ANTWERP CITY WASTESCAPES – HISTORIC INTERPLAYS BETWEEN WASTE & URBAN DEVELOPMENT

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This paper analyses waste management and the production of space over time in the city of Antwerp, Belgium. By reconstructing how shifting waste practices simultaneously reshape our urban environments at multiple scales, this paper also articulates historic interplays between waste management, urban development and planning practices. Benefiting from available waste processes and materials is a practice that disappeared during industrialisation scale jumps and more linear processes of urbanisation and consumption indeed dominate the current practices. But cities like Antwerp are rethinking these resource consumptive processes and orienting their policies towards what is generally labelled as a resource independent 'circular economy'. In order to be resilient for climate change, Antwerp's centralized and heavily engineered and stressed waste collection and treatment installations of the last century require revision, if not systemic redefinition. After a century of dumping on peripheral locations, bottom-up initiatives such as repair cafés, zero waste shops, green schools and even supermarkets are changing the cultural appreciation of 'waste' in Antwerp by pulling 'waste practices' back into the city and activating social community spaces. What can we learn from the historic interplays between waste and urban development in Antwerp at the eve of Antwerp's next –circular- waste geography?

Keywords
urban form, waste and history, infrastructure, transition, Antwerp

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INTRODUCTION

This paper brings a retroactive planning history of Antwerp, from the angle of waste management. Such a reflexive exercise is timely at a moment when paradigms in waste management are once again shifting and a new phase in the interplay between waste and planning announces itself. Before industrialisation, waste did merely exist as such. It was not something to be disposed of. It was systematically integrated into cycles of reuse and considered as a resource.[1] With the rise of consumption society after the second world war, and with the centralisation of waste management by the Flemish waste Agency (OVAM), citizens and municipalities became more and more detached from their wastes. Waste travelled 'out of sight, out of mind' to inter-municipal, always peripheral, wastewater treatment plants, landfills, incinerators and recycling centres in city peripheries. Today, with resource scarcity around the corner, municipalities like the city of Antwerp are reorienting their waste policies from 'waste management' to 'sustainable materials management' in a transition towards a circular economy that is detached from resource extraction[2]. The reappearance of waste as a collective urban, social as well as economic, agenda, asks for reintegration of waste practices and infrastructures in urban space and life. By consequence, it becomes part of an integrated (public space, social innovation, ...) urban design and planning agenda.

The historic interplay between waste and urban development is closely linked to transitions between linear and cyclical practices. A waste, or better reuse, system that initially functioned as a (cyclic) (eco)system with limited waste streams, became more and more linear with the industrial revolution. Chemical fertilisers were more reliable and performant than biological residues and consumption society after the second world war massively generated what we know today as 'waste'.[3] The introduction of plastics and other not biodegradable materials substantially added to our modern 'waste issue'. Today, as a result of a resource crisis, waste is increasingly revalorised as a resource with economic, cultural and social value. The consequences of waste are gradually (re) integrated into spatial design agendas that spatialise the 'circular economy'.

WASTE AS A RESOURCE, A BLAST FROM THE PAST

Before industrialisation around 1900, waste flows were a more integrated part of daily life, economy and culture. Materials flowed in cycles between the city and the countryside. Poverty forced people to use and reuse every resource until it had no more use. Food scraps were given to pigs and chicken in the streets and organic waste such as human faeces was transported from the city to the countryside and used as natural fertilizer. As early as in the Roman Era, inert waste was used as foundations for buildings and roads[4].

In Antwerp, this biological cycle of 'waste as a resource' was supported by an infrastructure of inner-city waste farms such as the 'Mestkaai' in Antwerp, where waste was collected to be transported to the countryside across the Herentalse Vaart and later the Campine Canals. One of the arguments to construct a new canal to Antwerp in 1748 and to improve the Herentalse Vaart, was the possibility to ship up to 4.000 waste loads to the countryside.[5]

