



MICRO-CREDENTIAL

Circular Economy for Land and Waste Management

Week 6: Recycling and Material Recovery

Land impacts of recycling facilities

CELWS-W06-V03



Co-funded by
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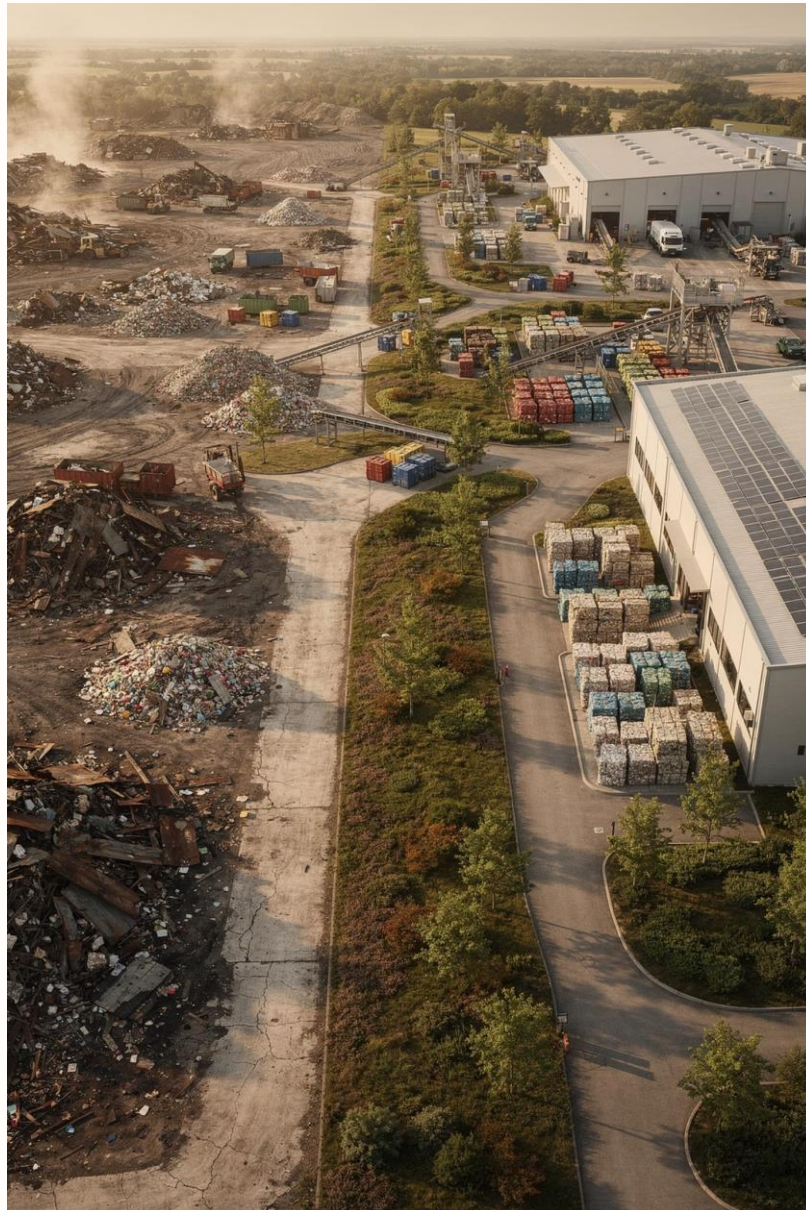
CIRCULAR ECONOMY FOR LAND AND WASTE MANAGEMENT

6.- Recycling and Material Recovery

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The Land Footprint of Recycling: From Burden to Benefit



How modern recycling infrastructure is reshaping land use — transforming waste liabilities into environmental assets and charting a course toward a circular economy.

The Growing Landfill Crisis

As urban populations expand and consumption patterns intensify, the land consumed by waste is reaching a tipping point. Understanding the true scale of this crisis is the first step toward meaningful change.



