MINISTRY STAFF SUMMARY REVIEW

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For: A.J. Downie
Director, Authorizations-South

1. Purpose

Summary review of the "Final Closure Plan" submitted pursuant to the March 15, 2017 amended Spill Prevention Order (SPO), Part A: Final Closure, Section 4. "Final Closure Plan".

2. Background

March 15, 2017: Ministry of Environment (MOE) issued an amended SPO to the Named Parties (Parties). The SPO indicated that the Parties may elect to permanently close the landfill or to remove all Contaminated Soil from the Facility. If the Parties elect to permanently close the landfill, then the Parties must comply with the provisions set out in Part A: Final Closure (sections 3 – 7). Section 3 requires by April 17, 2017, the Parties must submit to the Ministry complete up to date "As-Built" plans and specifications of the existing Facility. Section 4 requires by May 31, 2017, the Parties must submit a final plan to permanently close the landfill (the "Final Closure Plan") to the Ministry for review and approval.

March 17, 2017: MOE to the Parties. MOE provided technical input to be addressed and responded to in the Final Closure Plan.

April 13, 2017: MOE to the Parties. MOE acknowledged that based on previous communication, it is understood that the Parties intend to pursue Part A of the SPO (Final Closure), and also indicated that MOE is willing to consider the proposal to open up the landfill to dispose of the approximately 3000 tonnes of material currently in the Soil Management Area (SMA), if the Parties include this in the proposed Final Closure Plan.

April 18, 2017: The Parties to MOE. The Parties submitted As-Built plans and specifications (As-Built package) certified by Qualified Professionals (QPs).

May 18, 2017: MOE to the Parties. MOE provided Interim Additional Input to be addressed and responded to as part of the Final Closure Plan.

May 26, 2017: Independent QP Contractor (Hemmera Envirochem Inc.) to MOE. Hemmera provided its Independent Review of Engineering Design for the Shawnigan Lake Landfill, dated May 26, 2017.

May 26, 2017: MOE to the Parties. MOE provided the May 26 2017 Hemmera Independent Review of Engineering Design, as additional input to be addressed and responded to as part of the Final Closure Plan.

May 31, 2017: The Parties to MOE. The Parties submitted the Final Closure Plan (Sperling Hansen Associates (SHA) Final Closure Plan dated May 31, 2017).

June 22, 2017: Hemmera to MOE. Hemmera submitted its Independent Review of Final Closure Plan dated June 22, 2017.

3. Hemmera Independent Review of Engineering Design, May 26, 2017

The May 26, 2017 Hemmera Independent Review of Engineering Design included review of the As-Built package and background information including from the Shawnigan Research Group (SRG).

Hemmera (s. 4.1) compared the landfill to the 1993 LCMSW (in effect at time of landfill construction) and determined it mainly satisfied the 1993 LCMSW. As requested by the MOE, Hemmera (s. 4.2) also compared the landfill to the 2016 LCMSW (in effect today) and determined it did not conform to a number of sections.

Hemmera determined the As-Built package does not appear to be complete, up to date, and accurately reflect current conditions at the existing Facility (s. 5.1) (e.g. seepage blanket, anchor trench, cross-sections).

Hemmera (s. 6.0) concluded that based on all the information provided and reviewed there appears to be several short-comings of the work completed in the design, construction, operation and oversight during the entire process. Although some aspects of the PEA (permanent encapsulation area – i.e. landfill) exceed minimum requirements, many details are missing and are required to ensure the facility is designed, constructed and operated to minimize any risks to the environment. Major deficiencies include: lack of continuous QP oversight of the entire LCS (leachate collection system) and leakage detection system construction and testing, as well as membrane cover repair and integrity check. Minor deficiencies include missing geotextile over sand LCS, adequate cover liner weighting, lack of anchor trenches and no formal leachate management plan provided.

As requested by the MOE, Hemmera compared the landfill to the 2016 LCMSW and identified a number of deficiencies related to non-conformance with the 2016 LCMSW. It is noted that the 2016 LCMSW was posted in late August 2016, and was not yet in effect at the time of landfill design or construction. The 2016 LCMSW also indicate that the Siting Criteria, and the Design Criteria applicable to the site layout, landfill base design, landfill base liner, and leachate collection system, do not apply to existing landfill footprints where waste filling has already occurred (s. 2.1.2). Further, the 2016 LCMSW is a MOE guidance document that does not provide mandatory requirements but provides recommended practices that can be modified when technical justification is provided to demonstrate that the proposed site-specific alternatives provide equivalent or better environmental protection (Foreword & s 2.1.1).

In the context of avoiding any leaks or spills of leachate to the environment, and for the landfill PEA to more closely conform to the 2016 LCMSW, Hemmera made 11 recommendations (s. 7.0) to increase adequacy of the works to prevent the escape of leachate into the environment during the post-closure period and minimize the potential for environmental risk.

MOE provided the May 26 2017 Hemmera Independent Review of Engineering Design to the Parties as additional ministry input to be addressed and responded to as part of the Final Closure Plan.

4. SHA Final Closure Plan, May 31, 2017

The SHA Final Closure Plan proposes significant revisions and improvements to the landfill, leak detection system, leachate collection system and storage works, and the monitoring program. Briefly, the SHA Final Closure Plan proposes to:

- Cut the existing 40 mil LLDPE smooth cover geomembrane along the crest of the landfill and fold it to the south. Remove the existing 40 mil LLDPE smooth cover geomembrane from the North and East landfill slopes.
- Install a 10000 gallon (37.8 m^3) HDPE leachate collection tank, and a 2500 gallon (9.46 m^3) HDPE leak detection tank, approximately 20 m North of the landfill, located in a below ground lock block well lined with a 40 mil geomembrane liner (secondary containment), under a roof.
- Remove the existing 2500 gallon leachate collection tank and the existing 2500 gallon leak detection tank, on the North side of the landfill.
- Extend the landfill base liner system (includes shot rock seepage layer, 1 m secondary clay liner, sand leak detection layer, 40 mil LLDPE double-textured primary geomembrane liner, gravel drainage layer), leachate collection system, and leak detection system, to the North and East to allow flattening of the landfill slopes to maximum 3H:1V.
- Install a new additional leachate collection system on the extended 40 mil LLDPE double-textured primary geomembrane liner.
- Install a new additional leak detection system below the extended 40 mil LLDPE double-textured primary geomembrane liner and on the extended secondary clay liner. The new extended leak detection system is to be keyed into a notch in the extended secondary clay liner, to ensure that any leakage through the 40 mil LLDPE primary geomembrane liner is collected and detected.
- Relocate approximately 3360 tonnes (1867 m^3) of contaminated soil from the soil management area to the landfill.
- Re-grade the landfill North and East slopes to maximum 3H:1V.
- Install final cover system on the landfill crest (includes existing 40 mil LLDPE smooth geomembrane, 200 mm sand, 500 mm low permeability soil, and 300 mm topsoil), and on the landfill North and East slopes (includes geotextile, new 40 mil LLDPE double-textured geomembrane, geotextile, 200 mm drainage gravel, and 300 mm topsoil)
- Clean, wash-down (into the contact water/leachate storage pond) and decontaminate the soil management area.
- De-commission the contact water/leachate storage pond. Leachate, sludge and the liner will be removed and transported off-site for disposal. The pond will be backfilled.

