The Corporation of the
City of Burlington

REVIEW OF
1986 MONITORING REPORT
HALTON REGIONAL LANDFILL
- BURLINGTON
City of Burlington

May 1987
Ref. No. 1354 - 20

CONESTOGA-ROVERS & ASSOCIATES

CRA
Consulting Engineers

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May 12, 1987

Reference No. 1354-20

Mr. Allan Ramsay
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Corporation of the City of Burlington
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Dear Al:

Re: Review of 1986 Monitoring Report
Burlington Landfill

Conestoga-Rovers & Associates have completed a review of the 1986 Monitoring Report for the Burlington Landfill, prepared by Gartner Lee Ltd. for the Regional Municipality of Halton.

The purpose of this review was to assess the adequacy of the ongoing groundwater monitoring program, and to assess the validity of the conclusions presented in the Gartner Lee Ltd. 1986 Monitoring Report.

Our review indicates that the pattern of groundwater contamination at the site cannot be delineated with confidence. The natural hydrogeologic setting of the site, consisting of a complex flow system in fractured rock and naturally occurring highly mineralized groundwater preclude the delineation of the zone of contaminated groundwater. Because of this difficulty in delineating the extent of contamination and hence, the contaminant mass flux, it is recommended that future monitoring be directed in part to determining the contaminant mass flux entering the groundwater flow system at the site.

Should you have any questions or comments, please contact our office.

Yours very truly,

CONESTOGA-ROVERS & ASSOCIATES

John M. Petrie, M.Sc.

JMP/mm
Encl.

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1.0 INTRODUCTION

As part of an ongoing retainer with the City of Burlington (COB), Conestoga-Rovers & Associates (CRA) were requested on April 16, 1987 to undertake a review of the monitoring program developed and implemented by Gartner Lee Limited (GLL) at the Burlington Landfill for the Regional Municipality of Halton.

This review, undertaken by CRA and presented herein, was directed specifically to assess the adequacy of the groundwater monitoring program and the validity of the conclusions.

2.0 APPROACH

Three reports were reviewed for this undertaking, namely:

GLL 1986a - Burlington Landfill - 1985 Monitoring Report for the Regional Municipality of Halton, March 1986, project 85-61,

GLL 1986b - Burlington Regional Landfill - Plume Delineation Program Report for the Regional Municipality of Halton, December 1986, project 85-61, and

GLL 1987 - Halton Regional Landfill - Burlington 1986 Monitoring Report, March 1987, project 86-53.

Two of the above reports (GLL 1986a, 1986b) had previously been reviewed as part of CRA's assessment of the groundwater quality at the nearby Bayview Landfill. This assessment, prepared by CRA and entitled "Updated 1986 Monitoring Report - Bayview Landfill Site - City of Burlington", March 1987, Reference No. 1354-30, (CRA 1987), is referenced herein as part of this review.

The review focusses primarily on the most recent monitoring report (GLL 1987). The two earlier reports (GLL 1986a, 1986b) are referenced where appropriate. This

review follows the format of the 1986 monitoring report. The section headings follow that of GLL (1987) followed by the appropriate section number in parenthesis.

A groundwater monitoring program is generally undertaken to assess the impact on the groundwater quality of in this case, a landfill site. This is usually accomplished by determining groundwater quality background to the site. Groundwater quality downgradient of the site is then examined in light of the background quality. In addition, a comparison of the leachate quality with that of the downgradient groundwater quality allows for an assessment of the dilution and attenuation capacity of the groundwater flow system. This approach requires that background quality be defined and chemical species diagnostic of the contamination be identified.

This review was undertaken to assess the adequacy of the monitoring program in delineating the contaminant migration from the Burlington Landfill including the parameter list, the suitability of the well locations and also the reporting. A review of the observation well installation and the site engineering works has not been undertaken.

This review indicates that the pattern of contaminant migration cannot be delineated. In addition, a

number of shortcomings in the monitoring program are identified. Specifically these shortcomings are:

- the absence of reliable background water quality,

- the lack of a diagnostic indicator of groundwater contamination,

- the lack of an evaluation of historical data,

- the absence of a review of the history of the monitoring program with respect to changes in the parameter suite analyzed, justification for the wells sampled, and the sampling frequency,

- a discussion regarding the uncertainty attached to the analytical data generated from analysis of saline waters.