Global Land Impact

Landfills are among the most land-intensive infrastructure systems in the world. Globally, they occupy vast tracts that could otherwise support agriculture, habitat, or development. Beyond the active footprint, landfills require decades of post-closure monitoring and buffer zones, creating long-term land-use constraints that extend well beyond the fill boundary.

- Ecosystems disrupted by leachate contamination
- Methane emissions contributing to climate change
- Long-term remediation obligations lasting 30+ years

The Scale of the Problem

The average American generates **4.9 lbs of trash per day** — translating to nearly 900 lbs per person annually. Multiply this across hundreds of millions of residents, and the land demand becomes staggering.

The Wicklow Case: A New Landfill Approved

Project Overview

Kilsaran Concrete Unlimited Company received planning permission for a large landfill and materials recovery facility at **Ballinclare Quarry in Wicklow, Ireland**. The facility is designed to handle by-product materials and inert wastes generated by construction and development projects in the region.

Community & Land-Use Tension

Despite community opposition, the approval underscores the persistent demand for dedicated waste disposal sites. The case highlights a recurring dilemma in land management: the need for waste infrastructure in areas where local residents bear the environmental and aesthetic costs. The Wicklow approval is emblematic of decisions being made in communities worldwide as landfill capacity dwindles.



Landfills: A Growing Footprint



From above, the sheer scale of modern landfills becomes impossible to ignore. These engineered landscapes represent not just discarded materials, but permanently transformed land — a direct consequence of our linear take-make-dispose economy.

The Promise of Advanced Recycling



A new generation of recycling infrastructure is emerging — smarter, larger, and more efficient than ever before. These facilities promise to fundamentally alter the relationship between waste volume and land consumption.

The Investment

Waste Management (WM) is committing **\$1.4 billion** to expand and modernize its network of Material Recovery Facilities (MRFs) across the United States. This represents one of the largest single investments in recycling infrastructure in American history.

Orange, California Flagship

The new Orange, CA facility serves as a flagship for the initiative — a highly automated plant capable of processing materials at volumes and efficiencies that far exceed legacy systems. By concentrating recycling capacity in advanced facilities, WM aims to dramatically reduce the volume of materials destined for landfill.

Land-Use Logic

Each MRF built represents a calculated land trade-off: a smaller, productive industrial footprint today in exchange for avoiding far larger landfill expansions tomorrow. The net land impact over decades strongly favors investment in modern recycling infrastructure.

