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An urbanistic approach to aggregate quarrying: a case study in Brampton, Ontario

The reclamation of urban aggregate quarries has been recognised as a serious concern for built environment design and planning fields. However, much of the literature and research centered on this challenge tends to focus on the immediate techno-scientific reclamation practices employed at a site scale often towards the end of extraction. This essay argues for a reversal of this relationship between the designer/planner and the extraction-reclamation timeline. It does so by articulating an approach based upon 'scenario planning' that places reclamation planning and design at the beginning of the quarry timeline rather than at the end. Further, an example of this approach in Brampton, Ontario, is analysed to determine the strengths and weaknesses of urbanistic reclamation strategies. If we pivot towards designing reclaimed landscapes from the outset, we can use such sites as the beginning point for structuring cities, rather than leaving them as holes in the urban fabric.

Keywords: Urban quarry, scenario planning, reclamation, landscape-led urbanism, speculative design, sustainable cities and communities

Introduction

Modernity could be characterised by a single material: concrete. The relationship between the city and concrete is so critical that urban growth is considered hand-in-hand with aggregate extraction economics. This is because aggregate and its value-added products are low-value and bulky, so urban growth corridors are ideally planned around pre-existing or possible quarrying sites that can supply this material at an economically feasible rate. New extraction sites are also selected with the desire to impose a minimal degree of disruption to natural ecologies and landscape systems in mind, even though these sites tend to eventually become surrounded by the urban or suburban fields created from their material. However, the question of how these sites of extraction are reintegrated into the suburban context that eventually surrounds them has received less attention. Despite the future-oriented attention to the planning of where to extract, there has been much less attention given to what occurs after with an equally long-term vision. While during the planning stage of a development corridor or area, these quarries are treated as urbanistic problems, their reclamation tends to be a site-based one. As such, the design opportunities are typically confined to the site's cadastral, as the surrounding area has been fragmented through parcellation and colonised by concrete.

Looking at the challenge of future-oriented urban quarry reclamation through the lens of scenario planning offers insight into how the complex relationships between government bodies, local communities (existing and future), and industry operators might be better managed throughout spatial planning and design. The lack of trust between these actors has been well documented, though communities tend to feel the

most aggrieved through a perceived lack of transparency or knowledge in the reclamation process (Bauer, 1982, p. 52). Addressing the reclamation of urban quarries through scenario planning at an urban scale could benefit all parties.

This essay considers the framework of scenario planning as a pathway to treat these sites as urbanistic reclamation problems rather than site-based ones. Such a framework offers the potential for these landscapes to play an active role in their urban contexts beyond just producing the material to build them. To introduce built-environment planners and designers to this approach, this essay will first outline the context of urban aggregate quarries and their reclamation. Second, scenario planning will be introduced in the context of spatial planning practices. Third, an example of this urbanistic reclamation approach in Brampton, Ontario is unpacked to gain insight into the reclamation scenario planning process by comparing the proposed scenarios against the actual built form. Fourth, the pitfalls and possibilities of this approach as learned from the Brampton example are taken forward as critical points of inquiry for planners and designers.

Background and Context

The Problem of Urban Aggregate Quarries

As this author has previously argued, urban aggregate quarries are in an "unenviable double bind", finding themselves as "modernity's unsung hero" at the same time as being "maligned makers" of urban growth (Rosier, 2024, p. 151). Contemporary cities as we know them would not be possible without the extraction of aggregate material from the landscape. As such, aggregate-related activities are a fundamentally urban land use (Bauer, 1993b) necessitated by the relationship of low value yet high bulk material where transportation costs can double by traveling as few as 20 miles (Baker & Hendy, 2005, p. 2; Bauer, 1993b, p. 626; McLellan, 1979, pp. 46-47). However, once the cities that these quarries have developed sprawl to meet them, those who occupy this realm of concrete consider the whole ordeal of extraction undesirable (Bauer, 1991, pp. 40-41; Edwards, 2022, p. 383). This is a spatial problem as much as it is an economic one, with planners, economists, and geologists grappling with the problem of predicting urban growth alongside finding suitable locations to mine material to make that growth possible. The scholarship from the past several decades has illuminated a rising need to protect and preserve aggregate deposits from urban developments that would preclude extraction. The thrust of those arguments is that aggregates should be considered with the same care and attention as any other natural resource or environment (Baker & Hendy, 2005; Langer et al., 2002). As such, suitable aggregate sources should not be built over or prevented from extraction by other causes. Instead, they should be planned around so that they are held in reserve until needed. Once covered by development or precluded from extraction, these resources are often impossible to access.

In contrast to this future-thinking approach toward the management of aggregate resources, the question of what happens to those locations post-extraction has not received similarly projective forms of attention. Current approaches to the rehabilitation of urban aggregate quarries tend to be preoccupied with returning the post-extraction landscape as closely as possible to its original, or 'natural' condition (Corry et al., 2011; Darmer & Dietrich, 1992; Hine & Kirsch, 2014; Martin Duque et al., 2021; Tang et al., 2011). This position is driven by both legislation (for example: the *Surface Mining*

Control and Reclamation Act of 1977 in the United States and the *Aggregate Resources Act* in Ontario, Canada) and public expectation that a return to the original condition is the correct reclamation result (Corry et al., 2011, p. 64).