- Carry out ongoing leachate removal from the new leachate collection tank and transport to an off-site facility.
- Install new standpipe monitoring wells in the seepage layer (below the secondary clay liner), along the North toe of the landfill, to allow monitoring of water quality below the secondary clay liner.
- Carry out ongoing post-closure inspection, operation, maintenance, and environmental monitoring program including monitoring of leachate, groundwater, surface water, and the seepage layer below the secondary clay liner.

5. Hemmera Independent Review of Final Closure Plan, June 22, 2017

The Hemmera review of the SHA Final Closure Plan included:

- Review of SHA's assessment of the adequacy of the existing landfill facility including technical justification for proposed site-specific alternatives (s. 2.1).
- Comparison to the 2016 LCMSW including review of technical justification for proposed site-specific alternatives and review of completeness with the SPO section 4 requirements including response to input from ministry staff (s 2.2)
- Discussion of review results and SRG concerns (s 3.0)
- Conclusions (s 4.0).
- Recommendations for the Final Closure Plan to more closely conform to the 2016 LCMSW and prevent any leaks or spills of leachate to the environment (s 5.0).

Hemmera (s 2.0) noted that the SHA Final Closure Plan appears to address the 2016 LCMSW closure plan requirements in a well prepared and comprehensive document, and also includes information pertinent to the 2016 LCMSW design and performance objectives and information required by the SPO section 4.

Hemmera (s 2.1) noted that the 2016 LCMSW Design Criteria with regard to site layout, landfill base design, landfill base liner, and leachate collection system, do not apply to existing landfills. Hemmera reviewed SHA's assessment of the adequacy of the existing landfill facility including the basal seepage layer, clay secondary liner, 40 mil LLDPE primary liner, texturing of base and cover liners, leachate collection layer, soil filter, leachate collection piping, and landfill grading. In general, Hemmera agreed with SHA technical rationale and professional opinion for proposed site-specific alternatives, and the Final Closure Plan proposals to improve the works.

Hemmera (s 2.2.) compared the Final Closure Plan to the 2016 LCMSW including review of technical justification for proposed site-specific alternatives and completeness with the SPO section 4 requirements including response to input from ministry staff. This review included the landfill base design, landfill base liner, leachate collection system, surface water management works, final cover design, final contours, closure and post-closure criteria, and monitoring criteria. In general, Hemmera agreed with SHA technical rationale and professional opinion for proposed site-specific alternatives and found the Final Closure Plan proposals to improve the works to be in conformance with the 2016 LCMSW. However, Hemmera did identify several items that were in non-conformance, where information was not complete, or where improvements were recommended.

Hemmera (s 3.0) indicated that overall, the Final Closure Plan was comprehensive and many aspects of the landfill closure design exceed the minimum requirements of the 2016 LCMSW. However, several deficiencies were identified and discussed (s 3.0 & 3.1) and are summarized as follows:

- Lack of additional contingency measures to address any failure of the works or the escape or spill of leachate, for example a plan for collection of leachate from the seepage blanket should the basal liner system be found to be compromised.
- Continuous QP inspection during closure activities is implied but not specifically stated.
- As-built cross-sections of the landfill base provided by SIRM (not certified by a QP) continue to not show details of clay berms between the three landfill cells or details of the current leachate and leak detection piping that are expected to intersect the liner in the vicinity of these berms. It is anticipated that system modifications further to the landfill extension will mitigate any apparent shortcomings with the construction in these areas.
- Lack of discussion of extended primary geomembrane liner leak detection survey and secondary clay liner organic carbon content and leachate stability.
- Lack of discussion of a temporary system for collecting leachate and any leakage during the transition from the existing to the new leachate and leak detection collection and storage works.
- Lack of discussion of a plan to reduce or eliminate surface water ingress into the leakage detection system along the upper part of the landfill (south and west perimeter).
- More frequent inspections or telemetry monitoring of leachate storage tank level may be necessary to ensure no leachate spillage to the environment.
- Additional seepage layer monitoring wells installed to competent bedrock are warranted to detect any leakage below the secondary clay liner and from the piping to the new leachate and leak detection storage tanks.
- Lack of explicitly stated property end use, no southern or western fence, and no discussion of submission of a site profile under Contaminated Sites Regulation upon decommissioning (s 2.2).

Hemmera (s 3.2) reviewed the SRG information submissions and considered this information during their review. Hemmera identified that the concerns included issues such as:

- questions regarding the basal liner integrity further to apparent wrinkles or folding of the geomembrane;
- questions regarding the representativeness of the as-builts;
- extent of buffer zones and PEA contours;
- chemical sample data that suggests a leachate source for chemical parameters that are present in the ephemeral stream downgradient of the site,
- concerns with wrinkles forming in the upper liner due to shrinkage of the soils.

Hemmera noted that:

- Some issues raised, such as the presence of buffer zones for the landfill, are noted to not apply to existing landfills in the LCMSW.
- The issues raised regarding the wrinkles or folds in the liner are noted, and agreed to not be optimal, however the geomembrane exceeds the design criteria in place at the time of

construction, and it has been shown that the leakage through composite liners is only a very small fraction of that expected for either a geomembrane or clay liner alone.

- Due to the location of the landfill within a rock quarry, there are multiple potential sources of contamination in the vicinity of the landfill. The modifications to the facility, such as to the landfill basal liner, leachate and leak detection collection systems, and cover as presented in the Landfill Closure Plan, are expected to facilitate the direct monitoring of site conditions to more accurately confirm if the landfill closure is protective of the environment. Until the modifications are complete and the proposed monitoring plan initiated, it is the reviewers opinion that it is not possible to draw conclusions regarding the source of chemical parameters in the ephemeral stream downgradient of the site.

Hemmera concluded (s 4.0) that the Closure Plan appears to be a comprehensive document that substantially addresses the requirements of Section 4 of the SPO as well as input from MOE staff contained in letters dated March 17, April 13, and May 18, 2017, and appears to provide sufficient technical justification to demonstrate that proposed site-specific alternatives provide an equivalent or better level of environmental protection relative to LCMSW including for worst case conditions such as 200 year design storm event(s) plus snowmelt and multi-day precipitation events. While many aspects of the Landfill Closure exceed minimum criteria requirements, some details require further clarification to ensure the facility is designed, constructed and operated to minimize any risks to the environment. The recommendations from the May 26, 2017 Hemmera report were also in general adequately addressed, however there was no discussion of provisions to eliminate non-contact water from entering the leakage detection system.

Hemmera (s. 5.0) made 8 recommendations for the landfill to more closely conform with the 2016 LCMSW, to avoid any leaks or spills of leachate to the environment, and to increase adequacy of the works to prevent the escape of leachate into the environment during the post-closure period and minimize the potential for environmental risk:

1. Ensure that the leachate collection and storage system is adequately maintained such that it continues to operate effectively throughout reconstruction of the landfill toe area during modifications being made to accommodate the final cover slopes. During final closure construction, the current contact water treatment system will be decommissioned. Please confirm if a temporary leachate collection system will be needed to manage leachate accumulations during the transition to the newly installed leachate storage facility.
2. Final cover design should contemplate construction methods to divert surface water and precipitation away from leak detection system. Confirm that there are provisions in the Closure Plan Final Cover design to minimize non-contact water from entering the leakage detection system.
3. Confirm and discuss any potential issues that may arise further to unknowns regarding clay organic carbon content and stability of compacted clay liner (structure and permeability) when exposed to leachate.
4. Confirm that the frequency of the storage tank inspections will be sufficient to identify water levels in the tanks, or meter leachate flow into the leachate collection tank, such that leachate accumulations can be removed with sufficient remaining capacity to accommodate unforeseen increases in leachate volume. The required capacity should be determined and the maximum tank

volumes specified in the monitoring and maintenance plans. Remote monitoring (telemetry) of the tank levels should be considered, possibly as part of the proposed leachate metering, to ensure that sufficient tank capacity is maintained regardless of tank inspection frequency.

