequent monitoring for phosphorous would be possible if testing for other non problematic substances was reduced (e.g. metals). Dr. Blouin indicated that he would follow up with Mr. Hanusiak on this matter.

Mr. McLean suggested that it was important to identify the source points. He further suggested that having more sampling sites at strategic points will allow for a greater number of options in terms of management.

MOVED by Mr. Connor, seconded by Dr. Trevorrow the Dartmouth Lakes Advisory Board endorse establishing a total phosphorus level for Russell Lake and further that:

1. **Total phosphorus in the lake be monitored on at least a monthly basis for one year.**

2. **HRM investigate and remedy potential sewage infiltration into the southwest part of the lake.**

3. **Voluntary phosphorus reduction strategies, such as reducing the use of lawn fertilizers, be adopted throughout the Russell Lake watershed.**

4. **The current development and any future developments be required to monitor phosphorus levels at a near source of discharge, whether it be at point source or nearest predicted area of release of potential phosphorus, in addition to the current monitoring sources.**

MOTION PUT AND PASSED.

MOVED by Dr. Trevorrow, seconded by Mr. Connor the Dartmouth Lakes Advisory Board recommend to Harbour East Community Council that a phosphorus threshold value of 12 micrograms (μg) per litre (L) based on an annual average be established for Russell Lake.

A brief discussion ensued during which Dr. Blouin distributed a document entitled 'Use of Canadian Guidance Framework for the Management of Phosphorus in Freshwater Systems (Environment Canada, 2004) and the CCME: Phosphoreus Guideline. Dr. Blouin briefly reviewed the document and in particular two illustrative case studies. He indicated that the recommendation made by staff is reasonable, however, the guidelines are flexible.

MOVED by Mr. Clement, seconded by Mr. McLean that the motion be amended to include a recommendation that HRM expediently remediate the sewage issues which are presently impacting the phosphorus level. MOTION PUT AND PASSED.

MOVED by Mr. McLean, seconded by Mr. Clement that the motion be further amended to provide for an option to revisit the phosphorus threshold level every five (5) years with a view to reducing the level should the data indicate it is appropriate to do so. MOTION PUT AND PASSED.

The vote on the amended motion, as follows, was taken.

MOVED by Dr. Trevorrow, seconded by Mr. Connor that the Dartmouth Lakes Advisory Board recommend to Harbour East Community Council that:

1. **A phosphorus threshold value of 12 micrograms (μg) per litre (L) based on an annual average be established for Russell Lake.**

2. **HRM expediently remediate the sewage issues which are presently impacting the phosphorus level.**

3. **The phosphorus threshold level be revisited every five (5) years with a view to reducing the level should the data indicate it is appropriate to do so.**

MOTION PUT AND PASSED.

5.1.1 <u>Phosphorus Threshold for Morris Lake</u>

A staff report dated May 26, 2006 was before the Board.

Dr. Blouin addressed the Board briefly reviewing the May 26, 2006 staff report. He noted that there is less background data relative to Morris Lake, however, the lake is in a mesotrophic state based on existing data. Like Russell Lake, Morris Lake is significantly urbanized. Morris Lake is a larger lake with a more complex basin and testing has indicated that the existing phosphorus level in the lake is 12.5 micrograms (μg) per litre (L).

A brief discussion ensued including the following points:

- Morris Lake experiences rapid flushing due to the water which is utilized by the oil refinery
- A monitoring program will be carried out on Morris Lake in conjunction with the Phase 4 and 5 development of Portland Hills. This program will be a basic

monitoring program done by HRM and partially funded by Clayton Developments as part of the terms of the Development Agreement on Phase 4 and 5.

MOVED by Mr. Connor, seconded by Ms. Hoehne the Dartmouth Lakes Advisory Board endorse establishing a total phosphorus level for Russell Lake and further that:

1. **Total phosphorus in the lake be monitored on at least a monthly basis for one year**

2. **Voluntary phosphorus reduction strategies, such as reducing the use of lawn fertilizers, be adopted throughout the Russell Lake watershed.**

3. **The current development and any future developments be required to monitor phosphorus levels at a near source of discharge, whether it be at point source or nearest predicted area of release of potential phosphorus, in addition to the current monitoring sources.**

MOTION PUT AND PASSED.

MOVED by Mr. Connor, seconded by Ms. Hoehne the Dartmouth Lakes Advisory Board recommend to Harbour East Community Council that:

1. **A phosphorus threshold value of 12 micrograms (μg) per litre (L) based on an annual average be established for Russell Lake.**

2. **The phosphorus threshold level be revisited every five (5) years with a view to reducing the level should the data indicate it is appropriate to do so.**

MOTION PUT AND PASSED.

Attachment 3

HALIFAX
REGIONAL MUNICIPALITY

PO Box 1749
Halifax, Nova Scotia
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Dartmouth Lakes Advisory Board
May 31, 2006

TO: Chair and Members, Dartmouth Lakes Advisory Board

SUBMITTED BY: Paul Dunphy, Director, Planning & Development

DATE: May 26, 2006

SUBJECT: **Russell Lake Phosphorus Threshold**

ORIGIN

Morris-Russell Lake Secondary Planning Strategy (SPS); Russell Lake West Development Agreement

RECOMMENDATION

It is recommended that :

DLAB approve a phosphorus threshold value for Russell Lake of 15 micrograms (μg) per liter (L).

BACKGROUND

Lakes may be classified into three basic categories, based upon their biological productivity. These categories (trophic classes) are determined largely by total phosphorus (TP) concentration:

Oligotrophic: Low TP, low productivity, low chlorophyll, un-impacted
Mesotrophic: Medium TP, moderate productivity, medium chlorophyll, some impact
Eutrophic: High TP, high productivity, high chlorophyll, noticeable impact

In their natural state, lakes with undisturbed drainage basins tend to become gradually enriched over century time-scales with nutrients and organic material carried into the lakes with runoff. This natural process, termed "eutrophication", makes lakes more biologically productive. In an undisturbed state, the productivity of a lake is limited by the nutrients which plants and ultimately the invertebrates and fish require for growth. In most freshwater systems, phosphorus is the most limiting nutrient, and as phosphorus concentrations increase through enrichment, the lake becomes more eutrophic. Water quality changes from very clear to more cloudy due to increased growth of unicellular algae floating in the water column, more growth of aquatic plants occurs in the shallower areas, more organic matter and sediment builds up on the lake bottom. Oxygen concentrations in the water may be reduced by decomposition, and fish communities tend to change from those preferring cold, clear waters to other species more tolerant of enriched conditions.

When human activity disturbs part of a drainage basin or watershed, increased concentrations of nutrients are carried into the lake both in suspended particles and in solution. This causes an acceleration of the eutrophication process as a result of the human disturbance of soils and organic materials in the watershed, and through increased runoff of nutrients and organic material from sewers, lawn and paved areas. This is termed "cultural eutrophication" and can occur on a relatively short timescale of years. The lake may not be as desirable for swimming, there may be fewer game fish, increased growth of macrophytes (plants), and algal blooms may cause surface scum and odour.

Phosphorus Thresholds

A phosphorus threshold level is a management tool, which sets a limit for phosphorus beyond which further assessment is needed. The Morris-Russell Lake area SPS requires eutrophication (TP) threshold levels to be set for these lakes (Attachments A, B). Watershed management controls and development potential are to be revisited if the threshold is exceeded, existing plan policies are to be reviewed, and an appropriate course of action determined regarding watershed management and future land use.

The Canadian Council of Ministers of Environment (CCME) has created a Phosphorus Guideline as part of the Canadian Environmental Quality Guidelines. The Guideline is based on the Canadian Guidance Framework for the Management of Phosphorus in Freshwater Systems (Environment Canada, 2004).

The steps in the CCME Framework are as follows:

- Set Ecosystem Goals and Objectives: Goals and objectives for lake water quality may be set based on inherent lake value, and on the value of human uses of the lake.

- Define Reference Conditions: Reference condition refers to the lake's phosphorus concentration under natural conditions prior to any human development of the watershed. Various methods may be used in determining reference conditions:

  - Phosphorus modelling
    - TP export from varying land uses
    - Reset watershed to undeveloped state
    - Backcast of Background TP
  - Use historical data when available
  - Compare to similar undeveloped watersheds/lakes
  - Paleolimnology
    - Sediment fossil diatom assemblages
  - Regional TP Background
  - Ecoregion/ecozone approach
  - 25th percentile method

- Select Trigger Ranges: The trigger range encompasses the lower and upper limits of the trophic category (Attachment C) within which the lake's reference condition would fall, based on total phosphorus reference level as determined above.

- Determine Current Phosphorus Concentration: TP is used as a measurement of phosphorus, either from a single measurement at spring turnover, or from seasonal average over the year.

- Compare Current or Predicted Concentration to Trigger Range: If current or predicted concentration exceeds the trigger range, then there is a risk of impact, and further assessment is recommended.

- Compare Current or Predicted Concentration to Baseline Condition: If the trigger range is not exceeded, then an increase in TP of over 50% above the baseline (reference) condition indicates a risk of impact, and further assessment is recommended.

- Management Decisions: Compare the measured or predicted TP concentration to the original goals, and the trigger values, and decide if the degree of change is acceptable. Consider short and long term strategies. Management actions may include: No action; Reduction in Phosphorus Input; Remediation and Conservation.

DISCUSSION

Goals and Objectives: Russell Lake is a valued community resource, and is used for a variety of recreational activities including contact recreation. As such, it is desirable to at least maintain the lake in its current state, and prevent forcing the lake from its present trophic category into a higher category. The current state of water quality in Russell Lake is better than it has been in the past (mesotrophic vs eutrophic). This is a small lake with an urbanised watershed, and so preservation of the current mesotrophic status is a reasonable objective.

Define Reference Conditions: The phosphorus modelling report provided by Clayton Development suggests using a comparison with three nearby lakes (Topsail, Lamont and Major) which have similar geology, and relatively undeveloped watersheds (as drinking water supply protected watersheds). Due to some limited development, as well as long-range influences, these lakes are indicative but not truly pristine. This approach is consistent with one of the CCME options for determining reference conditions (compare to similar undeveloped lakes), and based on 1980 data give a suggested reference level of 7 micrograms (μg) per liter (L).

Phosphorus modelling uses derived or estimated phosphorus transport coefficients for differing land cover/uses to model the amount of phosphorus transported to a lake via runoff. Phosphorus models supplied to HRM by Mr. S. Mandaville may also be used to estimate a reference TP level, by setting the watershed area to an undisturbed condition (ie. using a phosphorus export coefficient suitable for undisturbed forest). Using a coefficient for forested land of 0.054 kgP/ha/yr, this model gives a reference lake TP level of 4 μg/L. The Clayton model uses a higher coefficient of 0.1 kgP/ha/yr for forested land (estimated by calibrating the model to give TP levels similar to Topsail, Lamont and Major 1980 levels). Using a coefficient of 0.1 in the Mandaville model gives a reference TP level of 6.4 μg/L. A rough preliminary calculation using the standard phosphorus model developed by NSDEL for use in Nova Scotia provides a reference TP level of 4.5 μg/L.

Historical data which is available indicates that Russell Lake has in the past experienced much higher TP levels than are currently measured, so historical data presents a mixed picture. TP values well into the eutrophic range (>35 μg/L) have been measured by NSDoE (1975-1977). Likely sources of historic phosphorus were agricultural operations within the watershed, principally a pig farm on the western side of the lake. Levels since the mid-1980s have been typically within the mesotrophic range (with occasional eutrophic levels), indicating an improvement in trophic status.

Thus, the CCME Reference Condition for Russell Lake would be in the 4-7 μg/L range.