However, recent scholarship has begun to challenge this assumption by considering these sites from a perspective outside the embedded nature/culture dichotomy. For example, René Davids stresses the absurdity of viewing sites of extraction as negative cultural acts and instead argues that they should be seen as creative expressions of the world at large (2021, p. 9). In relation to the Marble Cliff Quarry in Columbus, Ohio, which has developed an emerging ecology of its own in the middle of the city, Katherine Jenkins argues that its future reclamation and management must "uphold, rather than interfere with, the its [*sic*] existing performance, allowing for novel and, as yet unimagined, interactions to occur" (2019, p. 319). Rather than seeking to reintroduce former ecologies in the search for a nostalgic past (Hine & Kirsch, 2014, pp. 123-125), a hybrid condition reminiscent of the "cyborg landscapes" as described by Elizabeth Meyer (1997) might be a better orientation for thinking through the problem of urban aggregate quarries.

Scenario Planning

A future-oriented approach to reclaiming urban aggregate quarries needs a conceptual framework for what it might mean to plan and design these reclamation processes from the outset of extraction. Given the economic, political, and societal changes that will inevitably occur throughout a quarry's lifetime, flexibility is paramount. One strategy to facilitate this planning and design regime is *scenario planning*, developed by American military think tanks in the 1950s and adopted by corporations in the 1960s and 1970s. Perhaps most famously, Royal Dutch Shell used this approach to avoid catastrophe in the 1973 oil crisis by 'game-playing' a series of scenarios to better understand market forces and interests.

A scenario planner must first understand why actors might make a decision in order to speculate on what that decision might be. From this basis, a scenario planning method would typically determine the relevant drivers, inhibitors, and other forces/agents related to a given problem, at the same time as analysing what uncertainties are known or might arise. A set of internally consistent empirical or intuitive assumptions are formulated alongside what is already known, acknowledging that both the future, and the complexity of our present reality can never be fully known (Veeneklaas & Van den Berg, 1995). From this basis, several distinct narratives, based on speculated future conditions, are used to test how different futures might evolve by weighing factors against each other in creative configurations. A broad range of possibilities can be compared against each other without pre-emptively selecting against undesirable outcomes (Abou Jaoude et al., 2022). Importantly, the scenario planner does not seek to predict the future, but rather they set out to explore its possibilities (Veeneklaas & Van den Berg, 1995, p. 12).

Several scholars have argued that scenario planning has significant potential in design and planning fields. Bernardo Secchi and Paola Viganò argue that a structure plan—developed through testing various scenarios—empowers planning processes to bypass the inherent uncertainty and inertia found in comprehensive plans (Secchi & Viganò, 2009, pp. 5-6). In their study of Antwerp, Secchi and Viganò develop seven 'images' of future conditions centred around a "what if…" statement that triggers a

radical departure from present conditions. These images deterritorialize and then reterritorialize the figures, objects, and forces of the city to produce new possibilities, aiming to appropriate and give expression to the city's collective imagination (Secchi & Viganò, 2009, pp. 25-26). The Dutch architecture and urban design firms MVRDV and OMA/AMO have experimented with how speculative narratives describing possible future conditions can drive design processes for the here-and-now as well as there-and-then. OMA's work before 2000 in particular exhibits an intellectual curiosity in following the 'what if' question. What if the entire population of the Netherlands were shifted to the country's southern portion toe closer to other economic centres, or conversely, what if the Dutch people were concentrated into a compressed point-like city (Koolhaas & Mau, 1995, pp. 889-893)? Or what might happen in the process of reconfiguring the spatial structure of Paris's centre if each building older than 25 years was potentially removable (Koolhaas & Mau, 1995, p. 1105)? Similarly, MVRDV base much of their work on experimentation through data driven and derived parameters that not only allow for the generation of "endless streams of possible outcomes" but also ways of thinking (Zuidgeest et al., 2013, p. 95). As several members of the firm describe, sticking to standard approaches limits the development of novel spatial, social, and ecological futures precisely when we need them most (Zuidgeest et al., 2013, p. 92). Speculative strategies are not necessarily naïve tabula rasa treatments, but rather attempts to get *under the skin* of a city, region, system, or problem—to find room for experimentation through determining design hypotheses.

Of particular interest to this essay is scenario planning's ability to champion visionary thinking, fold qualitative inputs into quantitative decision-making systems, and engage non-technical stakeholders via inclusive and creative processes (Abou Jaoude et al., 2022; Al-Kodmany, 1999; Chakraborty & McMillan, 2015; Khakee, 1991; Ljubenovic et al., 2014; Stewart, 2004). As Kristi Grišakov suggests, immense value can be found in scenario planning for its capacity to "re-frame" situations by "stretching from what exists towards the possible future[s]" (2023, p. 116). Doing so in an iterative manner supports the growth of spatial futures, allowing us to "avoid the 'trap' of positivist thinking" (Grišakov, 2023, p. 116), or what James Corner referred to as the *tyranny of positivism* (1991, p. 117). Such speculative visions for the future empower planners and designers to avoid falling into the same pitfalls that claimed the 20th century's utopic urbanism promises (Abou Jaoude et al., 2022, p. 468; Hoch, 2016, p. 6).

