



Memorandum

To: Matthew Keliher, Halifax Regional Municipality Ref. No.: 088605-10

From: Andrew Philopoulos/Christine Skirth/mb/19 Date: November 16, 2015

cc: Robert Orr, Halifax Regional Municipality

Re: Comments on Final Technical Submissions for Vertical Expansion Approval

GHD Limited (GHD) on behalf of Halifax Regional Municipality (Halifax) has provided herein comments on the adherence to scope and technical content of each submission completed by Dillon Consulting (Dillon) on behalf of Mirror Nova Scotia (Mirror NS) for vertical expansion of the Residual Disposal Facility (RDF) located at the Otter Lake Facility. The technical submissions fulfil the requirements outlined in GHD's Scope of Work (SOW) Requirements for Vertical Expansion Approval (dated March 13, 2015), and include the following:

- Daily Cover Material Options Analysis
- Geotechnical Investigation Report
- Leachate Collection System Assessment
- Cell Design and Sequencing Plan
- Landfill Gas (LFG) Management Plan
- Stormwater Management and Erosion and Sedimentation Control Plan
- Revised Operations Plan for Residual Disposal Facility (RDF)

Overall GHD is of opinion that the technical submissions submitted by Mirror NS are comprehensive, technically sound, and demonstrate that vertical expansion can be implemented while maintaining the current level of environmental protection and in some instances the implementation of the proposed plans will improve the level of environmental protection (e.g., improved landfill gas management approach). The Plans do not identify any technical reason why vertical expansion cannot be implemented.

1. Adherence to Scope

Overall the submissions meet the intent of the SOW. The following discrepancies between the submissions and the SOW are noted:

- As part of Section 2.0 (Contractor Data Requirements) of the SOW, Mirror NS was to collect leachate levels and determine leachate elevations from a minimum of 10 LFG wells located in Cell 1, 2, and 3 on

two separate occasions. The leachate levels were to assist in evaluating the presence of leachate mounding within the older landfill cells and to confirm that leachate is migrating to the leachate collection system. Dillon (Technical Memo dated October 6, 2015 addressing GHD's comments) has concluded that measuring leachate levels is not required in order to confirm that leachate generated within the cells is reaching the leachate collection system based on: limited leachate mounding observed during the geotechnical investigation; limited indicators of leachate mounding historically (e.g., side slope seeps); and the use of porous Construction and Demolition (C&D) matrix as daily cover has facilitated the vertical passage of leachate.

- As part of Section 4.1 (Leachate Collection System Assessment) of the SOW, Mirror NS was to install monitoring wells in the sumps of Cells 1 and 3 and monitor the leachate level on three occasions. The purpose was to evaluate the extent of biofouling in the two sumps. During the work, Mirror NS proposed to test pit the two sumps in place of installing monitoring wells; this was accepted as an improved method to more directly evaluate the condition of the sumps.
- As part of Section 4.5 (Stormwater Management and Erosion and Sediment Control Plan) of the SOW, Mirror NS was to review the current sizing/configuration of the two sedimentation ponds; and prepare preliminary design drawings of the minor and major drainage systems to meet applicable quantity and quality control guidelines. Part of the intent was that preliminary design drawings of any proposed changes to the sedimentation ponds would be included. Dillon's Stormwater Management and Erosion and Sedimentation Control Plan evaluated the capacity of the north and south sedimentation ponds but did not include an assessment on the effluent quality under vertical expansion. Dillon's report indicates that the north sedimentation ponds will not meet storage requirements (i.e., 25-year 24 hour storm event) and has provided options to address the issue during detailed design. Through discussion with Dillon, they have indicated that minor modification to the ponds, such as additional baffles or modifications to the flocculation system are not required to be submitted for approval, as these are considered operational changes only.
- As part of Section 4.6 (Updated Design and Operations Plan) of the SOW, landfill cover removal procedures (including liner anchoring details) were to be included. The intent was to layout a short procedure with regards to how the liner would be cut, anchored, and subsequently extended during final cover placement of the vertically expanded areas. A conceptual detail was provided by Dillon with the Cell Design and Sequencing Plan, however, Mirror NS has indicated that these details are not required for approval and that they will be finalized as part of vertical expansion detailed design.

2. Summary of Findings and GHD Comments

The below is a summary of key findings and GHD's comments with regards to each technical submission.

