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### ecomaine: AN INTEGRATED WASTE MANAGEMENT SYSTEM

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#### ABSTRACT

**ecomaine** manages solid waste for its member communities through an integrated strategy that includes a single sort recycling center, a waste-to-energy (WTE) power plant and a 250 acre landfill for residual ash. The public organization has over 40 member communities in Maine which equates to over 24% of the State's population. Established as a non-profit in the 1970's with a mission to address trash disposal for future generations, a comprehensive waste system has emerged. The method of balefilling municipal solid waste (MSW) was replaced by a state-of-the-art WTE facility in 1988 and the multiple-sort recycling system was upgraded to a single-sort advanced system in 2007. Roughly 170,000 tons of MSW are processed through the WTE facility each year. This results in an average of 83,000-105,000 megawatt-hours of electricity generated annually. Since 2005, recycling tonnage has increased 71% from 21,000 to 36,000 tons. The State of Maine established a "Solid Waste Management Hierarchy" in 2007 cascading in disposal preference from Reduce, Reuse, Recycle, Compost, Waste-to-Energy to Landfilling MSW. **ecomaine** is researching the feasibility of implementing an organics recovery system that would include food waste to further advance the Solid Waste Hierarchy and State's recycling goal of 50%.

**ecomaine** continues to manage its resources through innovation that highlight the resiliency of an integrated waste management system. For example, **ecomaine** has adapted to periods of waste shortages through strategies of caching MSW during times of higher waste generation and storing that waste until it is needed. **ecomaine** selects cover material for temporary use that is combustible so that it can efficiently be processed through the WTE facility. When fuel is scarce, the cached material is returned to the WTE as a fuel input. Another example, of matching a waste to a beneficial reuse is **ecomaine's** ash metals mining project for the recovery of both ferrous metals and valuable non-ferrous material from screened ash. **ecomaine** strives to sustainably treat residual waste streams after enhanced resource recovery, re-use and recycling efforts and embrace an integrated waste management system. While challenges face many waste disposal operations such as changing regulations, **ecomaine** communities believe an integrated system with a good design and forward-looking plant management allow for a robust and effective service, as the **ecomaine** example shows.

**KEY WORDS:** Integrated solid waste management, waste-to-energy, single-stream recycling, composting, sustainability, solid waste hierarchy.

## WASTE HIERARCHY

**ecomaine** believes that an integrated waste management system is closely aligned with the solid waste management hierarchy espoused by State and Federal governments. The State of Maine's legislature passed Title 38 section 2101 (38MRSA§2101) which specifies an order of preference for handling waste from reduce, reuse, recycle, compost, waste-to-energy to lastly landfilling. **ecomaine** has developed a business model which strives to follow the hierarchy as closely as possible.

Figure 1: Solid Waste Management Hierarchy [1]



As the country's largest publicly owned and operated WTE [2], **ecomaine** functions as a collaborative of many communities that have an active and genuine interest in its operation. The **ecomaine** Board of Directors represent the State's largest municipalities including city managers, council members and public works directors. The board members impart extensive knowledge and take long-views for the stewardship of **ecomaine** in the best interest of their communities which is critical to the success of **ecomaine's** integrated waste management system.

Figure 2: Communities of **ecomaine** [3]

