



APPENDIX G

Compost Processing and Storage Area Design and Operations



December 2014

APPENDIX G

Compost Processing and Storage Area Design and Operations Volume IV Design and Operations Report Capital Region Resource Recovery Centre

REPORT



Report Number: 12-1125-0045/4500/vol IV





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Figure 1: Compost Processing and Storage Area Plan

Figure 2: Compost Processing and Storage Area Flow Chart



1.0 INTRODUCTION

This appendix to the Design and Operations (D&O) Report has been prepared to describe the proposed compost processing and storage area, a processing area that will operate as a component of the Capital Region Resource Recovery Centre (CRRRC). This appendix should be read in conjunction with the D&O Report for the complete CRRRC Site that is Volume IV of the document package. The D&O Report has been prepared to support an application for approval under the *Environmental Assessment Act* (EAA) (MOE, 2010a), and also for subsequent approvals under the *Environmental Protection Act* (EPA) (MOE, 2010b) and *Ontario Water Resources Act* (OWRA) (MOE, 2011) in support of the application for an Environmental Compliance Approval (ECA) for the CRRRC.

The compost processing and storage area will require a total footprint of 3.5 hectares, and will be located in the northern part of the Site, adjacent to the organics processing facility (see Appendix F of Volume IV). The proposed compost processing and storage area consists of a paved processing and storage pad, and is designed to process and compost incoming leaf and yard (L&Y) waste and clean wood from the construction and demolition (C&D) processing facility, and to process/cure digested product from the organics processing facility.

This D&O Report has been prepared to describe the design of the compost processing and storage area and the on-Site operations, which include the following activities:

- The receipt and processing of a maximum of 20,000 tonnes per year of L&Y waste;
- The processing/curing of digested product from the organics processing facility (which will receive up to a maximum of 50,000 tonnes per year for processing);
- A maximum storage quantity of 400 tonnes of L&Y waste waiting to be ground and 20,000 tonnes of finished product;
- Receiving hours of 6:00 a.m. to 6:00 p.m., Monday to Saturday; and,
- Operating hours of 6:00 a.m. to 7:00 p.m., Monday to Saturday.

The Compost Processing and Storage Area D&O Report, in conjunction with the D&O Report for the complete CRRRC Site, has been prepared in accordance with the Ministry of the Environment and Climate Change (MOECC) Guide to Applying for an Environmental Compliance Approval (MOE, 2012c), and with the MOECC Ontario Compost Quality Standards (MOE, 2012b).

1.1 Regulations

The Guideline for the Production of Compost in Ontario (MOE, 2012a) recommends planning, design and operational practices for aerobic composting facilities. The companion Ontario Compost Quality Standards (MOE, 2012b) sets environmentally protective standards for the production of compost for beneficial use and applies to compost produced by aerobic composting of non-hazardous organic materials. The design and operations of the compost processing and storage area have been developed using the Ontario Compost Quality Standards and the Guideline for the Production of Compost in Ontario.



APPENDIX G, VOL IV – DESIGN AND OPERATIONS REPORT COMPOST PROCESSING AND STORAGE AREA D&O

Part IV and Part V of *Ontario Regulation* (O. Reg.) 101/94 (MOE, 1994) applies to sites whose only function is to accept and transfer municipal waste, as defined in O.Reg. 347 (MOE, 1990), for recycling or to compost L&Y waste. Part IV and Part V of O.Reg 101/94 were used as guidance when developing this appendix to the D&O report for the compost processing and storage area.

Materials produced from the compost processing and storage area that are categorized as waste materials under O.Reg. 347 (MOE, 1990) will be managed in accordance with this regulation.



2.0 AREA DESIGN AND LAYOUT

2.1 Sources, Types and Estimated Quantities of Waste

The CRRRC compost processing and storage area will receive L&Y waste from the Industrial, Commercial and Institutional (IC&I) sector, clean wood waste from the on-Site C&D processing facility, and digested product from the on-Site organics processing facility.

2.1.1 Leaf and Yard Waste

The sources of L&Y waste will include:

- Collection from the IC&I sector; and,
- Drop-off of small loads (i.e., independent landscapers, property maintenance contractors).