Select Trigger Range: The trigger range, using a strict application of the CCME framework, would be the limits of the oligotrophic category, 4-10 μg/L TP. This would give a phosphorus threshold of 10 μg/L TP. The management objective of maintaining the lake within the mesotrophic category could allow a higher threshold of 15 μg/L TP (mid-range of the mesotrophic category) and still allow for appropriate action should the lake exceed the threshold.

Determine Current Phosphorus Concentration: Recent sample data between April 2005 and March 2006 for the deep station has yielded TP values between 4 and 25 μg/L TP, with a mean of 13.5 which is within the mesotrophic category. Spring 2005 level was 4 μg/L, and spring 2006 level was 15 μg/L. A more recent sample by HRM (May 2006) showed a level below 2 μg/L, but this needs confirmation as it appears excessively low.

Compare Current or Predicted Concentration to Trigger Range and Baseline: Current TP levels exceed the CCME trigger range upper limit (10 μg/L), and also exceed a level 50% above the baseline (calculated as 6-10 μg/L, depending on baseline value selected). Current levels are within the mid range (15 μg/L) of the mesotrophic category. Single sample results are not always indicative of the longer-term status of a lake, and so part of the assessment may involve an analysis of the frequency of levels exceeding the threshold. Annual averages may be more indicative.

Management Decisions: Watershed management controls and development potential are to be revisited if the threshold is exceeded. Depending on the threshold value chosen, current values are above or near the threshold value, suggesting the need for further assessment. If the management goal is to preserve the lake within the current trophic category, then ongoing efforts should seek to ensure that the TP level does not exceed 20 μg/L (the mesotrophic-eutrophic boundary). Modelling provided by Clayton Developments predicts that the planned Russell Lake West development will cause an increment in lake TP levels of about 1.5 μg/L. This would put the lake at the mid range of the mesotrophic category (15 μg/L), and above a TP threshold established using the CCME Framework. This level remains well below the lower limit of the next higher trophic category, which is 20 μg/L (meso-eutrophic).

Colour and depth can affect a lake's response to phosphorus, and may result in misleading classification of a lake based only on the deep-water TP level. Highly coloured lakes may have high TP but lower productivity than predicted ("dystrophic" lakes). Shallow lakes may have much of their production in the form of submerged or emergent microphytes in the shallows, and so may actually be in a higher category than the deep-water TP would indicate. Recent colour readings in Russell Lake are relatively low (although they have been higher in the past), so this should not be a factor. Parts of Russell Lake are shallow (mean depth 3.7 M, maximum depth 9 M), but there is a deep area which can stratify in summer. When a lake stratifies, the deep water is isolated form the surface, and can become anoxic in summer as decomposition uses up oxygen. Under these conditions, phosphorus may be released from the sediments, and redistributed within the lake during fall turnover ("internal loading"). It is possible that this is a source of part of the phosphorus load in Russell Lake, given its history of high TP inputs.

HRM has investigated a possible source of phosphorus entering the south end of Russell Lake, and will continue to assess the situation in an attempt to clearly identify, and if possible remediate or correct the situation. Possible sources include a sewage pumping station at Gaston Road, additional sewage effluent from further upstream through leaks or cross-connections, or drainage water pumped from the Clayton Development construction site.

CONCLUSION

Russell Lake prior to any development within its watershed was very likely an oligotrophic lake. During its history, it has at times been well within the eutrophic category due to various land uses within the watershed. Currently, Russell Lake seems to be within the mesotrophic category. A management goal should be to prevent Russell Lake transitioning to the next category of meso-eutrophic, which would reduce its aesthetic and recreational appeal. A TP threshold in the 10-15 μg/L range would be suitable to prevent this, assuming that strict controls are applied to any activity which is likely to increase the TP level beyond this threshold.

Strict application of the CCME Framework protocol yields a phosphorus threshold of 10 μg/L TP. It is recommended, based on the management objective for the lake, that a phosphorus threshold level of 15 μg/L TP be adopted for Russell Lake. This threshold will allow for appropriate action before the lake reaches the mesotrophic/meso-eutrophic boundary of 20 μg/L TP. Recent data from 2005-2006 indicate that the lake is near or at the threshold level of 15 μg/L presently, and so further assessment is warranted.

Watershed management controls and development potential are to be revisited if the threshold is exceeded. Ongoing monitoring will be important to assess any changes. Further investigation of an apparent source or sources of phosphorus in the Gaston Road area, entering the lake through the south-west inlet, is warranted.

BUDGET IMPLICATIONS

N/A

FINANCIAL MANAGEMENT POLICIES / BUSINESS PLAN

This report complies with the Municipality's Multi-Year Financial Strategy, the approved Operating, Capital and Reserve budgets, policies and procedures regarding withdrawals from the utilization of Capital and Operating reserves, as well as any relevant legislation.

ALTERNATIVES

None recommended.

ATTACHMENTS

A. SPS Water Quality Policy
B. Russell Lake West Development Agreement, Water Quality Policy
C. Trophic Category Limits for Canadian Lakes/Rivers

A copy of this report can be obtained by contacting the Office of the Municipal Clerk at 490-4210, or Fax 490-4208.

Report Prepared by: [signature]
Manager, Environmental Performance

ATTACHMENTS

A. SPS Water Quality Policy

Morris Russell Lake Secondary Planning Strategy

Monitoring

The eutrophication process is gradual and takes place over many years. Its progress will be seen in extension of vegetation in shallow areas and the seasonal occurrence of algae. In the Morris Lake Watershed Study a Phosphorus Loading Model was used to determine the relationship of the lake phosphorus inputs to trophic status.

The model determined that Morris Lake is currently mesotrophic and is within 10 to 15 percent of the eutrophic boundary. Thus, the amount of land developed within the watershed should be controlled to prevent Morris Lake from reaching a borderline eutrophic state. The actual amount of land that can be developed can only be determined by undertaking a well designed lake monitoring program and adopting a preset maximum permissible limit for total phosphorus. If the results indicate that Total Phosphorus continues to increase, the watershed management plan will have to be revised and development controls strengthened.

ML-30 A water quality monitoring program shall be undertaken for Morris and Russell Lakes to track the eutrophication process. The program is to be designed and undertaken by qualified persons financed in whole or part by developers within the secondary plan area. Specifics of the program are to be negotiated under the terms of a development agreement in consultation with the Dartmouth Lakes Advisory Board.
The monitoring program shall:

(a) specify the duration of monitoring for the pre-construction, construction and post-construction phases of the development;

(b) Specify the physical and chemical water quality indicators to be measured, the location and frequency of testing and the format of submissions to the Municipality in each phase referenced under clause (a);

(c) Establish eutrophication threshold levels for the lakes which would be used as a basis for reevaluating watershed management controls and future development potential within the area;

(d) Conform with all water quality policies, specifications, protocols and review and approval procedures approved by Regional Council.

ML-31 Pursuant to policy ML-30, in the event the critical water quality threshold for Morris or Russell Lakes are reached, it shall be the intention of Council to immediately undertake a review of existing plan policies contained herein and determine an appropriate course of action respecting watershed management and future land use development in this area. Critical water quality thresholds shall be made available to the public.

B. Russell Lake West Development Agreement, Water Quality Policy

PART 3: SUBDIVISION OF THE LANDS

3.1 Environmental Protection

(a) The terms and conditions of a water quality monitoring program for Russell Lake as prepared by a person deemed qualified by the Municipality have been agreed to by the Municipality. All costs associated with the program are to be assumed by the Developer. The Development Officer shall refer the proposed monitoring program to the Dartmouth Lakes Advisory Board and the Community Council for an opinion regarding it's acceptability and may seek the advice of any person deemed qualified within the Municipality or the Province.

(i) specify the duration of monitoring for the pre-construction, construction, and post-construction phases of development.

(ii) specify the physical and chemical water quality indicators to be measured, the location and frequency of testing and the format of submissions to the Municipality in each phase referenced under Clause (i); and

(iii) establish eutrophication threshold levels for the lake which would be used as a basis for reevaluating watershed management controls and future development potential within the area;

The Development Officer shall refer the proposed monitoring program to the Dartmouth Lakes Advisory Board for an opinion regarding it's acceptability and may seek the advice of any person deemed qualified within the Municipality of the Province.

3.3 The Developer agrees that the monitoring program, approved under clause 3.1 (a) of this agreement, is to be undertaken by a person deemed qualified by the Municipality and the findings are to be submitted to a person designated by the Municipality. The Municipality may require that a security, in a form and amount acceptable to the Municipality, be provided to ensure performance of all work required by the approved monitoring program. The Developer agrees to present the findings of the monitoring program to the Dartmouth Lakes Advisory Board and the Community Council on an annual basis until such time as all obligations under the monitoring program have been completed.

C. Trophic Category Limits for Canadian Lakes/Rivers (CCME Canadian Environmental Quality Guidelines)

Trigger Ranges based on Environment Canada (2004 - Table 1.1)	
TP (μg/L)	Trophic state
0-4	Ultra-oligotrophic
4-10	Oligotrophic
10-20	Mesotrophic
20-35	Meso-eutrophic
35-100	Eutrophic
100+	Hypereutrophic

Attachment 4

HALIFAX
REGIONAL MUNICIPALITY

PO Box 1749
Halifax, Nova Scotia
B3J 3A5 Canada

Dartmouth Lakes Advisory Board
June 28, 2006

TO: Chair and Members, Dartmouth Lakes Advisory Board

SUBMITTED BY: Paul Dunphy, Director, Planning & Development Services

DATE: June 16, 2006

SUBJECT: **Morris Lake Phosphorus Threshold**

ORIGIN

Morris-Russell Lake Secondary Planning Strategy (SPS); Portland Hills Phase 4&5 Development Agreement

RECOMMENDATION

It is recommended that:

Dartmouth Lakes Advisory Board consider a phosphorus threshold value for Morris Lake of 15 micrograms (μg) per liter (L).

BACKGROUND

In follow-up to the staff report to DLAB of May 31st on a phosphorus threshold level for Russell Lake, the present report is provided in relation to setting a phosphorus threshold for Morris Lake. As indicated in the May 31st report, the Morris-Russell Lake area SPS requires eutrophication (TP) threshold levels to be set for these lakes. Watershed management controls and development potential are to be revisited if the threshold is exceeded, existing plan policies are to be reviewed, and an appropriate course of action determined regarding watershed management and future land use. A development agreement for the Portland Hills Phase 4&5 Development is presently under consideration by HRM, and a phosphorus threshold needs to be set for Morris Lake.

As previously outlined in the May 31st report, the steps in the CCME Framework for setting a phosphorus threshold are as follows:

- Set Ecosystem Goals and Objectives
- Define Reference Conditions
- Select Trigger Ranges
- Determine Current Phosphorus Concentration
- Compare Current or Predicted Concentration to Trigger Range
- Compare Current or Predicted Concentration to Baseline Condition
- Management Decisions

DISCUSSION

Goals and Objectives: As for Russell Lake, Morris Lake is a valued community resource, and is used for a variety of recreational activities including contact recreation. As such, it is desirable to at least maintain the lake in its current state, and prevent forcing the lake from its present trophic category into a higher category. This lake has an urbanised watershed, and so preservation of the current status is a reasonable objective. Morris Lake is currently near or within the mesotrophic category, based on limited available data (see below).

Define Reference Conditions: As for Russell Lake, one approach to defining reference conditions under the CCME Framework is by comparison to nearby lakes (Topsail, Lamont and Major) which have similar geology, and relatively undeveloped watersheds (as drinking water supply protected watersheds). Based on 1980 data for these lakes, this gives a suggested reference level of 7 micrograms (μg) per liter (L), which is in the oligotrophic category.