These shortcomings indicate that some uncertainty is attached to the conclusions drawn from this report. However, it must be recognized that these short comings are a function of the natural hydrogeologic setting of the site; specifically, fractured shales which contain highly mineralized groundwater.

3.0 REVIEW

3.1 BACKGROUND PHYSIOGRAPHY AND GEOLOGY (4.0)

This section could most usefully provide an overview of the monitoring program from inception to date. For completeness, this overview should address the following:

- the wells sampled including any additions or deletions from the program and the well construction details including date of installation for all wells on the site,

- the parameter list and any changes to that list throughout the duration of the monitoring program, and

- the sampling frequency.

In addition, a summary of the development history of the site would assist in reviewing the monitoring data provided. While it is recognized that the site history is detailed in other reports, the current situation, delineating areas of active and closed landfilling is not presented.

3.2 LEACHATE (5.0)

3.2.1 Leachate Collection (5.1)

The point is raised (p.10) that some infiltration into the landfill may by-pass the leachate collection system and enter the groundwater flow system. This was determined by comparing the assumed volume of infiltration with the volume of leachate removed by pumping from the toe drain. Continued monitoring of the site will allow evaluation of this point. Such an evaluation could be directed toward determining the contaminant mass flux entering the groundwater flow system, as well as evaluating the efficiency of the leachate collection system beneath the northern portion of the site and a comparison of this efficiency with that of the toe drain system at the south end of the site.

It has not been possible to delineate with confidence the extent of groundwater contamination at this site. Thus, it is recommended that the contaminant mass flux entering the groundwater flow system at the site be qualified. This could be done by estimating the moisture content, field capacity, as well as the infiltration and surface water inputs into the site. The contaminant mass loading could then be estimated using the average leachate quality.

The purpose of this monitoring would be to compare the contaminant mass loading to the groundwater flow system with that could be developed from the observation well data. It may then be possible to establish the degree of representativeness of the groundwater monitoring data.

3.2.2 Leachate Chemistry (5.2)

Average leachate chemistry data is provided (GLL 1987 p.12). No mention is made of the source of this leachate, be it from seeps, wells or the toe drain.

Inspection of these data indicate a somewhat dilute leachate quality. It is recommended that leachate quality be determined at observation wells screened within the waste with the view to establishing the representativeness of the leachate quality data obtained at the toe drain. This point is of significance in determining a contaminant mass flux to the groundwater flow system.

3.2.3 Leachate Seepages (5.3)

Four leachate seepages are shown on Figure 2 but only three are discussed in the text. It appears that the seep beside SW15 is not discussed.

Inspection reports of each seepage estimating flow and appearance would provide for useful comparisons with previous seepage inspections.

3.3 GROUNDWATER (6.0)

3.3.1 Groundwater Flow (6.1)

The lack of historical water level data (pre 1985) prevent the reader from assessing historical water level trends. Representative hydrographs covering the period since the site was developed would be most useful in assessing the trend of groundwater fluctuations. Such an assessment could contribute to a better understanding of the complex groundwater flow system at this site.

The groundwater flow direction shown in GLL (1987) is probably representative of site conditions.

3.3.2 Groundwater Quality (6.2)

This discussion on Groundwater Quality is divided into two subsections: one essentially focussing on the water quality in the silt till that underlies the

northern portion of the site, and the second on the groundwater quality in the shales beneath and downgradient of the southern portion of the site.

3.3.2.1 North End of the Landfill (6.2.1)

Chloride is identified as an appropriate leachate indicator at this portion of the site underlain by silt till. Based on the chloride levels detected, GLL (1987) conclude that leachate has not impacted this area of the site. It must be pointed out that a background water quality has not been defined for this portion of the site.

3.3.2.2 South End of the Landfill (6.2.2)

The GLL (1986b) report describes a program involving the use of routine water quality parameters to delineate the leachate plume in the shale bedrock downgradient of the site. This program was unsuccessful due to the "naturally poor water quality in the shale particularly at depth, which masks the presence of attenuated leachate" (p.18, GLL 1987).