Scenario planning offers significant potential to the problem of urban aggregate quarry planning, operation, and reclamation. As outlined earlier, these extraction landscapes are significant actors within the city, literally fuelling their growth. Rather than letting suburbia envelop these quarries in an unguided fashion, scenario planning empowers a more strategic spatio-temporal decision-making process. An individual scenario might be oriented to a specific goal or configuration, for example: recreation landscapes, housing developments, ecological restoration, or mixed uses. Alternatively, they could be kept open and flexible to respond to changes in demand and perspective from industry, communities, and developers. Rather than positing concrete realities, they hold value by instigating public debate on the future of the city and its landscape conditions (Weller, 2008, p. 28). As such, scenario planning has the potential to entirely reconfigure how we conceive the potential futures of urban aggregate quarries, and by extension the city at large.

Speculations on the Brampton Esker

There has been surprisingly little written about the role scenario planning might have in the development and eventual reclamation of urban quarries. Most of the literature focuses on either techno-scientific remediation, territorial scales where land use configurations are typically privileged over spatial configurations, or individual site-scale studies. Further, outside this author's prior work, there is little discussion of how designers or planners might intersect with the economics and mechanisms of extraction to shape desired outcomes throughout the life-of-mine (Rosier, 2021, 2024). However, one result, "Recreation Design Alternatives for a Disturbed Urban Landform" written by Reiner Jaakson in 1981, appears to be the singular documented example of scenario planning being used for an urbanistically oriented quarry reclamation scheme. Jaakson's study focuses on developing several scenarios for a series of aggregate quarries distributed along the length of a (former) esker in the city of Brampton, Ontario. These scenarios focus on the potential to develop recreational landscapes, leveraging the future reclamation of the quarries as a group so that the scheme can engage with them as a larger urbanistic, rather than site-based, problem. Given the lack of scholarship in this area, Jaakson's study deserves close attention. The following sections unpack this work by comparing what the scenario plans envisaged against the condition of contemporary Brampton. Doing so provides insight into the tensions and opportunities of using scenario planning in relation to the realities of capitalist development forces such that future studies might be able to more readily hold onto their visions of the future.

Figure 1: Map locating the Greater Toronto Area along the US-Canada Border, where much of the Canadian population lives. Image created by the author.

Figure 2: Map of the Great Lakes region, locating Brampton in relation to nearby Toronto, Lake Ontario, and the region's other cities. Image created by the author.

An Introduction to Brampton and its Esker

The city of Brampton is located within Canada's Ontario province, located adjacent to Lake Ontario towards the country's east coast (Figure 1 and 2). It has emerged in conjunction with Toronto's western suburban expansion, forming a part of the contiguous Greater Toronto Area (GTA) that houses more than 6.2 million residents (Figure 3). Brampton's population is approximately 656,000, increasingly sharply since the 1980s when the population was 200,000 (Statistics Canada, 2023). This increase has led to an extremely rapid growth of the city's suburban area and infrastructure. To fuel the GTA's explosive urban growth, extensive amounts of aggregate material have been necessary to produce concrete, crushed gravel, and sand. These materials must be sourced locally to be economically feasible, therefore Brampton hosted several quarries to fuel its growth with the Brampton Esker supplying easily accessible, high-quality aggregate. The Brampton Esker is estimated to have formed approximately 20,000–25,000 years ago in the Late Wisconsin Glacial Episode, the peak of the most recent glacial period (Saunderson, 1975). Eskers are typically formed by streams flowing above, within, or beneath glacial ice masses. Those streams deposit sediment along the final sections of their flow path, which, when glacier formations retreat, reveal long, narrow ridges of sedimentary material—an esker (Banerjee & McDonald, 1975). This material is valuable for the aggregate industry as it typically contains a mix of sands, gravels, and other smaller-grade stones with irregular geometries ideal for producing cement and concrete products. The Brampton Esker is 4.35 miles (7 kilometres) long and varies in width between approximately 650 and 2,100 feet (200 and 600 meters), though much of its form has been erased. Its geometric profile also differed from other eskers, being uncharacteristically wide and shallow-sloped throughout its length (Saunderson, 1975).

Figure 3: The City of Brampton is shown here on the left in relation to the wider GTA. The Brampton Esker study area as determined by Reiner Jaakson is outlined in White. Image created by the author.

It is unclear when extraction began along the Brampton Esker, though one source notes four quarrying operations in the area in 1918 (Ledoux, 1918, as cited in Yundt, 1995, p. 227). These quarries supplied material for the GTA's aggregate demand of 32.7 million tonnes as measured in 1977, likely coinciding with the peak of extraction along the Brampton Esker (Peat, 1980, p. 17). At this time, the Peel Region, within which Brampton resides, provided the second-largest gross quantity of aggregate products to the GTA, and it supplied the most sand products by a significant margin (Peat, 1980, p. 31). By 1985 the quarries along the esker were dramatically reduced in number and scope, with many of these sites becoming surrounded by suburban development, which S. E. Yundt suggests is the appropriate land use (1995, p. 226).