The L&Y waste types to be accepted include leaves, brush, branches, hedge and tree trimmings, garden plants and trimmings, sod, and tree stumps. L&Y waste received in biodegradable bags, with the exception of plastic biodegradable bags, will be accepted. L&Y waste in non-biodegradable (or plastic biodegradable) bags will not be accepted.

It is estimated that the compost processing and storage area will receive approximately 20,000 tonnes of L&Y waste per year. L&Y waste will be received at the compost processing and storage area via the primary scale upon arrival at the CRRRC Site, or from the small loads drop-off area.

2.1.2 Organics Processing Facility Digested Product

Digested product will be received at the compost processing and storage area from the on-Site organics processing facility, initially from the demonstration-scale operation and then the full scale operation. The digested product is the result of the processing of source-separated organics (SSO) and organics from the mixed IC&I waste stream. The proposed processing involves anaerobic digestion of the organic materials, mixed with a bulking agent and carbon source, for a period of approximately 12 to 18 months, followed by aeration prior to placement at the compost processing and storage area. Biogas and liquor generated during the process are removed from the digested product during the treatment cycle.

2.1.3 Wood Waste

Clean wood from the on-Site C&D processing facility may be accepted at the compost processing and storage area from time to time, as needed for mixing with other materials for composting. Clean wood is clean ground wood product from the C&D processing facility excluding painted, treated or laminated wood.

2.2 Area Design

2.2.1 Layout

The approximately 3.5 hectare paved compost processing and storage area will house the receiving, storage, composting and curing operations. The general layout of the compost processing and storage area is illustrated on Figure 1. The CRRRC compost processing and storage area will be comprised of an outdoor windrow/trapezoidal pile composting operation for L&Y and wood waste. Processing/curing of the digested product from the on-Site organics processing facility will also occur on the outdoor compost pad, separate from L&Y materials, and downgradient (in terms of surface water runoff) of the windrow/trapezoidal pile curing of L&Y and wood waste.



2.2.2 Water Management

The paved compost processing and storage area will be sloped to a series of catchbasins. The surface water runoff that enters the catchbasins will be conveyed to a stormwater management pond referred to as pond 4a. Pond 4a will be a two celled storage pond dedicated to receive runoff from the proposed compost pad area. One cell will be dedicated to receive runoff from final curing areas of the pad while the other will be for runoff from the remainder. This pond is sized to contain runoff equivalent to 110 % of a 1:25 year, 24 hour event for the pad area, without discharge to off-Site surface water. The stored water within the pond cells will be managed to maintain adequate capacity by re-using the water from the appropriate cell for compost pile spraying and Site irrigation. To ensure Site irrigation is a viable option, water quality samples from both cells of pond 4a will be collected for analysis during the demonstration phase of the organics processing facility. Should water quality be such that Site irrigation is not possible, it is contemplated that surplus water from pond 4a would be taken to the City of Ottawa wastewater treatment plant with the pre-treated wastewater from the Site.

Further, aerators would be considered for this pond as a contingency, if odour were to become an issue.

Further details on the design of stormwater management pond 4a are provided in Volume IV, Appendix A – Stormwater Management System Design.

2.3 Area Capacity

The compost processing and storage area operations will take place on an outdoor asphalt pad. In general, the Site is designed for:

- The receipt and processing of a maximum of 20,000 tonnes per year of L&Y and wood waste; and,
- The processing/curing of digested product from the organics processing facility (which will receive up to a maximum of 50,000 tonnes per year for processing). Digested product from the organics processing facility will be removed progressively from the primary reactor cells and placed at the compost processing and storage area for final processing/curing. The need for any further processing of the digested product and length of the curing period will be determined during the initial, demonstration scale operation of the BioPower organics processing facility.

The asphalt pad has been sized based on the area required for receipt, pre-processing, windrow or trapezoidal composting, processing/curing of digested product, screening and storage of the final product.

2.4 Waste Storage

The compost processing and storage area can store the following:

- A maximum of 400 tonnes of unprocessed L&Y waste; and,
- A maximum of 20,000 tonnes of final product.

It is expected that the digested product from the organics processing facility will be placed directly into its processing/curing configuration and as such will not be included in the storage tonnage.