Thus, the CCME Reference Condition for Russell Lake would be 7 μg/L.

Select Trigger Range: The trigger range, using a strict application of the CCME framework, would be the limits of the oligotrophic category, 4-10 μg/L TP. This would give a phosphorus threshold of 10 μg/L TP. A management objective of maintaining the lake within the mesotrophic category could allow a higher threshold of 15 μg/L TP (mid-range of the mesotrophic category) and still allow for appropriate action should the lake exceed the threshold.

Determine Current Phosphorus Concentration: The limited historical data which is available indicates that Morris Lake has been in the mesotrophic category (10-20 μg/L TP range) in the early 1990s, oligotrophic (<10 μg/L TP) in the late 1990s, and more recently (2000) at the mid-mesotrophic level (15 μg/L TP). Overall average of the historical data has been 12.5 μg/L TP. Data collected in May 2006 by HRM showed a level of 8 μg/L TP.

Compare Current or Predicted Concentration to Trigger Range and Baseline: Recent TP levels (2000 data) exceed the CCME trigger range upper limit (10 μg/L), and also exceed a level 50% above the baseline which would also be approximately 10 μg/L TP. Current levels (2006 spring data) are just below the oligotrophic-mesotrophic boundary, based on a single sample.

Management Decisions: Watershed management controls and development potential are to be revisited if the threshold is exceeded. Depending on the threshold value chosen, current values are below or near the threshold value. If the management goal is to preserve the lake within the current mesotrophic category, then ongoing efforts should seek to ensure that the TP level does not exceed 20 μg/L (the mesotrophic-eutrophic boundary).

Colour and depth can affect a lake's response to phosphorus. Recent colour readings in Morris Lake are relatively low, so this should not be a factor. Parts of Morris Lake are shallow (mean depth 3.7 M, maximum depth 13 M), but there are deep areas which may stratify in summer (historical data from 1991-1992 did not show summer stratification occurring).

Current (May 2006) Secchi depth is 3.3M, and chlorophyll level is 7.5 μg/L. These values would tend to place the lake near or into the meso-eutrophic category (Environment Canada, 2004).

Conclusion

Morris Lake prior to any development within its watershed was very likely an oligotrophic lake. During its history, it has at times been within the mesotrophic category due to various land uses within the watershed. Currently, Morris Lake seems to be near the oligotrophic-mesotrophic boundary (possibly above or below). A management goal should be to prevent Morris Lake ransitioning to the category of meso-eutrophic (>20 μg/L TP), which would reduce its aesthetic and recreational appeal. As for Russell Lake, a TP threshold in the 10-15 μg/L range would be suitable to prevent this, assuming that strict controls are applied to any activity which is likely to increase the TP level beyond this threshold.

Strict application of the CCME Framework protocol yields a phosphorus threshold of 10 μg/L TP. It is recommended, based on the management objective for the lake, that a phosphorus threshold level of 15 μg/L TP be adopted for Morris Lake. This threshold will allow for appropriate action before the lake reaches the mesotrophic/meso-eutrophic boundary of 20 μg/L TP.

Watershed management controls and development potential are to be revisited if the threshold is exceeded. Ongoing monitoring by HRM under the Portland Hills Phase 4&5 development agreement will be important to further establish current conditions and assess any changes.

BUDGET IMPLICATIONS

N/A

FINANCIAL MANAGEMENT POLICIES / BUSINESS PLAN

This report complies with the Municipality's Multi-Year Financial Strategy, the approved Operating, Capital and Reserve budgets, policies and procedures regarding withdrawals from the utilization of Capital and Operating reserves, as well as any relevant legislation.

ALTERNATIVES

None recommended.

ATTACHMENTS

A. SPS Water Quality Policy
B. Trophic Category Limits for Canadian Lakes/Rivers

A copy of this report can be obtained by contacting the Office of the Municipal Clerk at 490-4210, or Fax 490-4208.

Report Prepared by: Tony Blouin, Manager, Environmental Performance, 490-4610

ATTACHMENT A -
SPS Water Quality Policy

Morris Russell Lake Secondary Planning Strategy

Monitoring

The eutrophication process is gradual and takes place over many years. Its progress will be seen in extension of vegetation in shallow areas and the seasonal occurrence of algae. In the Morris Lake Watershed Study a Phosphorus Loading Model was used to determine the relationship of the lake phosphorus inputs to trophic status.

The model determined that Morris Lake is currently mesotrophic and is within 10 to 15 percent of the eutrophic boundary. Thus, the amount of land developed within the watershed should be controlled to prevent Morris Lake from reaching a borderline eutrophic state. The actual amount of land that can be developed can only be determined by undertaking a well designed lake monitoring program and adopting a preset maximum permissible limit for total phosphorus. If the results indicate that Total Phosphorus continues to increase, the watershed management plan will have to be revised and development controls strengthened.

ML-30 A water quality monitoring program shall be undertaken for Morris and Russell Lakes to track the eutrophication process. The program is to be designed and undertaken by qualified persons financed in whole or part by developers within the secondary plan area. Specifics of the program are to be negotiated under the terms of a development agreement in consultation with the Dartmouth Lakes Advisory Board.
The monitoring program shall:

(a) specify the duration of monitoring for the pre-construction, construction and post-construction phases of the development;

(b) Specify the physical and chemical water quality indicators to be measured, the location and frequency of testing and the format of submissions to the Municipality in each phase referenced under clause (a);

(c) Establish eutrophication threshold levels for the lakes which would be used as a basis for reevaluating watershed management controls and future development potential within the area;

(d) Conform with all water quality policies, specifications, protocols and review and approval procedures approved by Regional Council.

ML-31 Pursuant to policy ML-30, in the event the critical water quality threshold for Morris or Russell Lakes are reached, it shall be the intention of Council to immediately undertake a review of existing plan policies contained herein and determine an appropriate course of action respecting watershed management and future land use development in this area. Critical water quality thresholds shall be made available to the public.

ATTACHMENT B
Trophic Category Limits for Canadian Lakes/Rivers
(CCME Canadian Environmental Quality Guidelines)

Trigger Ranges based on Environment Canada (2004 - Table 1.1)	
TP (μg/L)	Trophic state
0-4	Ultra-oligotrophic
4-10	Oligotrophic
10-20	Mesotrophic
20-35	Meso-eutrophic
35-100	Eutrophic
100+	Hypereutrophic

Attachment 5

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REPORT

Modeling the Watershed of Russell Lake

CLAYTON DEVELOPMENT

REPORT NO. SD19184.

REPORT NO. SD19184.

REPORT TO	**Clayton Developments**
FOR	**Modeling the Watershed of Russell Lake**
AUTHOR	**Dr. Walton Watt** **1686 Henry St** **Halifax NS** **B3H 3K3**

May 3, 2006

Jacques Whitford

EXECUTIVE SUMMARY

In accordance with Section 3.1 of the Russell Lake West Development Agreement between the Halifax Regional Municipality (HRM) and Clayton Developments Limited a water quality monitoring program is currently being conducted to establish baseline conditions for the Russel Lake, Dartmouth (MPS Policy ML-30). One of the intended outcomes of the program is to "establish eutrophication threshold levels for the lakes which would be used as a basis for re-evaluating watershed management controls and future development potential within the area." To assist in this aim, Clayton Development Limited has contracted Jacques Whitford Limited, in collaboration with Dr. Walton Watt, to undertake phosphorus modeling for Russell Lake.

The objectives of the phosphorus modeling exercise are twofold:

1) To estimate how the mean total phosphorus concentration in Russell Lake will be affected by the Russel Lake West Development; and
2) To suggest ways to mitigate the potential increase in the lake's total phosphorus (TP) concentration that will be brought about by this change in land use.

Water quality sampling was conducted on a seasonal basis, along with supplementary sampling as needed, to collect necessary information on phosphorus loading as well as general water chemical characterization. This report provides the predictive modeling methodology and resulting effects of an increase in phosphorus loading to Russell Lake that will be attributed to the Russell Lake West Development.

In most Canadian lakes, high levels of algal production are the most obvious sign of pollution problems. Algal blooms were reported from Russell Lake in the 1970's and 80's. With freshwater algal blooms, the nutrient phosphorus is usually the controlling factor, and by limiting the amount of total phosphorus (TP) that enters the lake it is usually possible to control the level of algal and other plant growth. Phosphorus concentration in Russell Lake water declined between 1980 and 2005 to the point where the lake was thought to be free of algal blooms.

Monitoring of the water chemistry in Russell Lake in 2005-06 indicated that the lake appears to be undergoing rapid seasonal nutrient concentration changes. During a one year period of sampling in 2005-06, the lake progressed from oligotrophic (low) nutrient levels in the spring to mesotrophic (moderate) levels in the fall. The lake appears to be responding to siltation loading from previous projects in its drainage area. Unusually high phosphorus levels were observed entering the lake from the south-west inlet, possibly due to sewage contamination.

The mathematical model of TP in the watershed of Russell Lake described in this report was constructed primarily to forecast how much additional TP would be entering the lake as the result of changing the land use on the west side of the lake from undeveloped (forest, scrub growing in old farm fields, and wetland) to an urban residential area with sport fields and parkland. The model uses TP export coefficients estimated from data collected at inlets to the lake.

The TP export coefficient for undeveloped drainage was estimated by running the Russell Lake model 'backwards' until the predicted TP concentration matched the April 1980 mean TP level in lakes Lamont, Topsail and Major. These are nearby drinking water lakes with similar geochemistry but undeveloped, protected drainage areas. It is recommended that these lakes be used as undeveloped controls for Russell and other urbanized lakes in the vicinity.

The model predicts that the land use changes accompanying the Russell Lake West Development will cause an additional TP loading to Russell Lake of about 9 kg/y, which, under 2005-06 conditions would increase the TP concentration in the lake by about 1.5 mg/M^3 (µg/L). This potential increase is unlikely to change the trophic status of the lake.

Since sewage contamination contributed about 25 kg/y of TP to the lake in 2005-06, it is suggested that the TP increase contributed by Russell Lake West Development can be more than adequately mitigated by reducing or stopping the input of sewage to the lake.