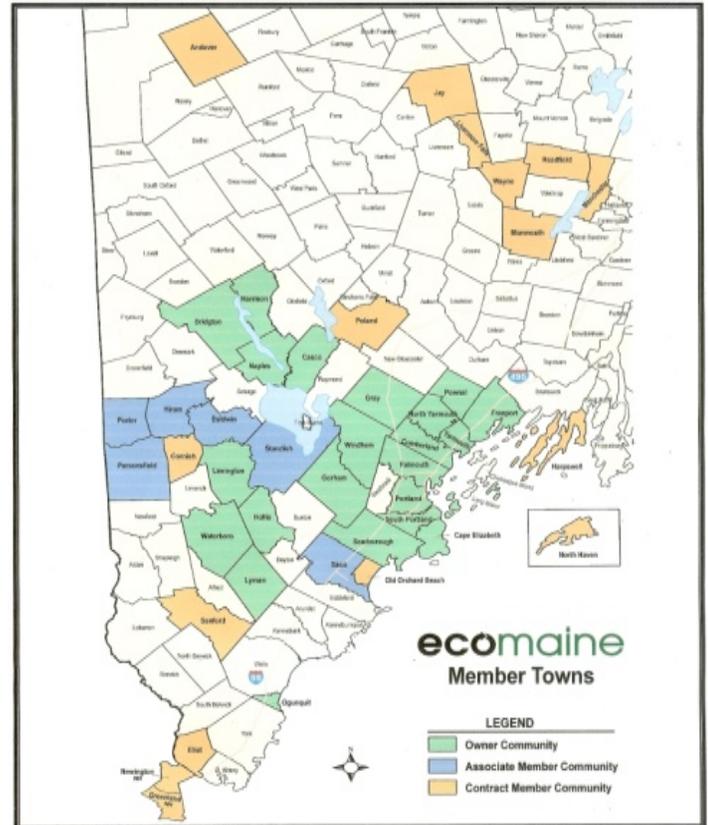


Table 1: Board of **ecomaine** Directors

Name	# Rep	Meet	Functions
Full Board	29	quarterly	Policy makers, elect officers, adopt budget, amend by-laws, elect committee members
Executive Board	9	monthly	Propose budget, disburse funds, review financial audit, directs general manager
Finance Committee	8	quarterly	Organize budget, monitor financial performance
Audit Committee	6	quarterly	Annual audit
Recycling Committee	12	monthly	Recycling/ environmental programs and promote outreach

In an effort to highlight an integrated waste system, this paper will discuss each rung in the pyramid of the solid waste hierarchy.

## REDUCE

As the 'host facility' for NAWTECs Spring conference, **ecomaine** can highlight many activities that comprise an integrated waste management system and the elements of the waste hierarchy. Starting with the top tier of the waste hierarchy, reduce. At the 2011 Fall annual Open House event, **ecomaine** highlighted a new partnership with the non-profit national organization entitled "Catalog Choice." Through the arrangement, **ecomaine** communities are encouraged to register to stop unwanted advertising mail and phone books. Based on the first four months [Sept-Jan] of the partnership, **ecomaine** participants have reduced 26.5 tons CO<sub>2</sub> from entering the atmosphere, saved 127,624 gallons of water and reduced 9.4 tons of waste from production. While Catalog Choice reduces the amount of material input to the recycling center, **ecomaine's** organization supports the overarching goal to "reduce" in keeping with the solid waste hierarchy.

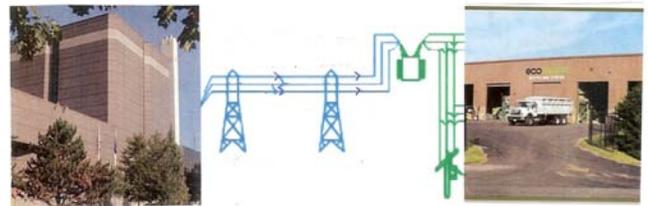
**ecomaine** also actively promotes educational information to the public in ways they can be more efficient with waste by reducing its use. For example, at Christmas time community television stations feature a segment on reduce, reuse and disposal preferences for wrapping paper and related packaging material. Incentives have been provided to **ecomaine** communities to recycle more and reduce the volume of trash produced which directly translates into lower tipping fees charged back to the communities.

## REUSE

The WTE power plant at **ecomaine** embraces several reuse scenarios. For example, floor drain water is reused as dilution water in the reactor to control scrubber temperatures and it is also used in the ash extractor quench tanks. Cooling tower blowdown water is used in the lime slaker and it is cycled through the reverse osmosis system where it is demineralized

for other process uses. **ecomaine** replaced natural gas heaters in the ash truck garage by redirecting the excess plant heat on the top floor of the boiler house to heat the ash garage; therefore, reducing thermal release out the roof and eliminating greenhouse gases generated from the fossil-based natural gas. Two 15,000 gallon boiler drain tanks hold boiler tube water in the event of maintenance and boiler shutdown as opposed to discharging to the City water district. **ecomaine's** distributed energy resource system provides an enhanced alternative for electricity supply at the **ecomaine** Recycling Center where its power is provided by the **ecomaine** Waste-to-Energy plant.

