New and emerging technologies in waste management

A range of new and emerging technologies potentially applicable to the City of Ottawa's future solid waste management will be explored throughout development of the Solid Waste Master Plan. In order to have conversations about the various technologies, and their advantages and disadvantages, it is important to acquire an understanding of the range and type of available and upcoming new technologies and their potential role in managing waste.

While this information gives an indication of what may be possible in Ottawa, all of the options will be carefully considered and evaluated in Phase 2 and will be accompanied by more fulsome business cases to consider factors, such as financial, environmental, operational and regulatory implications, as well as benefits and risks.

New and emerging technologies that will be explored can be categorized according to the following aspects of waste management:

- Waste avoidance, reduction and reuse;
- Waste diversion;
- Collection fleet;
- Collection approach alternatives;
- Recycling processes;
- Source separated organics;
- Mixed waste processing;
- Recovery; and,
- Landfill disposal.

Avoidance, reduction and reuse

This category includes approaches and technologies that help to avoid the creation of waste, reduce the amount of waste generated and increase the reuse of waste to the maximum extent possible prior to sending it for processing and/or disposal. For example, the avoidance and reduction of food waste can be advanced through disposal bans on food waste in landfills, campaigns to reduce food waste, programs to avoid and reduce food waste, and the use of mobile apps. New approaches include:

- Flashfood App: An app developed for grocery stores to advertise food that they otherwise would throw out at a reduced price.
- Love Food Hate Waste Canada: A national food waste education campaign launched by the National Zero Waste Council in July 2018.

Waste diversion

Waste diversion technologies and approaches look to keep material out of the landfill and include regulatory approaches, promotion and education, waste collection options and waste diversion targets. One approach being discussed globally, nationally and at the municipal level across Canada is the target goal of Zero Waste. This aspirational goal sets the context for the development of waste management initiatives and some municipalities, including Toronto and Calgary, have included it as a vision, guiding principle or goal in their solid waste management plans. Other regulatory approaches include:

- Implementing bylaws that specify how materials should be set out for collection;
- Imposing landfill bans to reject certain materials;
- PAYT (Pay As You Throw) systems that encourage diversion by applying user fees for garbage; and
- Introducing clear bags so that contents of garbage bags are visible, which facilitates enforcement of waste separation at the curb.

Diversion of textiles, such as clothing and linen, from landfill has become a topic of interest for many municipalities. Most clothing ends up being disposed at the end of its life with only a small amount being donated for reuse and recycling purposes. Many Canadian municipalities, such as Markham and New York, have implemented successful textile waste diversion collection programs and often partner with community organizations or non-profits in the collection of textiles.

Collection fleet

There are several types of alternative collection fleet technologies that can provide several benefits, such as helping to reduce greenhouse gas emissions, supporting operational efficiencies and addressing challenges with recruiting and retaining collections staff. The

technology includes new types of vehicles, such as electric, hybrid and autonomous, and alternative fuels.

The Terminology

Electric powered vehicles run on electricity and use an electric motor powered by electricity from batteries or a fuel cell. Rio de Janeiro has introduced a new fleet of all electric waste collection trucks. Testing of electric waste collection trucks is yet to be completed in cold climates, such as Ottawa.

A **hybrid vehicle** uses a combination of electricity and fuel (e.g., gasoline, diesel) to power it. The City of New York's Department of Sanitation has over 50 hybrid waste collection trucks (of the 2,100 collection truck fleet) that are achieving a 10 to 15 percent improvement in fuel economy.

Autonomous (and semi-autonomous) vehicles use sophisticated computer systems linked to cameras and sensors to pilot a vehicle without the need for a human driver (or partially without the need for a human operator). The technology is still being tested for waste collection vehicles.

The use of **alternative fuels** (for example, Compressed Natural Gas (CNG), biogas, biodiesel, Liquefied Natural Gas) for waste management purposes can replace the need for traditional petroleum-based fuels, such as diesel and gasoline. The City of Surrey in British Columbia uses a closed-loop system where Green Carts are collected via CNG powered vehicles and the fuel used is generated from a biofuel facility which processes food and organic waste.

Collection approach alternatives

Various waste collection approaches can provide alternatives to 'traditional' waste collection methods. Benefits to these approaches can include a reduction in the number of collection vehicles, increased convenience to residents, operating efficiencies and increased recycling capacity. One common approach is the use of automated collection to collect waste carts. Automated collection involves a specially designed truck that uses 'arms' to pick up carts, empty them and then return them to their original position. Multiple jurisdictions use

automated cart collection for all streams of waste and many offer variable sizes of carts, with savings for residents that choose to use smaller garbage carts.