Plasrefine's Proposal

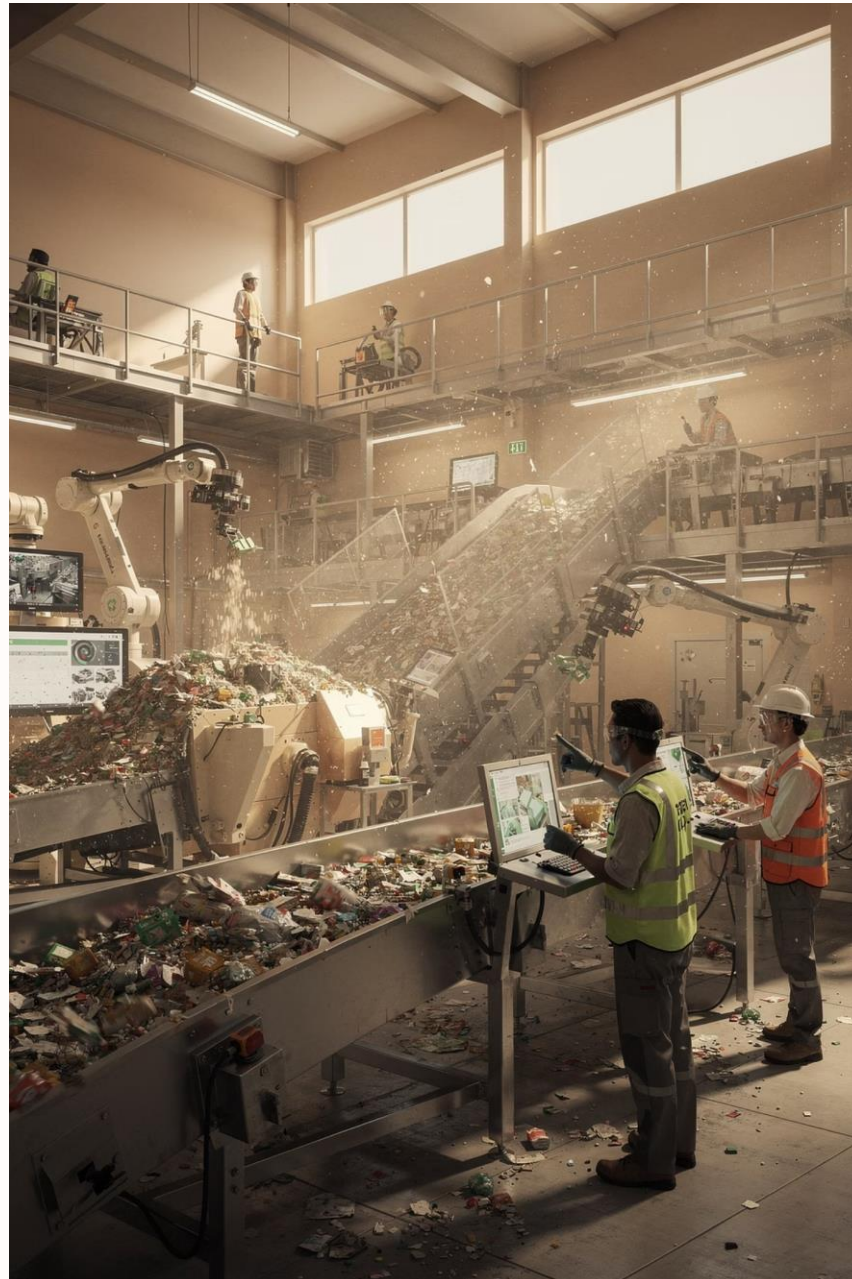
Plasrefine has proposed building Australia's largest plastics recycling plant in **Moss Vale, NSW**. The facility is engineered to recycle up to **120,000 tonnes of plastic annually** — a volume that would make a significant dent in Australia's plastic waste burden, which currently sees the majority of plastics end up in landfill or exported.