Figure 3: Electric distribution between **ecomaine's** WTE and Recycling Center



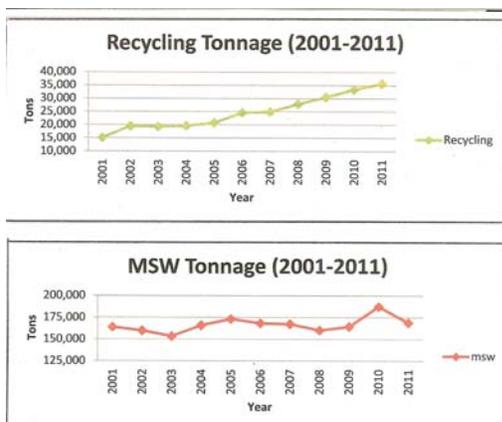
The electricity generated from waste is used to power the recycling center as well as for WTE offices. **ecomaine's** integrated waste management system acts as an industrial metabolism allowing one section's waste to feed another section's input material.

## RECYCLING

In 2006, **ecomaine's** Board of Directors agreed to expand the multi-sort recycle center into a state-of-the-art single sort facility and is the only facility in the State of Maine. The solid waste management hierarchy is a driving force in **ecomaine's** goal of continuous environmental improvement which has also served to strengthen its integrated waste management system. By implementing a single-sort recycling strategy, another rung in the hierarchy, organics recovery or composting, is now an option that could be relatively easy to implement through a 3 bin system.

**ecomaine** markets the end-products of paper, plastic, aluminum, tin and glass to local markets first, then regional, domestic and overseas distributors. The number of tons of recycling materials has increased by 71% in the last 6 years. The graph below illustrates the amount of recycling and MSW tonnage over the past decade. The data also demonstrate the compatibility between recycling and WTE [4].

**Figure 4:** Graphs of last 10 years [2001-2011] for recycling and waste tonnage



The recycling facility has even greater capacity with the potential to run additional shifts which could expand the recycling program and add revenue. The recycling operation has tremendous potential and has been a great source of pride for the **ecomaine** communities as evidence by educational outreach response and from the Board of Directors of whom several members actively serve on the Recycling Committee.

**ORGANICS RECOVERY & COMPOSTING**

**ecomaine** continues to strive for ecological excellence and is actively investigating municipal food waste recovery and composting programs. Ideally, **ecomaine** would like to offer comprehensive disposal opportunities to its members that include MSW, recycling and organics recovery/composting. While the weight associated

with current organic waste deliveries may decrease if this fraction is diverted to composting with a related reduction in revenue from tipping fees, **ecomaine** feels strongly this activity is the right thing to do and adheres to the solid waste hierarchy. An organics recovery/composting program could potentially stimulate new enterprises such as marketing the compost material or cogenerate electricity, etc.

**ecomaine’s** mission and flexibility as a multi-faceted organization has resulted in strategies to source organics and recycling first in conformance with the waste hierarchy while non-recyclables and non-recoverable materials are sent to WTE.

**WASTE-TO-ENERGY**

The next level of the solid waste hierarchy is WTE. **ecomaine’s** waste-to-energy facility was constructed in 1987 and came-online in 1988.

**Figure 5:** **ecomaine** WTE, Portland, Maine



The WTE is comprised of two Steinmuller massburn design boilers with capacity to handle 550 tons per day (tpd) of MSW. The plant processes 170,000 tons of waste annually with 43% from municipal sources, 40% commercial source and 17% from spot market. Over 2200 tons of scrap metal is also recovered annually. The boilers continuously combust MSW and the construction of welded membrane water-walls are the nexus to generate steam and turn the turbine. **ecomaine’s** annual electric production is 105,000 MW hours. The waste-to-energy process is a renewable

source of electricity for which RECs are procured. In addition, the efficient reduction of MSW to ash allows disposal practices at **ecomaine**'s ashfill well beyond 2038. The combined ash is a mixture of bottom ash and flyash in a 9:1 ratio with approximately 45,000 tons ash disposed at the ashfill annually. **ecomaine** has two sets air pollution control technology (APCT) systems – (carbon, urea, lime slurry, ESPs) and duplicate continuous emissions monitoring systems (CEMS/CERMS/COMS) to assure compliance with regulatory air requirements. In fact, removal efficiencies of pollution controls consistently demonstrate minimal impact of **ecomaine** operations on the surrounding environment. **ecomaine** has continuously maintained its ISO 14001 certification for its environmental management system (EMS) at all three facilities: WTE, recycling and landfill/ashfill.