Jaakson's Scenario Plans for the Brampton Esker

Intent behind the scenarios

Jaakson notes that in complex and large-scale projects such as reclaiming the Brampton Esker, the relationship between planners, designers, local government, and industry operators is "acutely fragile", with miscommunication of intent often leading to conflict (1981, p. 65). To help alleviate this, Jaakson's use of scenario planning produces a range of possibilities, with their driving forces and calculations laid bare so that all parties can see what is possible from a range of perspectives. The individual scenario plans, which will be discussed below, provide the "broad framework within which detailed analyses and site-by-site design may subsequently be carried out" (Jaakson, 1981, p. 50).

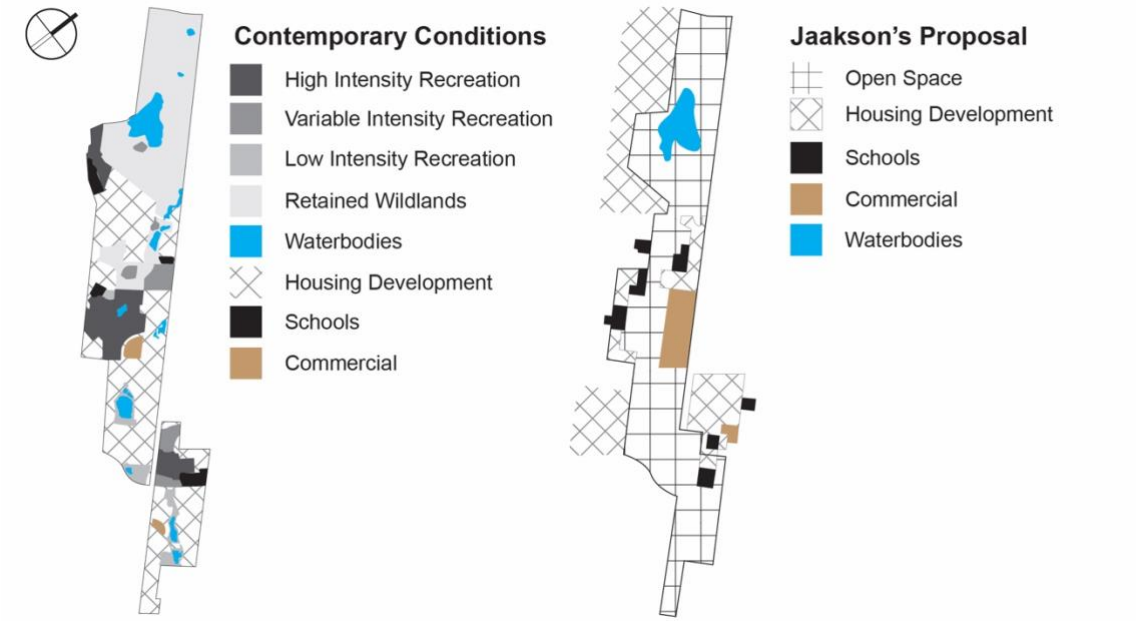

Figure 4: Comparison of the contemporary land use conditions and those proposed by Jaakson in 1981. Image created by the author.

Within Jaakson's land use plan (Figure 4), we can see a greater level of specificity in the diagrammatic plan compared to the drawings developed for each scenario. There is a sense of implied publicness present within this diagram, with the long strip of what Jaakson labels 'open space' traversing the entire length of the study area. Even though this label is non-descriptive and specifies less information than can be found on the more diagrammatic scenario plans, its graphic labelling of dense, largely contiguous vegetative cover suggests a condition like other large urban parks such as New York's Central Park or Paris's Bois de Boulogne. The extension of two parkways through the esker builds upon the latent intent for this to be a significant urban landscape within Brampton. Likewise, the inclusion of residential and commercial zoning within the study area and along its peripheries allows the esker landscape to be read as having a dialectic relationship to the wider city and its (sub)urbanism.

What do the scenarios offer the city?

Each of Jaakson's scenario plans interrogates a possible future for the post-extraction esker within its urban situation. Their capacity to speculate on what could be instead of what should be allows for a range of experimental options to emerge. It also allowed Jaakson to grapple with the capabilities and possible demands of the aggregate industry, environmental quality, adjacent land uses, and recreational opportunities. As shown in Table 1, a 'trade-off matrix' was developed to indicate how each scenario engaged with these factors, allowing policymakers, planners, and communities to understand the trade-offs and benefits of each scenario. Jaakson's scenarios can be found in full in his original publication, though for this essay's clarity their naming scheme is included here: Urban Wild Lands (S1), Wild Land Nodes (S2), Low Intensity Nodes (S3), Transition Plan (S4), Compartmentalised Plan (S5), Water Dominant Plan (S6), and Nucleus Plan (S7).