The Land-Use Challenge

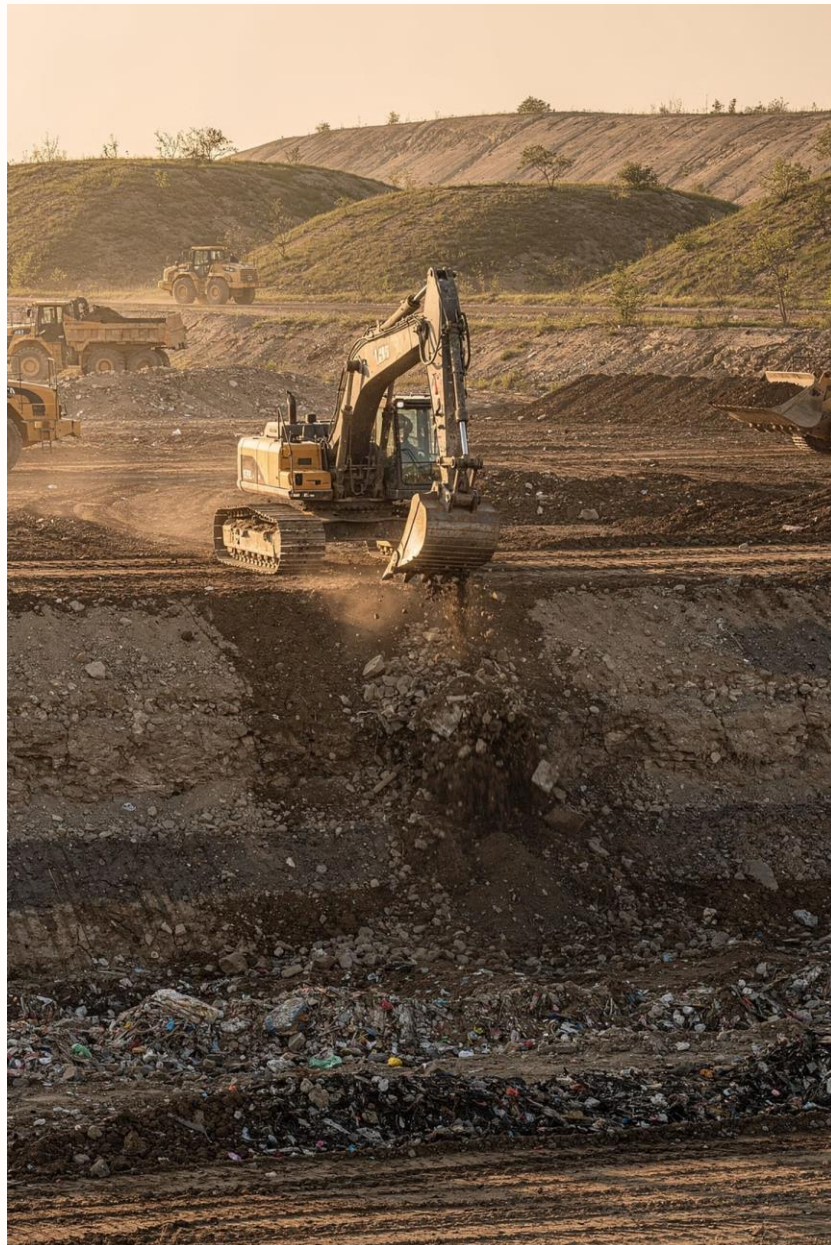
The proposed **7.7-hectare site** hosts a four-story processing facility situated just over **200 meters from residential zones**. This proximity has sparked intense community debate, surfacing the fundamental tension in waste management siting: the facilities we need are rarely welcomed where they are built. The project illustrates that land use for recycling is never purely a technical decision — it is a social and political one.

Innovation in Recycling Infrastructure

Today's leading recycling facilities bear little resemblance to the sorting sheds of decades past. Robotics, optical sensors, and AI-driven systems now operate at speeds and accuracy levels that make large-scale material recovery genuinely viable — and commercially competitive.



Landfill Mining — Reclaiming the Past



Some of the most promising land recovery opportunities lie not in new sites, but beneath our feet.

Enhanced Landfill Mining is rewriting the story of closed and legacy waste sites around the world.

Excavation & Recovery

ELFM involves systematic excavation of legacy waste deposits, recovering materials that were buried before effective recycling infrastructure existed. Metals, plastics, and combustible fractions can all be extracted and redirected to appropriate processing streams.

Circular Economy Integration

By treating old landfills as material banks rather than permanent waste stores, ELFM creates a direct link to the circular economy. Recovered resources re-enter manufacturing supply chains, reducing the need for virgin material extraction.

Land Rehabilitation

Once excavated and processed, former landfill land can be remediated and returned to productive use — whether as parks, agriculture, commercial development, or natural habitat. This is the ultimate land-use benefit of ELFM: turning liabilities into assets.