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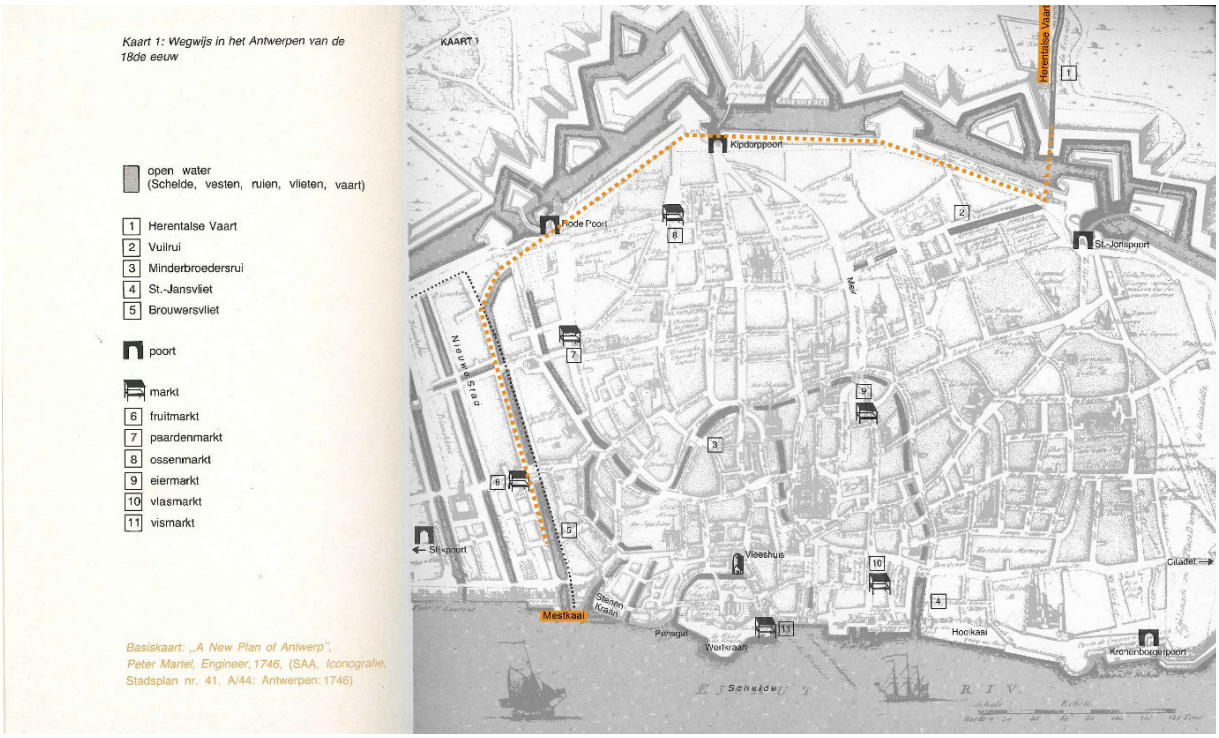

FIGURE 1 18th-century map of Antwerp showing the 'Mestkaai', where waste was collected, and waste transportation routes (open water connecting underground to Herentalse Vaart).

The countryside functioned as the vacuum cleaner of the city, producing food for the city, that was transported back across the same canals. This 'circular economy' initiated a series of trades and professions around waste. In Antwerp city accounts of 1401 mention a civil servant who is responsible to keep important public and economic places clean, the 'slykmyder'[6]. Around the middle of the 15th century, waste was a lucrative business. In the city of Antwerp waste was collected selectively by specialized haulers with a monopoly over a certain type of waste, the 'gruismeester' for construction waste, the 'moosmeier' for household waste and the 'pachters van beer' for faeces[7]. From the 16th century onwards, waste collection and treatment became a source of income for the municipality, by granting exclusive rights to waste collection[8].

Despite local 'circular economies' around waste, there was still quite some waste left and the medieval city was smelly. Around 1400 most city streets were unpaved. Horses and carriages were the main transportation mode. Farmers travelled with their cattle over the roads from the field to the slaughterhouse. On the way the animals produced manure. Inhabitants and craftsmen also did not have a formal 'dumping' place for their wastes, so many of it ended up on the streets or in waterways. Small animals such as pigs, chicken or goose were scratching the streets. All that that did not really contribute to a hygienic environment[9], but norms and standards of cleanness and the like were of course very different in that time.

WASTE AND THE EMERGENCE OF URBAN DESIGN: THE RUIEN AS A TRANSFORMATIVE MULTIPURPOSE URBAN INFRASTRUCTURE

Waste has been an important factor in the emergence of the discipline or urbanism. One could say that dealing with the hygienic condition of the 19th-century was the reason for urban management to emerge. Pressured by congestion, diseases and impossible living conditions, streets were widened, sewage pipes were introduced below ground and waste management systems such as the collective waste bin (Paris) were put in place[10].