2.1 Daily Cover Material Options Analysis (Dillon, dated October 15, 2015)

The purpose of the Daily Cover Material Options Analysis was to evaluate the use of soil based daily cover, in conjunction with or in place of the C&D matrix currently used as daily cover. The options analysis evaluated the following three scenarios:

Scenario 1: Use of C&D matrix material as daily cover (150 mm)

- Scenario 2: Use of C&D matrix as daily cover (150 mm) and soil as interim cover (300 mm); Scenario 2a considered using soil from on-site sources, while Scenario 2b considered using soil from off-site sources
- Scenario 3: Use of soil as daily cover (150 mm) and interim cover (300 mm); Scenario 3a considered using soil from on-site sources, while Scenario 3b considered using soil from off-site sources

Key findings made by Dillon:

- Dillon has recommended Scenario 3a (soil based daily and interim cover soils from on-site sources) be implemented during vertical expansion. Scenario 3a is recommended for its benefits in minimizing leachate generation, controlling odours, and overall net cost. The assessment considered that 75 mm of the daily cover would be removed prior to the start of landfilling each day, resulting in additional air space available for the disposal of waste. Dillon noted that by not using the C&D matrix as daily cover may impact Halifax's ability to meet diversion objectives. In view of meeting diversion objectives, Dillon has noted that Scenario 2a is an acceptable option and that there are no significant operational concerns with the continuation of the practice of using the C&D matrix as daily cover.

GHD Comments:

- Both Scenarios 2 and 3, combined with the revised LFG management approach of using horizontal collectors (which will facilitate the early collection of LFG) and the vertical expansion cell design and sequencing plan (e.g., minimizing the size of the active face), are acceptable with regards to environmental protection (e.g., mitigating odours, vectors and vermin, litter). The use of soil based daily cover (Scenario 3) will improve the current level of environmental protection by better mitigating odours and may facilitate better capture of LFG with the horizontal collectors. The use of the C&D matrix as daily cover and soil based interim cover (Scenario 2), is similar to current site practices and should provide an acceptable level of environmental protection.
- There is risk that the soil placement and salvage values quantities used for Scenario 3 will not be realized in practice, meaning the full cost benefit may not be realized as presented. As an example, soil based daily cover requirements would typically be assumed to be 20% of the landfill fill volume (i.e., 80% waste and 20% soil). Scenario 3 includes less than 5% of soil in the landfill fill volume estimate.

2.2 Geotechnical Investigation Report (Conquest Engineering, dated October 22, 2015)

The purpose of the geotechnical assessment was to evaluate slope stability of the proposed vertically expanded waste mound and provide design recommendations. Dillon retained Conquest Engineering to complete the Geotechnical Investigation Report.

Key findings made by Conquest Engineering:

- Slope stability for the vertically expanded waste mound was shown to have an acceptable minimum factor of safety (1.8).
- The current 2.8H:1V slope between Cell 6 and 7 showed an acceptable factor of safety (1.7), however, it was recommended that the existing slope be extended when Cell 6 is being capped to a 4H:1V slope to account for any variability in residual material type or condition and to ensure long term stability.

- Cell 4 settlement (1 to 4 m in areas) was attributed to moisture content during placement, lift thickness during placement, or pockets of different residual material. Overall it was noted that observed settlements of up to 4 m was not unexpected for a landfill. It was recommended that settlement in Cell 4 be monitored during vertical expansion relative to other cells.
- Settlement in native foundation soil due to increased loads from vertical expansion will be negligible.

GHD Comments:

- Given the calculated factor of safety of 1.7 by Conquest Engineering, the slope between Cell 6 and 7 likely does not need to be built out to a 4H:1V slope unless it is determined that in the future Cell 7 will not be constructed after completion of the vertical expansion over Cells 1 to 6. In addition, construction and monitoring of interim cover over Cell 6 instead of constructing final cover at this time is in keeping with the Operations Plan and is more cost effective. Use of an enhanced interim cover (e.g., 0.3-0.6 m of low permeable material completed with topsoil and hydroseed) and possibly building out the 2.8H:1V slope to 3H:1V would minimize maintenance requirements and facilitate maintenance of the vegetative cover (e.g., mowing of the grass) Building out the slope to 4H:1V and completing Cell 6 with final cover is estimated to cost approximately 10 million dollars based on discussions with Halifax. Constructing an enhanced cover and 3H:1V slope versus a final cover and a 4H:1V slope will offer comparable levels of environmental protection and save on capital expenditures. In addition, if routine monitoring indicates that the slope between Cell 6 and 7 is failing corrective action could be implemented (e.g., toe armoring).