Figure 6: **ecomaine**'s ISO 14001 Certificate



**ecomaine**'s achievement of ISO 14001 certification recognizes a high standard to manage environmental responsibilities and a commitment to continuous improvement. **ecomaine**'s EMS provides a framework for managing environmental responsibilities. Developed by the International Organization for Standardization (ISO) based in Geneva, the system outlines procedures and policies for organizations to use to manage their potential impact on the environment. **ecomaine**'s commitment to environmental protection is evidenced by the registration of the Waste-to-Energy Facility in March 2002, the Recycling Center in October 2002, and the Landfill/Ashfill in March 2007. Every 6 months **ecomaine**'s three facilities

are audited and the ISO 14001 certification has been consistently maintained since each facility was first registered.

## LANDFILL

Landfilling municipal solid waste (MSW) was practiced by the regional waste cooperative that became **ecomaine** during the first phase of handling trash in the Greater Portland region; therefore, the bottom tier of the solid waste hierarchy is evidenced.

Figure 7: An example of a balefill [5]



The original stakeholders of **ecomaine** obtained 250 acres in South Portland and Scarborough to operate a landfill (balefill) as well as a structure two miles away in Portland to bale the MSW for disposal. The balefill section of the landfill stopped receiving MSW in 1988 and a closure permit was issued in 1998. Today, over 20 years later the closed balefill is a viable habitat and environmentally stable site through the process of closure.

Figure 8: **ecomaine**'s closed landfill



The closed balefill is vigilantly monitored for geotechnical stability, surface water, groundwater and the installation of a flare to control methane production, a greenhouse gas (ghg). **ecomaine** maintains complex gas control systems and an air permit with the Air Bureau of the MDEP in conformance with regulatory requirements.

Many concerns abound with landfilling raw MSW including the production of methane and the generation of leachate. Research conducted by **ecomaine** in 2007 demonstrated many advantages to the alkaline ashfill leachate from WTE air pollution controls. The higher pH (potential of hydrogen) associated with the alkaline ash serves to stabilize heavy metals while reducing the release of cadmium (Cd) or lead (Pb) to leachate [6]. The more acidic pH of leachate from MSW landfills release heavy metals to the leachate, thus, the environmental impacts are more significant than ashfill leachate. According to the National Renewable Energy Lab, processed MSW residue by way of WTE, stabilize the waste for efficient and secure disposal at ash landfills. Ashfills provide a sustainable future by ensuring the longevity of the land due to 90% reduction in volume by processing MSW through a WTE rather than storing the trash in a landfill. Consequently, Waste-to-Energy Plants address consumption practices of a population longer into the future.

Figure 9: Classic image from Lancaster County Solid Waste District in PA Comparing the Disposal of MSW at landfill and the 90% reduction of Ash from the processing of MSW at WTE [7]



As an integrated waste management system, **ecomaine**, utilizes landfill property in a manner which affords flexibility in assuring a constant fuel source at the WTE. For example, during the year there are times when waste-fuel is plentiful and times when fuel is scarce. **ecomaine** has employed a system of ‘caching’ MSW temporarily at the landfill until it is needed at the WTE. Part of the benefit of this strategy is to locate a temporary cover material that has heating value for combustion purposes at the WTE. It is also advantageous to broker a material that has a tipping fee. The Landfill Manager has devised a ‘bunker’ space at the landfill to accommodate and manage waste during these episodes. In 2010, 10,000 tons were stored in this manner and to date, nearly 100% of the waste has been returned to the WTE for fuel. The financial calculation means, tipping fees are collected when the material is first delivered and later when it is burned and the electric generation returns the investment through kwh produced.