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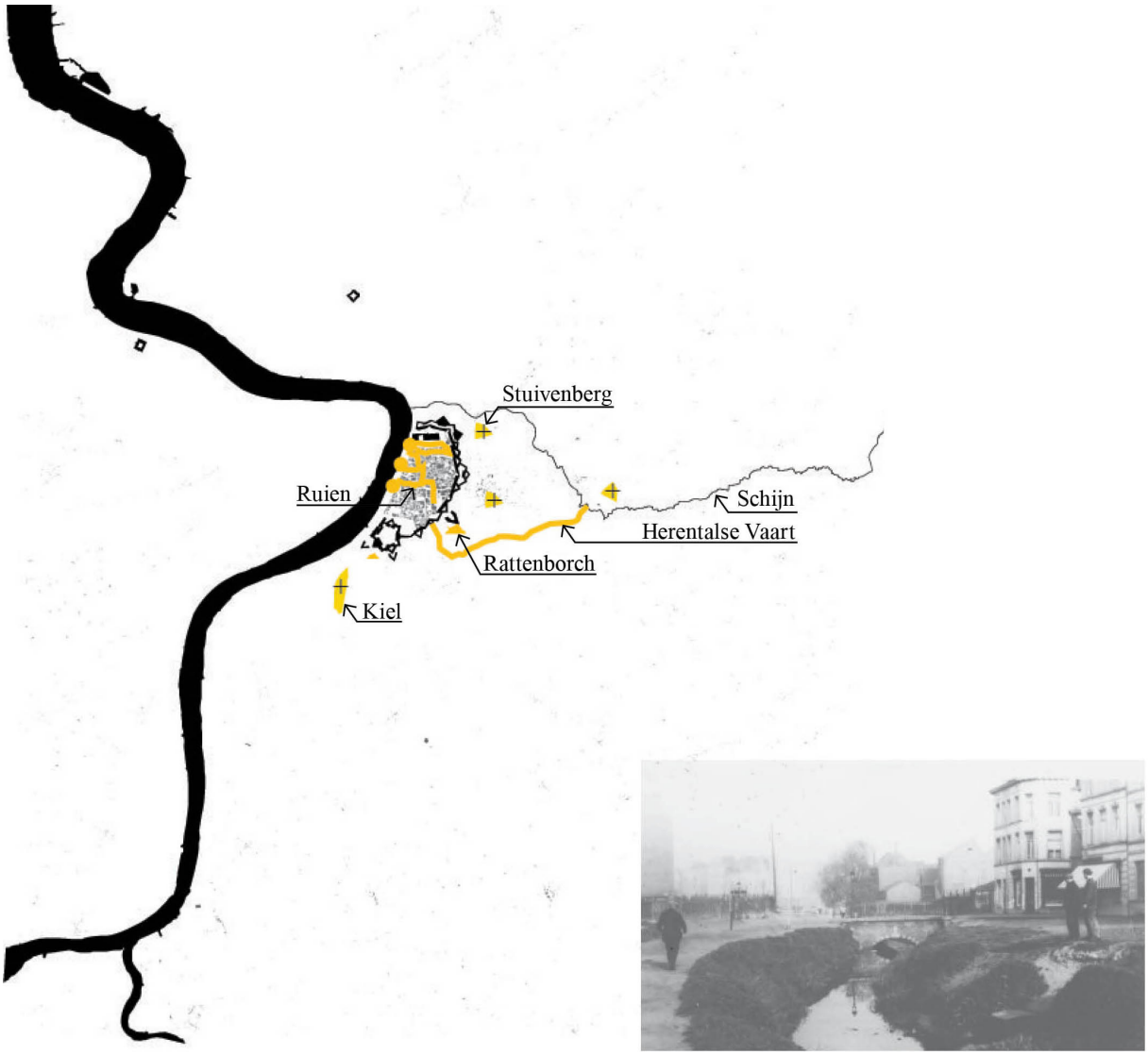

FIGURE 2 Pre-industrial waste infrastructures in Antwerp. Situation around 1783 (map) and photograph of Herentalse Vaart (1928).

The Ruien (indicated in light grey on Figure 1), a network of small-scale waterways conceived in the 11th century, are one great example of how hygienic conditions were translated into infrastructural transformations, even before the concept of hygiene was widespread. Originally, the Ruien drew in water from the Scheldt river for multiple purposes. The water was pumped up as drinking water or used by craftsmen such as painters or delivered to watermills. Inner-city ports were created for the transhipment of goods. With time tidal changes increased and the Scheldt water became brackish. In order not to pull brackish water into the city, a series of sliders was put in place to stop the brackish water from entering the city. At the same time these sliders became a mechanism allowing to gather water in the Ruien, enabling to clean the Ruien bij purging the water at once into the Scheldt. But by the late Middle Ages the Ruien had transformed into open dumps. Craftsmen dumped their industrial waste in the Ruien and citizens connected their 'privaten' (toilets) directly to the Ruien.

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FIGURE 3 Situation between 1850 and 1950 (map). The Ruien were entirely covered and integrated into the municipal sewage system, evacuating waste water in the Scheldt River. Waste was transported to the countryside via the Campine Canal (1885-1916) (picture) and railway network.

In the 16th century, when the dumping of waste in the Ruien and the streets started to create discomforts such as smells, pests and diseases, it became the municipality's problem. In an attempt to keep the inner-city clean, Antwerp ordered its inhabitants to clean the street in front of their houses every two weeks.[11] Instead of dumping the collected dirt in the Ruien or other ditches, they had to bring the waste to Antwerp's first legal landfill, Rattenborch. Rattenborch was located on a swatch of vacant land at the edge of the city, between the Begijnen and Sint-Jorispoort. Animal cadavers had also to be taken outside city walls, near the water at het 'Kiel'. In 1783, there was also a new rule by Kaiser Jozef II that human corpses should be buried outside of city walls. In this case, Antwerp selected a couple of terrains in the north (current Stuivenbergplein) and the south (current Kielpark).[12]