3.0 COMPOST PROCESSING AND STORAGE AREA OPERATIONS

3.1 Hours of Operation

The compost processing and storage area will operate between the hours of 6:00 a.m. and 7:00 p.m., Monday through Saturday. Waste will be received at the CRRRC between the hours of 6:00 a.m. and 6:00 p.m. The Site is expected to operate between 300 and 312 days per year.

3.2 Operating Parameters

Composting is a controlled aerobic microbiological process that decomposes organic matter into carbon dioxide, water, minerals and stabilized organic matter. The operational criteria that the compost processing and storage area procedures are designed to meet are:

- A minimum C:N ratio of 20:1 for the curing of digested product from the organics processing facility and a minimum 25:1 for the L&Y waste operation; C:N ratios are controlled through appropriate mixing of feedstocks;
- A target of 10% oxygen content, which is controlled through targeting a compost mass porosity of 20% free air space and turning of windrows/trapezoidal piles;
- A moisture content between 40% and 55% with an optimal target of 50%. Moisture levels, which are initially set during feedstock preparation, can be controlled through turning (windrows/piles), by addition of water from on-Site sources, by increasing compost mass temperature and by boosting the percentage of bulking amendments in the compost mass;
- A particle size of between 2.5 and 5 centimetres achieved by grinding the waste during the pre-processing phase; and,
- Temperatures between 40 and 60 degrees Celsius depending on the compost processing phase.

Activities and processes associated with the operation include the receiving of waste, pre-processing (grinding, and mixing), formation of windrows for composting (L&Y and clean wood waste), active composting, curing (of aerobically composted material and of digested product from the organics processing facility) and screening. The manner in which the composting operations will be carried out is described in the following sections.

3.3 Waste Acceptance Procedure

Additionally, small L&Y waste loads may be accepted at the small loads area; it is expected that this will make up a very small percentage of the total incoming waste stream. All incoming vehicles must enter and exit over the weigh scale to determine the weight of waste coming into the compost processing and storage area. The scale attendant will do an initial visual screening of the load. After the initial weigh-in, and assuming the initial screening indicates suitable material, the incoming vehicle will be directed to the compost processing and storage area. An employee located at the compost processing and storage area receiving area will do a final inspection of the incoming material to ensure that the load does not contain any unacceptable or prohibited wastes or materials. Loads that do contain prohibited materials will be rejected and will be reloaded onto the vehicle delivering the load.



In the unlikely event that unacceptable or prohibited material is not detected until the hauler has left the Site, the material will be segregated, characterized, and managed in accordance with O. Reg. 347 (MOE, 1990). An incident report will be completed. Effort will be made to identify and contact the customer and/or generator of the materials to ensure that prohibited materials will not be delivered to the Site in the future.

3.4 Composting Procedures

The operational flow chart for the compost processing and storage area is shown on Figure 2. The following sections describe the different aspects of the compost processing and storage area.

3.4.1 Pre-Processing

Pre-processing of L&Y waste will involve grinding of material and mixing. L&Y waste accepted at the compost processing and storage area may be stored for up to one week (up to a maximum quantity of 400 tonnes) prior to pre-processing.

Digested product from the primary reactor cells of the organics processing facility may be mixed with shredded L&Y waste to enhance aerobic activity prior to curing.

Clean, chipped wood waste from the C&D processing facility will be mixed with L&Y waste or digested product for composting from time to time, as required.

3.4.2 Composting

The windrows/trapezoidal piles will be oriented such that they run parallel to the constructed slope of the asphalt pad to allow for proper drainage. Windrows will be formed to measure approximately five to eight metres wide, three to four metres high and up to fifty metres in length. The dimensions of windrows may vary depending on feedstock characteristics, time of year, ambient temperatures and other factors affecting composting operations. Trapezoidal piles will vary in length and width depending on the amount of feedstock received and operational limitations on size. Spacing between the windrows/trapezoidal piles will be approximately 2 metres to allow movement between, and the routine turning of piles. The orientation and spacing between windrows/trapezoidal piles may be modified from time-to-time at the discretion of the operator.

The shape of the windrows/trapezoidal piles can be modified as necessary, depending on moisture requirements. For example, if additional moisture is required, the top of windrows/piles can be of concave shape to promote capture of precipitation. If it is desirable to shed excess rainfall, the top of the windrow/pile can be convex. This will be monitored and adjusted as necessary during operation.