2.3 Leachate Collection System Assessment (Dillon, dated October 28, 2015)

The purpose of the leachate collection system assessment was to evaluate the condition of leachate collection infrastructure in Cells 1, 2, and 3 as Mirror NS has previously raised concerns over the condition of the leachate collection and conveyance system (e.g., biofouling). Prior to development of the SOW, Mirror NS indicated that the design of sumps in Cells 4, 5, and 6 were in good working condition.

Key findings made by Dillon:

- The leachate collection and conveyance infrastructure can accommodate quantities of leachate associated with proposed 15 m vertical expansion.
- There are no concerns associated with the vertical passage of leachate through the waste mound to the leachate collection system during the development of the vertical expansion area.
- No significant concerns were identified in the leachate collection and conveyance infrastructure based on video inspection results. The frequency of video inspections of the leachate collection and conveyance system should be increased to annually from bi-annually during vertical expansion over Cells 1-3, given the fact that the sumps are smaller than in subsequent cells.
- Sumps in Cell 1 and Cell 3 were observed to be in good condition with no biofouling based on test pit results.
- Forcemain F1 (located between Cell 1 sump and leachate holding tank) was reported to be blocked beyond the extent of the video inspection. Replacement of a section of the forcemain is needed, however it was recommended that the entire forcemain be replaced and upsized from 100 mm to 150 mm to accommodate a larger pump in Cell 1.

- New dedicated pumps have been recommended for sumps in Cell 1 and Cell 3. An increase in pump capacity (increased from 5 l/s to 10 l/s) has been recommended to better match generation rates seen in newer cells and to more quickly reduce volumes of leachate from the sumps.

GHD Comments:

- Dillon noted in the report that leachate generation rate forecast prior to the commencement of landfilling in Cell 1 was significantly lower than observed leachate generation due to the use of the C&D matrix as daily cover. However it is likely that the forecasted leachate generation rates are lower than actual due to the model inputs not including precipitation that comes into contact with daily cover or waste being managed as leachate as part of the original site design. Best management practices indicate that all water that comes in contact with waste or daily cover should be infiltrated through the waste and managed as leachate. As such the under-sizing of the original forcemain and pumps in Cells 1 and 3 is likely due to incorrect model input parameters and not as a result of the use of C&D as daily cover.

2.4 Cell Design and Sequencing Plan (Dillon, dated October 15, 2015)

The objective of the Cell Design and Sequencing Plan was to provide an overview of the vertically expanded RDF including details on landfill development.

Key findings made by Dillon:

- Vertical expansion has been designed in 5 areas above Cells 1-6 to accommodate approximately 1,497,450 MT of waste; for a total site life of approximately 15 years based on 100,000 MT of annual incoming wastes to the Otter Lake Facility.
- Final cover removal has been planned to occur 12 times in each of the 5 areas; final cover removed at one time will range from approximately 2,300 to 3,600 m².
- The cost to remove final cover material was estimated to be approximately \$0.5 million per area. Significant quantities of vegetative soil (71,200 m³) and 25 mm clear stone (42,650 m³) will be recovered and reused in landfill works.

GHD Comments:

- Overall, the Cell Design and Sequencing Plan is well laid out and allows for vertical expansion to be developed to both accommodate landfill operations while minimizing the active face of the landfill and areas requiring final cover removal.

2.5 Landfill Gas (LFG) Management Plan (SCS Engineers, dated November 9, 2015)

The purpose of the LFG Management Plan was to determine the best option(s) for LFG management at the RDF during vertical expansion from both a technical and financial perspective, while maintaining or improving the current level of environmental protection at the Site with regards to LFG emissions including odours. Dillon retained SGS Engineers to complete the LFG management Plan.

Key findings made by SCS Engineers:

- As part of vertical expansion both horizontal collectors and vertical wells are proposed to recover LFG.

- The LFG recovery potential during vertical expansions will be between approximately 920 and 1,100 scfm at 50 percent methane. Current flaring capacity at the site can accommodate approximately 2,950 scfm of LFG and is therefore adequate.
- LFG collectors should be tuned to recover LFG at 40 to 50 percent methane, less than 1 percent oxygen, at temperatures less than 125°F and applied vacuum greater than 0 inches of water column.
- The flare skid should be relocated as necessary to increase system vacuum and provide additional LFG combustion at targeted areas within the LFG collection system.