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Smells and diseases became a big problem in the 16th century, Antwerp's golden century as a metropole of trade, when population, and by consequence the waste they produced, increased. The municipality tried to regulate waste dumping by encouraging the use of sceptic tanks, giving fines for dumping waste in the Ruien and by organising big 'rui-cleanups' in which sludge was removed from the Ruien. But these clean-ups cost the municipality a lot of money and the inhabitants along the Ruien who were asked to share in the costs were complaining about this. In the meantime, initiatives took place to incrementally start covering the smelly Ruien. The Jesuits for example, created a new square and the current Sint-Carolus Borromeus church by covering two Ruien. From the 17th century onwards, when the Ruien started losing their economic importance, the municipality also started subsidizing inhabitants to cover the part of the Ruien in front of their houses. Parts of the Suikerrui and the Minderbroedersrui were covered in that way by citizen committees as they were allowed by the municipality to construct new buildings on top of the Ruien on the reclaimed 'land'.[13]

In 1803 Napoleon ordered the complete coverage of the Ruien. By 1835 around three-quarters of the Ruien were covered and it would take until 1882 for the entire covering of the Ruien[14]. By that time population in Antwerp was still growing, as was the number of poor people with bad sanitation infrastructures. The introduction of the water closet made the sceptic tanks overflow and cholera, pocks and dysentery were forming another health threat.

Only in 1849, the link between contaminated drinking water and cholera was made. The thousands of victims urged the municipality to get some order in the management of the Ruien, that became officially part of Antwerp's sewage infrastructure in 1882. Advised by expert committees the municipality improved the water level to increase the water's force in order for it to take with it waste along its way. In 1862, a public sanitation department was created. The 'Régie des Vidanges, Boues et Immondices' kept the public domain clean and collected household waste.[15]

The hygienic conditions in the city improved relatively quickly. The demolition of the Spanish city walls around 1860 enabled a city expansion, allowing the population pressure in the centre to release. By the end of the 19th-century the open ditch system of the Ruien had completely disappeared. In 1898 the city allowed home owners to connect their toilets directly to the Ruien, which were then officially part of Antwerp's sewage infrastructure. From then on, the originally multipurpose water infrastructure of the Ruien became a subterranean waste infrastructure (Figure 4 middle picture).

The Ruien accumulate traces of its tumultuous history, such as segments of the incremental coverings and original stone walls. The Ruien are still part of the current municipal waste water infrastructure. Two collector pipes, one for wastewater and one for rainwater, collect this water from the entire city center and bring them to a 3km collector along the Scheldt Quays, that was installed in 2002 and directs the water to the waste water treatment plant just south of Antwerp (Kielsbroek). Only in case of heavy rainfall, rainwater spills over directly in the Ruien instead of through the drainage pipes.

The interplay between the Ruien and the production of urban form is closely linked to water. Besides drawing in water from the Scheldt river, the Ruien were fed by the Schijn river, that formed a natural edge to Antwerp until the 15th century. At the end of the 19th- Century, when the Ruien were integrated into the municipal sewage infrastructure, the Schijn was disconnected from the Ruien[16], canalised and rerouted in different phases around the ever expanding docks of the Antwerp Port.