After windrow/trapezoidal pile formation, the location on the composting pad, as well as the month, day and year of formation of the windrow/trapezoidal pile, will be recorded and tracked.

The composting process will be managed so that it enters into a high rate or active phase. It is also the part of the compost processing used to inactivate any pathogens that may be in the incoming feedstocks. This part of the composting process is characterized by temperatures exceeding 55°C. The windrows/trapezoidal piles will be maintained at 55°C for at least fifteen days. This fifteen day period will not necessarily be consecutive, but will be cumulative. Windrows/piles will be turned a minimum of five times during this period.



The temperature of each windrow/pile will be measured in accordance with the operating schedule for the Site (i.e., measurements not recorded on Sundays or statutory holidays) at a depth of at least one metre deep into the windrow/pile mass, at a minimum of five representative locations. The mean temperature of each windrow/trapezoidal pile will be calculated and recorded. Moisture content will also be monitored by squeeze test or sampling for laboratory analysis, if required.

It is also possible that an aerated pile composting process may be utilized on the pad, wherein air is introduced to the material to be composted in order to sustain elevated oxygen content within the material and thereby further assist/accelerate the pathogen kill and composting process. If this process is to be utilized, the compost pad would be designed/equipped to supply the air and collect the liquid generated from this process; the liquid would be re-used to moisture-condition the material.

3.4.3 Curing

Once a windrow/pile has achieved 55 degrees Celsius on fifteen separate days, (or three days if using aerated pile composting), the compost mass will be relocated on the asphalt pad to the curing area. Digested product from the organics processing facility will also be cured in this area. The location on the pad, as well as the month, day and year of formation of the curing windrow/pile will be recorded and tracked. Curing windrows/piles will be left to cure until the final compost meets the Provincial requirements for compost quality (MOE, 2012b). This curing process will be a minimum of thirty days but can take up to six months. Curing windrows/piles will be maintained such that conditions for curing under the Ontario Compost Quality Standards are met.

During the curing stage, the temperature of each windrow/pile will be measured at a depth at least one metre deep into the windrow/pile mass, at a minimum of five representative locations, on at least a weekly basis. The mean temperature of each windrow/pile will be calculated and recorded. While the windrows/piles are in the curing stage they will be turned on a frequency of not less than once per month. L&Y waste compost that has cured for 6 months or more will be considered stable without further testing. For L&Y waste compost that has cured for less than 6 months, standard Solvita testing will be used on-Site as an indicator of maturity. Off-Site sample testing by an accredited laboratory will be used in determining final stability of the finished product.

3.4.4 Screening

At or near the end of the curing period, the product will be screened to eliminate oversized residues (overs). Overs will be stockpiled at the compost processing and storage area and inspected. Overs largely consisting of wood materials may be re-shredded and re-composted. More contaminated, or otherwise unsuitable, overs will be transferred to the on-Site landfill for use as daily cover.

3.5 Compost Final Use

The final product derived from the composting and curing of L&Y waste will be sold to landscapers, soil blenders and farmers as a soil amendment. The final product derived from the digested product from the organics processing facility will be assessed for potential commercial sale. The final product may also be used on-Site for various uses.

3.6 Waste Receiving Sites

Waste residuals screened out of the compost and cured digested product as overs will be sent to the on-Site landfill.



3.7 Equipment

The compost processing and storage area operation will utilize the following mobile equipment:

- Ford F-150 4x4 pickup truck (shared with organics processing facility);
- 3 Caterpillar 966 loaders (one shared with organics processing facility);
- Rotochopper B-66 chipper/shredder;
- McCloskey 36×100 ST uncovered conveyor;
- Caterpillar M318 excavator;
- Vermeer CT1010TX compost turner;
- 2 McCloskey 621/628 screens; and,
- Komptech Hurrikan air classifier.

Note that all models are presented on an “or equivalent” basis.

A preventative maintenance program will be followed for each piece of equipment based on manufacturer’s specifications.