[Note: Table 1 is not included in this version as it is copyrighted and printed with permission in the full Landscape Research version]

Three of the seven scenarios (S1, S3, S7) focus on major 'wildland' restoration efforts, leveraging the post-extraction landform configuration to create unique and site-specific ecologies for habitat and passive recreational opportunities. The remaining four scenarios introduce wildland 'nodes' or restrict this ecological focus towards the Northwestern half of the esker where a similar condition is pre-existing around the Heart Lake Conservation Area. Four scenarios retain most of the pre-existing quarry pit lakes or intentionally set aside unfilled pits as lakes (S1, S2, S3, S6), whereas the others reduce the number or scale of these water bodies. The plans that reduced or did not allow for an increase in extraction (therefore restricting the creation or deepening of pits) are shown to have greater environmental value regarding runoff and groundwater table recharge (Table 1).

Comparison of Jaakson's Scenarios and the Contemporary Condition of the Brampton Esker

By comparing Jaakson's scenario plans against the built conditions we can begin to unpack what was gained and lost through the processes of land development. This allows us to speculate what similar future planning exercises might do differently to capitalise on the potential of urban (post-)extraction landscapes.

The most striking difference we can see between Jaakson's proposed and the as-built land use diagrams (Figure 4) is that the contemporary condition has significant housing and retail development within the study area boundaries. None of Jaakson's scenarios expressed development to this degree, with only two scenarios even noting the possibility of housing within those boundaries. It is unclear why such extensive development occurred, though it can be speculated that the land was sold to developers due to financial or political pressure, or that capitalist land economics saw the esker properties as too valuable to not be developed.

To interrogate these historic planning, extraction, and development forces further, two locations within Jaakson's study area will be investigated at a closer scale. These locations were selected because they evidence strong interactions between these forces throughout historic imagery and raise questions on what might have been under different circumstances. These two locations, shown in Figure 5, have been investigated through remote 'desk study' analysis using historic and contemporary orthophotos alongside LiDAR (Light Detection and Ranging) data in the form of rendered point clouds. Historic aerial imagery from 1961–1985 was sourced from the City of Toronto Archives, and aerial imagery from 2002–2023 was provided by the City of Brampton. LiDAR data was also sourced from the City of Brampton and processed using Autodesk Recap Pro to provide visualisations of the landscape conditions.

Figure 5: Jaakson's esker study area indicated by the more opaque aerial imagery with this study's two focus areas highlighted. Image created by the author

Study Area 1: Parr Lake South

The first area of investigation lies at the South-Eastern tip of Jaakson's study area. Beginning in the late 1960s, the area surrounding this edge of the esker underwent extensive residential development under the name of 'Bramalea Woods'. However, this piece of suburbia still had to compete with the pre-existing quarries. In the available 1961 orthoimagery we can see that extraction operations on the esker are still underway and expanding drastically by 1968 (Figure 6). At this point, several new houses in the Bramalea Woods suburb have been erected. By 1971 this section of the suburb is fully constructed, yet the quarry's extraction continues. The 1975 imagery shows some revegetation occurring along the quarried surfaces, indicated by the darker areas that contrast with the brighter exposed aggregate material. The now extracted esker begins to be remodelled for housing and roads through levelling and compacting of the topographic surface, homogenising the landscape condition. The next available orthoimagery, captured in 2002, shows Bramalea Woods in its completed state, with two pit-lakes, Parr Lake North and South, being all that remains of the quarrying operations.

Figure 6: Historical aerial imagery of the esker remnant next to Parr Lake South, highlighted in red in contemporary conditions. Imagery dates from top-left to bottom-right: 1961, 1968, 1971, 1975, 1994, 2023. Image created by the author.

However, these pit-lakes are not all that have resisted the flattening forces of suburbanisation. Upon examining the former esker landscape through point cloud data, a topographic anomaly appeared. A mound standing 33 feet (10 meters) high can be seen directly adjacent to Parr Lake South, strongly contrasting the otherwise regimented suburban surface. This mound can also be seen outlined throughout the historic aerial imagery in Figure 6 and in the LiDAR point cloud in Figure 7. Even though the earliest visual records available are from 1961, given the density and structure of the vegetation indicated in that orthoimage, one can reasonably assume that this surface has not been modified in a significant period, if at all. This suggests that this mound formed part of the esker's shoulder, as it lays adjacent to the main line of quarries. Outside of the Heart Lake Conservation Area at the esker's Northwestern tip, this appears to be the only remaining piece of the pre-extraction topography.