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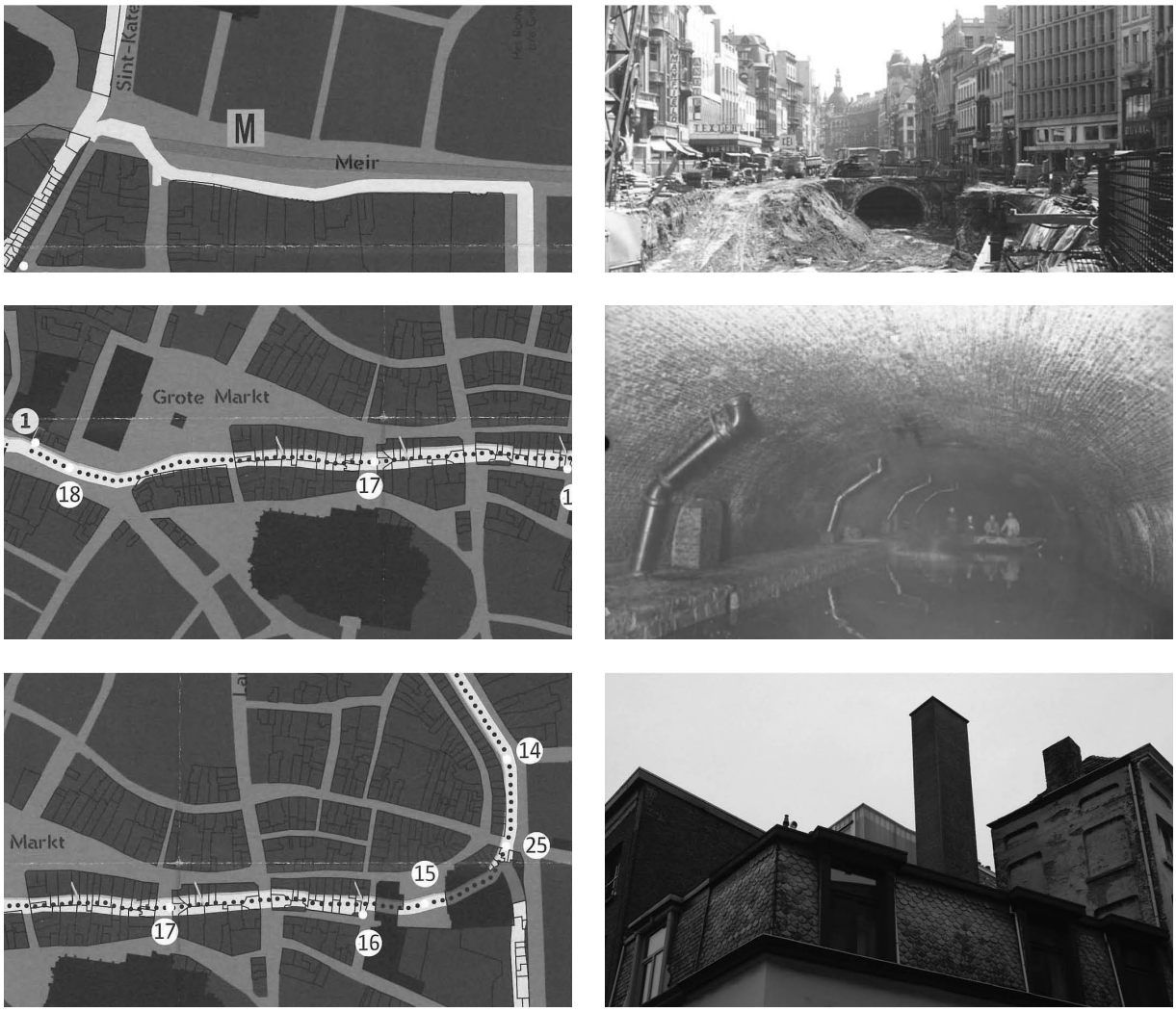

FIGURE 4 The Ruien tunnels were partially recovered and rerouted for the construction of the premetro in 1970 (top). For a large part, houses were built on the covered Ruien. Their sewage was directly connected to the underground Ruien network (middle). Where the Ruien were transformed into streets, such as the Minderbroedersrui, the width of the street is quite generous, based on its subterranean 'water size' (bottom left). Above ground, elements such as ventilation shafts offer clues of the now entirely covered Ruien network (bottom right).

BREAKING CYCLES: FINDING SPACE FOR WASTE

The industrial revolution at the beginning of the 20th- century meant the start of our modern waste issues. Industrialisation brought specialisation, mass production and upscaling for the economies of scale, centralisation and increased technicality. Gradually, material streams were segregated in efficient industrial processes.
The idea of getting waste 'out of sight', gradually disconnected waste production and processing from daily life and economy, erasing it from the collective conscience 'out of mind', as it increasingly became something people did not need to worry about as soon as the trash bins and the like were picked up from the curb side.
While innovations in production processes were thriving, methods of waste disposal remained similar to those from the Roman era. Ideas of re-cycling and conserving surely existed, but were meant to save labour rather than natural resources. From the point of view that 'our natural resources are ample for all our present needs'[17], commodities were extracted from nature, efficiently turned into products, to be dumped after consumption. Production was a linear process, from commodity to product to waste.

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FIGURE 5 Map of polluted soils (light orange) and former landfills (dark orange), often located in naturally floodable areas (light grey).

The spatial context of Flanders' dispersed urbanisation[18], with its dense occupation and little, but crucial leftover open spaces, caused high land prices. Together with the lack of a market for compost, this made municipalities, who were responsible by law for their waste, opt for an incineration oven rather than a composting facility or a landfill, like the city of Merksem in 1978 to the north of Antwerp. Only financial arguments, not environmental ones, were taken into account[19].
The fact that each municipality in Flanders dealt with waste in its own way, resulted in a landscape of scattered landfills and incinerators. In Antwerp it was not different. A confetti of former landfills in what used to be Antwerp's edge or periphery, is now hidden under forests or parks such as the Rivierenhof in Deurne. Many of them are located in the riverbed of the Groot Schijn, since this type of wet land was considered useless or unproductive, waste-land[20].

Up to the 1970s, there was a general ignorance about the causality between waste disposal and environmental problems such as soil, water and air pollution. As a result of environmental issues and disasters which had previously been hidden or unknown, at the end of the 1960s a new social movement arose that placed the environment as a priority. In the Antwerp Province, local Action Committees such as 'Actiecomité Leefmilieu Rupelstreek', opposed against environmental pollution in their immediate surroundings. Growing incidents around waste and pollution led to the creation of the first Belgian Waste Law on toxic waste in 1974. In Antwerp environmental activism was fierce. Around that time (1979) the political ecological party AGALEV (To live differently) was founded. AGALEV was one of the forerunners of opposition against illegal dumpings in the Hooge Maey landfill in Antwerp.