3.8 Staff Training

A training plan will be developed and maintained for all employees that operate the compost processing and storage area. Trained personnel will supervise all receiving of waste at the compost processing and storage area. All employees directly involved with activities relating to the area will be trained in the following:

- Relevant waste management legislation, regulations and guidelines;
- Major environmental concerns pertaining to the waste being handled;
- Occupational health and safety concerns pertaining to the processes and waste to be handled;
- Management procedures including the use and operation of equipment for the processes and waste to be handled;
- Environmental emergency and contingency procedures for the processes and waste to be handled;
- The use and operation of the equipment to be used by the operator;
- Procedures for the refusal of unacceptable loads;
- Site specific written procedures for the control of nuisance conditions;
- Record keeping procedures; and,
- The requirements of the ECA.

A record of the employee training, including the date of training, the name and signature of the employee and a description of the training provided will be maintained.



3.9 Quality Control

3.9.1 Feedstock Quality

An acceptance procedure for L&Y waste as described in Section 3.3 will be followed. The feedstock will meet the quality guidelines as per the Ontario Compost Quality Standards (MOE, 2012b).

Digested product from the organics processing facility and wood waste from the C&D processing facility will have previously undergone screening when it was accepted at the organics processing facility or the C&D processing facility.

3.9.2 Cross-Contamination

Good material management practices will minimize the likelihood of cross-contamination. Cross-contamination-reducing practices designed into the operating procedures include the following:

- Equipment used for the processing and turning of materials that have yet to complete the requirements for pathogen inactivation will be decontaminated prior to their use in the processing and turning of curing materials;
- Placement of L&Y and wood waste materials upgradient (in terms of surface water) from the digested product from the organics processing facility;
- Dedicated bucket for the transfer and turning of curing materials;
- Separation of active composting stage and curing materials; and,
- Designated receiving area.

3.9.3 Final Product Sampling and Analysis

Sampling of the final compost will be conducted to determine the quality of the final product. Sampling and analysis will be conducted as required by the Ontario Compost Quality Standards (MOE, 2012b) as amended and/or any other applicable regulations/standards.

Finished product will not be removed from the Site until the curing period is complete and until the product has been sampled and analyzed and the quality shown to meet the applicable quality requirements.

The results of the analysis will dictate the final use of the compost. If compost analyses indicate that the final product meets the applicable requirements, the material is considered a product and not a waste.

Compost derived from L&Y waste only that is not of acceptable quality for use will be returned to the start of the windrow composting process and incorporated into the incoming feedstock, or sent to the landfill as daily cover, or possibly used to support vegetation growth on the landfill final cover. Compost derived from digested product that is not of acceptable quality for use will be returned to the start of the organics processing facility and incorporated into the incoming feedstock, or sent to the landfill as daily cover, or possibly used to support vegetation growth on the landfill final cover.



3.9.4 Data Review

Prior to the release of finished compost, the data collected in the composting process will be reviewed.

The data reviewed for the digested product from the organics processing facility operation will include the following:

- Date that the material was pre-processed and loaded into the primary reactor;
- Date that the digested product was removed from the primary reactor and formed into curing windrows/trapezoidal piles or possibly aerated piles;
- Temperature readings, date of windrow/pile turnings and end date of curing period; and,
- Analytical results with respect to finished product quality, compost maturity, foreign matter, pathogens and trace elements.

The data reviewed for the open windrow/pile composting operation will include the following:

- Component make-up of the windrow/pile;
- Date and time of windrow/pile formation;
- Temperature readings, date that temperature readings were taken and date of windrow/pile turning to ensure that pathogen inactivation requirements have been met;
- Date that windrows/piles were transferred and re-formed on curing pad;
- End date of curing period; and,
- Analytical results with respect to finished product quality, maturity, foreign matter and trace elements.



4.0 ODOUR MANAGEMENT PLAN

Odour at the compost processing and storage area can be reduced through proper compost management, best management practices and odour monitoring.

4.1 Compost Management

It is important to ensure that the L&Y waste is prepared properly so that the feedstock has the proper carbon to nitrogen (C:N) ratio. L&Y waste being composted in outdoor windrows/trapezoidal piles should have a C:N ratio of 25:1 to 30:1. The presence of an ammonia odour is a sign that nitrogen levels are too high, and in some cases leaves or other carbon sources should be incorporated into the windrow/pile so that a suitable C:N ratio is restored, (i.e., roughly 1 part green to 3 parts brown material).