5. Have continuous QP inspection and documentation of all work completed on the landfill closure. Inspection and QP approval of the modifications to the Basal liner system and the Leachate Collection and Leak Detection systems to be completed prior to regrading of landfill material.

6. The number of seepage blanket monitoring wells should be increased to at least three, with the western most well relocated further to the west (east well spacing may also require adjusting to provide representative coverage) and an additional well installed adjacent to the subsurface leachate collection system piping near to the storage tanks to monitor any potential leaks in the piping. A fourth well may be required on the west portion of the seepage blanket to provide representative coverage for groundwater capture.

7. The seepage blanket monitoring well screens should be extended to the competent bedrock surface (regardless of depth) to ensure all groundwater within the seepage layer is captured in the wells.

8. Provide contingency measures to address any failure of the works or the escape or spill of Leachate or Contaminated Soil into the environment.

6. MOE Review

The SPO section 4. (Final Closure Plan) Requirements including technical input from MOE staff dated March 17, April 13 & May 18, 2017, the May 26, 2017 Hemmera Independent Review of Engineering Design, the SHA Final Closure Plan May 31, 2017, the Hemmera Independent Review of Final Closure Plan June 22, 2017, and several SRG information submissions, were reviewed.

A Summary Table of the SPO Final Closure Plan requirements (section 4.) and corresponding relevant content for the SHA Final Closure Plan and the Hemmera Independent Review of Final Closure Plan was prepared and is attached as Appendix A. Appendix B, C & D include the SHA Final Closure Plan, the Hemmera Independent Review of Final Closure Plan, and SRG Information Submissions of May 31, June 8, June 13 and June 21, 2017.

Consistent with Hemmera's conclusions, it was concluded that the SHA Final Closure Plan substantially addressed the SPO section 4. (Final Closure Plan) Requirements including technical input from MOE staff, the May 26 2017 Hemmera Independent Review of Engineering Design, the 2016 LCMSW, and the specific technical requirements of the SPO, including:

- Certification by a QP (Dr. Tony Sperling, P.Eng. President SHA).
- Use of the 2016 LCMSW for guidance and technical justification for proposed site-specific alternatives.
- Consideration and response to the technical input from MOE staff and the May 26 2017 Hemmera Independent Review of Engineering Design.
- Assessment of the adequacy of the existing Facility and recommended revisions to remedy any inadequacies.
- A plan for the management of contaminated soil stored in the soil management area.

- Proposed landfill final cover including slopes, layers, cross-sections, topsoil, vegetation and storm water management works.
- A Leachate collection and storage plan.
- A plan for Leachate removal and transport to an off-site facility.
- A post-closure inspection, operation, maintenance and environmental monitoring program.
- An implementation schedule which provides for commencement of closure activities by July 1, 2017, and completion of all closure activities by October 31, 2017.

The SHA Final Closure Plan proposes significant revisions and improvements to the landfill, leak detection, leachate collection and storage works, and monitoring program. The post-closure inspection, operation, maintenance and environmental monitoring program includes inspections of the landfill, monitoring of leachate, surface water, groundwater and the seepage layer, and QP assessment of the monitoring data and the performance of the landfill including the base and cover liners.

The Hemmera Independent Review of Final Closure Plan recommendations (s 5.0) to further improve the Final Closure Plan are also supported. Additional comments are:

- The SHA Final Closure Plan (s 9.4 & 9.3) does not explicitly identify sampling and analyses of the ephemeral creek immediately downstream of the settling pond outlet (EMS site E305365) or leak detection tank water,
- The SPO (section 7.) refers to quarterly implementation reports including records of inspections, operations, etc. and environmental monitoring program records interpreted and certified by a QP (i.e. not an annual report as indicated in the SHA Final Closure Plan s. 9.10).
- With regard to Hemmera's comment (s 3.1.5) regarding the lack of explicitly stated property end use, no southern or western fence, and no discussion of submission of a site profile under Contaminated Sites Regulation upon decommissioning (s 2.2), it is noted that the site is regulated under an active MINISTRY OF ENERGY AND MINES Quarry permit.

SRG Information Submissions

SRG information submissions to MOE on May 31, June 8, June 13 and June 21, 2017, included technical concerns with regard to:

- The As-Built package is inaccurate and the landfill base liner, leachate collection system and leak detection system design and installation were inadequate.
- The landfill base liner(s) is(are) leaking.
- The landfill doesn't satisfy the 2016 LCMSW.

With regard to the As-Built package, the May 26, 2017 Hemmera Independent Review of Engineering Design determined that the As-Built package was not complete, up to date, and accurate, identified deficiencies including lack of continuous QP oversight, and made recommendations to increase adequacy of the works to prevent the escape of leachate into the environment during the post-closure period and minimize the potential for environmental risk. A number of deficiencies identified by Hemmera related to non-conformance with the 2016 LCMSW that, as previously noted, were not yet in effect at the time of landfill design and construction. The SHA Final Closure Plan included additional As-Built drawings (not certified by a QP), considered the SPO requirements

including technical input from MOE staff, the May 26 2017 Hemmera Independent Review of Engineering Design, the 2016 LCMSW, and the specific technical requirements of the SPO. SHA noted that it was not involved in the design, construction or QA/QC of the base liner system (s 3.4), however based on review of As-Builts and construction documents, SHA does not foresee any technical or stability issues with the design of the Landfill (Executive Summary p2). However, the June 22, 2017, Hemmera Independent Review of Final Closure Plan also indicates as summarized below:

- As-built cross-sections of the landfill base provided by SIRM continue to not show details of clay berms between the three landfill cells, that details of the current leachate and leak detection piping that are expected to intersect the liner in the vicinity of these berms are also not provided, however that it is anticipated that system modifications further to the landfill extension will mitigate any apparent shortcomings with the construction in these areas (s 3.1.1)
- The issues raised regarding the wrinkles or folds in the liner are noted, and agreed to not be optimal, however the geomembrane exceeds the design criteria in place at the time of construction, and it has been shown that the leakage through composite liners is only a very small fraction of that expected for either a geomembrane or clay liner alone (s 3.2).

The concerns regarding the As-Built package and the landfill base liner, leachate collection system and leak detection system design and installation, are acknowledged. The SHA Final Closure Plan proposes significant revisions and improvements to the landfill, leak detection, leachate collection and storage works, and monitoring program. The post-closure inspection, operation, maintenance and environmental monitoring program includes inspections of the landfill, monitoring of leachate, surface water, groundwater and the seepage layer, and QP assessment of the monitoring data and the performance of the landfill including the base and cover liners.