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FIGURE 6 (situation 2015) As a result of waste centralisation policies, Antwerp's waste processing facilities are composed of a series of outer city waste hubs that combine different waste related infrastructures such as waste water treatment plants and municipal recycling parks. Picture: Hooge Maey.

On the Flemish level, this 'environmental awareness' resulted amongst others in the creation of the Flemish Waste Agency (OVAM). Being part of modernist planning at that time, gradually, responsibility for waste management was centralised at the Flemish level, resulting in a 'cleaning' and upscaling of waste processing facilities. But the centralisation of waste management immediately created problems, in terms of increasing the burden of waste handling on certain communities and in terms of the cost of waste transport. In Antwerp, an inter-municipal waste incinerator (ISVAG) was created in 1975 about 5 km to the south of Antwerp in the middle of a housing area. The creation of ISVAG immediately caused protest by inhabitants. After a high number of birth defects and health problems with neighbouring citizens, ISVAG became a symbol file in the battle against waste incinerators. Advised by a panel of scientists, in 1994 a judge closed the ISVAG incinerator in Wilrijk because of environmental and health issues[21]. Today, ISVAG is still burning waste and is positioning itself as a 'green' industry, converting waste to energy for about 20.000 families[22].

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BACK TO THE FUTURE? GRADUAL TRANSITION TO A CIRCULAR ECONOMY

Within the transition to a circular economy, the city of Antwerp is aiming to go much further than simply recycling waste. Its latest administrative agreement sets out ideas for 'innovative materials management- circular economy'[23]. In an optimisation effort of its building stock, the city is working on a centralising project of Antwerp's current 18 waste collection facilities into two multifunctional technical clusters, one in the north and one in the south of the city. These two clusters will be developed as exemplary hubs for the circular economy, integrating innovative and sustainable technology and synergies between various public services. There will be publicly accessible workshops where materials as well as tools are shared and reused. While sharing collective spaces and materials is definitely in line with the philosophy of sustainable resource use in a circular economy, the idea of centralising solid waste appears a continuation of the 20th- century centralisation thought.
Antwerp appears to be vulnerable to the consequences of climate change. The city will become hotter, dryer and is expected to experience more peak moments of pluvial flooding[24]. 19th-and 20th- century energy and sewage networks were not conceived for these extreme future conditions. The existing sewage network has an under capacity to respond to these changes, but because of the high cost to adapt this existing infrastructure, the city council prefers infrastructural interventions above ground. The city will over dimension new sewage pipes, new city developments will limit paved surfaces to allow rain water to infiltrate in the soil, and where possible rain water is buffered. Urban areas are being greened as much as possible.[25]

At the same time when the municipality is recovering the cyclic ideas from the past about materials reuse and nature-based solutions[26] for rainwater management, a renewed collective interest in 'waste as a resource' can be identified in Antwerp, as in many other cities both in Flanders and abroad. Small-scale waste practices such as flea markets, repair cafés or 'geefkasten', are collaborations between the city and community organization to encourage reuse or give a second life to clothes, electronics or even food in a stimulated 'sharing economy'. Other initiatives, such as the Flemish MOS or 'green' schools initiative, support primary and secondary schools to make the school a sustainable and environmentally friendly learning environment where limiting waste production is one point of attention. Also in the private market, waste-conscious businesses such as a 'zero waste' shop without packaging are making their entry. Not only do these waste practices contribute to the reduction of waste volumes, they also bring back waste as part of daily life and economy.

CONCLUSION

At this moment, paradigms in waste management are once again shifting. With the introduction of the circular economy, a new cycle in the interplay between waste and planning announces itself. Untangling the intricate historical relationships between waste flows and the production of space in Antwerp, reveals direct interdependencies between choices related to waste management, urban economies, infrastructures, natural systems and urban spaces. After decades of centralist waste handling outside of the collective realm, the transition to a circular economy could be seen as a chance to reconnect waste flows to daily urban life, economies and urban form as well as to intigate synergies between varying public agendas (social, economic, ecological, ...).
The subsequent uses and appearances of Antwerp's Ruien infrastructure give us an insight in how flexible and hybrid infrastructures can adapt over time, supporting an evolving urban tissue. The Ruien are a fantastic example of a polytechnic infrastructure[27], a layered, flexible and transformative infrastructure that combined different uses over time, while remaining strongly intertwined with urban form. The Ruien were conceived as a functional water infrastructure, anchored by the natural hydrographic system of the Scheldt and the Schijn rivers. The Ruien evolved into municipal sewage infrastructure, sometimes in combination with transportation infrastructure (part of Meir metro). They demonstrate that resilient infrastructures have the potential to be reinscribed in new logics that give them meaning in subsequent layers and transformations of urban form. At the same time studying the Ruien reveals the strong interconnection of Antwerp's waste and water flows and the river system.