Contamination Complexity

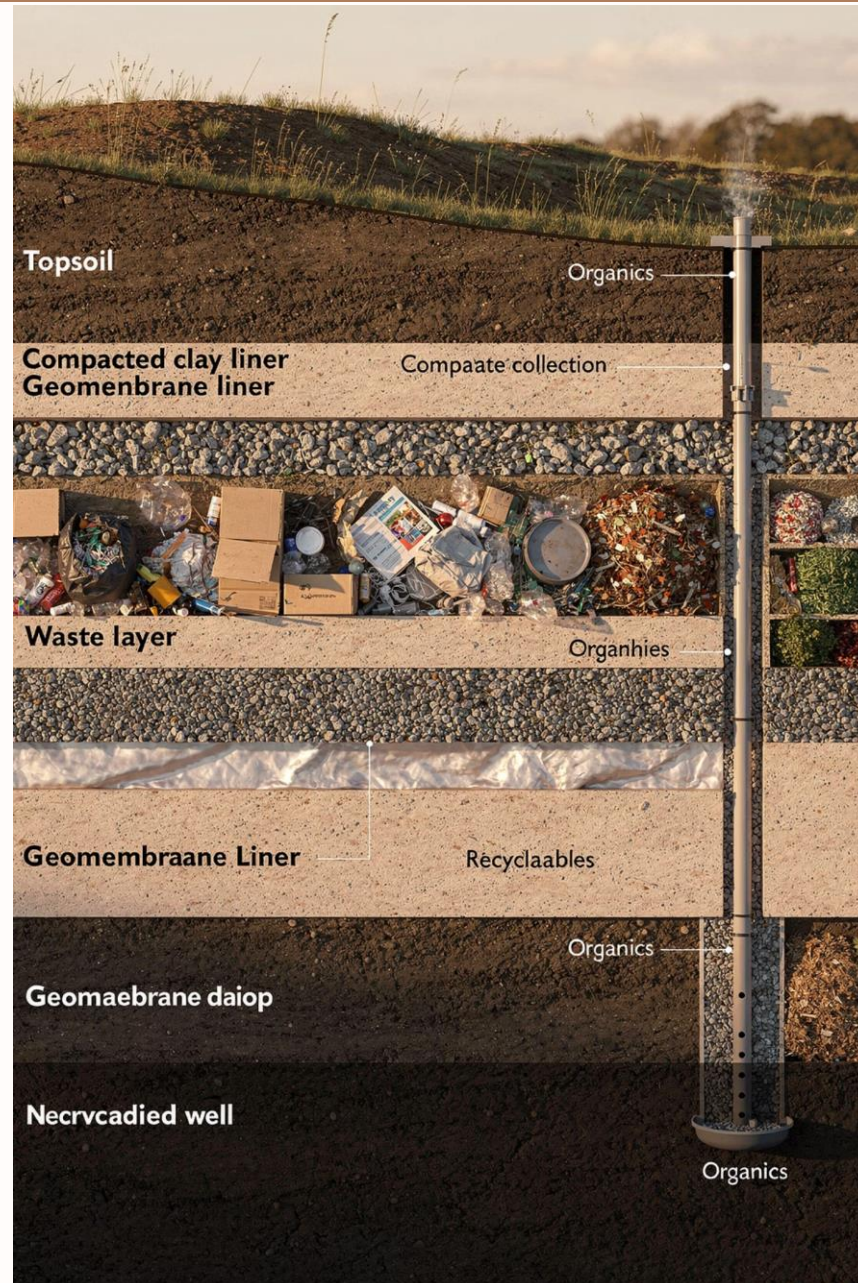
Landfills are not monolithic — they contain heterogeneous mixtures of materials deposited over many years. Soil-like fractions recovered during ELFM or site remediation are frequently contaminated with heavy metals, persistent organic pollutants, and leachate residues. Before reuse is possible, these materials must undergo treatment — a process that is both technically demanding and costly.

The Transport Problem

Moving excavated soils to off-site processing facilities introduces additional environmental costs: fuel consumption, road wear, and emission generation. Critically, this transport burden is often underweighted in environmental assessments, creating a blind spot in the apparent sustainability of soil reuse programs.

Landfill Mining: Unearthing Resources

What was once considered a permanent burial site is increasingly viewed as a stranded asset. Landfill mining re-frames our waste legacy — treating historic disposal sites as untapped material deposits waiting to be reclaimed and repurposed.



Case Study: Dumpsite Remediation in India



Research examining dumpsite remediation across Indian municipalities reveals both the challenges and the transformative potential of landfill mining in developing-world contexts. Legacy open dumpsites — many operating for decades without engineered liners or leachate controls — present acute environmental risks to surrounding communities and groundwater systems.