Odours also become problematic when the compost mass becomes anaerobic. Providing sufficient wood chips or overs to achieve 20% porosity and ensuring that the compost mass is maintained at less than 60% moisture to prevent over saturation will help maintain aerobic conditions.

4.2 Best Management Practices

The following best management practices will be maintained to prevent the generation of odours:

- Loads of grass clippings will be incorporated into windrows/trapezoidal piles on the day of receipt and no later than within four days of receipt;
- Any standing water on the compost pad will be removed, and modifications made to the pad/ pad drainage to prevent water from ponding;
- Windrows/piles will be turned based on temperature, moisture and oxygen requirements to prevent anaerobic conditions;
- The windrows/trapezoidal piles will be turned only when wind direction and atmospheric pressure conditions are suitable. Windrow/pile turning will be avoided during weather inversions, during early morning and late evening and during east winds (i.e., when winds are blowing in the direction of sensitive receptors). Windrow/pile handling will be minimized during humid climate conditions; and,
- Any material in an advanced anaerobic state, if it cannot be brought back to an aerobic state, will be landfilled.

4.3 Contingencies

An aerator(s) for the stormwater pond receiving runoff from the compost processing and storage area would be implemented if required due to objectionable odour.

4.4 Odour Monitoring

Subjective compost processing and storage area odour monitoring will be conducted on a continuous basis. If any compost processing and storage area odours are detected, the cause of the odour will be investigated and the problem corrected. The date and time of the odour problem, the compost processing and storage area activities that were happening that may have caused the odour, and the corrective action will be recorded in order to implement continual improvement management practices.



5.0 MONITORING, ENVIRONMENTAL EMERGENCY AND CONTINGENCY PLAN

An Environmental Emergency and Contingency (E2C) Plan will be developed for the entire CRRRC Site as described in the D&O Report for the complete CRRRC Site.

Environmental monitoring related to the compost processing and storage area will be carried out concurrently with the overall Site monitoring program. As such, reference should be made to the overall facility D&O report for monitoring, trigger mechanisms and contingency measures related to groundwater, leachate, surface water, sediment, dust, noise, odour and biology.



6.0 CLOSURE PLAN

The compost processing and storage area will be decommissioned and closed prior to a change in use or sale of the property. A closure plan will be completed and submitted to the District Manager of the MOECC at least six months prior to closure.

In general the closure plan will:

- Cease acceptance of L&Y waste and digested product from the organics processing facility;
- Continue operations until all L&Y waste has been processed and digested product from the organics processing facility has been cured. Alternatively, unfinished product may be transferred to another approved composting facility to complete the process, or be landfilled;
- Transfer final product to markets;
- Remove all residual waste to final disposal; and,
- Remove all equipment.



7.0 CLOSURE

We trust that this report meets your current needs. If you have any questions, or if we may be of further assistance, please contact the undersigned.

GOLDER ASSOCIATES LTD.