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Julie Marin is an Architect and Urban designer. Today she is a Phd candidate at KULeuven (BE). Julie's doctoral research by design focuses on the potential of transitioning geographies of waste and resources to (re)structure the Flemish diffused territory. At KULeuven, she is teaching assistant in multiple courses and urban design studios for which she collaborates with governments, public and private stakeholders. Before joining the KU Leuven in 2014, Julie worked as an architect and urban designer at Scape/Landscape Architecture in New York City and as an Associate in Architecture at the Urban Design Program of Columbia University.

Endnotes
1 Sabine Barles, *L'invention Des Déchets Urbains: France (1790-1970)* (Editions Champs Vallon, 2005).
2 In 2015, an adjunct coordinator was assigned within the City Administration for 'Innovative Waste Management – Circular economy'.
3 Torsten Feys, *Ovam 30 Jaar. De Openbare Vlaamse Afvalstoffenmaatschappij in Historisch Perspectief.* (Gent: Academia Press, 2011).
4 Ibid. 13
5 Peter Poulussen, *Van Burenlast Tot Milieuhinder: Het Stedelijk Leefmilieu 1500 - 1800* (Kapellen : Pelckmans, 1987). 32-42
6 Lampo, "Huisvuil En Hygiëne in Antwerpen Door De Eeuwen Heen. Stank in De Stad".
7 Peter Poulussen, *Van Burenlast Tot Milieuhinder: Het Stedelijk Leefmilieu 1500 - 1800* (Kapellen : Pelckmans, 1987). 32-42
8 Torsten Feys, *Ovam 30 Jaar. De Openbare Vlaamse Afvalstoffenmaatschappij in Historisch Perspectief.* (Gent: Academia Press, 2011). 13
9 Lampo, "Huisvuil En Hygiëne in Antwerpen Door De Eeuwen Heen. Stank in De Stad".
10 de Silguy, *Histoire Des Hommes Et De Leurs Ordures : Du Moyen Âge À Nos Jours.* 30-35
11 Tijs, Rutger. *Tot Cieraet Deser Stadt: Bouwtrant En Bouwbeleid Te Antwerpen Van De Middeleeuwen Tot Heden : Een Cultuurhistorische Studie over De Bouwtrant En De Ontwikkeling Van Het Stedebouwkundig Beleid Te Antwerpen Van De 13de Tot De 20ste Eeuw*. Antwerpen: Antwerpen: Mercatorfonds, 1993. 293
12 Lampo, "Huisvuil En Hygiëne in Antwerpen Door De Eeuwen Heen. Stank in De Stad".
13 A lot of the information described here was collected from a guided tour in The Ruien on April 3rd 2015.
14 Lampo, "Huisvuil En Hygiëne in Antwerpen Door De Eeuwen Heen Stank in De Stad".
15 Ibid.
16 Karlien Vandecasteele, "Ruimte Voor Het Schijn" (Artesis Hogeschool, 2006).
17 Henry Ford and Samuel Crowther, *Today and Tomorrow* (Cambridge: Productivity Press, 1988). 91-100
18 Bruno De Meulder et al., "Sleutelen Aan Het Belgische Stadslandschap = Patching up the Belgian Urban Landscape," *OASE: tijdschrift voor architectuur = OASE: architectural journal*, no. 52 (1999).
19 Feys, *Ovam 30 Jaar. De Openbare Vlaamse Afvalstoffenmaatschappij in Historisch Perspectief.*
20 Vittoria Di Palma, "Wasteland : A History," (2014).
21 OVAM. "Vera Dua (gewezen minister van Leefmilieu)over toekomst consumptiemaatschappij". Accessed 31 March 2016, http://www.30jaarovam.be/items/show/332.
22 ISVAG. "Welkom bij ISVAG". Accessed 4 April 2016, www.isvag.be
23 Stad Antwerpen, "Bestuursakkoord," (2013). 10-11
24 Patrick Willems, "Impact Van De Klimaatverandering Op Antwerpen," *Waterproef* 2015.
25 Bart Brinckman, "Stad Erg Kwetsbaar Voor Klimaatverandering. Hitte En Overstroming," *De Standaard* 2015.
26 Gorm, Dige. "Exploring Nature-Based Solutions. The Role of Green Infrastructure in Mitigating the Impacts of Weather- and Climate Change-Related Natural Hazards." 66. Luxembourg: European Environment Agency, 2015.
27 In his book Technics and Civilization (1934), Mumford elaborated the idea that technology is twofold. On one hand 'polytechnic', which enlists many different modes of technology that provide a complex framework to solve human problems opposed to 'monotechnics', which is technology for its own sake, oppressing humanity as it moves along its own trajectory.