Table of Contents

EXECUTIVE SUMMARY i

1.0 INTRODUCTION 1

2.0 OBJECTIVES OF THE STUDY 1

3.0 URBAN LIMNOLOGY 1

4.0 PHOSPHORUS EXPORT COEFFICIENTS 3

5.0 LAKE WATERSHED MODELING 4

6.0 GEOPHYSICAL SETTING 5

7.0 THE RUSSELL LAKE BYPASS ISSUE 5

8.0 THE EXCESS PHOSPHORUS ISSUE 6

9.0 ESTIMATING PRE-DEVELOPMENT TP 7

10.0 THE YEAR IN RUSSELL LAKE 8

11.0 RESULTS OF RUSSELL LAKE WATERSHED MODELING 9

12.0 CONCLUSIONS 17

13.0 REFERENCES 17

List of Tables

TABLE 4.1 Published Phosphorus Export Coefficients (mg/M^2/y) (from Reckhow *et al.*, 1980) 3

TABLE 10.1 TP Concentrations (mg/M^3) for Russell Lake and the Southwest Inlet in 2005-06 9

TABLE 11.1 Estimates of Total Phosphorus Export Coefficients for the Russell Lake Drainage Area 9

TABLE 11.2 Physical Parameters for Watershed Modeling of Russell and Penhorn Lakes 10

TABLE 11.3 Other Modeling Parameters for the Period 15 March 2005 – 14 March 2006 10

TABLE 11.4 The Russell Lake Watershed Model Baseline Simulation of Pre-Construction TP Inputs and Estimated Mean Lake TP Concentration for the Time Period 15 March 2005 – 14 March 2006 12

TABLE 11.5 Russell Lake Watershed Model Output for Post-construction of a Residential Development on the West Side (Drumlin Slope) of the Lake. 13

TABLE 11.6 Another Pre-construction Model Run with a More Elaborate Breakdown of the SW Inlet Drainage that Yields an Estimate of 25 kg/y of Phosphorus Flushed into Russell Lake from the Excess TP Source (Sewage Contaminated Wetland) During 2005-06 14

TABLE 11.7 Pre-Construction Run Similar to that in Table 11.6 but with the Phosphorus Loading from the Excess TP Source (Sewage Contamination in the West Wetland) Set to Zero 15

TABLE 11.8 Output of the Complete Post-construction Mode Incorporating Both the Residential Development on the West Side of Russell Lake, and the Additional Residential and Urban Park Areas in the Sub-drainage of the SW Inlet 16

1.0 INTRODUCTION

In accordance with Section 3.1 of the Russell Lake West Development Agreement between the Halifax Regional Municipality (HRM) and Clayton Developments Limited a water quality monitoring program is currently being conducted to establish baseline conditions for the Russell Lake, Dartmouth (MPS Policy ML-30). One of the components of the program is to "establish eutrophication threshold levels for the lakes which would be used as a basis for reevaluating watershed management controls and future development potential within the area." Data and information are provided in this report to assist the Dartmouth Lakes Advisory Board and HRM staff with establishing the threshold level and providing a recommendation to the Harbour East Community Council.

Clayton Development Limited contracted Jacques Whitford Limited, in collaboration with Dr. Walton Watt, to conduct phosphorus modeling in Russell Lake. Water quality sampling was undertaken on a seasonal basis, along with supplementary sampling as needed, to collect necessary information on phosphorus loading as well as general water chemical characterization. This report provides the predictive modeling methodology and resulting effects of an increase in phosphorus loading to Russell Lake that will be attributed to the Russell Lake West Development.

2.0 OBJECTIVES OF THE STUDY

The objectives of the phosphorus modeling exercise are twofold:

1) A housing development is now under construction on the west side of Russell Lake in Dartmouth, Nova Scotia. A computer model of the lake and drainage area was thought to be the best way to estimate how the mean total phosphorus concentration in Russell Lake will be affected by the conversion of an area that was regrowth forest and old farm fields into an urban residential area.
2) It was also hoped that the study would be able to suggest ways to mitigate the anticipated increase in the lake's total phosphorus (TP) concentration that will be brought about by this change in land use.

3.0 URBAN LIMNOLOGY

A watershed area is all the area inside the line that divides the direction of flow between different lakes or streams. A drainage basin is all of the land and water areas that drain toward a particular lake. The area of the drainage basin plus the area of the lake constitutes the watershed area. Thus, a watershed is defined in terms of the selected lake (or river). There can be sub-watersheds within watersheds. For example, a tributary to a lake has its own watershed, which is part of the larger total drainage area to the lake.

The water quality in a lake is a reflection of the quality of the water coming from its drainage basin. More specifically, a lake reflects the drainage basin's size, topography, geology, land use, soil fertility and erodibility, and vegetation. Typically, nutrient loading increases with an increasing ratio of watershed area to lake area. This is obvious when one considers that as the watershed to lake area increases there are additional sources and volumes of runoff to the lake.

Land use has an important impact on the quality and quantity of the water entering a lake. In urban areas the high proportion of impervious surfaces prevents rainwater from penetrating into the soil and so increases the volume of surface water flow directly to the lake. This is especially so when the flow is in underground storm sewers. The high flow rates from urban areas can increase erosion and provide sufficient force to carry particles of soil to the lake. Soil particles, especially clays, can carry large quantities of adsorbed phosphorus with them. Thus, water quantity and velocity also affect water quality.

As water flows over streets, parking lots and rooftops, it accumulates nutrients and contaminants in both dissolved and particulate form. The nutrient phosphorus is particularly important because in fresh water systems it is the availability of phosphorus that usually controls the amount of algal growth and the overall aesthetic aspect (trophic level) of a lake. The influence of soil type and slope are also important because finer particles and steeper slopes mean higher phosphorus inputs to the lake. Phosphorus occurs in several chemical forms that are readily interchangeable, so the commonly accepted best practice is to measure total phosphorus (TP).

Water in lakes has a tendency to stratify. In summer water forms a top layer called the epilimnion and a deep water layer which is lower in temperature called the hypolimnion. When precipitation falls on a lake surface the TP that accompanies it promotes algal growth, and if sufficient additional TP enters the lake from other sources the algal growth will proliferate and eventually die and sink through the water column. As it sinks it decays and as it decays it consumes oxygen from the water. If enough of the organic matter accumulates on or near the bottom of the lake it can consume all of the oxygen in the layer of deeper water, the hypolimnion.

HRM soils are naturally high in iron and aluminum hydroxides, both of which readily bind to organic and inorganic phosphorus. When such soils are eroded into a river or lake they carry this bound phosphorus with them in particulate form. Once in the lake, a good proportion of the soil and other particles sink to the bottom, carrying the phosphorus with them. As long as the water in the lake contains dissolved oxygen, the phosphorus is likely to remain sequestered in the lake sediments. However, if the water at the bottom of the lake becomes anoxic (no oxygen) as a result of the decay of organic matter sinking through the water column, then the chemistry changes and the metals release the inorganic phosphorus into the anoxic water. In this way high concentrations of phosphorus can accumulate in the hypolimnion of the lake. When the lake's water is mixed, which occurs each spring and fall, the released phosphorus is distributed throughout the entire lake and becomes available in the surface waters where it promotes further algal growth. This phenomenon is called internal phosphorus loading, and it is generally accepted as an undesirable sign of eutrophication.

Lakes can be classified according to their 'trophic' (a Greek root meaning food) status. Oligotrophic lakes have low food production and eutrophic lakes have high food production. Mesotrophic is in the middle. Although the lake and its biosystem is indifferent, most nearby human residents and fishers object when their lake becomes eutrophic, because eutrophic lakes support less desirable fish species and the algae and other plants may be considered unsightly and can sometimes smell bad. In general oligotrophic and mesotrophic lakes are more pleasant to live beside.

Trophic status in lakes is roughly related to mean TP concentration. Lakes with a mean TP concentration less than 10 mg/M^3 are usually oligotrophic and this is the natural (pre-development) status of most HRM lakes. Lakes in the 10 - 20 mg/M^3 range are usually mesotrophic. HRM's lakes in urbanized drainage areas are not likely ever to be restored to their original oligotrophic state, but urban communities need to strive to keep their lakes at least at the mesotrophic level. Controlling the TP input to a lake is one of the most practical and proven ways of controlling its trophic status.

4.0 PHOSPHORUS EXPORT COEFFICIENTS

Each type of land use causes different amounts of phosphorus to be released into the lake. In an undisturbed system the phosphorus input is largely supplied by deposition with precipitation, and also dry deposition as dust. For modeling purposes the Nova Scotia bulk (wet and dry) TP deposition from the atmosphere was taken to be 25 mg/M^2/y (Vaughan Engineering Assoc., 1993) (i.e., the atmospheric deposition of TP on water or ground is providing 25 mg/M^2/y of phosphorus).

When this falls on undeveloped land such as a forest, much of the phosphorus (for example, about 60%) is cycled through the biological system and eventually winds up in plants or chemically bound to metals in the soil. The other 40% of the phosphorus that falls on the forest remains dissolved in the rainwater which drains into the lake. Thus the forest, while receiving 25 mg/M^2/y of TP would only be releasing 10 mg/M^2/y to the lake, and for modeling purposes the value 10 mg/M^2/y is called the TP export coefficient for the land use category 'forest'. Typical TP export coefficients for Nova Scotia forests might range from about 5 mg/M^2/y for undisturbed old-growth forest up to about 25 mg/M^2/y when a forest growing on a steep slope has been logged.

In a residential area the opportunity for the phosphorus that falls with the precipitation to become bound in plants and soil is somewhat limited by impermeable surfaces like roofs, driveways, sidewalks and streets, so we would expect more than the 40% of our previous example to escape to the lake. In addition, more phosphorus will have been added in the form of lawn and garden fertilizer and dog and cat urine and faeces. Typical TP export coefficients for low density urban residential land use areas are usually in the range 15 - 30 mg/M^2/y. Higher density residential areas, like apartment blocks, will have even higher export coefficients, similar to commercial areas.

Commercial areas have high export coefficients because they are usually completely paved over and since the precipitation has virtually no contact with soil, all of the 25 mg/M^2/y TP falling from the atmosphere runs directly off in storm sewers to the lake. In addition, the precipitation falling on the roofs, streets and parking lots of commercial areas comes into contact with dust, food waste, pigeon faeces, automotive emissions, fly-ash and other sources of TP. Typical export coefficients for commercial areas can range from 30-300 mg/M^2/y, or even higher.

Establishing accurate TP export coefficients is a difficult task: ideally one chooses an area where one can sample the runoff from a single land use category and takes multiple samples from every precipitation event for at least one year. Usually one has to settle for much lower sampling rates. Alternatively, one can select from many published values (see Table 4.1).

TABLE 4.1 Published Phosphorus Export Coefficients (mg/M^2/y) (from Reckhow *et al.*, 1980)

	High	Mid	Low
Commercial	500	80-300	50
Urban Residential	270	56-110	19
Forest	83	14-40	2
Precipitation	60	20-50	15

The problem with the published values is that they are seldom applicable to the watershed of interest, and with such a wide choice available it is possible to produce a model that will give almost any answer that might be desired.

Although only limited sampling is available for the Russell Lake watershed, the author has opted to use this on-site data to estimate export coefficients for each of the lake's sub-drainages. These data are very specific to the Russell Lake drainage area and as such should yield higher accuracy than the generalized published values even though the coefficients are estimated from a very small data series. Using local data gives the advantage that, if a lake (like Russell) shows signs of undergoing rapid changes in trophic status, then the watershed can be modeled for one specific data year only.

5.0 LAKE WATERSHED MODELING

What follows is a description of the modeling methodology that has been used to estimate the TP loading and the mean TP concentration in Russell Lake for the annual period 15 March 2005 to 14 March 2006.

The area of the watershed in square metres (M^2) was multiplied by local rainfall (1.46 M in this period) and by 0.67 which is the mean annual runoff coefficient for Nova Scotia (the proportion of the precipitation that actually reaches the lake outlet - the rest is lost to evaporation and transpiration) to estimate the total amount of water (M^3/y) that exited the lake over the year. The total volume of water that exited the lake divided by the volume of the lake gives the **flushing rate** in times/year.

Next the estimated TP export coefficient in milligrams per square metre per year (mg/M^2/y) for each sub-drainage was multiplied by the area to give the total input of TP (mg/y) for that particular sub-drainage. All TP inputs were then summed (not forgetting the precipitation directly on the lake) to get the **total TP loading** (kg/y).

Phosphorus retention by the lake is a function of the TP settling velocity (M/y) and the total depth of water relative to a reference surface which is usually taken as the surface area of the lake. This is called the **areal water loading rate**. It is calculated as the total volume of water exiting the lake (M^3/y) divided by the surface area of the lake (M^2) to give areal loading rate in M/y. The proportion of TP retained by the lake should be directly proportional to the ratio of the settling velocity to the sum of settling velocity plus areal loading rate. However, TP settling rates are notoriously difficult to estimate directly. The best approach is to do it empirically by measuring the total amounts of TP entering and leaving a lake for several years, and then back calculate for the mean settling velocity. This was done by Dillon *et al.* 1986 using several years of data on small Precambrian Shield lakes which are geochemically similar to the Nova Scotia lakes on the Meguma Group rocks. Thus, the settling rates are not really settling rates at all, but rather empirically derived values that make the function fit.