M.K. Farnel, P.Eng.
Environmental Engineer

P.A. Smolkin, P.Eng.
Principal

ALC/MKF/PAS/sg

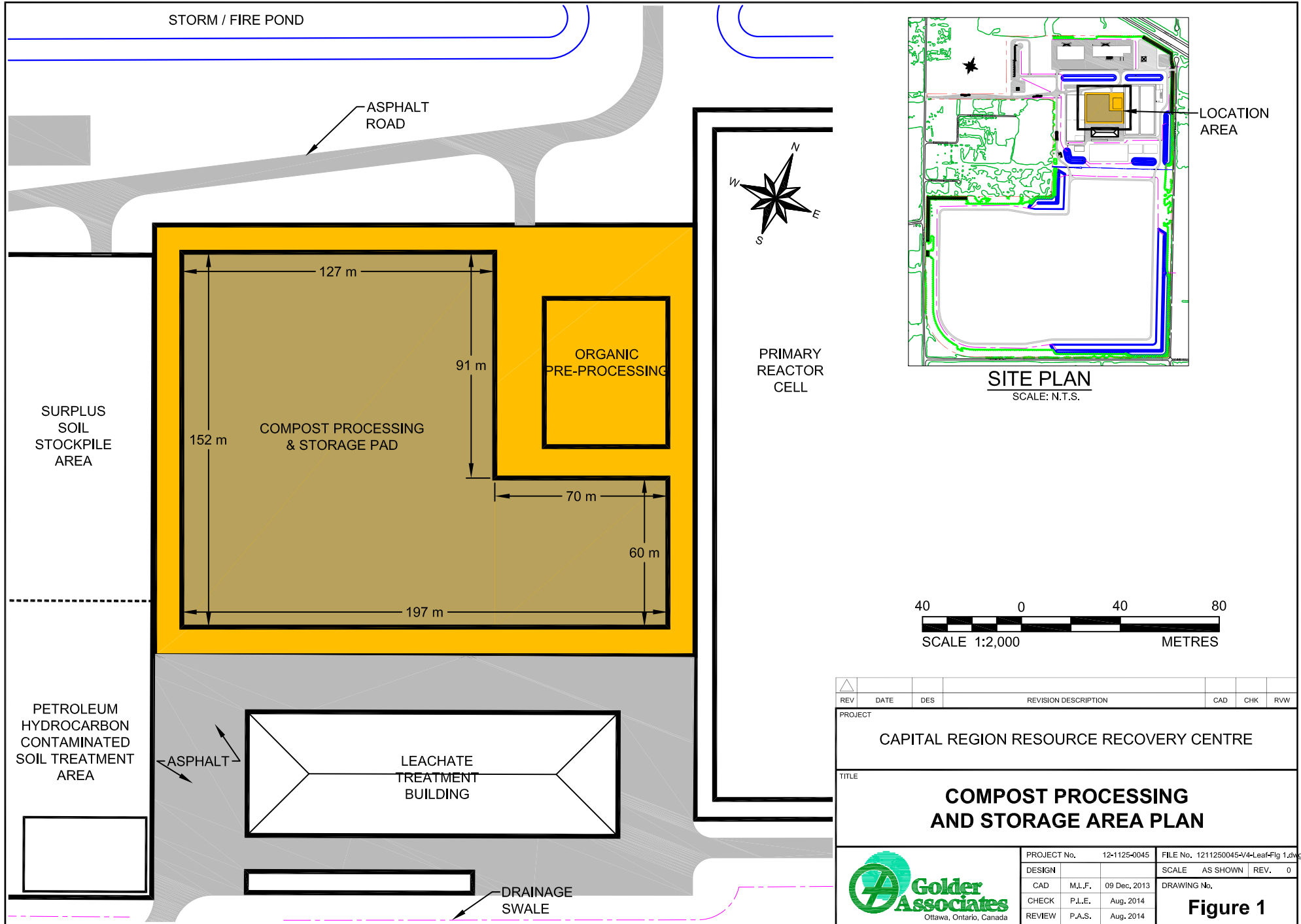
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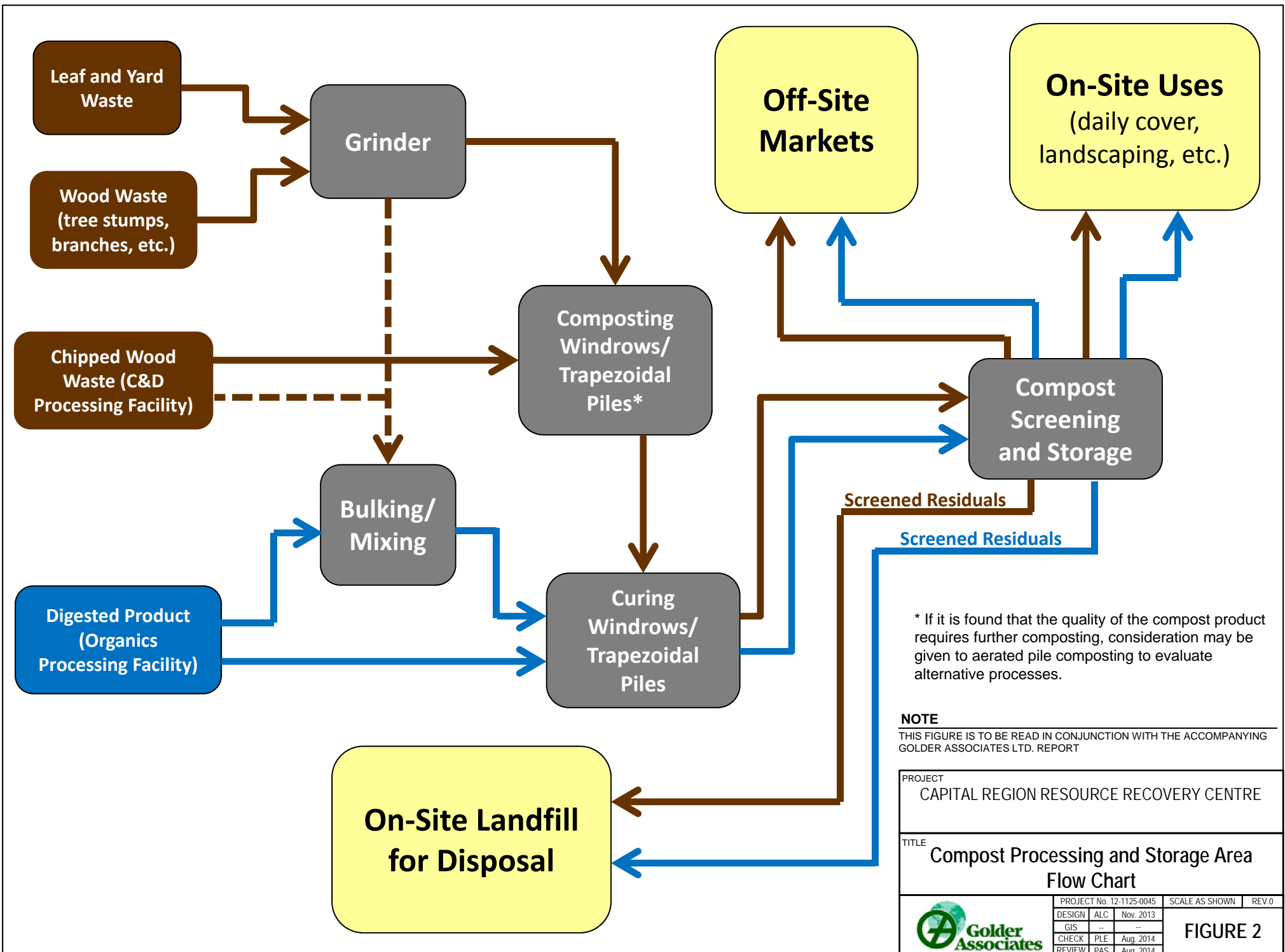