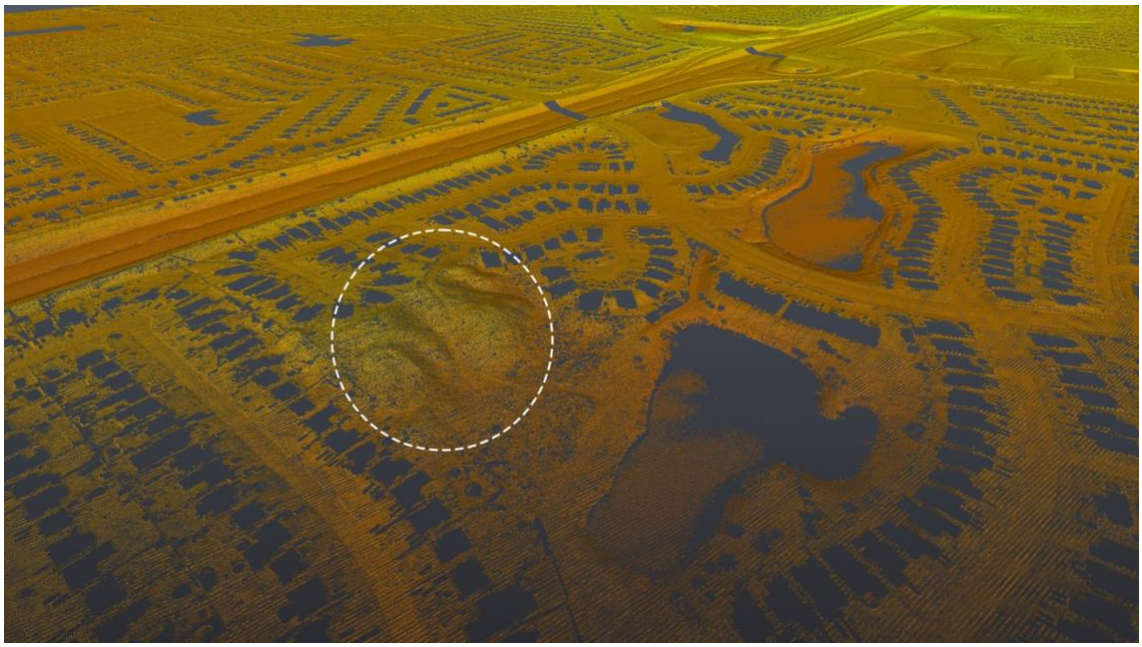

Figure 7: Remnant mound from the pre-extraction esker landscape, highlighted with white circle, situated against its suburban surroundings. Image created by the author.

This condition starkly contrasts with Jaakson's land-use and scenario plans. Three scenarios suggested this portion of the esker be set aside for wild lands (S1, S2, S7), with the others suggesting varying degrees of recreational intensity. Only one scenario, the 'transition plan' (S4), notes the possibility of residential development alongside higher intensity recreational activities, transitioning to variable and then low intensity uses towards the northern edge, reflecting the urban conditions and growth of Brampton itself (Jaakson, 1981, p. 58). Looking at the historical imagery, a tipping point in the potential for the esker to be a public landscape appears. In 1971 the esker's boundary and some aspects of its form are somewhat intact, yet by 1975 we can see that these conditions are being effaced. In 1994 only homogenous recreational space around the pit-lakes remains, alongside the residual piece of the esker' shoulder. Surrounding the mound in every direction are the flattened building lots, created to form a "blank canvas that enables the 'great suburban dream' to be pursued irrespective of the natural topography of the site"—a distinctly modern condition that both supports and is supported by the appropriation of stone (Kullmann, 2014, p. 332).

Study Area 2: Turnberry Golf Club

The largest quarry site within Jaakson's study area has seen the greatest degree of transformation since extraction was completed. Operating across approximately 165 acres, this quarry likely supplied a significant portion of the aggregate material used within Brampton. Extraction continued here later than the other sites along the esker, likely due to its scale and contiguous land area. Though the historic aerial imagery doesn't show the point at which the quarry closed, it probably would have been enveloped by suburbia, leaving a hole in an otherwise orderly fabric.

Figure 8: Historical aerial imagery of the central esker quarry and later Turnberry Golf Club. Imagery dates from top-left to bottom-right: 1975, 1994, 2000, 2002, 2010, 2018. Image created by the author.

The earliest available aerial imagery of this quarry dates from 1971, showing a partial image of the site's south-eastern extent (Figure 8). In this and the 1975 imagery, we can see an extensive degree of surface-level extraction occupying the esker's width. The surrounding context consists of small agricultural properties, though suburban growth is encroaching. The gap in aerial imagery documentation shrouds what occurred between 1975 and 1994, by which time extraction had ceased and the quarry pit had

filled with water. The western extents of the quarry where extraction did not go significantly below surface-level have now been colonised with housing and two schools. Despite their proximity, the pit-lake remains cut off from its urban surroundings. The height of the quarry walls can be seen in the aerial imagery, notably on the south-eastern edge, suggesting some dramatic topography remains. In the 2002 imagery, significant changes have occurred, including the draining and filling of the pit-lake. The lowered water level has begun to expose more of the pit's depth at the northern edge, giving expression to the sheer quantity of material removed. By 2004 the pit-lake had been almost entirely drained and filled in, with very little topographic geometry left to suggest its former condition. The 2007 imagery shows an almost complete resurfacing and smoothing of the site, alongside the initial configuration of what will become the golf course's water hazards. Figures 9 and 10 show the degree of topographic reworking midway through the reclamation process from an on-the-ground perspective. In 2010 when the Turnberry Golf Course opened, we can see effectively no traces of the site's former quarrying history. The briefly smoothed-over landscape has been replaced with artificial mounds and patches of flatness, covered in low ecological value grass. Further housing has been implemented within the site on the northern edge, and 'big box' retail on the eastern edge. The rendered point cloud (Figure 11) clearly shows the synthetic landform that has been posited atop the effaced esker: the long, linear mounds of the golf course starkly contrast with the homogenous suburban flatness outside the site's boundary.