With regard to SRG concerns that the landfill base liner(s) is(are) leaking, the May 26 2017 Hemmera Independent Review of Engineering Design made recommendations to ensure the leak detection system collector piping at the landfill slope toe has been adequately keyed into the clay layer such that it captures all potential leakage (Recommendation 1.), to design and install a representative groundwater monitoring program in the seepage blanket down-gradient of the PEA, and compare chemistry results to up-gradient background, leachate, and leak detection system water monitoring results to assess liner integrity (Recommendation 11.). The SHA Final Closure Plan considered and addressed these, and other, recommendations and proposes significant revisions and improvements to the landfill, leak detection system, leachate collection and storage works, and monitoring program, including:

- The new extended leak detection system is to be keyed into a notch in the extended secondary clay liner, to ensure that any leakage through the 40 mil LLDPE primary geomembrane liner is collected and detected.
- Install new standpipe monitoring wells in the seepage layer (below the secondary clay liner), along the North toe of the landfill, to allow monitoring of water quality below the secondary clay liner.
- Leachate and leak detection tank quantity will be recorded during each leachate removal and/or leachate tank monitoring event, and correlated to precipitation data.
- Environmental monitoring program including leachate, surface water, groundwater, and seepage layer, and QP assessment of monitoring data.

The June 22, 2017, Hemmera Independent Review of Final Closure Plan also indicates:

- Due to the location of the landfill within a rock quarry, there are multiple potential sources of contamination in the vicinity of the landfill. The modifications to the facility, such as to the landfill basal liner, leachate and leak detection collection systems, and cover as presented in the Landfill Closure Plan, are expected to facilitate the direct monitoring of site conditions to more accurately confirm if the landfill closure is protective of the environment. Until the modifications are complete and the proposed monitoring plan initiated, it is the reviewers opinion that it is not possible to draw conclusions regarding the source of chemical parameters in the ephemeral stream downgradient of the site (s 3.2).

MOE Monitoring, Assessment and Stewardship staff reviewed recent selected data to determine if there is any evidence in the sampling data to suggest that the containment liner at the contaminated soil facility (Lot 23) is leaking, and if potential contaminants are being released to a nearby ephemeral stream. The MOE Monitoring, Assessment and Stewardship Memorandum - Review of water quality data from Cobble Hill Holdings contaminated soil facility, dated June 22, 2017, is attached as Appendix E. The Conclusions and Recommendations of this Memorandum are:

- Based on the available data, there is no strong evidence to indicate that contaminants are leaching into the shallow aquifer at Lot 23 and surfacing downstream in the ephemeral creek. However, it cannot be said with certainty that the containment liner is not leaking. More information is needed about upgradient and nearby groundwater quality, and other ephemeral creek water quality, to make further conclusions about whether the concentrations at site S-3 are usual for the area or not. While it was beyond the scope of this review, additional monitoring of leachate, surface water, shallow groundwater, deep groundwater, and a comprehensive assessment of results, may be warranted.
- It should be noted that not all the lab data from the June sampling event (e.g., sites S-1 and S-2) conducted by Associated Environmental was available in time for this review. However, with the addition of this data, it is not expected to change the assessment and conclusions provided above.

The concerns regarding potential landfill base liner leakage are acknowledged. The SHA Final Closure Plan proposes significant revisions and improvements to the landfill, leak detection, leachate collection and storage works, and monitoring program. The post-closure inspection, operation, maintenance and environmental monitoring program includes inspections of the landfill, monitoring of leachate, surface water, groundwater and the seepage layer, and QP assessment of the monitoring data and the performance of the landfill including the base and cover liners.

With regard to the 2016 LCMSW, it was posted in late August 2016, and was not yet in effect at the time of landfill design or construction. The 2016 LCMSW also indicate that the Siting Criteria, and the Design Criteria applicable to the site layout, landfill base design, landfill base liner, and leachate collection system, do not apply to existing landfill footprints where waste filling has already occurred (s. 2.1.2). Further, the 2016 LCMSW is a MOE guidance document that does not provide mandatory requirements but provides recommended practices that can be modified when technical justification is provided to demonstrate that the proposed site-specific alternatives provide equivalent or better environmental protection (Foreword & s 2.1.1). Regardless, as required in the SPO, the SHA Final

Closure Plan used the 2016 LCMSW for guidance and included a number of aspects of final cover that exceeded the 2016 LCMSW and technical justification for proposed site-specific alternatives.

7. Conclusions

The SHA Final Closure Plan substantially addressed the SPO section 4 (Final Closure Plan) Requirements including technical input from MOE staff, the May 26 2017 Hemmera Independent Review of Engineering Design, the 2016 LCMSW, and the specific technical requirements of the SPO.

The SRG concerns regarding the As-Built package, the landfill base liner, leachate collection system and leak detection system design and installation, and potential landfill base liner leakage are acknowledged. MOE Monitoring, Assessment and Stewardship staff suggested in their review that additional monitoring of leachate, surface water, shallow groundwater, deep groundwater and a comprehensive assessment of results, may be warranted. Hemerra indicated that the modifications to the facility, such as to the landfill basal liner, leachate and leak detection collection systems, and cover as presented in the Landfill Closure Plan, are expected to facilitate the direct monitoring of site conditions to more accurately confirm if the landfill closure is protective of the environment.

The SHA Final Closure Plan proposes significant revisions and improvements to the landfill, leak detection, leachate collection and storage works, and monitoring program. The post-closure inspection, operation, maintenance and environmental monitoring program includes inspections of the landfill, monitoring of leachate, surface water, groundwater and the seepage layer, and QP assessment of the monitoring data and the performance of the landfill including the base and cover liners. Hemmera has also identified recommendations to further improve the Final Closure Plan.

The SPO section 4 states the Final Closure Plan may be approved with conditions. If the Final Closure Plan is approved, the following conditions are suggested for consideration:

1. Before the commencement of closure activities, submit an Addendum to the Final Closure Plan certified by a "Qualified Professional" as defined in the Landfill Criteria for Municipal Solid Waste, Second Edition, June 2016 ("Qualified Professional"), that describes how each of the Recommendations in Section 5.0 of the Hemmera Independent Review of Final Closure Plan, dated June 22, 2017, will be carried out, and includes in the environmental monitoring program regular sampling and analyses of the ephemeral creek immediately downstream of the settling pond outlet (EMS site E305365) and any water in the leak detection tank, for review and approval.
2. During all closure activities, a "Qualified Professional" approved by a Director must be continuously present on-site and supervise, inspect, photograph, document, approve and certify all closure activities including construction, installation, inspections, approvals, quality assurance and quality control, seam and leak testing, etc.
3. In the twice per month records submitted pursuant to the SPO section 1 d, include Final Closure Plan implementation updates including photos, status, and confirmation that a "Qualified Professional" is continuously present on-site.

4. In the As-Built plans and specifications submitted pursuant to the SPO section 6, include the "Qualified Professional" certified information, and related information, required by Condition 2.
5. In the SPO section 7, the duration specified in the approved Final Closure Plan is the post-closure period.
6. Carry out the closure activities set out in the approved Final Closure Plan with conditions and Addendum, to the satisfaction of the Minister. The Minister may amend the Final Closure Plan and conditions.

SHA requests MOE approval of the Final Closure Plan by June 15, 2017, and states that that if MOE approval, and contractors, cannot be lined up to commence by July 1, 2017, then SHA recommends that closure works be initiated during the 2018 construction season.