Environmental Protection

Excavation and proper processing eliminates ongoing leachate migration and gas emissions from legacy sites.

Value-Added Products

Recovered materials — including metals, aggregates, and refuse-derived fuel — generate revenue that can offset remediation costs.

The Environmental Impact of Recovery



Not all recycling and recovery processes are created equal. Life cycle thinking is essential to understanding which approaches genuinely reduce land and environmental pressure — and which simply shift the burden elsewhere.

Construction & Demolition Waste

Construction and Demolition Waste (CDW) is one of the largest waste streams globally, comprising concrete, timber, metals, and mixed inert materials. A rigorous life cycle assessment of CDW recovery technologies reveals that while all processing approaches carry some environmental cost, well-optimized systems can sort the **majority of materials** for effective recycling or reuse — diverting them from landfill.

The Optimal Solution

Solution No. 2 in the landmark study demonstrated the lowest total environmental impact across all measured categories — including land use, energy consumption, and emissions. The determining factor was facility design efficiency: the layout, sequencing of sorting steps, and material handling systems all contributed to a dramatically lower environmental footprint per tonne processed.

Transformation: From Waste Site to Site to Natural Habitat



The most powerful argument for landfill mining and advanced recycling is visible in the landscape itself. Sites that once defined environmental degradation can, with commitment and investment, be returned to thriving, productive land — a testament to what circular waste management can achieve.

The Short-Term Cost

New recycling facilities require real land — industrial parcels, buffer zones, access roads, and utility corridors. This footprint is visible, local, and often contested.

Communities near proposed sites bear an immediate and tangible land-use impact that shapes public perception of recycling infrastructure.

The Long-Term Benefit

Every tonne diverted from landfill extends the life of existing disposal sites and reduces the pressure to develop new ones. Over a 20-30 year horizon, the land savings generated by high-diversion recycling systems far outweigh the footprint of the facilities themselves. The calculus strongly favors recycling investment.

Mining as Land Recovery

Landfill mining offers a unique pathway: it simultaneously addresses legacy contamination, recovers valuable materials, and liberates previously encumbered land. In this framing, mining a closed landfill is not merely a waste management strategy — it is a land reclamation project with resource recovery as a co-benefit.

The Future of Land and Waste Management



Forward-looking communities are designing waste infrastructure for the next 50 years — not the last 50. The projects emerging today are integrating recycling capacity, community need, and land-use strategy in ways that previous generations could not have imagined.