Figure 9: Image of the extensive earthworks to remodel the central esker quarry into the Turnberry Golf Club. Bietenholz, S. 2006 "sumac in front of earth mound at subdivision development south of White Spruce Park, Brampton, Ontario". https://flic.kr/p/2cFkPH.

Figure 10: Monumental-scale earthworks necessary to remodel a quarry in relation to the suburban field beyond. Bietenholz, S. 2006 "suburban development at north-west of Heartlake Road and Boviard Drive, Brampton, Ontario". https://flic.kr/p/4Knep3. CC BY-NC 2.0.

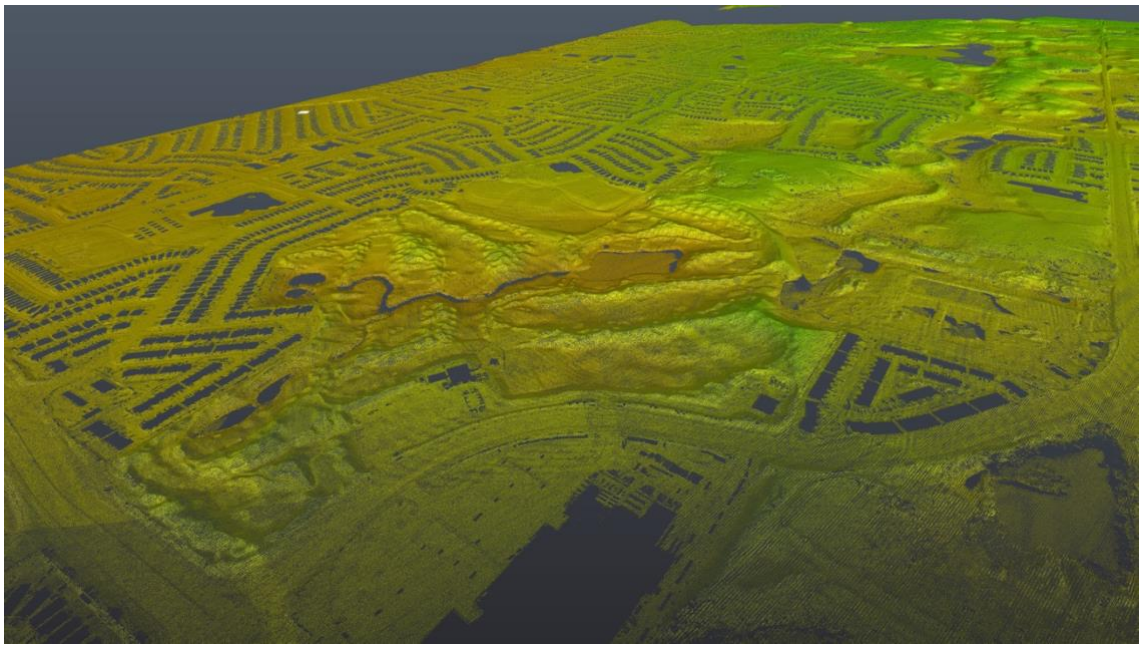

Figure 11: The artificial landscape of the Turnberry Golf Club emerged from a complex series of earthwork manoeuvres that dramatically erased and then re-inserted topographic relief. Image created by the author.

Pitfalls and Possibilities for Reclamation Scenario Planning

These two examples of Brampton's development highlight some weaknesses and potentials of using scenario planning for quarry reclamation in such a contested urban landscape. The visions that Jaakson articulated in 1981 did not eventuate, with much of the former esker being reconfigured as low-density residential housing. This starkly contrasts with many of his scenario indicating a large park-scape that interacts with the city beyond its borders. The actual development and condition of this landscape suggest that the development forces and interests should have been attended to in some way in Jaakson's initial study, though it is unlikely that the degree of Brampton's population growth and housing demand could have been predicted. This illuminates a weakness in scenario planning in this context: given the timescales at play, demographic and economic changes can be remarkably difficult to predict. To counter this, as Anthony Bauer notes, quarry operators and city planners must recognise that a "more sensitive and organized approach" is necessary, where urban quarry landscapes are looked at as a whole from a design perspective (1993b, p. 639). Treating the act of quarrying as an inherently temporary, yet designerly act might offer the means to bridge the gap between industry and the communities they supply. By centring discussions around the unfolding designed-quarry landscape, communities will likely feel satisfied that the outcomes align with their values (Corry et al., 2011; Legwaila et al., 2015), industry operators have increased community acceptance of their activities and will therefore have easier access to aggregate sites in the future (Baker & Hendy, 2005), and local governments are able to better plan for their infrastructural, social, and environmental futures (Henriquez et al., 2023).