Allan Leuschen
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Authorizations- South

APPENDICES

APPENDIX A	Summary Table
APPENDIX B	SHA Final Closure Plan May 31, 2017
APPENDIX C	Hemmera Independent Review of Final Closure Plan June 22, 2017
APPENDIX D	SRG Information Submissions May 31, June 08, June 13 & June 21, 2017
APPENDIX E	MOE Memorandum - Review of water quality data from Cobble Hill Holdings contaminated soil facility June 22, 2017

APPENDIX A - SUMMARY TABLE		
SPO Final Closure Plan Requirements (Section 4.)	**SHA Final Closure Plan May 31, 2017**	**Hemmera Independent Review of Final Closure Plan June 22, 2017**
By May 31, 2017, the Named Parties must submit a final plan to permanently close the landfill (the "Final Closure Plan") to the Ministry for review and approval. The Final Closure Plan must use the LCMSW for guidance and provide sufficient technical justification to demonstrate that any proposed site-specific alternatives provide an equivalent or better level of environmental protection, be certified by a Qualified Professional,	Used the 2016 LCMSW for guidance. Included discussion of differences between the As-Built package and the 2016 LCMSW and technical justification (s. 3.4 Landfill Design Assessment). Certified by a QP (Dr. Tony Sperling, P.Eng. President SHA).	Hemmera concluded (s 4.0) that the Closure Plan appears to be a comprehensive document that substantially addresses the requirements of Section 4 of the SPO as well as input from MOE staff contained in letters dated March 17, April 13, and May 18, 2017, and appears to provide sufficient technical justification to demonstrate that proposed site-specific alternatives provide an equivalent or better level of environmental protection relative to LCMSW including for worst case conditions such as 200 year design storm event(s) plus snowmelt and multi-day precipitation events.
address and respond to any input from Ministry staff:		
MOE March 17, 2017 technical comments Item 1 a) to f) with regard to "As-Built" plans and specifications. Items 2 to 8, with regard to the Final Closure Plan.	The As-Built package addressed Item 1 a) to f) with regard to "As-Built" plans and specifications. Items 2 to 8, with regard to the Final Closure Plan, were substantially addressed in the SHA Final Closure Plan.	May 26, 2017 Hemmera Independent Review of Engineering Design (s. 2.1) reviewed the response to the MOE March 17, 2017 letter item 1 a) to f) with regard to "As-Built" plans and specifications. Hemmera concluded (s 4.0) that Closure Plan substantially addressed MOE March 17, 2017 letter.
MOE April 13, 2017 letter: Regardless of whether the leachate is treated on-site or not, it must be removed and transported to an off-site facility that is authorized to treat and/or dispose of the leachate. MOE is willing to consider the proposal to open up the landfill to dispose of the approximately 3000 tonnes of material currently in the Soil Management Area (SMA), if the Parties include this in the proposed Final Closure Plan	On-site leachate treatment not proposed (s. 5.4 etc.). Includes proposal to relocate approximately 3360 tonnes (1867 m^3) of contaminated soil in the soil management area to the landfill.	Hemmera concluded (s 4.0) that Closure Plan substantially addressed MOE April 13, 2017 letter. Acknowledged proposal to relocate contaminated soil in the soil management area to the landfill.
MOE May 18, 2017 letter: Please ensure the Final Closure Plan includes complete up to date accurate "As-Built" details, layers and cross-sections, including North-South and East-West cross-sections for all landfill Cells. Please address and respond to differences between the As-Built package and the 2016 LCMSW in the Final Closure Plan, section 4 a. (assessment of the adequacy of the existing Facility).	Includes additional landfill cross-sections (Appendix B) – not certified by a QP. Includes discussion of differences between the As-Built package and the 2016 LCMSW and technical justification (s. 3.4 Landfill Design Assessment).	Hemmera concluded (s 4.0) that Closure Plan substantially addressed MOE May 18, 2017 letter. Hemmera (s.3.1.1) indicates that As-built cross-sections of the landfill base provided by SIRM continue to not show details of clay berms between the three landfill cells that are apparent in photographs taken during the cell construction. Details of the current leachate and leak detection piping that are expected to intersect the liner in the vicinity of these berms are also not provided. It is anticipated that system modifications further to the landfill extension will mitigate any apparent shortcomings with the construction in these areas. Hemmera (s 2.1) also reviewed SHA's assessment of the adequacy of the existing facility (see Table below).
May 26, 2017 Hemmera Independent Review of Engineering Design Recommendations: 1. Ensure the leak detection system collector piping at the landfill slope toe has been adequately keyed into the clay layer such that it captures all potential leakage and non-contact infiltration from the surface of the underlying clay barrier. 2. Based on current construction, confirm that there are provisions in place to minimize non-contact water from entering the leakage detection system. For example, the base liner could be notched into the clay on the	1. A new leak detection perforated collector pipe will be keyed into the secondary clay liner. (s. 3.1). 2. Not addressed. 3. Leak detection tank piping was reinstated/repaired (SIRM email May 21, 2017). Leak detection tank quantity to be recorded during each monitoring event and correlated to precipitation data (s. 9.3). Leak detection water chemistry monitoring not explicitly clear. 4. New extended leachate collection system and leak detection system proposed. 5. Additional landfill cross-sections provided (Appendix B) – not certified by a QP.	Hemmera (s 4.0) concluded: The recommendations from the May 26, 2017 Hemmera report were also in general adequately addressed, however there was no discussion of provisions to eliminate non-contact water from entering the leakage detection system. (Recommendation 2). Hemmera (s 2.2, 3.1.2) notes that SHA Final Closure Plan appears to suggest but not specifically state that continuous QP inspection and documentation of all work particularly the geomembrane will occur.