Different (lower) settling velocities are used for modeling lakes which develop anoxic hypolimnia. The alternative would be to use a two layered limnological model, but it has been shown that single layer models with empirically derived lower settling velocities (to reduce the amount of TP predicted to be retained in the lake) are just as accurate as two layer models and much less complicated.

The theoretical TP concentration in the lake is then calculated as:

$$\frac{\text{Total TP loading} \times (1 - \text{proportion of phosphorus retained})}{\text{lake volume} \times \text{flushing rate}}$$

The model uses an estimate of lake discharge, after phosphorus precipitation on the lake and after phosphorus retention by the lake; hence the TP concentration calculated is actually the one at the outlet of the lake. In some data sets there may be a significant difference between TP concentrations in the main lake and at the outlet. This can be corrected by dividing the output of the above function by the mean ratio of TP concentration at the outlet to TP concentration at the lake station. It is best to use paired data (collected on the same day) for this.

6.0 GEOPHYSICAL SETTING

Russell Lake lies on quartzite bedrock, part of the Goldenville Formation in the Meguma Group, which also includes the Halifax Formation of slates (Keppie, 2000). The rock is overlain by a 2-5 metres thick layer of reddish Lawrencetown till, which has a relatively high clay and fine silt content. The east and west sides of the lake are bordered by steep sided drumlins composed of the same till though with lesser rock inclusion. As the reddish colour implies, Lawrencetown till includes material transported from the Carboniferous rock region to the north (Prime, 2001); and, especially on the drumlins, it produces Wolfville soils with moderately good agricultural potential and is rated as "good crop land" by MacDonald *et al.*, 1963.

Precipitation falling on the sides of the drumlins drains directly into the lake. The steep slopes and fine textured soil mean that any surface disturbance will result in a high turbidity runoff. Fine soil particles, especially clays, can carry a lot of chemically bound phosphorus with them into the lake. The slope on the east side is the site of a recent residential development built about the turn of the century. It is steeper than that on the west side which is presently undergoing development.

There is a relatively large wetland behind (west of) the west drumlin. The wetland drains into a small brook which flows south and then east to empty into the lake in the southwest corner. Another small brook (seasonally intermittent) entering from the southeast drains a small area of undeveloped wetland and forest. The north end of the lake is bordered by wetland and the main inlet from the northwest has been blocked by a soil and rock berm, forcing the water to pass through the adjacent wetland before entering the main lake. This wetland also receives the drainage from the northeast. The lake's outlet is in the northeast corner, not far from the current north inlet.

7.0 THE RUSSELL LAKE BYPASS ISSUE

A moderate problem in modeling Russell Lake is the extent to which water flowing into the lake under the north boardwalk (the primary north inlet to the main body of the lake) goes directly to the adjacent outlet, bypassing the main lake. Griffiths Muecke, 1998 assumed a virtual 100% bypass in modeling the routing of water from Russell to Morris lakes, but there appears to be no documented evidence of this.

The best data set found for studying this issue was Dr. Donald Gordon's data from June - August 1993 (reported in Griffiths Muecke, 1994) on the water chemistry of Russell Lake, its inlets and the outlet. From these data five variables were chosen that were at substantially higher concentrations in the North Pond than in the main body of the lake. The variables were selected because of the likely precision in the methods of their analyses. It was reasoned that if a bypass existed then these variables should be higher at the outlet than in the middle of the main lake. The three stations in the main lake were not significantly different for any of these variables. Three of the variables (Na^+, Cl^- and turbidity) showed no significant difference (paired data 't' tests) between the mid lake station and the outlet. For the other two, pH was significantly lower at the outlet and colour was significantly higher. There is, thus, no evidence of an operating bypass in the summer of 1993. It is tentatively concluded that this is not a quantitatively significant phenomenon.

Further resolution of this issue has not been assigned a high priority because at the present time it seems obvious that summer trophic conditions in Russell Lake are largely controlled by the quantity of TP entering the lake from the south. The 2005-06 water chemistry data indicate that in April the water quality in the lake was controlled by the quality of the (much larger) drainage from the north, but that this changed as the seasons progressed.

A series of seasonal samples from water flowing into the main lake from the north wetland (under the boardwalk, after the mixing of NW and NE drainages), at mid lake and at the outlet would probably resolve the issue. A bypass feature would be most significant when the water entering from the north is less dense (warmer or less saline) than the surface water of the main lake and there is a wind from the south or southwest.

8.0 THE EXCESS PHOSPHORUS ISSUE

Previous investigators have noted high levels of total phosphorus entering the lake from the southwest inlet. Over the years various sources have been proposed, including an industrial chemical leaching in from Imperial Oil lands, continuing contamination from a large pig farm that ceased operations about 1980 and sewage input from a trailer park. It has also been noted (Griffiths Muecke, 1994) that the trophic status of the lake appears to be declining, with fewer algal blooms in evidence in recent years. The April levels of total phosphorus in the lake appear to reflect the trophic decline with total phosphorus concentrations for April 1980, April 1991 and April 2005 of 22, 11 and <5 mg/M^3 respectively (Gordon *et al.*, 1981; Keiser *et al.*, 1993; and the current study).

It should be noted that the apparent lowering of the trophic status of Russell Lake in recent years has two possible causes. One possibility is a reduction in TP input. The other is increased silt loading (which has been noted) from construction activity in the drainage area. Excess silt would bury the high phosphorus sediments on the bottom of the lake, and the reduction in internal phosphorus loading would lower the trophic status. If this is the case, then the situation will reverse itself as the silt load declines.

TP concentrations entering the lake via the southwest inlet in 2005-06 were consistently much higher than those in the lake or in any other inlet. Identifying the source of the phosphorus in the drainage of the SW inlet was considered a priority. The 2005 data show TP concentrations of about 44 mg/M^3 in April, June and August, about 90% of which was in orthophosphate form (in other inlets only about 10% was orthophosphate). Total nitrogen (TN) of about 400 mg/M^3, giving a N/P ratio of about 9/1, which is quite normal. The ratio in biological organisms is usually 7/1 by weight and ratios from there up to 30/1 are common in aquatic environments because inorganic nitrogen is much more mobile than phosphorus. However, when the TP concentration at the SW inlet went up to 88 mg/M^3 (still 90% orthophosphate) in November of 2005, the TN did not go up at all, bringing the N/P ratio down to about 4/1. Biological processes do not produce 4/1 ratios. Even pig manure, which is high in phosphorus, would not do that. The data suggest a source of inorganic phosphorus somewhere in the drainage.

In an effort to resolve this issue, two water samples were collected from the ditch on the trailer park side of the Circumferential Highway culvert on 11 October 2005 and analyzed for faecal coliform bacteria and total phosphorus.[i] The faecal coliform counts were high (>200.5) in both samples, suggesting the presence of sewage. Total phosphorus concentrations were also extremely high at 243 and 257 mg/M^3.

It was then decided to do soil (actually peat) analyses from the wetland, below the Circumferential Highway (111) culvert. This wetland is part of the headwaters of the SW inlet. It consists of a small treeless cattail swamp and, downstream of that, a larger forested bog. On 8 February 2006 one peat sample was taken from the cattail swamp, six samples from the downstream bog and a control sample from forested wetland in the completely undeveloped drainage of the SE inlet. The results showed 11 g/kg (dry wt.) of total phosphorus (1.1% phosphorus) in the cattail swamp, an average of 2.3 g/kg in the six samples from the wooded wetland downstream of the swamp and 1.3 g/kg in the control sample.

The peat in the cattail swamp contains 8.5 times more TP than the control sample, and the six peat samples from the wooded downstream wetland contain about double the TP content of the control sample. The phosphorus in the swamp is 86% inorganic, and is probably orthophosphate adsorbed onto metals in the peat. The peat is particularly high in calcium, aluminium and iron, all of which bind readily with orthophosphate. The N/P ratio in the swamp is 3/1, in the wooded wetland it is 9/1 and in the control it is 14/1. If the original source is sewage (as seems likely from the high calcium in the peat and high faecal coliform in the water at the other end of the culvert), then considerable nitrogen loss has taken place in the swamp. Denitrification is to be expected since swamps generally have low oxygen levels. A period of low oxygen in the swamp followed by heavy rain would flush out large amounts of orthophosphate.

The cattail swamp is almost certainly the penultimate source of the excess phosphorus that has been plaguing Russell Lake. The swamp is upstream from the pig farm site and immediately downstream from the highway culvert that drains the trailer park. It would appear that raw sewage is somehow entering from the trailer park (perhaps from the sewer overflow pipe) and is being broken down biologically in the swamp. The wetland is providing primary through tertiary treatment since high levels of faecal coliform bacteria have not been found at the mouth of the inlet and most of this TP enters the lake in the inorganic orthophosphate form. The high TP concentration gradient between the cattail swamp and the downstream bog suggests that sewage input is still occurring.

9.0 ESTIMATING PRE-DEVELOPMENT TP

There are three nearby lakes (Topsail, Lamont and Major) that have similar geological conditions and whose watersheds have been protected from development because these lakes are used to supply drinking water. Of course, the lakes are not strictly "pristine" with regard to total phosphorus because present day rainfall and windblown dust almost certainly contain higher concentrations of phosphorus than they did in pre-settlement days, and the drainage areas do contain some construction of water control and treatment facilities. However, these lakes can be used as reference sites to estimate what

[i] This sampling took place after two days of very heavy rain so the ditch was flowing vigorously. The samples were taken on either side of the sewage overflow pipe, which was not spilling at the time of sampling. A tank truck was busy pumping out the adjacent sewage collection tank and workers volunteered the information that this had to be done after every heavy rain.

the concentration of total phosphorus could have been, with undeveloped drainage areas, for those Dartmouth lakes whose drainage areas are currently urbanized.

The Dartmouth drinking water supply lakes Topsail and Lamont are on Meguma Group bedrock that is covered with a layer of Lawrencetown and Halifax tills. Lamont and Topsail also have adjacent drumlins with Wolfville soils. Lake Major is also on Meguma quartzite, and has primarily Halifax (quartzite) till. The earliest known determinations of total phosphorus in these lakes was in 1980 (Gordon *et al.*, 1981). A second survey done in 1991 (Keizer *et al.*, 1993) is suspect because the authors felt that there was a problem with the analyses for total phosphorus.

Using just the 1980 survey data for the Dartmouth water supply lakes Topsail, Major and Lamont, there are seven analyses from the three lakes, and the overall mean and standard error are 7.4 ± 2.5 mg/M^3.[ii] It is suggested that 7 mg/M^3 be used as the pre-development reference level for mean total phosphorus concentration in Russell Lake.

10.0 THE YEAR IN RUSSELL LAKE

Russell Lake was sampled in the northern portion over the deepest part of the lake. A data series was collected in 1993 (Griffiths Muecke, 1994) in which, from June to September, five water samples were analyzed from each of three stations down the length of the lake. It showed that all three lake stations, including one at the north end over the deepest part, were chemically almost identical. So, the 2005-06 data series for this station are considered to be representative of the entire main body of the lake. There were also sampling sites at all inlets and at the outlet. Not all sites were sampled each time.