Other alternative collection approaches include:

- In-ground containers, which have been successfully used in various European countries, including Sweden. This technology allows garbage to be stored underground and taken away by pipe instead of trucks. The vacuum system also helps to reduce odors associated with the garbage.
- Optibag systems, where different coloured bags are used for the different waste streams. The bags can be placed in one collection container and then sorted at an optical sorting processing facility. Optibags are often used in conjunction with a vacuum/chute collection system. The technology is primarily used in Europe and has been successfully employed in Oslo.
- Monitoring technology, such as Radio Frequency Identification (RFID) chips that are used for tracking waste generation rates, diversion statistics and container capacity.

Recycling Processes

New technologies can supplement traditional manual recycling sorting. Source separation allows for the waste generator to get involved in the early stages of sorting; the more a homeowner sorts at the source, the higher the quality recyclables are for processing. While sorting at source results in the highest quality of recyclable material, user convenience, collection system considerations and increasing types of materials being recycled has resulted in the evolution of sorting technologies at recycling facilities. Common equipment currently used to sort materials at these facilities includes optical sensors and magnets, and new and emerging processing technology includes robotics and artificial intelligence.

In addition to source separation processes, technology is currently being developed that could potentially change how recyclables are processed. Chemical recycling is one such emerging technology. Chemical recycling of waste plastic is a process where a polymer is chemically reduced to its original form so that it can eventually be processed and remade into new plastic materials that are made into new plastic products.

Source Separated Organics

New and emerging technologies look to modify ways to handle and process source separated organics, including household food waste and leaf and yard waste. Approaches currently being used to process organic waste include aerobic and anaerobic digestion and emerging technologies include mechanical/chemical processing, co-digestion of sewage and organics and biological processing.

The Terminology

Aerobic composting is a *naturally* occurring process where organisms break down organic material in the presence of oxygen. This composting process is used by many municipalities that have food and yard waste collection programs, including the City of Ottawa.

Anaerobic digestion *biologically* converts organic waste into biogas under anaerobic conditions (without oxygen). The biogas can be used as fuel for boilers, be converted into electricity, and can be upgraded to Renewable Natural Gas (RNG). The City of Toronto has two facilities that create biogas, one of which is currently being upgraded to allow transformation of biogas into RNG.

Mechanical/chemical processing uses a combination of heat, alkali, and shear mixing to effectively breakdown biological material. Recycling this product back into anaerobic digesters enhances the biogas production. This technology is currently being used for biosolids (glossary) but is still an emerging technology as an application for food waste.

Biological processing uses insects or worms to decompose organic material into compost.

Co-digestion of sewage and organics at wastewater treatment plants mixes organic food waste with municipal sewage sludge, which are then anaerobically digested to create biogas.

Mixed Waste Processing

Mixed waste processing technology uses processing equipment and labour to sort mixed waste to remove recyclable items for market and possibly recover organic material for processing, resulting in a residual waste stream that is then further processed into a refuse-derived fuel or landfilled. Mixed waste processing starts with unsorted and unseparated solid waste from residential and/or commercial collection vehicles being off-loaded onto a tipping floor. Materials are first sorted on the floor using manual labour (if appropriate) and mobile equipment. Materials are then processed through multi-stage screens to separate fibre, plastic, metal and glass containers, and small contaminants.

The technology is more widespread in Europe, but facilities are becoming more common in the US, such as the Montgomery/RePower South facility, which opened in 2018.

Recovery technologies

Recovery technologies are emerging as a replacement to the ‘traditional’ method of disposing of garbage in a landfill. These approaches explore the use of technology such as mass burn incineration (sometimes referred to as waste-to-energy). Waste-to-energy technology uses traditional combustion methods to burn waste in order to generate energy in the form of electricity or heat. The end result of the combustion process also produces fly ash and bottom ash. Ash can be disposed of at a regular landfill and fly ash, typically being hazardous due to concentrations of heavy metals and other pollutants, is usually disposed of at a hazardous waste landfill.

Another technology, landfill mining, involves excavating previously landfilled waste to recover valuable recyclable materials, soils and/or space. This technology is proven and has been used at several municipalities, including Durham Region. Their pilot project was conducted between October 2018 and January 2019 and recovered approximately 98 tonnes of scrap metal, and 500 tires.

Landfill disposal

Various landfill disposal technologies are currently being used by many municipalities to maximize space, reduce environmental impacts and generate energy. Many landfills go through an optimization process to review current operations and assess what the benefits would be to enhance operations, such as maximizing the amount of waste landfilled within existing approved contours.

One landfill disposal technology currently being used is **baling**. Fredericton Region's landfill became the first landfill in Atlantic Canada to bale solid waste. Baling involves garbage being placed in a large compactor which compresses the waste into rectangular cubes. Baling reduces the environmental impact of leachate, keeps the site clean by reducing and preventing blowing litter and helps extend the lifespan of the landfill.