Quarrying should be seen as a device to shape and structure the city. Yes, quarries provide the literal material for the city's construction, but the way they figure the urban field around them should also be harnessed as a creative force. After all, the only infeasible use for these sites post-extraction is another quarry (Bauer, 1993a, p. 44). Given the largely low-density character of the housing coupled with the fragmentation and parcelisation of the Brampton's esker landscape, one might consider whether an approach like several of Olmsted's great large parks could have offered greater potential. Given the effort required to erase these former quarried landscapes and then reinsert another manufactured condition that has little ecological function in its place, one might ask whether this was right or just. Considering how the Turnberry Golf Course site's size and location within Brampton's suburban field, there was an opportunity for it to be a major urban park as Jaakson suggested in several scenarios (S4, S6, S7). An opening was available to connect public life and imagination to the *longue* durée, geology, and experiential dimensions of the Brampton Esker through the design of public and private space

As seen in the Parr Lake South example, portions and aspects of the esker can be retained and have urban development folded around or integrated into them. Similarly, the north-western corner of the esker remains relatively undisturbed and is now protected as the Heart Lake Conservation Area. Here, topographic and geologic markers of the region's glacial past can be encountered alongside recreational activities throughout the site. We should question what possibilities have been lost by covering up the fact quarrying occurred throughout this landscape, alongside the almost complete erasure of a culturally significant landform. These sites of extraction are products of a

nature-culture, to use Bruno Latour's term (1993), and as Davids argues, just because we can restore a landscape to an 'original' condition doesn't mean we should, especially in the case of a quarry's "monumental walls or roofless building interiors that are nevertheless still part of the earth's topography" (2021, p. 2). The Turnberry Golf Course location, more so than other locations given its scale, presented an opportunity, before its conversion to an ecologically negative and socially exclusive land use, to imagine quarry reclamation as a "critical cultural practice" (Langhorst & Bolton, 2017, p. 177).

While it is easy to lament the foregone possibilities of the Brampton Esker, we should instead recall the potential that Jaakson's experimentation with scenario planning offered Brampton and our contemporary practices. With urban stagnation and liveability issues becoming more ubiquitous, I posit several ways in which a design-led form of scenario planning can create positive differences in city shaping processes. First, as these aggregate quarries are established in anticipation of the urban field catching up to them, they can be seen as a series of 'seed crystals' that enable a process of crystallization-like urban growth. From the outset, these quarries can act as a *morphological frame* that the city emerges from and is structured by (Brighenti & Kärrholm, 2021, p. 10). This attentiveness to formative processes over form itself aligns with the speculative nature of scenario planning. Second, it re-politicises landscape architectural design by having one reach far beyond the boundaries of any one site (in space and time) to have any facility in making multi-variate scenario narratives. At least in the US, landscape architects have seemingly become pre-occupied with the design of 'place' at the expense of being able to engage with the larger arrangement of systems at play. If done from the soil, or stone, up rather than the McHargian map down, scenario planning can avoid falling into the "technical and managerial rationale" that can hinder rigorous socio-cultural and socio-political difference making (De Block et al., 2019, p. 5). Third, as Jaakson implies in several of his scenarios, we must start shifting towards living *with* the natural resources we rely on at present, rather than living *from* them. Rather than consumption based on ignorance, an urban morphology forming around reciprocal engagements with material (Hutton, 2020) would better serve our necessary ambitions for more sustainable, equitable, and just futures. In this vein, an approach to scenario planning that emerges out of the ground could contribute to the inquiry on self-sustaining territories by Alberto Magnaghi and others (Forster et al., 2021; Magnaghi, 2020). Similarly, a change in scale or approach to extraction—which might (re)occur at a more vernacular or local scale—can play a part in establishing circular material economies (Marjanović et al., 2022).

Conclusion

The literature around quarry reclamation tends to focus on the techno-scientific methods of environmental recovery, typically in the remote locations where large extraction operations are found. However, urban aggregate quarries are different conditions altogether, and as this author and others have argued, perhaps returning to a false natural condition is not the ideal outcome for these landscapes. Given their material and spatial relationship to the city, this essay argues that urban aggregate quarries might be better thought of as a structure device for the urban field around them rather than being left as holes in that fabric to be patched over at a later date when finances, community goodwill, and ecological value have been drained.

Given the time scales that urban aggregate quarries are currently planned around, using scenario planning as a core tool in their implementation, operation, and unfolding reclamation processes holds immense value. Scenario planning will allow for multiple futures to be conceived where industry demands for aggregate material, population growth, infrastructure, socio-cultural needs, and environmental factors can be balanced. Perhaps most importantly, it forces the spatial future of these sites to be interrogated significantly earlier in the overall life-of-mine, rather than at the end. While there have been significant advances made in environmental design and planning approaches towards these quarries as site-based problems, scenario planning allows for them to be leveraged at an urban scale. Whilst this essay does not offer a tested way forward to address the problem of reclaiming aggregate quarries through scenario planning, it does offer a conceptual basis for doing so. To do so would allow for the acts of extraction to be a structuring device for the city, influencing where and how we build dwellings, recreational and ecological landscapes, infrastructure, and workplaces. Then the quarry becomes the spatial seed-crystal for the city, not just a point of extraction. This also empowers a greater ability to cross-leverage actors and forces to better shape our built environment towards more sustainable, equitable, and holistic outcomes. Given the long lifespan of these quarries, the best time to enact this kind of action through scenario planning is now.

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