For the inlet with the largest drainage (NW inlet at culvert) the data series (n=4) showed little variation with a mean and standard error of 29 ±3 mg/M^3. For the Russell Lake station and the SW inlet, however, that was definitely not the case (see Table 10.1). On 22 April the main lake station actually had a TP concentration of <5 mg/M^3 (the detection limit), but at the same time the concentration at the nearby outlet was 7. It was clear that if the actual concentration at the lake station was less than 5 it could not be very much less, so 4 was assumed. The concentration apparently remained low for the early part of the summer, from which we can conclude that there was no spring release of large amounts of excess TP from the contaminated wetland behind the west drumlin even though the rainfall in May was very high[iii]. However, by the end of August lake stratification had set in, the hypolimnion had become anoxic and internal loading had produced high TP concentrations in the deeper water. The value of 16.4 mg/M^3 in the table for August is a mean whole lake concentration arrived at by calculating the TP contained within each subsurface layer of the lake and combining them. Later that fall, the SW inlet whose TP concentration had hitherto been in the 40's (substantially higher than at any other inlet) increased to near 90 mg/M^3 as it released mainly inorganic phosphate. This was probably prompted by the exceptionally high rate of precipitation in October which flushed out phosphorus that had been released by summer anoxic conditions in the contaminated wetland. As a result of this and the internal loading, the TP concentration in Russell Lake in November had climbed to 25 mg/M^3 and an algal bloom ensued.

[ii] There are three other local drinking water supply lakes (First Chain, Second Chain and Long) on the west side of Halifax. These lakes have had similar watershed protection but are on very different geology – granite bedrock with thin granite derived till and virtually no soil. There are five analyses available from 1980 and the mean and standard error are 3.2 ±0.4 mg/M^3 of TP. The three Halifax drinking water lakes have a naturally lower total phosphorus concentration than the Dartmouth lakes because of the geochemical differences in the watersheds.

[iii] This probably reflects a lack of anoxic conditions in the wetland during winter and spring.

TABLE 10.1 TP Concentrations (mg/M^3) for Russell Lake and the Southwest Inlet in 2005-06

Sample Date	Main Lake	SW Inlet
22 Apr 05	4	42
29 Jun 05	7	46
29 Aug 05	16.4	43
21 Nov 05	25	88
09 Mar 06	15	31
14 Mar 06		39
MEAN	**13.5**	**48.2**

By March the TP concentration in the SW inlet was back down to normal (for it) but the late winter concentration of TP in the main lake was still high and may result in a spring bloom and other eutrophic phenomena in Russell Lake in 2006.

11.0 RESULTS OF RUSSELL LAKE WATERSHED MODELING

The modeling approach is as described for "export coefficient modeling" in Environment Canada, 2004. Total phosphorus export coefficients (except for undeveloped drainage) have been calculated using local data (n=4 except 6 for the SW inlet) for three types of sub-drainage to Russell Lake, and then rounded to the nearest 5 mg. The coefficients estimated in this manner are presented in Table 11.1.

TABLE 11.1 Estimates of Total Phosphorus Export Coefficients for the Russell Lake Drainage Area

Drainage	Export Coefficient (mg/M^2/y)
Undeveloped Drainage	10
Southwest Inlet (TP Source)	45
Northwest Inlet (Culvert)	30
Residential Area (Russell L East)	25

The procedure was to take the mean concentration and multiply by the total precipitation and the runoff coefficient: thus for the northwest inlet (culvert at the intersection of Baker and Norman Newman drives) the mean TP concentration was 28.8 mg/M^3. This was multiplied by 1.46 M of precipitation and by 0.67 (the runoff coefficient) to get 28.1 mg/M^2/y which was then rounded up to 30 mg/M^2/y. The northeast sub-drainage has urban development similar to the northwest, so the same export coefficient was used for both.

The export coefficient for undeveloped drainage could not be derived this way. To get an estimate of this coefficient it was necessary to first build a model of the watershed of Russell Lake. It was then assumed that the hypothetical pre-development Russell Lake would have an entirely forested drainage area like the Dartmouth drinking water lakes do now, and, like them, would have a mean TP concentration of about 7 mg/M^3. The model was then run 'backwards' to see what value of export coefficient for undeveloped drainage would give that concentration of TP in the modeled lake. The value was 9.9 mg/M^2/y, so the TP export coefficient for undeveloped drainage was set at 10 mg/M^2/y.

The physical geographic parameters required for watershed modeling are listed in Table 11.2 for Russell and Penhorn Lakes. Because the outlet of Penhorn Lake feeds into an underground storm sewer that is part of the northwest drainage of Russell Lake, it was necessary to model the Penhorn watershed too so as to allow for Penhorn Lake's phosphorus retention. Other model parameters specific to the period 15 March 2005 - 14 March 2006 are given in Table 11.3.

TABLE 11.2 Physical Parameters for Watershed Modeling of Russell and Penhorn Lakes

	Russell Lake	Penhorn Lake
Lake Area	343,000 M^2	45,000M^2
Lake Volume	1,063,300 M^3	130,000 M^3
Mean Depth	3.1 M	2.9 M
Runoff Coefficient	0.67	0.6
Total Watershed Area	3,484,000 M^2	199,000 M^2
Total Drainage Area	3,096,000 M^2	154,000 M^2
NW Sub-drainage	1,042,000 M^2	
NE Sub-drainage	490,000 M^2	
Russell West Side (Drumlin)	449,000 M^2	
Russell East Side (Drumlin)	202,000 M^2	
SW Inlet (TP Source)	160,000 M^2	
SE Inlet (Intermittent)	160,000 M^2	

TABLE 11.3 Other Modeling Parameters for the Period 15 March 2005 – 14 March 2006

Precipitation at Shearwater Airport	1.46 M
Mean (whole lake) TP conc. in Russell Lake	13.5 mg/M^3
Mean ratio of TP at outlet to TP in main lake	1.25

Outputs from the model, based on various scenarios are provided in Tables 11.4 to 11.8. The watershed model output depicted in Table 11.4 is for the period prior to construction of the Russell Lake West residential development on the drumlin slope on the west side of the lake. The Russell Lake West drainage coefficient is set to undeveloped drainage (10 mg/M^2/y, from Table 11.1). This estimates total phosphorus loading from the lake's drainage area of 87.1 kg/y and predicts a mean whole lake TP concentration of 13.0 mg/M^3, which is gratifyingly close to the observed mean of 13.5 mg/M^3 for the 2005-06 data series at the Russell Lake station.

It was considered instructive to run the same configuration of the model but with the Russell Lake West drainage area (the lake side of the west drumlin) set to the coefficient for residential drainage (25 mg/M^2/y, from Table 11.1). The output (Table 11.5) estimates the post-construction total phosphorus loading from the drainage area at 93.8 kg/y and predicts a mean whole lake TP concentration of 13.9 mg/M^3. This is an increase of about 7 kg in TP loading as a result of the land use change in the west side drainage area, and an increase of about 1 mg/M^3 for the mean TP concentration in the lake. Note that 13.9 mg/M^3 is not a prediction of what will happen to the TP concentration in Russell Lake in the future, but rather what would have happened in 2005-06 if the residential development on the west side of Russell Lake were already built and of the same age as the residential development on the east side of the lake. In actual fact this is a rather conservative estimate of that, because the slope on the west side is not as steep as that on the east side from which the residential TP export coefficient was derived. There is also the fact that present plans call for equipping the storm sewers on the west side with CDS units (for particulate removal) at the outfalls. However, at this stage, the level of TP retention by a CDS unit is uncertain.

Another portion of the Russell Lake West Development will lie in the SW inlet's drainage area, a more complicated sub-drainage area to model. Even without the apparent sewage input, the SW inlet drains the storm runoff from the trailer park and part of the immediately adjacent residential area (the total area involved is about 9.5 ha). A more complex pre-construction version of the watershed model was run with the SW inlet drainage separated out into three categories: undeveloped, residential, and TP loading from the excess TP source. The output has been constrained to match up with the baseline model run (Table 11.4). The model output results are depicted in Table 11.6. The run yields an estimate of 25 kg/y of excess phosphorus released from the contaminated wetland of the SW inlet in 2005-06. That much phosphorus represents the quantity of TP stored in about 2 metric tonnes of dry peat at the concentration found near the surface of the cattail swamp.[v]

By running the model in the absence of the 25 kg identified as coming from the contaminated wetland we can arrive at an estimate of what the 2005-06 nutrient conditions in Russell Lake might have been without the excess TP from the west wetland. This run is shown in Table 11.7. The result is a total TP loading of 62 kg/y (down from 87 kg/y) and a predicted mean TP concentration in Russell Lake of 9.6 mg/M^3. The implication of a predicted mean TP concentration of 9.6 mg/M^3 is that without this source of excess TP the lake would probably have been in a consistent high borderline oligotrophic state, pretty much as it appeared to be in the spring and early summer of 2005.

Current plans call for the portion of the development in the SW inlet sub-drainage to contain an urban park and recreational area (where the west wetland currently is) of about eight hectares, and an additional residential portion also of about eight hectares. Table 11.8 shows the model output with these additions to the SW inlet's drainage. The TP export coefficient for the urban park and recreational area was assumed to be close to that for a residential area. The main development area on the west side of Russell Lake is also included in this run of the model, so this run incorporates the entire portion of the Russell Lake West Development that will drain toward Russell Lake. The total phosphorus loading has gone up to 96 kg/y from a pre-development loading of 87 (Table 11.4). The development has increased the phosphorus loading by 9 kg. The predicted final post-construction TP concentration in Russell Lake is 14.3 mg/M^3. So, the anticipated total increase that would have occurred in the TP concentration in Russell Lake under 2005-06 conditions is about 1.5 mg/M^3.

Given the wide variation that was observed in the TP concentrations in Russell Lake during 2005-06, it is unlikely that an increase of 1.5 mg/M^3 could be noticed. Nevertheless, the Russell West development can be mitigated by reducing or stopping the input of excess phosphorus from the contaminated wetland in the SW drainage. Even if the sewage is stopped, however, there appears to be a backlog of phosphorus stored in the peat. It might be necessary to remove or seal off the peat in the present cattail swamp portion of the wetland. When the final version of the model (Table 11.8) was run with the annual phosphorus contribution from the wetland peat reduced by 10 kg/y (which should be an easily achievable goal) the estimated mean TP concentration in Russell Lake becomes 12.9 mg/M^3, virtually the same as for the pre-construction model run in Table 11.4. Completely eliminating the excess phosphorus input reduces the total phosphorus loading to 71 kg/y and yields a post-construction estimate of 10.9 mg/M^3 for TP concentration in the lake.

[v] The total quantity of peat in the swamp has not yet been determined, neither is it known to what depth the peat is contaminated.

TABLE 11.4 The Russell Lake Watershed Model Baseline Simulation of Pre-Construction TP Inputs and Estimated Mean Lake TP Concentration for the Time Period 15 March 2005 – 14 March 2006

		TP Coef. (mg/M²/y)	TP Loading (kg/y)
NW drainage area(Culvert):			
Export from Penhorn Lake	154,000 M²		1.94
Other urban drainage	888,000 M²	30	26.64
Total NW	1,042,000 M²		
NE drainage area (urban):	490,000 M²	30	14.70
Russell E drainage area:			
Residential	122,000 M²	25	3.05
Forest & wetland	80,000 M²	10	0.80
Total East side	202,000 M²		
Russell W drainage area:			
Scrub, forest & wetland	449,000 M²	10	4.49
SE inlet:			
Forest & wetland	160,000 M²	10	1.60
SW inlet:			
Forest, wetland & TP source	753,000 M²	45	33.89
Total Drainage Area	3,096,000 M²		
Total Watershed Area	3,484,000 M²		
TP in precipitation	25 mg/M²/y	**Total TP Loading**	**87.11**
Model Estimates for Russell Lake			
Precipitation TP	8,575,000 mg P/y		
TP from Drainage	87,107,511 mg P/y		
Total TP input	95,682,511 mg P/y		
Lake discharge	3,408,049 M³/y		
Areal loading rate	9.9 m/y		
Flushing rate	3.2 times per year		
TP retention coefficient	0.42		
Estimated Mean TP conc.	**13.0 mg/M³**		
Observed mean TP 2005-06	13.5 mg/M³		

TABLE 11.5 Russell Lake Watershed Model Output for Post-construction of a Residential Development on the West Side (Drumlin Slope) of the Lake.