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east, south and west sides of the PEA. 3. Reinstate leak detection tank piping and measure volumes collected. Correlate with rainfall events. Provide leakage water chemistry each time the leak detection tank is emptied. 4. Have a QP document and inspect the LCS and leak detection system. 5. Provide a complete set of as-built cross-sections (North-South & East-West) for each cell including down and across the base liner slopes, as well as confirmation of the clay liner extent southwards. Provide details showing the connections between cells 1A, 1B and 1C to confirm as-built construction. 6. Provide QP opinion and sign-off on the difference in base liner thickness, material, and expected life span relative to the use of 40 mil LLDPE vs 60 mil HDPE in the LCMSW. 7. Provide QP opinion and sign-off on the adequacy of not installing geotextile above the sand drainage layer to minimize fines intrusion into the leachate collection system. 8. Meter leachate flow into the leachate collection tank so that it can be correlated to precipitation data to assess and confirm cover integrity. Demonstrate that there is no correlation between rainfall events and leachate production due to cover liner leaks. Collect a sample for leachate chemistry before each tank is emptied. 9. Provide QP opinion and sign-off on the adequacy of the existing cover liner thickness and type (40 mill LLDPE smooth non-textured) relative to the use of textured geomembrane or geocomposite equivalent to a 600 mm barrier layer with a hydraulic conductivity >= 1 x 10-7 cm/sec as specified in the LCMSW. As well, the use of smooth non-textured geo-membrane should be re-evaluated before the final cover is started. 10. Have continuous QP inspection and documentation of all work completed on the PEA closure. 11. Design and install a representative groundwater monitoring program in the seepage blanket down-gradient of the PEA that will remain intact following final cover completion. Compare chemistry results to up-gradient background, leachate, and leak detection system water monitoring results to assess liner integrity.	6. Discussed in section 3.4. SHA indicates the existing 40 mil LLDPE primary geomembrane base liner and 1 m secondary clay liner is equivalent to the 2016 LCMSW 60 mil HDPE primary liner and 0.75 m clay liner (The CHHL membrane is a little thinner and the clay liner is a little thicker). SHA further indicates the 40 mil thickness will be adequate to provide the desired long term performance and a service life in excess of 100 years is anticipated (however, as SHA has not had any involvement in the construction of this liner it cannot warrant the liner integrity or service life). 7. Discussed in section 3.4. SHA indicates the 300 mm sand layer is expected to provide a high degree of filtration capacity and should be effective in preventing migration of fines toward the leachate collector and that furthermore, given that there is no new water entering the PEA there is no opportunity for water to carry the fines into the drainage layer and ultimately into the leachate collection system. 8. Leachate tank quantity will be recorded during each leachate removal and/or leachate tank monitoring event, and correlated to precipitation data. Metering not proposed. Leachate sample to be collected and analysed during each leachate removal event (s. 9.3) 9. Discussed in section 4.7. SHA indicates that proposed final cover layers exceed the 2016 LCMSW. Flattening of slopes to 3H:1V and installation of 40 mil LLDPE double-textured geomembrane cover proposed (s. 4.5). 10. SHA proposes QP inspection of the existing geomembrane cover (s. 4.5) but continuous QP inspection and documentation of all closure activities not explicitly stated. 11. Seepage blanket monitoring proposed – 2 standpipe monitoring wells excavated approximately 3.0 m into the seepage blanket at the landfill North toe (s. 9.6).	Hemmera (s 5.0) made new related Recommendations to address these items: (s 5.0): 2. Final cover design should contemplate construction methods to divert surface water and precipitation away from leak detection system. Confirm that there are provisions in the Closure Plan Final Cover design to minimize non-contact water from entering the leakage detection system. 5. Have continuous QP inspection and documentation of all work completed on the landfill closure. Inspection and QP approval of the modifications to the Basal liner system and the Leachate Collection and Leak Detection systems to be completed prior to regrading of landfill material.
and include the following: a. assessment of the adequacy of the existing Facility, including landfill stability (static and seismic), leachate collection and storage works, to prevent an escape or spill of Leachate into the environment during the post-closure period (determined in accordance with the LCMSW) and, if applicable, recommended revisions to the Facility to remedy any inadequacies;	Landfill Design Assessment and technical justification (s. 3.4) included the basal seepage layer, depth to water table, clay secondary liner, 40 mil LLDPE primary liner, texturing of liner, leachate collection layer, soil filter, leachate collection piping, and landfill grading. Geotechnical Considerations (s. 7.0) included static and seismic landfill slope stability analysis (s. 7.3) and final cover veneer stability analysis (s. 7.4) for the proposed revised works. The results indicate a high degree of landfill slope stability and low risk of failure (s. 7.3.4), the proposed final cover veneer will be very stable under worst case expected pore pressure conditions (s.7.4.1) (provided a good drainage layer is present that will prevent saturation of topsoil layer). The proposed new 40 mil LLDPE double-textured geomembrane and drainage gravel layer on the North and East landfill slopes is important for cover veneer stability.	Hemmera (s 2.1) noted that the 2016 LCMSW Design Criteria with regard to site layout, landfill base design, landfill base liner, and leachate collection system, do not apply to existing landfills. Hemmera reviewed SHA's assessment of the adequacy of the existing landfill facility including the basal seepage layer, clay secondary liner, 40 mil LLDPE primary liner, texturing of base and cover liners, leachate collection layer, soil filter, leachate collection piping, and landfill grading. In general, Hemmera agreed with SHA technical rationale and professional opinion for proposed site-specific alternatives, and the Final Closure Plan proposals to improve the works. Hemmera (s 2.2) noted: The Final Closure Plan included geotechnical considerations with regard to the stability of the landfill for both static and seismic conditions. There are no geotechnical design criteria for

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	Revisions to the Facility include: • Cut the existing 40 mil LLDPE smooth cover geomembrane along the crest of the landfill and fold it to the south. Remove the existing 40 mil LLDPE smooth cover geomembrane from the North and East landfill slopes. • Install a 10000 gallon (37.8 m^3) HDPE leachate collection tank, and a 2500 gallon (9.46 m^3) HDPE leak detection tank, approximately 20 m North of the landfill, located in a below ground lock block well lined with a 40 mil geomembrane liner (secondary containment), under a roof. • Remove the existing 2500 gallon leachate collection tank and the existing 2500 gallon leak detection tank, on the North side of the landfill. • Extend the landfill base liner system (includes shot rock seepage layer, 1 m secondary clay liner, sand leak detection layer, 40 mil LLDPE double-textured primary geomembrane liner, gravel drainage layer), leachate collection system, and leak detection system, to the North and East to allow flattening of the landfill slopes to maximum 3H:1V. • Install a new additional leachate collection system on the extended 40 mil LLDPE double-textured primary geomembrane liner. • Install a new additional leak detection system below the extended 40 mil LLDPE double-textured primary geomembrane liner and on the extended secondary clay liner. The new extended leak detection system is to be keyed into a notch in the extended secondary clay liner, to ensure that any leakage through the 40 mil LLDPE primary geomembrane liner is collected and detected. • Relocate approximately 3360 tonnes (1867 m^3) of contaminated soil from the soil management area to the landfill. • Re-grade the landfill North and East slopes to maximum 3H:1V. • Install final cover system on the landfill crest (includes existing 40 mil LLDPE smooth geomembrane, 200 mm sand, 500 mm low permeability soil, and 300 mm topsoil), and on the landfill North and East slopes (includes geotextile, new 40 mil LLDPE double-textured geomembrane, geotextile, 200 mm drainage gravel, and 300 mm topsoil) • Clean, wash-down (into the contact water/leachate storage pond) and decontaminate the soil management area. • De-commission the contact water/leachate storage pond. Leachate, sludge and the liner will be removed and transported off-site for disposal. The pond will be backfilled. • Carry out ongoing leachate removal from the new leachate collection tank and transport to an off-site facility. • Install new standpipe monitoring wells in the seepage layer (below the secondary clay liner), along the North toe of the landfill, to allow monitoring of water quality below the secondary clay liner. • Carry out ongoing post-closure inspection, operation, maintenance, and environmental monitoring program including monitoring of leachate, groundwater, surface water, and the seepage layer below the secondary clay liner. SHA further indicates: • The results of our as-built and data review do not indicate any significant technical issues with the engineering of the Cobble Hill Landfill. (cover letter page 2).	comparison within the 2016 Landfill Criteria. However, SHA concluded the deep seated factor of safety (FOS) for static and seismic conditions were more than 1.5 and 1.0, respectively, indicating that the landfill will be globally stable. Further recommendations are made for erosion control measures and closure construction considerations. The information presented in the Final Closure Plan appears reasonable, however the reviewers are not qualified to review geotechnical issues.