King County's NERTS Project: Modernizing Waste Infrastructure

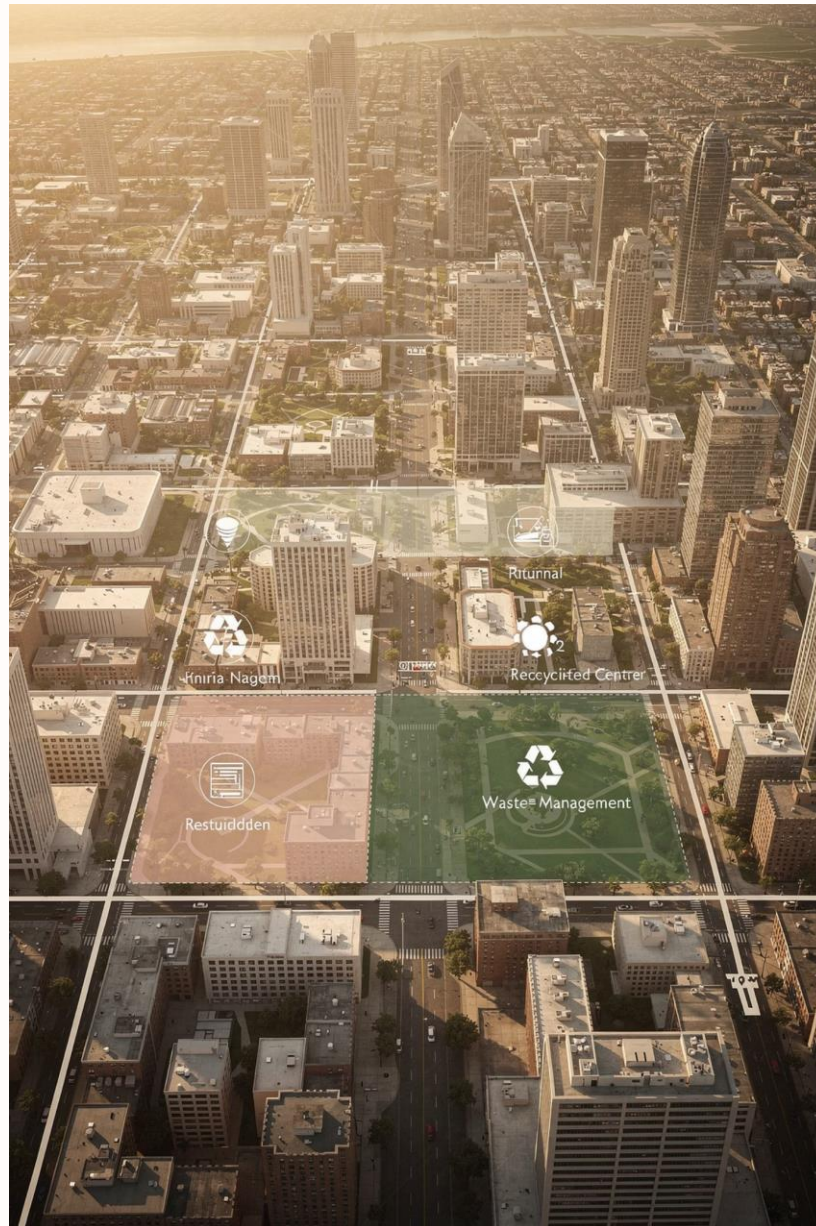
The Project

King County, Washington is developing the **Northeast Recycling and Transfer Station (NERTS)** to replace an aging facility that has served the region for decades. The project is driven by population growth across the county and the need to dramatically expand processing capacity for both recyclables and residual waste.

Strategic Land Planning

NERTS represents a model for how modern waste infrastructure can be sited and designed with long-term land use in mind. By incorporating advanced recycling capabilities alongside transfer functions, the facility maximizes the productive use of its footprint — processing more material types on the same land area that a legacy facility would use purely for waste transfer. The project is designed to serve the region's needs well into mid-century, avoiding the need for additional sites.

Strategic Land Use for a Circular Circular Economy



A circular economy requires circular land planning. Mapping waste infrastructure alongside green corridors, habitat zones, and reclaimed sites reveals how intentional siting decisions — made at the regional scale — can transform the land impact of waste management from a net negative into a net positive over time.



120K

Tonnes/Year

Plastic recycling capacity of Australia's proposed Plasrefine plant — if market demand can absorb the output.

4.9

Lbs/Day Per American

Average daily waste generation — the baseline demand pressure that recycling markets must absorb to reduce landfill reliance.

\$1.4B

WM Investment

Waste Management's commitment to MRF modernization — contingent on viable markets for sorted commodities.

Conclusion — A Path to Sustainable Land Use

The journey from landfill dependency to a genuinely circular waste system is long — but the direction is clear. The cases and technologies explored in this presentation point toward a future where land and waste are managed as interconnected, recoverable resources.





Advanced Infrastructure

Investments like WM's \$1.4B MRF program and Australia's Plasrefine plant signal a decisive shift — from waste disposal as a land burden to waste recovery as a productive land use. Modern facilities process more, waste less, and occupy far smaller footprints per tonne than the landfills they replace.



Mining the Past

Enhanced Landfill Mining unlocks the hidden potential of legacy waste sites — recovering materials, eliminating contamination, and returning encumbered land to productive use. From Indian dumpsites to European ELFM pilots, this approach is proving its value across contexts and scales.