GHD Comments:

- Overall, the use of horizontal collectors in combination with vertical wells represents a significant improvement to site LFG management practices as:
 - Horizontal collectors will facilitate the early capture of LFG and should enhance environmental protection
 - The use of the temporary LFG system (i.e., connecting Big-O pipe to vertical wells) will be eliminated or only used as a contingency. The elimination of the use of temporary LFG system removes the labour intensive need of draining condensate manually.
 - The elimination of the use of Big-O pipe will allow Mirror NS to apply lower vacuums to the LFG collection field and minimize atmospheric air intrusion. Adjusting horizontal collectors and vertical wells to collect LFG as specified by SCS Engineers (e.g., 40 to 50 percent methane and less than 1 percent oxygen) represents an improvement to Health and Safety aspects of the site operation by mitigating the potential of collecting an explosive mixture of LFG.
 - The report notes that the permanent flaring system was constructed in 2003-2004, prior to Nova Scotia enforcing CSA B149.6 (Code for Digester Gas and Landfill Gas installations). The flare skid was inspected and certified in accordance with the 2011 revision of CSA B149.6. Note:
 - Halifax should review with Mirror NS requirements to upgrade the permanent flaring system to the latest version of CSA B149.6
 - The flare skid, constructed in 2013, is not operational. The report notes that the use of the system is currently awaiting provision of operational training to Mirror NS staff.

2.6 Stormwater Management and Erosion and Sedimentation Control Plan (Dillon, dated October 29, 2015)

The purpose of the Stormwater Management and Erosion and Sediment Control Plan was to include a general review of current stormwater management system and determine the stormwater management requirements for vertical expansion.

Key findings made by Dillon:

- The existing conveyance system (ditches, culverts, etc.) is expected to provide adequate conveyance capacity for vertical expansion.
- Under vertical expansion conditions, the North Pond is expected to discharge over the spillway during the 25-year, 24-hour rainfall event. Options to mitigate, or potentially eliminate discharge include

increasing the storage pond capacity, creating in-line ditch storage capacity, diversion of flows to the South Pond, or increasing treatment capacity. The South Pond has the capacity to store the 25-year, 24-hour rainfall event.

- There is currently a significant shortfall between the recirculation and treatment capacity and the pond inflow volumes expected during heavy rainfall events. It was recommended that the performance of the ponds with respect to treatment capacity be monitored in the interim prior to vertical expansion. If necessary, a review of opportunities to upgrade the existing treatment system may be undertaken as part of detailed design.

GHD Comments:

- Dillon's surface water modelling, based on vertical expansion conditions, showed that the North Pond is undersized for the 25-year, 24-hour rainfall event. Our understanding is that NSE will require the North Pond to be able to store this event. Dillon has indicated that a solution can be determined during detailed design (by evaluating the options noted above). GHD is of the opinion that by better balancing flows to the North and South Pond, as part of this plan, the North and South Ponds may have been demonstrated to contain the required storm event.
- The plan suggests that there is significant shortfall between existing pump treatment capacity (i.e., with flocculent) and the inflow values for both ponds during significant storm events; and that expanding the storage volume of the ponds would increase the time available for treatment and circulation prior to discharge to the environment. GHD is of the opinion that:
 - Recent improvements to manage erosion and sedimentation by Mirror NS should be continued: e.g., improved vegetative cover on capped landfill areas (e.g., use of topsoil), seeding/sodding interim cover in select areas that can lead to high sedimentation loads for extended periods of time (e.g., winter months), ditch and temporary pond cleaning, and sedimentation pond cleaning.
 - The treatment capacity of the ponds system should be evaluated through establishing design criteria (e.g., sediment loading, settling velocity) and maximizing the retention time and flow path of the ponds (e.g., maximize the flow path by minimizing short-circuiting and maximizing the flow path of recirculated treated surface water).

2.7 Revised Operations Plan for the Residual Disposal Facility (RDF) (Mirror NS, dated September 2015)

The purpose of the revised Operations Plan was to revise site procedures in view of vertical expansion and based on the findings of the various studies and design plans completed. In particular, the revised Operations Plan includes:

- Revised odour control procedures
- Reflects the fact that horizontal collectors will now be used as part of the site LFG management operations
- Litter control measures as part of vertical expansion

GHD Comments:

- Overall the revised Operations Plan is adequate, however, the plan could have been more tailored to vertical expansion and more specific as to revised procedures (e.g., under which scenarios would interim cover be completed with hydroseed or sod; recording leachate generation per cell; and use of field olfactometer to quantify on and off site odours)

3. Conclusion

Overall the technical submissions met the intent of the SOW and are technically sound. From a technical perspective, pending successful amendment to the site's Approval to Operate to proceed with vertical expansion, the next step is to complete detailed design for vertical expansion for such items as leachate pumping and conveyance system upgrades, surface water management upgrades (as needed), and liner anchoring details.