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REV	DATE	DES	REVISION DESCRIPTION	CAD	CHK	RWW
PROJECT						
CAPITAL REGION RESOURCE RECOVERY CENTRE						
TITLE						
COMPOST PROCESSING AND STORAGE AREA PLAN						
PROJECT No. 12-1125-0045			FILE No. 1211250045-V4-Leaf-Fig 1.dwg			
DESIGN			SCALE AS SHOWN REV. 0			
CAD	M.L.F.	09 Dec, 2013	DRAWING No.			
CHECK	P.L.E.	Aug, 2014	Figure 1			
REVIEW	P.A.S.	Aug, 2014				



* If it is found that the quality of the compost product requires further composting, consideration may be given to aerated pile composting to evaluate alternative processes.

NOTE
THIS FIGURE IS TO BE READ IN CONJUNCTION WITH THE ACCOMPANYING GOLDER ASSOCIATES LTD. REPORT

PROJECT
CAPITAL REGION RESOURCE RECOVERY CENTRE

TITLE
Compost Processing and Storage Area
Flow Chart

PROJECT No. 12-1125-0045			SCALE AS SHOWN	REV.0
DESIGN	ALC	Nov. 2013		
GIS	--	--		
CHECK	PLE	Aug. 2014		
REVIEW	PAS	Aug. 2014		



FIGURE 2

As a global, employee-owned organisation with over 50 years of experience, Golder Associates is driven by our purpose to engineer earth's development while preserving earth's integrity. We deliver solutions that help our clients achieve their sustainable development goals by providing a wide range of independent consulting, design and construction services in our specialist areas of earth, environment and energy.

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