## BEST PRACTICES

**ecomaine** manages its three facilities which allow a level of flexibility such as caching MSW at the landfill for future consumption at the WTE. Operating an integrated system allows for a unique operation that is rigorous and eliminates Recycling facilities, WTEs and composting facilities from competing for the same or similar waste streams. **ecomaine** is not competing with itself for waste material and instead, critical thinking may be applied to decide the best use of material to benefit the best facility. In other words, this lack of competition amongst the **ecomaine** facilities actually strengthens the best practices for all waste materials. **ecomaine** confirms GAA’s premise that recycling and WTE can co-exist at a municipal level [4].

**ecomaine**’s business plan has addressed waste shortages by prospecting new members and growing **ecomaine**’s regional

service area. The capacity of both the WTE and the recycling center can continue to expand by attracting new members and engaging in innovative contracts to bring in more tonnage.

In another strategy for innovatively assessing its integrated resources, **ecomaine** recently commenced an 'ash metals mining' project. This is a pure resource recovery project where an outside firm has found the commodities market for iron-bearing metal and non-iron alloys to be lucrative enough to actually sieve the 20 years worth of ash. As a result, valuable ferrous metal and non-ferrous material such as aluminum and copper have been removed and sold. In addition, **ecomaine** is gaining valuable air-space to allow future disposal opportunities. A key component of an integrated waste management system is the maneuverability to think 'outside of the box' and implement innovative waste strategies.

In regard to concerns about sustainable practices for waste disposal, communities must consider the efficient use of their land. Fears for communities about filling up valuable landfill space and restrictions on locating new landfills are legitimate and was impetus for the members of **ecomaine's** regional waste system to make a substantial investment in the future by constructing a waste-to-energy power plant and a single sort recycling facility. Sustainable development is defined as activities that meet the needs of the present generation without compromising the ability of future generations to meet their own needs [8]. The Board of **ecomaine** took a long-view when they made the financial investment to construct a recycling facility and a WTE power plant to sustainably address their future solid waste disposal needs, enhancing the solid waste hierarchy and establishing an integrated waste management system.

## CONCLUSION

**ecomaine's** integrated waste management system closely aligns with the solid waste hierarchy and **ecomaine** continuously strives to embrace the top tiers. **ecomaine's** operations comply to the rules of the hierarchy to reduce before recycle, recycle before WTE, WTE before storing waste in a landfill for our future generations to address. **ecomaine** is evaluating another tier to offer food waste composting to its communities so that organics recycling could occur before WTE.

The solid waste hierarchy emphasizes a reduction in the volume of waste and stabilization of waste to make it suitable for ash landfilling. The hierarchy and integrated waste management system are parallel strategies toward achieving environmental sustainability. The ability to own and operate a single-sort recycling center, WTE and landfill/ashfill allows **ecomaine** flexibility to manage its resources and allow for an integrated system to use the industry's best practices in solid waste management. Each tier of the **ecomaine** system reinforces the other which allows a strategic approach to assure that all areas receive the feedstock they require to efficiently operate.

### Literature Cited:

- [1] Maine Legislature 2007, Title 38, Section 2101 Solid Waste Management Hierarchy,
- [2] Hauck, P., LoRe, A. & Trytek, K., 2011 "Has the Time Come for More Publicly Operated WTE Facilities in the US?" Nawtec19-5416
- [3] **ecomaine** Communities brochure, 2011
- [4] Berenyi, E. 2009 "Recycling and Waste-to-Energy: Are They Compatible?" Governmental Advisory Associates, Inc., (GAA) Westport, CT.
- [5] Photo of a Balefill [http://www.waste-to-fuels.com/proceedings/2011/content/pdf/CU\\_RRO\\_J.pdf](http://www.waste-to-fuels.com/proceedings/2011/content/pdf/CU_RRO_J.pdf) downloaded 12-19-11
- [6] National Renewable Energy Laboratory (NREL), 1992, "Data Summary of Municipal

Solid Waste Management Alternatives:  
Volume I.” Golden, CO.

[7] Photo from Lancaster County Solid  
Waste District, PA <http://www.lcswma.org/>  
downloaded 8-9-07

[8] World Commission on Environment and  
Development (WCED), 1987, “Our Common  
Future,” Oxford, UK

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