		TP Coef. (mg/M²/y)	TP Loading (kg/y)
NW drainage area(Culvert):			
Export from Penhorn Lake	154,000 M²		1.94
Other urban drainage	888,000 M²	30	26.64
Total NW	1,042,000 M²		
NE drainage area (urban):	490,000 M²	30	14.70
Russell E drainage area:			
Residential	122,000 M²	25	3.05
Forest & wetland	80,000 M²	10	0.80
Total East side	202,000 M²		
Russell W drainage area:			
Residential	449,000 M²	25	11.23
SE inlet:			
Forest & wetland	160,000 M²	10	1.60
SW inlet:			
Forest, wetland & TP source	753,000 M²	45	33.89
Total Drainage Area	3,096,000 M²		
Total Watershed Area	3,484,000 M²		
TP in precipitation	25 mg/M²/y	**Total TP Loading**	**93.84**
Model Estimates for Russell Lake			
Precipitation TP	8,575,000 mg P/y		
TP from Drainage	93,842,511 mg P/y		
Total TP input	102,417,511 mg P/y		
Lake discharge	3,408,049 M3/y		
Areal loading rate	9.9 m/y		
Flushing rate	3.2 times per year		
TP retention coefficient	0.42		
Estimated Mean TP conc.	**13.9 mg/M³**		

Notes:
The only input change from Table 11.4 is the substitution of the 'residential' land use TP export coefficient instead of that for 'undeveloped' for the Russell West Drainage Area.

TABLE 11.6 Another Pre-construction Model Run with a More Elaborate Breakdown of the SW Inlet Drainage that Yields an Estimate of 25 kg/y of Phosphorus Flushed into Russell Lake from the Excess TP Source (Sewage Contaminated Wetland) During 2005-06

		TP Coef. (mg/M²/y)	TP Loading (kg/y)
NW drainage area(Culvert):			
Export from Penhorn Lake	154,000 M²		1.94
Other urban drainage	888,000 M²	30	26.64
Total NW	1,042,000 M²		
NE drainage area (urban):	490,000 M²	30	14.70
Russell E drainage area:			
Residential	122,000 M²	25	3.05
Forest & wetland	80,000 M²	10	0.80
Total East side	202,000 M²		
Russell W drainage area			
Scrub, forest & wetland	449,000 M²	10	4.49
SE inlet:			
Forest & wetland	160,000 M²	10	1.60
SW inlet:			
Forest & wetland	**658000 M²**	**10**	**6.58**
Residential	**95,000 M²**	**25**	**2.38**
Excess TP source			**24.93**
Total SW	**753,000 M²**		**33.89**
Total Drainage Area	3,096,000 M²		
Total Watershed Area	3,484,000 M²		
TP in precipitation	25 mg/M²/y	**Total TP Loading**	**87.11**
Model Estimates for Russell Lake			
Precipitation TP	8,575,000 mg P/y		
TP from Drainage	87,107,511 mg P/y		
Total TP input	95,682,511 mg P/y		
Lake discharge	3,408,049 M³/y		
Areal loading rate	9.9 m/y		
Flushing rate	3.2 times per year		
TP retention coefficient	0.42		
Estimated Mean TP conc.	**13.0 mg/M³**		

TABLE 11.7 Pre-Construction Run Similar to that in Table 11.6 but with the Phosphorus Loading from the Excess TP Source (Sewage Contamination in the West Wetland) Set to Zero

		TP Coef. (mg/M²/y)	TP Loading (kg/y)
NW drainage area(Culvert):			
Export from Penhorn Lake	154,000 M²		1.94
Other urban drainage	888,000 M²	30	26.64
Total NW	1,042,000 M²		
NE drainage area (urban):	490,000 M²	30	14.70
Russell E drainage area:			
Residential	122,000 M²	25	3.05
Forest & wetland	80,000 M²	10	0.80
Total East side	202,000 M²		
Russell W drainage area			
Scrub, forest & wetland	449,000 M²	10	4.49
SE inlet:			
Forest & wetland	160,000 M²	10	1.60
SW inlet:			
Forest & wetland	**658000 M²**	**10**	**6.58**
Residential	**95,000 M²**	**25**	**2.38**
Excess TP source			**0**
Total SW	**753,000 M²**		**8.96**
Total Drainage Area	3,096,000 M²		
Total Watershed Area	3,484,000 M²		
TP in precipitation	25 mg/M²/y	**Total TP Loading**	**62.18**
Model Estimates for Russell Lake			
Precipitation TP	8,575,000 mg P/y		
TP from Drainage	62,177,511 mg P/y		
Total TP input	70,752,511 mg P/y		
Lake discharge	3,408,049 M³/y		
Areal loading rate	9.9 m/y		
Flushing rate	3.2 times per year		
TP retention coefficient	0.42		
Estimated Mean TP conc.	**9.6 mg/M³**		

TABLE 11.8 Output of the Complete Post-construction Mode Incorporating Both the Residential Development on the West Side of Russell Lake, and the Additional Residential and Urban Park Areas in the Sub-drainage of the SW Inlet

		TP Coef. (mg/M²/y)	TP Loading (kg/y)
NW drainage area(Culvert):			
Export from Penhorn Lake	154,000 M²		1.94
Other urban drainage	888,000 M²	30	26.64
Total NW	1,042,000 M²		
NE drainage area (urban):	490,000 M²	30	14.70
Russell E drainage area:			
Residential	122,000 M²	25	3.05
Forest & wetland	80,000 M²	10	0.80
Total East side	202,000 M²		
Russell W drainage area:			
Residential	**449,000 M²**	**25**	**11.23**
SE inlet:			
Forest & wetland	160,000 M²	10	1.60
SW inlet:			
Forest & wetland	498000 M²	10	4.98
Residential	**175,000 M²**	**25**	**4.38**
Urban Park	**80,000 M²**	**25**	**2.00**
Excess TP source			24.93
Total SW	753,000 M²		36.29
Total Drainage Area	3,096,000 M²		
Total Watershed Area	3,484,000 M²		
TP in precipitation	25 mg/M²/y	**Total TP Loading**	**96.24**
Model Estimates for Russell Lake			
Precipitation TP	8,575,000 mg P/y		
TP from Drainage	96,242,511 mg P/y		
Total TP input	104,817,511 mg P/y		
Lake discharge	3,408,049 M³/y		
Areal loading rate	9.9 m/y		
Flushing rate	3.2 times per year		
TP retention coefficient	0.42		
Estimated Mean TP conc.	**14.3 mg/M³**		

12.0 CONCLUSIONS

1) In recent years Russell Lake has been undergoing a rapid reduction in trophic status, but whether from a reduction in total phosphorus input or from reduced internal loading as a result of siltation is undetermined, though anecdotal evidence favours the latter.
2) During the study period in 2005-06 the lake passed through periods of apparent oligotrophy, then mesotrophy and eutrophy; and then by the end of winter it appeared to be back in a mesotrophic state.
3) In the 2005-06 study period, about 25 kg of excess phosphorus leached out of the contaminated west wetland area below the Circumferential Highway culvert.
4) The excess TP in the west wetland appears to be the result of sewage discharge from the trailer park on the other side of the Circumferential Highway.
5) The Russell West development is expected to increase the total phosphorus concentration in the lake by about 1.5 mg/M^3.
6) This anticipated increase in TP can be mitigated by reducing or eliminating the TP input from the trailer park and contaminated wetland.
7) It is not feasible to restore Russell Lake to its presumed pre-development oligotrophic condition because of the extensive land use changes in the drainage area.
8) Russell Lake can be restored to a stable mesotrophic state and maintained in that state for the foreseeable future. This would require the elimination of the excess TP contamination presently entering from the west wetland.
9) A likely scenario for Russell Lake is that siltation has buried the previous accumulation of high phosphorus sediments on the bottom of the lake. However, if nothing is done to control the excess phosphorus, the continued influx of high TP from the contaminated west wetland will build up a new layer of high phosphorus sediment. As more and more high phosphorus sediment accumulates, the internal loading will drive the trophic status higher and higher until a stable eutrophic state is achieved.

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Attachment 6

Russell Lake Residents Association

644 Portland Street
Unit 3 – 231
Dartmouth, Nova Scotia
B2W 6A3

TO: Chair and Members, Dartmouth Lakes Advisory Board

DATE: May 31, 2006

SUBJECT: **ITEM 5.1 and 5.2 - Russell Lake Phosphorus Threshold**

- We have reviewed the proponent's report (Item 5.1 – Russell Lake Modeling) on the May 31st agenda and will express our concerns. This is not an independent report, but one paid for by the proponent.

- We are also concerned that HRM Planning (Item 5.2) may be suggesting that you "approve" not an extensively researched CCME phosphorus threshold level, but instead a "reasonable" threshold level to allow development to proceed without incorporating phosphorus reduction strategies necessary to preserve this lake. We hope that you will insist that national guidelines designed to preserve Canada's freshwater lakes be followed to set this threshold level.

- Both above items concern the establishment of a phosphorus threshold level for Russell Lake.

- The Canadian Council of Ministers of the Environment (CCME) has created a well researched phosphorus framework to preserve freshwater lakes. These national guidelines were developed after extensive consultation and review of the scientific literature. The Nova Scotia Environment Department, as a member of the CCME, supports this framework. HRM mentions adherence to CCME guidelines in the draft Regional Plan. The CCME felt that basing criteria on the best scientific data would minimize any conflict surrounding desirable phosphorus levels.

- The CCME framework clearly describes how to set a phosphorus threshold level for a lake such as this. There is no potential for conflict of interest with national guidelines as the only goal is preservation of our freshwater resources through sound management decisions.

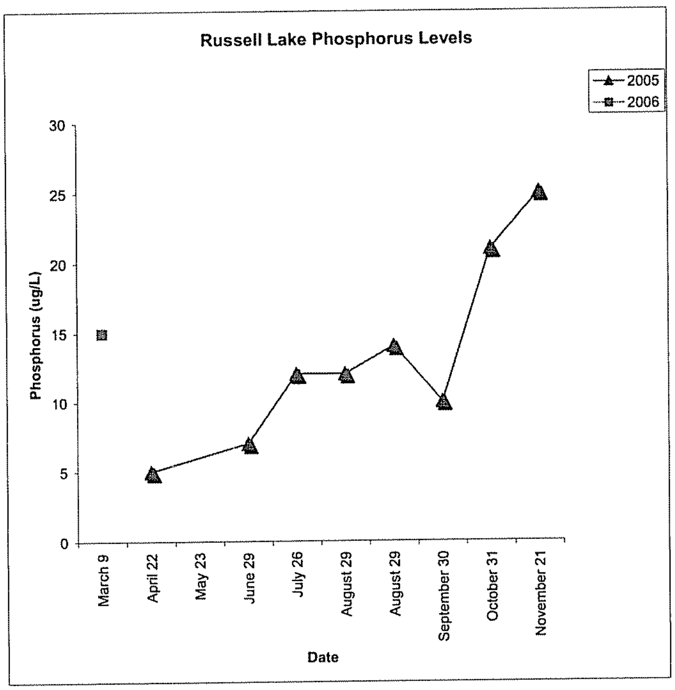
- Russell Lake is a valuable community resource. It has recovered, over the years, from eutrophic conditions with frequent algae blooms to relatively clear waters used for canoeing and swimming. This improvement was facilitated by closure of agricultural activities in the area and the fact that the majority of the shoreline of this small lake remained, until recently, undisturbed and undeveloped.