Bibliography
Antwerpen, Stad. "Bestuursakkoord 2013-2018." 2013.
Anversoise, Commission d'études pour l'aménagement de l'agglomération. "Rapport Du Comité Technique Sur L'écoulement Des Eaux Naturelles Et Résiduaires D'anvers Et De Sa Banlieue." edited by Ministère de l'Agriculture et des Travaux Publics, 128. Anvers, 1912.
Barles, Sabine. *L'invention Des Déchets Urbains: France (1790-1970)* Editions Champs Vallon, 2005.
Brinckman, Bart. "Stad Erg Kwetsbaar Voor Klimaatverandering. Hitte En Overstroming." *De Standaard*, 2015.
De Meulder, Bruno, Jan Schreurs, Annabel Cock, and Bruno Notteboom. "Sleutelen Aan Het Belgische Stadslandschap = Patching up the Belgian Urban Landscape." *OASE: tijdschrift voor architectuur = OASE: architectural journal*, no. 52 (1999): 78-113.
de Silguy, Catherine. *Histoire Des Hommes Et De Leurs Ordures : Du Moyen Âge À Nos Jours.* Paris Le cherche midi, 1996.
Delatter, Christof. "Wereldafvalcongres Komt Naar Antwerpen." *Lokaal*, no. 7 (2015).
Di Palma, Vittoria. "Wasteland : A History." 2014.
Feys, Torsten. *Ovam 30 Jaar. De Openbare Vlaamse Afvalstoffenmaatschappij in Historisch Perspectief.* Gent: Academia Press, 2011.

DOI: http://dx.doi.org/10.7480/iphs.2016.3.1261

Ford, Henry, and Samuel Crowther. *Today and Tomorrow* Cambridge: Cambridge : Productivity Press, 1988.
Kostof, Spiro. *The City Assembled: The Elements of Urban Form through History*. London: London : Thames and Hudson, 1992.
Lampo, Jan. "Huisvuil En Hygiëne in Antwerpen Door De Eeuwen Heen. Stank in De Stad." *EOS - Memo* (2016).
Lijn, De. "Omleggen Van De Ruien." http://www.tramstad.be/omleggen-van-de-ruien/.
MacArthur Foundation, Ellen. "Towards the Circular Economy Vol.1." (2013).
Mumford, Lewis. *Technics and Civilization*. 2e ed. ed. New York (N.Y.): New York (N.Y.) : Harcourt, Brace and World, 1963.
Poulussen, Peter. *Van Burenlast Tot Milieuhinder: Het Stedelijk Leefmilieu 1500 - 1800*. Kapellen: Kapellen : Pelckmans, 1987.
Rosso, Caterina; Van Maercke, Carmen. "Dirty Antwerp: Re-Engineering Flows, Editing the 20th Century Belt." KULeuven, 2015.
Ruien visit. "Onder de stad stromen geheimen". Accessed 30 March, 2016. http://ruien.be/nl/
Stadsarchief Antwerpen. "AVA." Accessed April 1, 2016. http://zoeken.felixarchief.be/zHome/Home.aspx
Tarr, Joel A. "The Search for the Ultimate Sink : Urban Pollution in Historical Perspective." Akron, Ohio: University of Akron press, 1996.
Vandecasteele, Karlien. "Ruimte Voor Het Schijn." Artesis Hogeschool, 2006.
Willems, Patrick. "Impact Van De Klimaatverandering Op Antwerpen." *Waterproef*, 2015.

Image sources

Figure 1: Peter Poulussen, Van Burenlast Tot Milieuhinder: Het Stedelijk Leefmilieu 1500 - 1800 (Kapellen: Kapellen : Pelckmans, 1987). maps 1 and 2 (edited by author)
Figure 2: by author, based on Rosso, Caterina; Van Maercke, Carmen. "Dirty Antwerp: Re-Engineering Flows, Editing the 20th Century Belt." KU-Leuven, 2015. 10 (map) & Stadsarchief Antwerpen, Digital Archive AVA [sa035160] (photograph).
Figure 3: by author, based on Rosso, Caterina; Van Maercke, Carmen. "Dirty Antwerp: Re-Engineering Flows, Editing the 20th Century Belt." KU-Leuven, 2015. 12 (map) & Stadsarchief Antwerpen, Digital Archive AVA [sa356005] (photograph).
Figure 4: left column: extracts from map Ruien visit, right (top): image from www.tramstad.be (edited by author), right (middle): Stadsarchief Antwerpen, Digital Archive AVA [sa307167] (photograph) (edited by author), right (bottom) photograph by author
Figure 5: by author, based on Rosso, Caterina; Van Maercke, Carmen. "Dirty Antwerp: Re-Engineering Flows, Editing the 20th Century Belt." KULeuven, 2015. 32 (map), data landfills: Openbare Vlaamse Afvalstoffenmaatschappij (OVAM), Mechelen, data flood zones: AGIV. "Geopunt". Accessed March 30, 2016. http://www.geopunt.be/
Figure 6: by author, based on Rosso, Caterina; Van Maercke, Carmen. "Dirty Antwerp: Re-Engineering Flows, Editing the 20th Century Belt." KU-Leuven, 2015. 14, cover (photograph) & Google. "Google Earth". 2015.

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