An evaluation of this same data by CRA (1987) indicates that organic nitrogen (TKN minus ammonia) is useful

in assisting in the delineation of groundwater contamination at this site. Organic nitrogen was not investigated by GLL (1986b). However, GLL (1987) state that these "saline waters cause analytical interferences which result in elevated levels of some parameters such as COD, TKN and ammonia" (p.18). GLL (1987) conclude that the reliability of such results is an open question.

Thus, for the inorganic constituents analyzed, neither a background concentration nor diagnostic leachate parameters could be reliably defined.

3.4 CONCLUSIONS (1.0)

CRA are in general agreement with the first three conclusions presented by GLL (1987 p1).

The fourth conclusion, namely that the leachate appears to be significantly diluted and attenuated has yet to be completely substantiated. As discussed in Section 3.2.1 of this review, CRA recommend that the contaminant mass loading to the groundwater flow system be determined in order to assess the representativeness of the groundwater monitoring data.

With respect to the fifth conclusion (GLL 1987 p2) CRA recommend that the monitoring program be directed in part to determining the amount of infiltration into the landfill.

3.5 RECOMMENDATIONS (2.0)

CRA is in general agreement with the recommendations provided by GLL (1987) and offer the following comments. Additional recommendations, not addressed by GLL (1987) are put forward by CRA in Section 5.0 of this review.

For the monthly inspections of the leachate seeps, an inspection report should be prepared. This report would tabulate an estimation of flow, the colour and odour of the fluid and a surveyed elevation.

CRA is in agreement with the recommended sampling of HC-15. If not already done so, CRA recommends that this well be developed to ensure that a representative sample of the groundwater is obtained.

In addition to the assessment of the short-term variability of volatile organic and phenol concentrations in groundwater, CRA recommends that the

potential for the naturally saline groundwater to interfere with the analysis of these constituents be evaluated. As indicated by GLL (1987 p18), such interference impacts the reliablity of TKN, ammonia and COD data. This concern should be evaluated for these constituents and also for DOC.

CRA is in agreement with the recommendation to install an additional observation well in the south-east corner of the site. This will provide for a more uniform distribution of observation wells.

It is not clear why observation well GL-17 is not included in the recommended monitoring plan.

parameters indicative of groundwater contamination limit the validity of the interpretation of the available groundwater quality data. This limitation must, however, be assessed in light of the site setting.

The Burlington Landfill is situated on fractured shales of the Queenston Formation and locally beneath the north end of the site, on silt till. The following discussion addresses the significance of the shale bedrock with respect to the monitoring program.

The Queenston Formation consists of fractured shales. In general, the frequency of fracturing decreases with depth. The groundwater flow system as described by Hewetson (1985) is complex and consists of discrete more permeable zones of fractured rock embedded in a low-permeable fractured rock matrix. The active groundwater flow system at this site is restricted to the discrete more permeable discrete fractured zones.

In general, groundwater flow is directed southeastwards, and in the vertical plane, is directed downwards. However, on a large scale the pattern is significantly more complex. Hewetson (1985) demonstrated local complexity in the flow system at, and downgradient of the Bayview Landfill. Such complexities in the flow system lead to significant uncertainties with respect to the

adequacy of observation well placement. It cannot be demonstrated with certainty that any observation well screen, open to a limited vertical interval of the bedrock, lies along a groundwater flow path that originates at the landfill. Thus, the absence of identifiable contamination at a downgradient observation well does not preclude the existence of a plume of groundwater contamination, but rather indicates its absence only at the point of measurement.

Observation wells could be completed with longer well screens in order to monitor a greater vertical interval of the bedrock. However, long screens provide for significant dilution such that a vertically restricted plume intercepting such an observation well may not be easily identified.

Groundwater in the Queenston Shale at the Burlington site is highly mineralized. Chloride concentrations range up to 50,000 mg/L and sulphate to 3,850 mg/L (CRA 1987).

Contaminant species which are commonly used to delineate the extent of groundwater contamination (e.g. chloride and sulphate) are found naturally in the groundwater at concentrations exceeding that commonly found in landfill leachate. For the Burlington Landfill, GLL (1987) reported average leachate chloride levels in the order of 1000 mg/L.