- Our association is not opposed to development, but simply wishes to ensure that development proceeds in an environmentally sustainable manner so that this community resource is preserved. Our association is also involved in a volunteer lake monitoring program. Volunteers obtain monthly water samples (total phosphorus, chlorophyll a, and fecal coliforms) and assess water clarity (Secchi depth) on a weekly basis.

- We firmly believe that a phosphorus threshold level should be set according to the CCME guidance framework. The process is very simple. Based on modeling and similar undisturbed lakes, the reference phosphorus condition falls within the oligotrophic category (4-10 µg/L). The proponent's consultant agrees with this reference range (page 8, third paragraph down). This gives a CCME phosphorus threshold level of 10 µg/L. This value should be adopted unless DLAB chair and members have scientific evidence identifying a problem in the CCME method of defining a threshold level.

- The Morris-Russell Lake Area SPS requires a threshold level to be set, before development begins, and if it is exceeded, current watershed controls and development potential are to be reassessed. The setting of this level has been delayed for almost a year while development proceeds and an additional extensive proponent's report has been submitted to justify a higher, more "reasonable" level. In addition, there is not a defined protocol that initiates if the level is exceeded.

- If the threshold is exceeded, it does not mean that development can not proceed, but simply means that more stringent phosphorus reduction strategies must be incorporated.
    - Perhaps CDS units are not adequate and detention basins or wetlands should be utilized as well for storm water outlet phosphorus reduction.
    - The use of in-lake booms to contain sediment should not be used routinely, but reserved for emergencies – sediment/phosphorus contained by these booms eventually enters the lake.
    - Drainage water pumped from the construction site should not be directed to the marsh area that eventually drains into the lake at the south end.
    - Sewage overflow entering the south end needs to be addressed.
- Most importantly, a threshold level of 10 µg/L is achievable for this lake as until recently the average value and spring levels were within the oligotrophic range (4-10 µg/L).
- We have included a summary table of the complete phosphorus data (2005 and 2006), collected at the appropriate deep lake station, both by the proponent and our association.



One can see the trend for increased values towards the fall, but the October and November values are abnormally high. We feel this reflects recent phosphorus loading due to watershed development activity that started in late summer and not simply "normal" seasonal variation.

As an example, in early October, the combination of heavy rain and interchange construction activity caused significant sediment and phosphorus to enter the south end of the lake. This colored the lake brown for almost two weeks, and reduced water visibility (Secchi depth) from 8 ½ feet to 2 ½ feet.

Dr Blouin has also indicated that his department is concerned that drainage (high in phosphorus) near the lake is being pumped over the hill and into a bog area which eventually drains back into the south end of the lake. Sediment also entered the lake at the north end of the lake, but was contained initially by in-lake booms.

We are very concerned that the spring 2006 phosphorus level is three times higher than it was last year.

- The proponent's report (item 5.1) did not mention these events which may have caused increased phosphorus loading. Instead they elected to incorporate the high phosphorus readings into the average "pre-development" phosphorus value. We feel this in incorrect. The October and November readings should be discarded as they reflect the impact of current development on the lake.
- The above graph demonstrates that the lake is already being affected by current development and increased phosphorus loading. Residents have also noticed corresponding changes in water quality.
    - Last fall residents noticed an algae bloom in the lake which hadn't occurred for years
    - This spring the lake appears murkier than last year.

- For these reasons, we hope that you will question Dr Blouin and HRM staff:
  - Why CCME guidelines (mentioned in the draft regional plan) are not being followed?
  - Has Dr Blouin identified a scientific problem with the CCME method of defining a threshold level and preserving a lake through phosphorus management?
  - Why the spring 2005 and 2006 values are so different if not due to recent watershed activity?
  - Why the impact of excessive phosphorus loading related to the interchange runoff and pumping of drainage water is not mentioned, and incorporated, into the proponent's report (Item 5.1)?
  - What has HRM done to date to stop sewage overflow from entering the south end of this lake?
- We feel that this lake has already been affected given the algae bloom last fall and current water conditions. Further deterioration can be prevented, but action must be initiated now by the DLAB and community council.
- **The phosphorus threshold level should be set according to CCME guidelines at 10 μg/L.**
- If DLAB elects to ignore national guidelines designed to preserve freshwater lakes, and approves a more "reasonable level" it is very likely that the lake will continue to deteriorate. When phosphorus values eventually reach the higher level, development and storm-water treatment infrastructure will probably be complete. It could then be financially impossible to correct the situation and Dartmouth will have lost a valuable community resource as a direct result of your decision tonight.
- The citizens of Dartmouth have entrusted the chair and all members of DLAB to speak on their behalf and to safeguard our lakes for future generations. Our association implores DLAB to live up to that trust.

Sincerely,

ORIGINAL SIGNED BY

Ben Jenkins
Russell Lake Residents Association

Russell Lake Residents Association
644 Portland Street
Unit 3 – 231
Dartmouth, Nova Scotia
B2W 6A3

TO: Chair and Members, Dartmouth Lakes Advisory Board

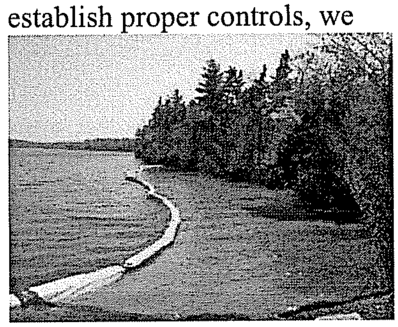
DATE: June 23, 2006

SUBJECT: **Russell Lake Phosphorus Threshold – JUNE 28, 2006 MEETING**

We enjoyed sitting through the meeting of the DLAB on May 31st. It was heartening to hear detailed and relevant questions from board members especially given the fact that the reports were distributed to members at the last minute. We apologize for the timing of our submission, but we also just learned on May 29th that the Russell Lake phosphorus level was an agenda item on the May 31st meeting.

Thank you, in advance, for your consideration of our concerns in regards to the setting of a phosphorus threshold level for Russell Lake. We were pleased to hear that the chair agreed that it was not the role of your board to "set" a phosphorus level, but merely to "advise" community council. That is very appropriate given the terms of reference for the board and the fact that the setting of this level is critical to the preservation of this lake. We feel very strongly that when specific Canadian scientific guidelines exist, and in fact are referred to in the draft Regional Plan, they should be followed. Upon reviewing the reports included on the May 31st meeting agenda, we were concerned that a "Staff Report" rather than a "Memo" had been submitted by HRM staff, and that the board was being requested to "approve a level" not consistent with Canadian phosphorus guidelines. We would have liked to have had the opportunity to ask questions during the proponent's presentation but realize it was not possible given the forum. I will not repeat the concerns outlined in our previous submission, but wish to clarify a few points raised by the proponent at the May 31st DLAB meeting.

We agree that the proponent is very good at what they do, but we believe that more could be done to protect the lake both during the development stage and subsequently. The current threats to this lake are construction sediment and phosphorus entering the lake along the shoreline and at the south inlet. Once development is complete, the threat will be additional phosphorus entering the lake through the three additional storm water outlets and erosion along the shoreline if the buffer zone is not preserved. The question, from one of your members, on monitoring in Morris Lake is very valid given the water flow from Russell Lake into Morris Lake. Whatever happens in Russell Lake is going to impact Morris Lake. If we fail to establish proper controls, we could lose both of these community freshwater resources.



Although attempts are made at minimizing exposed land during construction, significant sediment and phosphorus continues to enter the lake as evident by the brown murky water contained by the in-lake booms after each heavy rain fall. This is preventable and inappropriate given the fragile nature of this lake. These booms should be for emergencies only as the sediment is not removed and eventually disperses throughout the lake.

The chronic elevated phosphorus levels in the south feeder stream are likely related to ongoing sewage overflow and past farm activities in the area. This stream flows drains the bog area near the highway which contains a significant amount of phosphorus that has built up over the years. Although the bog works quite well at breaking down raw sewage and filtering storm water, phosphorus is obviously released as a function of water flow. Apparently, runoff from the interchange excavation, before being mitigated, was responsible for the event in October that colored the lake brown for almost two weeks. Dr Blouin has also expressed concern that construction runoff was being pumped up over the hill into this bog area, and was then entering the lake through this south stream. We were therefore surprised to hear the proponent's consultant suggest that the fall 2005 elevated phosphorus levels were not due to construction activity as the phosphorus entering the lake was more consistent with that from the bog area than from recent exposed soil. We are concerned and puzzled by that explanation. Obviously, this bog area is doing it's best to contain and filter construction sediment, but the increased flow through this area is washing out the "old phosphorus", contained in the bog, directly into the lake. Therefore, the fall increase is likely related to increased flow through the bog area due to excavation in the area and new drainage patterns and the "pumping of runoff." This is the most plausible and scientific explanation for the sudden dramatic increases in phosphorus observed in the south stream last fall. It also explains the fall algae bloom and higher lake phosphorus levels documented this spring?

The watershed modeling report, prepared by the proponent's consultant, is very interesting. As mentioned by the consultant himself, the variables utilized in these calculations are very subjective. Slight modification of the baseline phosphorus values, export coefficients or land mass would result in very different conclusions being drawn. We are particularly concerned that the phosphorus "baseline" level used for these calculations was based on measurements taken "during" recent development activity. In particular, as discussed above, significant phosphorus entered the lake through the southern inlet, in the fall of 2005. This was severe enough to color the lake brown for almost two weeks and an algae bloom was seen last fall for the first time in years. Spring 2006 phosphorus values are almost three times higher than pre-development 2005 values. Obviously, the 2005-2006 "average level", based on these measurements, was not normal pre-development, but rather a reflection of recent water quality deterioration. We question why this report was commissioned other than to justify a higher threshold level. It is not required, nor necessary, to set a CCME phosphorus threshold level.

The delay in setting this phosphorus threshold level is bewildering. Our past Provincial Environment Minister was president of the CCME and the HRM draft Regional Plan refers to these guidelines. By utilizing the guidance framework, the phosphorus level can be set based on historical data which is readily available. Mr Mandaville has studied Russell Lake for several years and has made the data readily available on his website and submitted the information directly to community council. The proponent's consultant describes his recommendation for the CCME baseline level in his report. This falls within the same range (oligotrophic) as that suggested by Mr Mandaville. There should be no confusion.

Utilizing this oligotrophic range and the CCME guidance framework, the phosphorus threshold for this lake is 10 ug/L. Unless the DLAB chair and members have identified scientific concerns in the CCME method of setting a threshold level, this level should be utilized as it is based on extensive consultation and review of the scientific literature with the simple objective to preserve Canada's freshwater lakes.

Because of both human and lake health, DLAB should insist that the sewage overflow entering this lake be investigated and corrected <u>immediately</u> by HRM. It is unacceptable.

It is the role of DLAB to provide the best unbiased scientific evidence to community council. Our elected officials may decide to approve a higher threshold level, as suggested by Planning, but that decision must be undertaken with the best available scientific knowledge as it may have significant environmental implications for this community freshwater resource.

The citizens of Dartmouth have entrusted the chair and all members of DLAB to speak on their behalf and to safeguard our lakes for future generations. Our association implores DLAB to live up to that trust.

Sincerely,
ORIGINAL SIGNED BY
Ben Jenkins
Russell Lake Residents Association