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	• Based on our review of As-Builts and construction documents, SHA does not foresee any technical or stability issues with the design of the Cobble Hill Landfill (Executive Summary p2). However, SHA also notes: • SHA was not involved in the detailed design nor construction QA/QC of those systems. We can only reflect on the commentary of those responsible for constructing the basal seepage layer (s. 3.4 basal seepage layer). • However, as SHA has not had any involvement in the construction of this liner we cannot warrant the liner integrity or service life, but only offer a professional opinion that a long service life is expected (s. 3.4 40 mil LLDPE primary liner).	
b. a plan for the management of any contaminated soil stored in the soil management area, in accordance with the Environmental Management Act;	Proposes to relocate approximately 3360 tonnes (1867 m^3) of contaminated soil from the soil management area to the landfill, and re-grade the North and East landfill slopes to maximum 3H:1V (s. 3.2).	Acknowledged proposal to relocate contaminated soil in the soil management area to the landfill.
c. proposed landfill final cover including slopes, layers, cross-sections, topsoil, vegetation and storm water management works including ditching on the landfill final cover. Stability assessment and hydrologic modeling that demonstrates the landfill final cover and ditching will be stable and adequate for worst case conditions including 200 year design storm event(s) plus snowmelt and multi-day precipitation events must be included;	Includes: • Final cover design for the landfill crest including layers (s. 4.5) • Final cover design on landfill slopes including layers (s. 4.6) • Cross-sections (Figure 4-2). • Final cover veneer stability analysis (s. 7.4) that confirmed the proposed final cover veneer will be very stable under worst case expected pore pressure conditions. North and East slope final cover system to include 40 mil LLDPE double-textured geomembrane and drainage gravel layer (important for cover veneer stability). • Surface (storm) water management (s. 6) including run-on diversion ditch, crest surface water ditch, and toe surface water ditch. Hydrologic modeling that concludes that all stormwater ditches and downchutes are designed to accommodate a 1 in 200-year rainfall event, with allowances for snowmelt and multi-day precipitation • Erosion control (s. 8) including hydroseeding, straw wattle ditch protection, straw slope protection, and erosion control in ditches.	Hemmera (s 2.2) reviewed the SHA Final Closure Plan final cover design and compared it to the 2016 LCMSW. Hemmera determined that the final cover design met or exceeded the LCMSW, the reviewers agree with final cover design, and it satisfied the additional requirements specified in the SPO.
d. a Leachate collection and storage plan including hydrologic modeling that demonstrates that the leachate collection and storage works including tanks, pipes, pumps, and leachate storage pond, will be adequate for worst case conditions including 200 year design storm event(s) plus snowmelt and multi-day precipitation events;	SHA (s 3.3) proposes to: De-commission the contact water/leachate storage pond. Leachate, sludge and the liner will be removed and transported off-site for disposal. The pond will be backfilled. Leachate Management Plan (s. 5) includes: • Hydrologic Evaluation of Landfill Performance (HELP) modeling of leachate production with the proposed final cover system that forecasts an average annual leachate production rate of 45 m^3/year. This is about 10 times less than the amount of leachate currently being captured, indicating that most of the contact water is being generated from consolidation of the soils within the PEA (s 5.3) • HELP modeling of worst case leachate production based on a 200-year wet winter weather forecast with monthly rainfall intensity of 1.5 times the average and including snow melt and multi-day precipitation, of approximately 58 m^3/year. (s. 5.3) • Current leachate production of approximately 0.5 m^3/day is expected to reduce to approximately 0.16 m^3/day or 58 m^3/year post-closure. (s. 5.3) Revisions to the facility include: • Install a new additional leachate collection system on the extended 40 mil LLDPE	Hemmera (s 2.2) noted that the SHA Final Closure Plan included HELP modeling and leachate generation estimation HELP modeling based on a 200-year wet winter weather with monthly rainfall intensity of 1.5 times the average and including snow melt and multi-day precipitation, and that the reviewers agree with the final cover design. However, Hemmera (s. 3.1.3) noted that removal of leachate from the storage tanks should be completed before levels exceed the capacity of the system to accommodate any unforeseen fluctuations in the leachate flow volume, as may be expected following extreme weather events. A remote telemetry level monitoring system may facilitate the ability to remove leachate in a timely manner, and more closely spaced inspections may be required in the absence of such a system until a clear trend in leachate accumulations in the new system is established. Hemmera (s. 5.0) made a related recommendation: 4. Confirm that the frequency of the storage tank inspections will be sufficient to identify water levels in the tanks, or meter leachate flow into

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	double-textured primary geomembrane liner. • Install a 10000 gallon (37.8 m^3) HDPE leachate collection tank, and a 2500 gallon (9.46 m^3) HDPE leak detection tank, approximately 20 m North of the landfill, located in a below ground lock block well lined with a 40 mil geomembrane liner (secondary containment), under a roof.	the leachate collection tank, such that leachate accumulations can be removed with sufficient remaining capacity to accommodate unforeseen increases in leachate volume. The required capacity should be determined and the maximum tank volumes specified in the monitoring and maintenance plans. Remote monitoring (telemetry) of the tank levels should be considered, possibly as part of the proposed leachate metering, to ensure that sufficient tank capacity is maintained regardless of tank inspection frequency.
e. a plan for Leachate removal and transport to an off-site facility that is authorized to treat and/or dispose of the Leachate;	Leachate stored in the tanks will be removed via a vac-truck (pumped truck) and transported off site to a regulated liquid waste facility for disposal. (s. 5.7)	Hemmera (s 5.0) made a recommendation with regard to leachate storage tank inspections (Recommendation 4)
f. a post-closure inspection, operation, maintenance and environmental monitoring program including: i. inspection, operation and maintenance of the landfill final cover including storm water management works on the landfill final cover, ditching, topsoil, vegetation and the repair of any damage due to erosion, leachate breakouts, slope failures, settlement and burrowing animals; ii. inspection, operation and maintenance of Leachate collection and storage works; iii. inspection, operation and maintenance of environmental monitoring works; and iv. an environmental monitoring program, including leachate monitoring, to verify that the escape or spill of Leachate into the environment has not occurred;	Post-closure monitoring plan (s. 9) that includes: • Suggestion that MOE consider the appropriate post-closure period (e.g. 25 year as per 1993 LCMSW vs. 50 year default as per 2016 LCMSW). • SHA is of the opinion that the characteristics of soil disposed at CHL will not pose a risk to human health or the environment beyond the 50-year post closure period and that aquatic life water quality objectives will be achieved at the property line after the post closure maintenance period has ended. (s 9.1) • Annual inspection (s. 9.8, 9.9 & 9.10) including landfill, final cover, ditching, topsoil, vegetation, leachate collection conveyance and storage facility, and environmental monitoring infrastructure. Repair and maintenance as required. • Environmental monitoring program (s. 9.3, 9.4, 9.5, Figure 9-1) including o Initial monthly monitoring of leachate collection tank level, and leak detection tank level, and correlation to precipitation data. o Leachate collection tank sampling and analysis during leachate removal. o Surface water sampling and analysis at 2 locations twice per year for 25 years, and then annually after 25 years. Monitoring locations are SW-2 immediately up-gradient of landfill, and SW-1 settling pond discharge. o Groundwater sampling and analysis of 3 wells, quarterly for 10 years, twice per year after 10 years, and annually after 25 years. Locations are MW-6 background up-gradient, and MW-2 and MW-3 down-gradient on west property boundary. o Seepage blanket sampling and analysis at 2 standpipe wells; quarterly conductivity readings and annual water quality analysis. Locations are standpipe wells (SHASB-1 & SHASB-2) excavated approximately 3.0 m into the seepage blanket at the landfill North toe (note Figure 3-1 indicates 3 proposed standpipe wells). o One-time monitoring run of VOC's emissions from a minimum of 10 locations (s. 9.7). • Annual report by a QP (s. 9.10) including assessment of monitoring data and recommendations.	Hemmera (s 2.2.) indicated: The reviewers agree with the SHA rationale and professional opinion provided regarding the expected contaminating lifespan of this landfill post closure (i.e. 50 years). The reviewers agree with the Post-Closure Leachate Monitoring plan. In general, the reviewers agree with the Post-Closure Groundwater and Surface Water Monitoring plan. Regarding the monitoring of the seepage blanket, the reviewers have two recommendations: 1. The number of monitoring wells be increased to at least 3, with the western most well relocated further to the west (east well spacing may also require adjusting to provide representative coverage) and an additional well installed adjacent to the subsurface leachate collection system piping near to the storage tanks to monitor any potential leaks in the piping. A 4th well may be required on the west portion of the seepage blanket to provide representative coverage. 2. That the seepage blanket monitoring well screens be extended to the competent bedrock surface (regardless of depth) to ensure all water within the seepage layer is captured in the wells. Hemmera also included these recommendations in Section 5.0 Recommendations 6 and 7. The reviewers agree with the Post-Closure Landfill Gas Monitoring plan.
g. contingency measures to address any failure of the works or the escape or spill of Leachate or Contaminated Soil into the environment; and MOE March 17, 2017 technical input (Item 8) included: The LCMSW (section 10.3.4) indicates that a closure plan must include practical and implementable contingency measures to address any failure of the works or non-compliance with the performance criteria. Contingency measures may include the following measures: extraction and treatment of groundwater	Includes: • A contingency measure to ensure no leachate is spilled into the environment (through leaking or cracked tanks) includes a secondary geomembrane liner and gravel cushion layer surrounding the storage tank, as well as a roof-structure to prevent precipitation (Executive Summary p2). • SHA notes that the proposed final cover system exceeds the 2016 LCMSW. These design enhancements have been incorporated into the design to ensure longevity of the cover, to minimize risk, and to minimize future leakage and treatment costs. By	Hemmera (s 3.0) identified: Contingency measures are provided for potential spills in the leachate storage tank area, such as a secondary geomembrane liner and gravel cushion layer surrounding the storage tank, as well as a roof structure to prevent infiltration of precipitation. The extra contingency afforded by the improvements to the cover design is also discussed. Additional contingency measures to address any failure of the works or the escape or spill of leachate, for example a plan for collection of leachate from the seepage blanket should the basal liner system be