In the leachate toe drain, sulphate values of less than 100 mg/L are reported (GLL 1987). The naturally high levels of a number of inorganic constituents precludes their use as indicators of groundwater contamination. In the same manner, it is not possible to adequately define background water quality at the site. It is not possible to reliably differentiate between background and contaminated groundwater on the basis of the general chemistry constituents monitored.

Recent work undertaken by Barker et al (1984) and Hewetson (1985) shows that low level constituents, organic nitrogen, phenols and DOC can be used to delineate the plume of groundwater contamination at the Bayview Landfill. CRA (1987) indicated that, based on the organic nitrogen data provided by GLL (1986b), contaminated groundwater has migrated downgradient to GL-26 and GL-17 located immediately north of the North Service Road. However, in the most recent monitoring report, GLL (1987) indicate that the naturally mineralized waters "cause analytical interferences which result in elevated levels of some parameters such as COD, TKN and ammonia" (p.18). The reliability of such data is therefore questioned. It is expected that analysis of DOC and phenols may be subject to similar interferences.

The natural occurrence of both DOC and phenols at low levels in the shales beneath the site

precludes the use of these constituents to delineate the maximum extent of groundwater contamination.

Synthetic organic compounds have been identified in the leachate at the Burlington Landfill. However, downgradient of the landfill, synthetic organics were encountered sporadically at trace levels. It is probable that synthetic organic contaminants are attenuated in the groundwater flow system to some degree and do not, therefore, define the maximum distance of contaminant migration.

It is apparent from this discussion that the difficulties encountered with monitoring at this site are a function of the natural hydrogeologic conditions. To summarize, these difficulties are:

- it is not possible to locate with certainty an observation well screened over a limited vertical interval across a flow path originating from the landfill,

- the naturally high levels of inorganic compounds preclude the use of the more common leachate constituents as indicators of groundwater contamination,

- less commonly used indicator parameters, such as TKN and ammonia occur at low levels in groundwater downgradient of

the landfill. While these may be used to delineate groundwater contamination, GLL (1987) state that naturally mineralized groundwater may cause interference in the analyses of these parameters,

- synthetic organic compounds occur at low levels and also are probably being attenuated to some degree and cannot be used with confidence to delineate the maximum extent of groundwater contamination, and

- it follows from the difficulty in identifying indicator parameters that the background water quality is also not easily defined.

In consideration of the above difficulties, the following provides our comments of the monitoring program at the Burlington site.

The low levels of synthetic organic compounds, TKN, ammonia, DOC and phenols indicates that the groundwater in close proximity to the landfill is not impacted by concentrated leachate. The findings of these monitoring reports are consistent with investigations conducted at the Bayview site (Barker 1984 and Hewetson 1985), namely that low to trace level contamination is identified in groundwater downgradient of the site. However, because the difficulties described above, it is not possible to delineate the extent of contaminant plume.

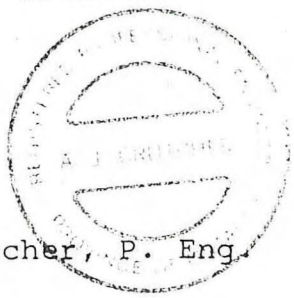
1. The contaminant mass loading to the groundwater should be estimated in order to assess the validity of the monitoring data generated.

2. Consideration should be given to utilizing groundwater quality data generated from the adjacent NSP lands. Alternatively, a new well could be installed in order to establish the background water quality at the site.

All of Which is Respectfully Submitted

CONESTOGA-ROVERS & ASSOCIATES

John M. Petrie, M.Sc.



Anthony J. Crutcher, P. Eng.

REFERENCES

Baker, J.F., Cherry, J.A., Carey, D.A., Hewetson, J.P., Pankow, J.F. and Reinhard, M. (1984). "Organic Contaminants in Groundwaters at Several Ontario Landfills". Proceedings of Technology Transfer Conference No. 5 (MOE), pp. 49-68, November 1984.

Hewetson, J.P., 1985. An investigation of the Groundwater Zone in fractured shale at a landfill. M.Sc. thesis, unpublished, University of Waterloo, 70pp.