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downgradient of the landfill site, establishment of monitored attenuation zones, and repair and/or installation of shallow leachate collection system.	adopting a conservative design approach our intent has been to avoid costs down the road post closure that would initiate the need for injection of funds from a contingency. It is important to recognize the many additional safety features of the proposed cover system design that go far beyond the minimum landfill criteria requirements to protect the environment. Although we have carried a 20% contingency in our calculations, we respectfully request that the Ministry recognize that the proposed closure system is going to cost two to three times as much as the minimum system outlined in the Criteria, and as such a 100% Contingency is already being invested in the project by Cobble Hill Holdings to minimize future risks to the environment. (s. 4.7) • Post Closure Monitoring (s 9) indicates inspections, maintenance and repairs will be carried out (s. 9.8, 9.9 & 9.10) and if significant issues with infrastructure are identified, a Qualified Professional should be retained to resolve them (s. 9.8).	found to be compromised, do not appear to have been included in the Final Closure Plan. Hemmera (s 5.0) made a related Recommendation: 8. Provide contingency measures to address any failure of the works or the escape or spill of Leachate or Contaminated Soil into the environment.
h. an implementation schedule which provides for commencement of closure activities by July 1, 2017, and completion of all closure activities by October 31, 2017.	SHA Final Closure Plan includes: • The Final Closure Design Chapter outlines a detailed guide for construction and closure of the landfill, as well as a conceptual construction schedule. (Executive Summary p2) • A list of work tasks to be completed prior to final cover system construction (s. 4.4). • It should be noted that all construction works associated with re-opening the PEA to complete regrading work and approved filling of remaining soil from the SMA area need to be completed during dry weather conditions during the summer of 2017 to ensure minimal contact between waste soil in the PEA and precipitation. This includes potential temporary tarping of exposure areas when inclement weather is forecasted. For this reason, it is imperative that timely approval from MOE be issued by June 15th, 2017 so that construction on this project can commence by July 1st, 2017; otherwise the work will have to be delayed to the summer of 2018. (s. 4.4) • Section 4.8 Closure Construction Scheduling - Based on Final Closure Plan approval from MoE before June 15th, 2017, CHH plans to begin closure works to the PEA by July 1st, 2017. SHA envisions approximately 8-12 weeks of construction time required to complete the recommended closure works. (s. 4.8) • If the works cannot be lined up to commence by July 1st, 2017 due to delays in approvals or availability of a suitable earthworks contractor and/or geomembrane installer, then SHA recommends that closure works be initiated during the 2018 construction season. In SHA's opinion, the PEA is secure, production of contact water is minimal and the risks to environment of deferring construction to a suitable construction window are far less than being caught by rains in the middle of construction (s. 4.8). • In SHA's professional opinion, sufficient time may not be available to secure all of the necessary contractors and materials to complete the recommended works by October 31st, 2017 (s. 4.8).	Hemmera (s 3.1.3) made comments: The discussion of the management of leachate during the basal layer extension works indicates that the new collection system will be established prior to the basal liner extension, however it is expected that a temporary system for collecting leachate will be required due to the extent of the system modifications. Hemmera (s 5.0) also made a related recommendation: 1. Ensure that the leachate collection and storage system is adequately maintained such that it continues to operate effectively throughout reconstruction of the landfill toe area during modifications being made to accommodate the final cover slopes. During final closure construction, the current contact water treatment system will be decommissioned. Please confirm if a temporary leachate collection system will be needed to manage leachate accumulations during the transition to the newly installed leachate storage facility.
The Final Closure Plan may be approved by the Minister, with or without conditions.		Hemmera made Recommendations to help avoid any leaks or spills of leachate to the environment and for the landfill closure to more closely conform with the 2016 LCMSW: 1. Ensure that the leachate collection and storage system is adequately maintained such that it continues to operate effectively throughout reconstruction of the landfill toe area during modifications being made to

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		accommodate the final cover slopes. During final closure construction, the current contact water treatment system will be decommissioned. Please confirm if a temporary leachate collection system will be needed to manage leachate accumulations during the transition to the newly installed leachate storage facility. 2. Final cover design should contemplate construction methods to divert surface water and precipitation away from leak detection system. Confirm that there are provisions in the Closure Plan Final Cover design to minimize non-contact water from entering the leakage detection system. 3. Confirm and discuss any potential issues that may arise further to unknowns regarding clay organic carbon content and stability of compacted clay liner (structure and permeability) when exposed to leachate. 4. Confirm that the frequency of the storage tank inspections will be sufficient to identify water levels in the tanks, or meter leachate flow into the leachate collection tank, such that leachate accumulations can be removed with sufficient remaining capacity to accommodate unforeseen increases in leachate volume. The required capacity should be determined and the maximum tank volumes specified in the monitoring and maintenance plans. Remote monitoring (telemetry) of the tank levels should be considered, possibly as part of the proposed leachate metering, to ensure that sufficient tank capacity is maintained regardless of tank inspection frequency. 5. Have continuous QP inspection and documentation of all work completed on the landfill closure. Inspection and QP approval of the modifications to the Basal liner system and the Leachate Collection and Leak Detection systems to be completed prior to regrading of landfill material. 6. The number of seepage blanket monitoring wells should be increased to at least three, with the western most well relocated further to the west (east well spacing may also require adjusting to provide representative coverage) and an additional well installed adjacent to the subsurface leachate collection system piping near to the storage tanks to monitor any potential leaks in the piping. A fourth well may be required on the west portion of the seepage blanket to provide representative coverage for groundwater capture. 7. The seepage blanket monitoring well screens should be extended to the competent bedrock surface (regardless of depth) to ensure all groundwater within the seepage layer is captured in the wells. 8. Provide contingency measures to address any failure of the works or the escape or spill of Leachate or Contaminated Soil into the environment.